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Sociodemographic Association in the Hemodynamic Challenge of Early Mobilization Post-Cardiac Surgery

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Abstract
Decreased functional capacity in post-cardiac surgery often leads to muscle atrophy and inactivity. Prolonged bed rest is the main contributor to the delay in recovery. This study investigates the association between hemodynamic challenge during early mobilization and socio-demographic factors with clinical cardiac monitoring such as gender, Body Mass Index (BMI), EuroSCORE in post-cardiac surgery patients. The finding showed gender, BMI, and EUROScore were associated with a hemodynamic challenge during early mobilization. In conclusion, the study suggests that early mobilization post-cardiac surgery is not only safe but cost-effective for the institution and the government.

Keywords: hemodynamic challenges; early mobilization; post-cardiac surgery.

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1.0 Introduction

Complications commonly associated with patients following cardiac surgery include muscle atrophy and a decrease in functional activity (Jolley et al., 2016). The primary factor contributing to delayed recovery is prolonged bed rest. Research by Hashem et al. (2016) revealed a significant correlation between the duration of the Intensive Care Unit (ICU) stay and diminished muscle strength in patients who did not undergo regular early mobilization in the ICU.

A strategy to counteract the negative effects of extended bed rest is early mobilization, aligned with enhanced recovery after surgery principles (Noss et al., 2018). Nevertheless, a significant issue to consider in the context of early mobilization after heart surgery is the possibility of hemodynamic instability while altering body posture. This instability is caused by individuals moving from prolonged anesthesia-induced cardiac stunning, which is associated with ischemia-reperfusion damage (Desai & Hwang, 2020). Recent studies emphasize the safety and benefits of early mobilization in the ICU, including improved functional recovery, decreased surgical complications, and shorter ICU stays (Santos et al., 2017). Nevertheless, a cautious evaluation of patients is necessary before implementing early mobilization to ensure safety and minimize the risk of adverse events. Training and education are crucial to enhance healthcare professionals' knowledge and skills in this regard (Hodgson et al., 2014).

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It is asserted that early mobilization represents a secure and cost-effective intervention to enhance the quality of life and reduce the mortality rate among post-surgery patients (Hunter et al., 2017).

2.0 Literature Review

Cardiac surgery is a costly surgery with a high risk of mortality and morbidity. Besides, patient after post-cardiac surgery, the level of physical activity may decline due to surgical stress, hospitalization, and the drug's effect (Prabhu et al.,2020). Besides, another barrier to early mobilization post-cardiac surgery is inadequate training and exposure among nurses (Leong et al.,2017). Enhance recovery after surgery is a comprehensive intention to reduce post-operative complications and improve the recovery process after surgery (Noss et al.,2018). One of the components of enhanced recovery after surgery is early mobilization. Bed rest may result in a decrease in cardiac output, deep vein thrombosis, pneumonia, pressure sore ulcer, and a decline in muscle mass and strength within the first few postoperative days (Goldfarb et al.,2020).

Gender, age, Ejection Fraction (EF) of the heart, Body Mass Index (BMI), European System for Cardiac Operation Risk Evaluation II (EuroSCORE II), Cardiopulmonary Bypass (CPB) time, and type of surgery may contribute to hemodynamic challenges with early mobilization post cardiac surgery. During ambulation, women's systolic blood pressure is lower than men's inconsequence women have reduced sympathetic response and increased vasodilation levels. Besides, the female's heart size is smaller compared to the male's. This suggests gender-related hemodynamic differences during ambulation (Bassareo & Crisafulli, 2019). An increase in age will increase the complexity of the treatment resulting in prolonged ICU stays (Bootsma et al.,2018). Besides, a study found that 264 elderly patients with a mean age of 77±9.3 years were frail and able to participate in early mobilization (Goldfarb et al., 2018).

Coronary Artery Bypass Grafting (CABG) surgery alone creates clinical improvement and improves long-term survival compared to complex surgery such as CABG with valve surgery which may delay the early mobilization process (Head et al.,2017). This is because combined surgery requires prolonged CPB time compared to CABG surgery alone. CPB machine is the heart-lung machine used during open heart surgery. CPB time refers to the duration of the heart-lung machine taking over the patient's heart and respiratory function during cardiac surgery. Successful weaning of CBP indicates patient's heart can maintain adequate circulation, oxygenation, and organ perfusion independently. Prolonged CPB time may require high in inotropic support, prolonged ventilation, and delay in mobilization (Brown et al.,2000; Xu et al, 2019)

EuroSCORE II is a worldwide cardiac risk model for predicting mortality following cardiac surgery (Doerr,2015). High scores of EuroSCORE are also related to an extended functional recovery process. Besides, patients with high mortality risk post-cardiac surgery are poor at adapting to hemodynamic changes during the ambulation process (Lazkani & Lebuffe, 2016). Patients with high EuroSCORE are usually associated with a low ejection fraction of the heart and are prone to lengthy CPB time and advanced cardiac support such as an intra-aortic balloon pump may indicate prolonged ICU stay and delay in mobilization (Liew et al.,2021).

Many international studies were done to enhance post-operative patients with various socio-demographic factors for early mobilization as it has huge positive outcomes (Arias-Fernández et al., 2018). This evidence is crucial in improving communication and collaboration among patients and healthcare providers (Berry et al.,2014).

3.0 Methodology

3.1 Design and Sample

This study employs a quantitative descriptive cross-sectional methodology in the Intensive Care Unit (ICU) of the National Heart Institute (NHI) in Malaysia. The study will take place from December 2022 to February 2023. Participants undergoing post-cardiothoracic surgery were selected through simple random sampling. Inclusion criteria required participants to be 18 years of age and above, having undergone CABG, valve, or a combination of both surgeries, with a stay in the ICU for 24 to 48 hours, extubated in less than 24 hours, hemodynamically stable, and free from arrhythmias. Exclusion criteria encompassed patients with intra-aortic balloon pumps, ejection fractions below 20%, pain scores exceeding four out of ten on numerical rating scales, and chest drain drainage exceeding 150mls/hr.. Utilising the sample size calculator from Rao Soft Inc., 184 participants were determined to be included in the study based on AICU census data. The calculation was performed under the assumption of a 50% response distribution, a 5% margin of error, and a 95% confidence level. A monthly average of 124 post-cardiac surgery cases, focusing on CABG, valve, and a combination of both surgeries, was reported in the AICU census data.

3.2 Research tool, data collection, and data analysis

This study involved the analysis of secondary data. The assessment of hemodynamic problems involved the utilization of frequently employed ICU markers, such as the continuous monitoring of Systolic and Diastolic Blood Pressure, Central Venous Pressure, and Saturation of Peripheral Oxygenation. Information was collected before, during, and after mobilization using the Intevellu Clinical Information Portfolio (ICIP) offered by Philips version 2007. Socio-demographic data, covering age, gender, ejection fraction, cardiopulmonary bypass (CPB) time, comorbidities, and type of surgery, were collected from patient medical records with approval from the National Heart Institute Ethic Committees. Data were analyzed using SPSS 26. Safety measures for early mobilization were based on the National Heart Institute's Physiotherapy and Rehabilitation Department's Physiotherapy Guideline titled (Rahman, 2021; Saidin, 2021), grounded in the safety aspect of mobilizing acutely ill patients (Stiller & Phillips, 2003).

Data collection involved informing the AICU's nurse manager and all AICU nurses about the study within one week after NHI's approval. Before initiating early mobilization, AICU nurses set up ICIP recording charts at 5-minute intervals continuously until 10 minutes after mobilization completion. The early mobilization procedures were conducted by AICU nurses and physiotherapists, involving various steps, and AICU nurses were responsible for calibrating and zeroing pressure transducers at each step.

Socio-demographic data was evaluated using descriptive statistics. The association between socio-demographic data and hemodynamic changes during early mobilization was analyzed using independent t-tests, One-Way ANOVA, and Simple Linear Regression. A statistical significance level of 0.05 was applied.

3.3 Ethical Consideration

The permission to conduct the research was obtained from the institutional ethics committee (500-FSK-PT .23/4), National Heart Institute Research Ethics Committee (IJNREC) - IJNREC ID-IJNREC/581/2022, and AICU Manager's permission.

4.0 Finding

This study initially involved a total of 183 participants. Regrettably, 53 participants were subsequently excluded due to factors such as drowsiness attributed to analgesia effects, hemodynamic fluctuations, arrhythmia issues, and chest re-opening resulting from cardiac tamponade and pericardial effusion. In conclusion, a total of 130 patients actively participated in this study, yielding a response rate of 71% (n=31).

4.1 Socio-demographic data

Table 1 presents an overview of the socio-demographic characteristics of patients who underwent cardiothoracic surgery at AICU NHI. The study comprised a total of 130 individuals, whose ages ranged from 18 to 80. The participants had an average age of 59.73 (10.48) years. Among the sample, the largest proportion of patients, accounting for 44.6% (n=58), belonged to the age group of 60-69. The study included a predominantly male population, with 76.9% (n=100) of participants being male, while the remaining 23.1% (n=30) were female patients. The study found that the average BMI of the patients was 26.03 (4.67), and approximately 43.1% (n=56) of them were categorized as overweight.

Hypertension was found to be a common comorbidity among patients who had undergone cardiac surgery, affecting 82.3% (n=107) of the individuals. Hyperlipidemia was observed in 74.6% (n=97) of the patients, whereas diabetes was present in 57.7% (n=75) of them. Approximately 34.6% (n=45) of patients exhibited three comorbidity factors. The majority of individuals (73.8%, n=96) were classified as non-smokers in terms of their smoking status. The average ejection percentage for patients in this study was 49.76% with a standard deviation of 8.80%. Almost half of the patients (50.8%, n=66) had an ejection fraction above 50%.

The study revealed that 78.5% of patients (n=102) had CABG surgery. The early mobilization method was successfully completed by nearly all participants, with just a little proportion (6.8%, n=9) encountering problems either during or after the mobilization process. The problems seen were nausea (1.5%, n=2), hypotension (3.8%, n=5), and sinus tachycardia (1.5%, n=2).

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

Sociodemographic Data	**Mean (SD)**	**Frequency (%)**
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)
Obesity Class 2		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 Association of hemodynamic challenge with early mobilization and socio-demographic data among patients post cardiac surgery.
The results from Table 2 indicate that there was a significant difference in the mean arterial pressure (MAP) between males and females, as determined by an independent t-test (t(128)=2.24, p=0.03). Male individuals exhibited a significantly higher average arterial pressure (M=84.80, SD=9.14) compared to female individuals (M=81.9, SD=11.78), with a mean difference of 4.56 and a 95% confidence interval of [-0.53,8.60]. Nevertheless, no statistically significant disparity was detected between gender and the alterations in hemodynamic challenge associated with early mobilization for other variables.

Moreover, the study results suggest that there is no statistically significant association between smoking status and the kind of surgery in relation to changes in hemodynamic challenges during early mobilization after cardiac surgery, with p-values greater than 0.05. The results showing a lack of substantial relationship is crucial in providing justification for the safety of implementing early mobilization following cardiac surgery.

Table 2 The association between gender and hemodynamic challenge changes with early mobilization among patient post cardiac surgery.

Variables	**Male (n=100) Mean (SD)**	**Female (n=30) Mean (SD)**	**Mean Diff (95% CI)**	**t-stat (df)**	**p-value**
SBP (mmHg)	126.34 (15.46)	120.14 (14.27)	6.24 (-0.01,12.50)	1.97(128)	0.051
DBP (mmHg)	65.85 (7.86)	62.97 (8.85)	2.87 (-0.45,6.22)	1.71(128)	0.09
HR (bpm)	87.07 (28.29)	81.9 (11.69)	5.17 (-5.33,15.67)	0.98 (128)	0.33
MAP (mmHg)	84.80 (9.14)	80.23 (11.78)	4.56 (-0.53, 8.60)	2.24 (128)	0.027
CVP (mmHg)	12.15 (3.93)	12.57 (6.32)	-0.41 (-2.30, 1.47)	-0.43 (128)	0.67
SPO2 (%)	99.61 (4.58)	99.48 (1.05)	0.13 (-1.54,1.80)	0.16 (128)	0.88

PaO2 (mmHg)	119.91 (31.63)	121.27 (27.47)	-1.36 (-13.25,10.52)	-0.23 (128)	0.83

4.3 Relationship of hemodynamic challenge with early mobilization and socio-demographic data among patients post-cardiac surgery. Table 3 illustrates a notable linear correlation between BMI and heart rate changes during early mobilization among post-cardiac surgery patients (F(1,128) =0.31, p=0.049). Specifically, for each unit increase in BMI, there was a corresponding decrease of 0.27 bpm in heart rate changes during early mobilization. The BMI variable accounted for 0.2% of the variance in heart rate changes during the initial post-operative early mobilization. Additionally, the analysis revealed no statistically significant relationship between BMI and other hemodynamic variables, as supported by a p-value greater than 0.05.

Similarly, Table 4 demonstrates a significant association between EuroSCORE and diastolic blood pressure (F(F1,128)=3.96, p=0.049), as well as mean atrial pressure (F(1,128)=5.42, p=0.02). Consequently, an increase in EuroSCORE corresponds to a reduction of 2 mmHg in diastolic blood pressure and 2.85 mmHg in mean atrial pressure during the initial operative mobilization after post-cardiac surgery. The regression model describes the variation in the change of 3% diastolic blood pressure and 4% of mean atrial pressure with early mobilization in post-cardiac surgery patients.

Table 3 The relationship between BMI and hemodynamic challenge with early mobilization among patient post cardiac surgery

Variables	**BMI**		
	b[a] (95%,CI)	**F-stat(df)**	**p-value**
SBP (mmHg)	0.39 (-0.178,0.97)	1.86 (1,128)	0.175
DBP (mmHg)	0.19 (-0.12,0.49)	1.52 (1,128)	0.221
HR (bpm)	-0.27 (-1.22,0.69)	0.31 (1,128)	0.049*
MAP (mmHg)	0.11(-0.26,0.48)	0.34 (1,128)	0.563
CVP (mmHg)	-0.01 (-0.18,0.16)	0.018 (1,128)	0.895
SPO2 (%)	-0.09 (-0.24, 0.07)	1.24 (1,128)	0.267
PaO2 mmHg	-0.76 (-1.9,0.37)	1.77 (1,128)	0.186

*correlation is significant at the level of p<0.05

Table 4 The relationship between EuroSCORE and hemodynamic challenge with early mobilization among patient post cardiac surgery

Variables	**EURO Score**		
	b[a] (95%,CI)	**F-stat(df)**	**p-value**
SBP (mmHg)	-2.76 (-6.55,1.02)	2.09 (1,128)	0.15
DBP (mmHg)	-2.0 (-4.0,-0.012)	3.96 (1,128)	0.049*
HR (bpm)	0.91 (-5.42,7.24)	0.08 (1,128)	0.78
MAP (mmHg)	-2.85 (-5.27,-0.43)	5.42 (1,128)	0.02*
CVP (mmHg)	0.25 (-0.89,1.38)	0.18 (1,128)	0.67
SPO2 (%)	-0.21 (-1.22,0.79)	0.18 (1,128)	0.68
PaO2 mmHg	-4.23 (-11.79,3.33)	1.22 (1,128)	0.27

*correlation is significant at the level of p<0.05

In contrast, there is no significant relationship indicated between EuroSCORE and other hemodynamic variables with early mobilization following post-cardiac surgery as evidenced by p-value> 0.05. In addition, there is no notable and favorable relationship between age, total comorbid numbers, ejection fraction and CPB time with hemodynamic challenge changes early mobilization post cardiac surgery as p-value>0.05. In summary, all the patients are safe and able to accomplish early mobilization without any contrary issues.

5.0 Discussion

5.1 Association of hemodynamic challenge with early mobilization and socio-demographic data among patients post cardiac surgery
Gender was identified as a factor associated with hemodynamic challenges during ambulation. The male heart's heightened sensitivity to calcium, leading to positive inotropic activation, results in higher mean systolic and diastolic blood pressure, and mean arterial pressure compared to females (Bening et al., 2013). Conversely, females' hearts exhibit better adaptability to physiological changes associated with diseases (Sharma et al., 2021). Women, however, attain a lower maximal stroke volume during dynamic exercise than men, indicating additional gender-related hemodynamic differences, possibly attributed to the smaller size of the female heart (Bassareo & Crisafulli, 2019).

On the contrary, there is no significant difference in smoking status and the type of surgery concerning hemodynamic changes during early mobilization. Smoking status does not impact oxygenation status as long as lung function is well preserved. Preserving lung function maintains lung volume and compliance, enhances ventilation and oxygenation, facilitates early extubation, and supports early mobilization (Ahmed H., 2019).

5.2 Relationship of hemodynamic challenge with early mobilization and socio-demographic data among patients post-cardiac surgery.
The study reveals a noteworthy relationship between hemodynamic challenges during early mobilization and BMI. An increase in BMI may result in decreased ventricular contraction, given that adipose tissue's expansion introduces a potent cardio-depressant effect, contributing to lower cardiac output (Bening et al., 2013). A rise in BMI elevates cardiac workload to maintain cardiac output during hemodynamic changes in the early mobilization process.

Additionally, a significant relationship is observed between EuroSCORE II and hemodynamic changes during early mobilization. EuroSCORE II serves as a valuable tool for decision-making and acts as a quality control standard for cardiac surgical care (Ad et al., 2016). High EuroSCORE II correlates with an extended time for functional recovery (Lazkani & Lebuffe, 2016). Perioperative high-risk surgical patients with a high mortality risk according to EuroSCORE II demonstrate poor tolerance for hemodynamic changes due to various factors such as surgical stress, post-operative bleeding, hypovolemic shock, and the effects of anesthetic agents (Lazkani & Lebuffe, 2016).

However, no significant relationships are identified between age, ejection fraction, and CPB time with hemodynamic changes during early mobilization post-cardiac surgery. Although these results lack significance, it is crucial to note that early mobilization post-cardiac surgery is considered safe. Aging is linked to emotional stressors and cognitive vulnerability, which, coupled with decreased muscle mass, strength, and function after surgery, may pose challenges. Nevertheless, previous studies have endorsed the viability of early mobilization for elderly patient recovery in posthospital syndrome, cognitive outcomes, and physical function (Goldfarb et al., 2020). Thus, early mobilization remains relevant across age groups, with healthcare providers weighing potential benefits, risks, and exercising extra precautions for elderly patients at a higher risk of fall injuries.

Moreover, ejection fraction, while influencing blood pressure and heart rate through its impact on cardiac output and stroke volume, does not hinder the safety of early mobilization. However, a thorough assessment of the patient's condition is imperative before initiating early mobilization. Lower ejection fractions are associated with prolonged hospitalization and may necessitate higher inotropic and intra-aortic balloon pump support (Bootsma et al., 2018). Protocols have been established for patients with femoral catheters to optimize early mobilization results (Bonacchi et al., 2020; Fischer et al., 2020; Mayer et al., 2020). However, implementation of such advanced practices in Malaysia faces challenges due to a lack of expertise and staffing.

Additionally, prolonged CPB may lead to hypovolemia and hypotension, linked to an extended ICU stay and the need for high inotropic support (Wang et al., 2014). Therefore, while early mobilization is crucial for optimizing functional activity and reducing ICU stays, healthcare providers must carefully weigh potential risks and benefits before incorporating early mobilization into practice in critical care settings in Malaysia.

6.0 Conclusion and Recommendations

Implementing early mobilization following cardiac surgery is not only safe and feasible but also demonstrates cost-effectiveness. Moreover, it holds the potential to cultivate a culture of critical care, enhance educational and training methodologies, and elevate essential nursing skills. This impact extends beyond post-cardiac surgery patients, benefiting a broader population. Ultimately, these efforts lead to improved patient outcomes and indirectly contribute to the cost-effectiveness of both institutions and the government.

Nurses bear the responsibility of thoroughly assessing patients before initiating the early mobilization process, identifying any abnormalities, and mitigating the risk of falls. Additionally, healthcare providers must continuously update their knowledge to align with the latest clinical practices, ultimately improving patient outcomes and enhancing critical care skills.

Intervention and education programs centered around early mobilization post-cardiac surgery are crucial for raising awareness among healthcare providers about the benefits of this practice. Such initiatives aim to foster an early mobilization culture within critical care units. The introduction and implementation of internationally published research on early mobilization in the Malaysian context are essential for advancing Malaysia's mobility protocols, optimizing patient care through early mobilization, and instilling enthusiasm for evidence-based practices within the healthcare system.

There are many limitations to this study especially since this study was only conducted at NHI and the findings are unable to be generalized to the whole Malaysian setting. Besides, another challenge in this study there are least publications, especially in Malaysia related to hemodynamic challenges with early mobilization. Therefore, in the future, this study can be conducted on a larger scale from various cardiac centers in Malaysia. Hopefully, this study is a milestone for other researchers to develop more studies related to early mobilization.

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Paper Contribution to Related Field of Study

This finding is evidence to improve the patient's confidence level to perform early ambulation after post-cardiac surgery. Besides, this study can reduce the perception gap among healthcare providers and improve communication and collaboration between the nurse, physician, and physical therapist. 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 numerous patients and not limited to post-cardiac surgery only but also can be implemented in other post-operative surgery. Furthermore, this study will enhance nurses' integration of more advanced practice in critical care nursing roles, especially in Malaysia.

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