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Identification of Hemodynamic Challenge Changes in Post Cardiac Operation Patient with Early Mobilization in National Heart Institute

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Abstract
Early mobilization should begin 24 to 48 hours after ICU admission. Early mobilization is a progressive process determined by the patient's functional abilities and endurance. The study aims to identify the hemodynamic challenge changes in post-cardiac operation at the National Heart Institute (NIH) Malaysia. Results show a significant association of hemodynamic challenge changes in Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP), Mean Arterial Pressure (MAP), and Saturation of Peripheral Oxygenation (SPO2) with early mobilization post-cardiac. In conclusion, early mobilization is a safe practice for post-operative cardiac surgery. Further study is required for implementation in other various cases in Malaysia.

Keywords:hemodynamic challenges; early mobilization; post-cardiac surgey

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1.0 Introduction

Hemodynamics is the study of the blood flow through the heart, and the heart pumps and circulates blood throughout the body to supply oxygenated blood to the vital organs and tissue (Nieswiadomy & Bailey, 2018). A hemodynamic challenge is a response to hemodynamic changes in body position during active mobilization (Cassina et al., 2016). Early mobilization is a progressive process determined by the patient's functional abilities and endurance (van Wijk et al., 2020). According to the Malaysian Society of Intensive Care, early mobilization should begin 24 to 48 hours after Intensive Care Unit (ICU) admission (KKM & MSIC, 2012; Weik, 2000). The primary concerns arise from inadequate hemodynamic reactions to shifts in body posture during the recovery of patients subjected to prolonged anesthesia and the risk of myocardial stunning associated with ischemic reperfusion injuries (Desai & Hwang, 2020). In a self-administered cross-sectional survey of 107 ICU nurses at Hospital Raja Permaisuri Bainun, Ipoh, most nurses, 82.9%, believed they lacked appropriate training to mobilize critically sick patients in the ICU (Leong et al., 2017).

Early mobilization in the ICU is practically safe and has a beneficial effect on the functional capacity of the critically ill patient, reduces the risk of deep vein thrombosis, improves muscle strength, and prevents pressure ulcer injury (Santos et al., 2017). This early mobilization education is crucial in considering the potential benefits versus the possible adverse events associated with early

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mobilization (Alaparthi et al., 2020). Besides, this study is also essential in proving early mobilization post-cardiac surgery suitable for Malaysia's cultural practice.

2.0 Literature Review

Cardiovascular disease is often associated with reducing the quality of life (Yazdchi et al., 2019). Besides, these post-procedures may reduce physical activity due to surgical stress, hospitalization, and the drug's effect (Prabhu et al., 2020). Prolonged bed rest is the main contributor to the delay in recovery (Goldfarb et al.,2020). Immobilization can lead to three significant cardiovascular changes such as orthostatic hypotension, an increase in cardiac workload, and thrombus formation due to a decline in blood circulation that results from bed rest (Ahmed, 2019). Prolonged bed rest after surgery may lead to acute respiratory distress syndrome, pleural effusion, hypoxemia, cerebrovascular incident, and infection at surgical sites (Moradian et al., 2017). Therefore, early mobilization is a global effort to enhance the recovery process.

The challenge of mobilization is faced by post-cardiac surgery patients, including hemodynamic instability, bleeding, invasive monitoring, chest drains, pre-existing mobility limitation, pain, sedation, and ischemia (Noss et al.,2018). A randomized trial study discovered that orthostatic intolerance hindered the initiation of early post-operative mobilization in 50% of patients just six hours following surgery. Additionally, systolic and diastolic pressure responses were generally compromised during mobilization compared to the preoperative assessment (Bundgaard-Nielsen et al., 2009). Nonetheless, the alterations in orthostatic hemodynamics were mitigated after 22 hours post-surgery, and only two out of the sixteen patients exhibited any signs of orthostatic intolerance. This underscores the significance of early evaluation and knowledge about early mobilization in preventing adverse outcomes associated with its initiation.

There was a modifiable and non-modifiable barrier in delaying patient movement out of bed, such as patients with hemodynamic and neurological instability, inadequate staffing, and extreme workplace stress (Alaparthi et al.,2020). Developing an ICU culture with early mobilization requires a rigorous and thorough instructional program for all staff to boost healthcare workers' confidence levels toward the early mobilization process. As with implementing care models, success is more likely to occur and be sustained if a motivated staff member is identified to lead the change in the ICU environment (Berry et al., 2014).

3.0 Methodology

3.1 Design and sample

Between December 2022 and February 2023, a quantitative cross-sectional study was carried out within the adult Intensive Care Unit (ICU) at the National Heart Institute in Malaysia. This study focused on post-cardiac surgery patients undergoing procedures such as Coronary Artery Bypass Graft (CABG), valve surgery, or a combination of both. The inclusion criteria of this study were patients aged 18 years and above post-CABG, valve, or combination of both surgeries, stayed in ICU within 24 to 48 hours, were extubated in less than 24 hours, were hemodynamically stable, and had no arrhythmias issues. Patients with ejection fraction less than 20%, pain score over four over ten using a numerical rating scale, chest drain more than 150ml/hr, and patients with intra-aortic balloon pumps were excluded from this study. Sampling for the study was conducted using a straightforward random sampling approach. Rao Soft Inc.'s sample size calculator determined a minimum sample of 184 participants. This calculation was based on parameters including a 5% margin of error, a 95% confidence level, and a 50% response distribution assumption. These considerations were guided by the adult post-cardiac surgery census data, which indicated an average of 124 post-cardiac surgery cases within the adult ICU per month.

3.2 Research tool, data collection, and data analysis

This study used secondary data analysis. The hemodynamic challenge consists of SBP (mmHg) monitoring, DBP (mmHg) monitoring, CVP (mmHg) monitoring, and SPO2 (%) are continuously monitored pre, during, and post early mobilization procedure to detect the hemodynamic challenge changes with early mobilization. Any clinical signs of intolerance, such as hypotension, blurred vision, and nausea during the mobilization process, will be recorded. Early mobilization intervention is based on the Physiotherapy Guideline title by the Physiotherapy and Rehabilitation Department National Heart Institute (Rahman, 2021; Saidin, 2021). This guideline is adapted from the Safety aspect of mobilizing acutely ill patients (Stiller & Phillips, 2003).

Data collection process in this study: First, the Adult Intensive Care Unit (AICU) nurses were briefed regarding this research project within one week with the National Heart Institute's permission and the AICU department's Nurse Manager for the research information to be distributed to all the nurses in AICU. This study records the hemodynamic monitoring by InteVellu Clinical Information Portfolio (ICIP) manufactured by Philips version 2007. Vital signs, bedside device data, labs, pathology reports, medication orders, planned interventions, and others are included in this chart. Therefore, the AICU nurse was briefed to set up the ICIP recording charting at 5-minute intervals continuously before starting the early mobilization process, in which the patient rests in bed until 10 minutes after the patient returns to bed when the early mobilization process is completed, and the patient rests. AICU nurses and physiotherapists of the National Heart Institute conducted the early mobilization process.

Initially, the patient is positioned in a supine position. Subsequently, the patient is on the bed with their feet on the floor, remaining in this position for 5 minutes. Following this, the patient is relocated to an armchair, where they must remain for a minimum duration of 30 minutes. Finally, the patient returns to the initial reclined position. The AICU nurses are responsible for zeroing the pressure transducers before each mobilization and noting a calibration remark in ICIP after the calibration process. Descriptive statistics were employed to assess socio-demographic information. Additionally, a pairwise Student's T-test was utilized to compare hemodynamic

responses before, during, and after mobilization after cardiac surgery. The relationships between pre, during, and post-mobilization hemodynamic responses post-cardiac surgery were explored using Pearson's Coefficient or Spearmen's rank correlation, with statistical significance defined at 0.05.

3.3 Ethical Consideration

The Ethical Approval was gained from the institutional ethics committee (500-FSK-PT .23/4), National Heart Institute Research Ethics Committee (IJNREC) -IJNREC ID-IJNREC/581/2022 and adult ICU Manager permission.

4.0 Findings

A total of 183 consecutive patients were involved in this study. However, 53 patients were secondarily excluded due to unstable hemodynamic conditions, unstable arrhythmias, chest re-opening due to pericardial effusion and cardiac tamponade, drowsiness, and inability to perform early mobilization due to analgesia effects with Richmond Agitation and Sedation Scale (RASS) less than -1. Finally, 130 patients were included in this study. Therefore, the response rate for this study was 71% (n=130).

4.1 Socio-demographic data

Table 1 summarizes the socio-demographic characteristics of patients who underwent cardiothoracic surgery at AICU National Heart Institute. 130 respondents, ranging from 18 to 80, participated in this study, with a mean age of 59.73 (10.48) years. The largest proportion of patients belongs to the age group of 60-69 years, comprising 44.6% (n=58) of the sample; approximately three-quarters of the patients were male (76.9%, n=100), while the remaining quarter comprised female patients (23.1%, n=30). The mean BMI of the patients in this study was calculated as 26.03(4.67), and almost half of the patients were classified as overweight (43.1%, n=56). One of the most prevalent comorbidity factors among patients who had had post-cardiac surgery was hypertension, affecting 82.3% (n=107) of the participants; three-quarters of the patients had hyperlipidemia (74.6%, n=97), and almost half of the patients had diabetes (57.7%, n=75). Among the patients, 34.6% (n=45) had approximately three comorbidity factors. Regarding smoking status, three-quarters of the patients were non-smokers (73.8%, n=96). The mean ejection fraction of patients in this study was 49.76(8.80) %, and almost half had an ejection fraction above 50% (50.8%, n= 66). In this study, three-quarters of the patients (78.5%, n=102) underwent CABG surgery. Nearly all patients involved in this study completed the early mobilization procedure. However, a small percentage of patients (6.8%, n=9) experienced complications during or post-mobilization. These complications included hypotension (3.8%, n=5), nausea (1.5%, n=2), and sinus tachycardia (1.5%, n=2).

Table 1: Socio-demographic Characteristic of 130 Patients (n=130)

Variables	Mean (SD)	n (%)
Age in years	59.73(10.48)	
Age Category in year		
18-29		2(1.5)
30-39		3(2.3)
40-49		15(11.5)
50-59		33(25.4)
60-69		58(44.6)
70-79		18(13.8)
80-89		1(0.8)
Gender		
Male		100(76.9)
Female		30(23.1)
BMI (kg/m^2)	26.03(4.67)	
Underweight		2(1.5)
Normal Weight		40(40)
Overweight		56(43.1)
Obesity Class 1		16(12.3)
		4(3.1)
Comorbidity		
Hypertension		107(82.3)
Diabetes		75(57.7)
Hyperlipidaemia		97(74.6)
Chronic Kidney Disease		23(17.7)
ESRF		4(3.1)
Acute Kidney Injury		1(0.8)
COPD		4(3.1)
Bronchial Asthma		7(5.4)
Benign Prostate Hyperplasia		7(5.4)

Cancer		5(3.8)
History of CVA		4(3.1)
Congestive Heart Failure		2(1.5)
Chronic Rheumatoid Heart Disease		1(0.8)
Total's Patient Comorbidity		
0 Comorbid		7(5.4)
1 Comorbid		15(11.5)
2 Comorbid		36(27.7)
3 Comorbid		45(34.6)
4 Comorbid		20(15.4)
5 Comorbid		7(5.4)
Smoking Status		
Non-Smoking		96(73.8)
Ex-Smoker		26(20)
Active Smoker		8(6.2)
Type of Surgery		
CABG Surgery		102(78.5)
Valve Surgery		21(16.2)
CABG and Valve Surgery		7(5.4)
EuroScore II (%)	1.36 (0.70)	
Ejection Fraction (%)		
Below 30%		3(2.3)
30-40%		19(14.6)
41%-50%		42(32.3)
Above 50%		66(50.8)
Cardiopulmonary Bypass time (min)	90.39(41.43)	
Complication post mobilization		
Hypotension		5(3.8)
Nausea		2(1.5)
Arrythmias		2(1.5)

4.2 Hemodynamic challenges changes pre, during and post early mobilization post cardiac surgery.

Table 2 displays the recorded hemodynamic parameters before, during, and after mobilization. The paired t-test analysis revealed noteworthy insights: the mean difference in systolic blood pressure from the supine position (M=127.35, SD=16.85) to the sitting position (M=123.32, SD=19.86) displayed statistical significance (t (129) =2.82, p=0.006), indicating a difference of 4.02 with a 95% CI [1.20,6.84]. Upon the patient's return to a recumbent position, systolic blood pressure (M=124.15, SD=28.04) exhibited a significant increase toward basal values, with a statistically significant difference (t(129) =2.17,p=0.032), reflecting a difference of 3.20 and a 95% CI [0.28,6.13]. Furthermore, the paired t-test unveiled that the mean diastolic blood pressure during the sitting position (M=64.30, SD=9.42) demonstrated a slight augmentation upon the patient's reversion to the bed rest position (M=65.96,9.95), showing statistical significance (t(129)=-2.15, p=0.034), with a difference of -1.67 and a 95% CI of [-3.19,-0.13]. The transition of patients from the supine position (M=84.85, SD=12.12) to the sitting position (M=82.88, SD=12.89) showcased a statistically significant reduction in Mean Arterial Pressure (MAP) (t(129) =2.03,p=0.045), indicating a difference of 1.97 and a 95% CI [0.05,3.89]. Moreover, the paired t-test underscored a statistically significant mean difference in partial pressure oxygenation (PaO2) during the transition from the supine position to bed rest (t(129)=6.16, p=0.001), revealing a difference of 15.97 and a 95% CI [10.84,21.11]. This suggests that the mean PaO2 (M=128.03, SD=36.74) in the supine position experiences reduction upon patient ambulation and subsequent return to bed rest (M=112.06, SD=24.78). Importantly, it is notable that no substantial alterations were observed in Central Venous Pressure (CVP), oxygen concentration (SPO2), and heart rate throughout the various phases of mobilization. These findings were substantiated by p-values exceeding 0.05, accompanied by 95% confidence intervals, indicating the lack of statistical significance in the results.

Table 2: Hemodynamic parameters during first postoperative mobilization in supine bed resting (T0), after 10 min in sitting position (T1) and after 10 min returning in bed (T2)

Hemodynamic Challenge	T(0) Mean (SD)	T(1) Mean (SD)	T(2) Mean (SD)	p T(0) Verses T(1)	p T(0) Verses T(2)	p T(1) Verses T(2)
Systolic Blood Pressure (mmHg)	127.35(16.85)	123.32(19.86)	124.15(28.04)	0.006	0.032	0.610
Diastolic Blood Pressure (mmHg)	65.30(9.63)	64.30(9.42)	65.96(9.95)	0.152	0.458	0.034
Heart Rate (Bpm)	83.77(11.12)	84.41(12.36)	89.46(69.58)	0.378	0.348	0.402
MAP (mmHg)	84.85(12.12)	82.88(12.89)	83.50(10.46)	0.045	0.196	0.510

CVP (mmHg)	12.19(3.68)	12.82(11.19)	11.74(3.45)	0.531	0.157	0.271
SPO2 (%)	99.46(1.27)	98.86(7.91)	100.42(8.84)	0.395	0.216	0.133
PaO2 (mmHg)	128.03(36.74)	120.59(61.40)	112.06(24.78)	0.197	0.001	0.108

4.3 Relationship between hemodynamic challenges changes pre, during and post early mobilization post cardiac surgery.

Table 3 presents an analysis showcasing noteworthy correlations among various hemodynamic parameters and the initial operative mobilization. The results indicate significant and strong positive correlations between systolic blood pressure (SBP) and the first operative mobilization from supine to sitting position (r=0.62, p=0.001), as well as a significant and moderate correlation between SBP and the first operative mobilization from sitting to returning to bed rest position (r= 0.54, p=0.001). Similarly, a significant positive correlation is observed between diastolic blood pressure changes and the first operative mobilization from the supine position to the sitting position (r=0.66, p= 0.001), from the sitting position to return to bed rest position (r=0.59, p=0.001), and from supine position to bed rest position (r=0.46, p=0.001). Furthermore, notable and favorable correlations have been established between alterations in heart rate and the initial transition from lying supine to a seated position (r=0.76, p=0.001), as well as from the seated position to a reclined bed rest position (r=0.18, p=0.046). Moreover, there are significant and positive associations between changes in mean arterial pressure (MAP) and the first mobilization from the supine position to sitting (r=0.60, p=0.001), from sitting to supine (r=0.60, p=0.001), and from supine to bed rest (r=0. 45, p=0.001).

Likewise, considerable positive correlations are evident between shifts in central venous pressure (CVP) and the initial mobilization from supine to the bed rest position (r=0.48, p=0.001) and from sitting to the bed rest position (r=0.18, p=0.045). Similarly, noteworthy relationships exist between SPO2 and the first mobilization after surgery, including transitions from supine to sitting (r=0.49, p=0.001), from sitting to bed rest (r=0.57, p=0.001), and from supine to bed rest (r=0.51, p=0.001). Furthermore, a significant and positive correlation emerges between PaO2 and the initial post-operative mobilizations, spanning from supine to sitting (r=0.19, p=0.04), from sitting to bed rest (r=0.26, p=0.03), and from supine to bed rest (r=0.6, p=0.001). The coefficient relation, rho (r), adheres to the following ranges: 0 to 0.25 indicates poor or no correlation, 0.26 to 0.5 indicates a fair correlation, 0.51 to 0.75 indicates a good correlation, and 0.76 to 1 indicates excellent correlation (Plichta & Garzon, 2009).In summary, the findings underscore significant correlations between hemodynamic challenge changes and the initial post-operative mobilization across different positions, encompassing the supine, sitting, and bed rest positions.

Table 4: Relationship between hemodynamic challenge changes and first postoperative mobilization, in supine bed resting position (T0), after 10 min in sitting position (T1), and 10 min after returning in bed (T2)

Variable		T(0)	T(1)	T(2)
SBP(mmHg)				
	T(0)	1		
	T(1)	0.619** 0.001	1	
	T(2)	0.535** 0.001	0.535** 0.001	1
DBP (mmHg)				
	T(0	1		
	T(1)	0.654** 0.001	1	
	T(2)	0.464** 0.001	0.587** 0.001	1
Heart Rate (Bpm)				
	T(0)	1		
	T(1)	0.759* 0.001	1	
	T(2)	0.142 0.106	0.175* 0.046	1
MAP(mmHg)				
	T(0)	1		
	T(1)	0.609** 0.001	1	
	T(2)	0.454** 0.001	0.604** 0.001	1
CVP(mmHg)				
	T(0)	1		
	T(1)	0.131 0.136	1	
	T(2)	0.482* 0.001	0.176* 0.045	1
SPO2 (%)				
	T(0)	1		

	T(1)	0.492** 0.001	1	
	T(2)	0.505** 0.001	0.570** 0.001	1
PaO2 (mmHg)				
	T(0)	1		
	T(1)	0.185* 0.035	1	
	T(2)	0.598* 0.001	0.256* 0.003	1

**correlation is significant at the level of p<0.01
*correlation is significant at the level of p<0.05

5.0 Discussion

5.1 Hemodynamic challenges changes pre, during and post early mobilization post cardiac surgery.

Implementing early mobilization is a practice rooted in evidence-based approaches to augment the recovery process within critical care settings (Kram et al., 2015). The central focus of early mobilization lies in upholding hemodynamic stability and ensuring sufficient organ perfusion throughout the mobilization process (Zafiropoulos et al., 2004). Notably, after 24 hours post-surgery, there was a discernible decrease in both systolic and diastolic arterial pressures during ambulation (Desai & Hwang, 2020). This decline can be attributed to the blood and fluid losses that occur during surgery, subsequently reducing central blood volume when assuming an upright posture. When standing upright, gravitational forces come into play, causing a decrease in both cardiac output (CO) and stroke volume.

Another finding in this study is that the partial pressure oxygenation (PaO2) from supine and returning to bed rest was statistically significantly reduced after ambulation. However, no statistically significant oxygen concentration (SPO2) with early ambulation exists. However, the mean of SPO2 is reduced from the supine to the sitting position, and the mean of SPO2 increases to the basal line after returning to rest in the bed position. Patients with post-operative Coronary Artery Bypass (CABG) surgery and valve surgery may desaturate when mobilized due to inadequate cardiovascular response (Ahmed, 2020; Kirkeby-garstad et al., 2006). During the mobilization process, the blood in the thoracic cavity flows downward, and venous pooling increases, resulting in insufficient venous return to the heart and reduced central venous pressure, thus leading to inadequate oxygen consumption (Cassina et al., 2016). According to (Stiller et al., 2009), a continuous decrease in oxygen concentration (SPO2) during mobilization from the first task to the second task resembles the patient's cardiorespiratory system is unable to achieve the need for oxygen demand during the mobilization process, and the SPO2 fall more than four percent.

5.2 Relationship of hemodynamic challenges pre, during and post early mobilization post cardiac surgery.

Based on the correlations identified within this study, noteworthy and statistically significant alterations in hemodynamic challenges are observed. These changes encompass metrics such as systolic blood pressure, diastolic blood pressure, central venous pressure, mean arterial pressure, heart rate, SPO2, and PaO2 following the implementation of early mobilization post-cardiac surgery. The transformations in body positioning and blood circulation, as well as alterations in intrathoracic pressure and gravitational influences, distinctly impact the readings related to hemodynamics. In summary, fostering education and comprehensive comprehension concerning hemodynamic shifts connected to early mobilization is paramount for cultivating critical thinking skills among nurses and healthcare professionals. Addressing the challenge of evaluating potential benefits and drawbacks for patients before initiating early mobilization, as well as the early detection of hemodynamic inadequacies, holds vital significance (Hashem et al., 2016).

6.0 Conclusion and Recommendations

Based on the findings, early mobilization among post-cardiac surgery patients is safe and practicable to practice. Nurses should play their role in assessing patients before, during, and after mobilization to detect any clinical deterioration and prevent any risk of falls. Besides, nurses need to improve their knowledge regarding hemodynamic challenge changes with early mobilization to weigh adverse risks and potential benefits involved in critical thinking elements. Intervention and education programs related to early mobilization are crucial to improving nurses' skills and other healthcare providers' awareness of the importance of early mobilization in patients. Thus, introducing a new internationally published study on early mobilization in the Malaysian setting is essential to improve Malaysia's mobility protocol, optimize all patients toward early mobilization, enhance nursing knowledge and skills, and initiate enthusiasm for evidence-based practice in the Malaysian setting.

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Paper Contribution to Related Field of Study

This finding also will improve the patient's confidence level to perform early ambulation after post-cardiac surgery. The nurses and other healthcare workers who assisted the patient are very knowledgeable and skillful. This study can enhance and develop critical care culture with early mobilization and improve education training approaches to improve essential care nursing skills and knowledge to be implemented in multiple patients and not limited to post-cardiac surgery only. Furthermore, this study will enhance nurses' integration of more advanced practice in critical care nursing roles, especially in Malaysia.

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