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Length of hospital stay among cardiovascular patients with valve repair combined valve replacement, Northeast Thailand

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ABSTRACT

Background: Hospital administration can impact patient's length of hospital stays, treatment costs, and quality of life after surgery. Thus, understanding the factors influencing the length of hospital stays in heart valve surgery patients is crucial for improving patient care and enhancing the efficiency of medical services.

Objectives: To investigate the length of hospital-stay and factors associated with length of hospital stay among cardiovascular patients with valve repair combined valve replacement.

Methods: This study employed a cross-sectional analytical design, involving 272 individuals who underwent combined valve repair and replacement at the Queen Sirikit Heart Centre of the Northeast from October 1, 2017, to September 30, 2023. Data were analysed using percentages and medians (min: max). Multiple logistic regression was also conducted to examine risk factors associated with extended hospital stays (> 14 days).

Results: The study showed that the length of hospital stays of patients undergoing open heart valve surgery was 14.07 ± 8 days. The risk factors related to a length of hospital stays longer than 14 days were found a history of smoking (AOR = 1.82; 95% confidence interval (CI) : 1.01 - 3.27), albumin level in blood (< 3.5 g/dl) (AOR= 2.28; 95%CI: 1.16 - 4.48), functional class 4 (AOR = 21.32; 95%CI: 4.37 - 104.06), postoperative infection (AOR = 3.25; 95%CI: 1.23 - 8.59) and arrhythmias (AOR= 2.33; 95%CI: 1.01 - 5.38).

Conclusion: This result highlighted that these factors are important for post-surgery patients to stay in the hospital longer than standard. Therefore, hospitals should promote health information, including quitting smoking and consuming behaviour, to patients to prepare before surgery. Hospitals must also design guidelines for patient care to prevent further complications.

Keywords: Cardiovascular, Length of hospital stay, Valve surgery

1. Introduction

Cardiovascular diseases (CVDs) represent an important contributor to both morbidity and mortality on a global scale, with over 75% of fatalities stemming from CVDs occurring in low- and middle-income nations [1]. In 2023, Thailand found CVD patients approximately 254,889 patients, and 43,838 patients died from CVD [2]. Moreover, northeast Thailand found 90,584 CVD patients, and 16,265 patients died in 2023 [2]. Valvular heart disease is one type of CVD that is the main cause of morbidity and death [3]. Valvular heart disease encompasses various classifications such as aortic valve disease, valvular stenosis, and prolapsed heart valve disease [4]. The typical manifestations of valvular heart disease comprise chest pain, heart palpitations (tachycardia), dyspnoea, fatigue, weakness, and diminished capacity for regular activities [5].

Patients with CVD may experience severe symptoms and face mortality in the absence of appropriate medical treatment. The successful management of CVD includes valve repair and valve replacement during which the physician evaluates the cardiac valve's pathology and the patient's clinical status for optimal therapeutic intervention [6]. Heart valve surgery, however, necessitates the utilization of sophisticated tools and technology, notably the Cardiopulmonary Bypass (CPB) machine. The CPB machine serves the purpose of temporarily assuming the functions of both the heart and lungs throughout the surgical procedure [7]. Consequently, this can result in a range of complications, leading to prolonged recovery periods and extended lengths of hospital stays for individuals [8].

The Queen Sirikit Heart Centre of the Northeast is a specialized tertiary healthcare facility focused on the instruction and management of cardiovascular ailments. It delivers healthcare assistance to individuals suffering from heart and vascular maladies in the northeastern region of Thailand, in addition to catering to a global clientele. The top three CVDs in Queen Sirikit Heart Centre of the Northeast such as the coronary heart disease (Acute Coronary Syndrome), valvular heart disease (Valvular Heart Disease), and cardiac arrhythmia [9]. Moreover, the Queen Sirikit Heart Centre of the Northeast is positioned at the top in terms of the number of cardiac surgeries carried out in Thailand. Within this category of surgeries, heart valve surgery exhibits the greatest patient volume, exceeding that of other cardiac procedures [10]. Accordingly,

the patients in this hospital had various lengths of hospital stay depending on age, gender, congenital disorder, post-operative infections, re-operation, and the length of heart surgery, etc. The length of hospital stay is a crucial metric that provides insights into the quality of care, financial aspects, and distribution of resources within the healthcare facility, encompassing the escalating expenses incurred by patients [11]. Therefore, identifying determinants associated with the duration of hospitalization holds significance in strategizing patient management, diminishing the length of hospital stay, formulating hospital and network hospital service frameworks, and distributing suitable resources and financial allocations. Accordingly, this study aimed to study the length of hospital stay and the factors associated with it among the cardiovascular patients with valve repair combined valve replacement in Northeast Thailand.

2. Methods

2.1 Study Area

This study conducted at the Queen Sirikit heart Centre of Northeast, Thailand.

2.2 Study Design

This retrospective study was conducted from 1 October 2017 to 30 September 2023.

2.3 Sample size and sampling

The sample size was calculated using the finite population proportion formula [12] as follows, the proportion of length of hospital stay longer than 11 days (p) was 0.29 [13]. For 7 years, the population was 1,766 patients diagnosed with heart valve disease who required open heart valve surgery at the Queen Sirikit Heart Centre of the Northeast. The total sample size for this investigation was 269 people. The inclusion criteria encompassed: (1) patients aged 18 years or older, (2) patients undergoing elective open heart valve surgery involving both heart valve repair and replacement for the first time, and (3) patients with a complete medical record. The exclusion criteria included: (1) patients who died following surgery, (2) patients who were transferred to other hospitals for organ treatment, and (3) patients who developed severe complications, such as acute or chronic kidney failure, postoperatively. Finally, this study found a total of 272 patients who passed the inclusion criteria.

2.4 Data Collection

The research instrument was the data record form that developed from the literature review about the factors related to the length of hospital stay. This form included 2 parts: 1) General characteristics including age, gender, weight, height, marital status, health care welfare, occupation, domicile, congenital disorder, and smoking history. 2) Medical history information, including the date of admission to the hospital, the date of surgery, the date of discharge from the hospital, and the diagnostic assessment of mortality risk associated with cardiac surgery (STS Score). Furthermore, the functional class serves as an evaluative metric of cardiac performance as delineated by the New York Heart Association (NYHA) classification, while the ejection fraction quantifies the volume of blood expelled from the heart during a single contraction. Additional parameters include serum albumin concentration (Alb), HbA1c, blood cholesterol level, type of operation, sepsis post-operation, reoperation, arrhythmia, and length of hospital stay in the hospital (days). The hospital length of stay for patients undergoing combined valve repair and replacement was classified into two groups, as follows: according to *Kim et al. (2023)* [14], (1) patients with a length of hospital stay of less than or equal 14 days, and (2) patients with a stay of longer than 14 days. The researchers used the form to record the data from the hospital information system and medical records of patients who had undergone heart valve repair surgery combined with open heart valve replacement between 1 October 2017 to 30 September 2023 at the Queen Sirikit Heart Centre of the Northeast.

2.5 Data Analysis

Descriptive statistics were used to analyse the data in this study, which was presented by frequency, percentage, mean, standard deviation, and median (Min: Max). For inference statistics, the multiple logistic regression analysis was used to test the factors related to the length of hospital stay. For adjusting confounding variables, all factors demonstrating a P-value inferior to 0.25 in the bivariate analysis were chosen. A P-value below 0.05 was deemed statistically significant. The results were presented using Adjusted Odds Ratio (Adj. OR) with a 95% Confidence Interval (95%CI) and statistically significant at 0.05 (P-value < 0.05).

2.6 Ethical Clearance

This study obtained approval from the Research Ethics Committee for Human

Research at Khon Kaen University and was granted an exemption from additional ethical review (HE671022, January 12, 2024). The purpose of the research was explicitly communicated to participants, and their participation was entirely voluntary. Written informed consent was secured from all participants before data and samples were collected.

3. Results

Of 272 patients who underwent open heart valve surgery by valve repair combined with heart valve replacement, 54.41% were male and 52.40% were aged between 40 to 59 years old. Most participants 83.82% were married, 70.26% were in agriculture, and 63.60% used the Universal Coverage Scheme (Table 1). Patients with smoking history, hypertension, dyslipidaemia, and myocardial infarction were 42.07%, 61.40%, 94.85%, and 99.63%, respectively. Moreover, 72.22% of the patients exhibited albumin concentrations exceeding 3.5 g/dl, while 80.88% of the patients presented with arrhythmias. Furthermore, the patient's surgery time was recorded as 275 (min, max:100, 1000) minutes. The details were described in Table 1.

Table 1: Baseline characteristics among patients who underwent heart valve repair surgery combined with valve replacement in northeast Thailand and bivariate analysis using simple logistic regression

Baseline characteristics	Number (%)	Number of patients who had the length of hospital stay more than 14 days (%)	Crude OR	95%CI
Gender				
Male	148 (54.41)	58 (39.19)	1	
Female	124 (45.59)	33 (26.61)	0.56**	0.33- 0.94
Age (Years)				
18 - 39.9	31 (11.44)	13 (41.94)	1	
40 - 59.9	142 (52.40)	36 (25.35)	0.47	0.21-1.05
≥60	98 (36.16)	41 (41.84)	1.00	0.43- 2.26
Mean ± SD	55.42 ± 12.61			
Marital status				
Married	228 (83.82)	157 (68.86)	1	
Single/Monastic/Divorced/Widowed	44 (16.18)	24 (54.55)	1.84	0.96-3.55
Healthcare welfare				
Self-pay	5 (1.84)	5 (100)	1	
Universal Coverage Scheme	173 (63.60)	113 (65.32)	0.99	0.57- 1.72
Social Security Scheme	14 (5.15)	11 (78.57)	0.51	0 .13-1.9
Government or State Enterprise Officer	80 (29.41)	52 (65)	NA	NA
Occupation				
Merchant/ Self-employed/ Contractor	16 (5.95)	61 (68.75)	1	
Company employees/State enterprise employees	5 (1.86)	3 (60)	1.47	0.18- 11.71
Government official	31 (11.52)	20 (64.52)	1.21	0.33- 4.39

Baseline characteristics	Number (%)	Number of patients who had the length of hospital stay more than 14 days (%)	Crude OR	95%CI
Unemployed/no career	28 (10.41)	19 (67.86)	1.04	0.28-3.91
Agriculture/worker	189 (70.26)	126 (66.67)	1.1	0.37- 3.30
BMI (Body Mass Index) *				
< 18.5	48 (17.65)	22 (45.83)	1.54	0.78- 3.03
18.5 - 22.99	124 (45.59)	44 (35.48)	1	
23.0 - 27.5	79 (29.04)	18 (22.78)	0.54	0.28- 1.02
>27.5	21 (7.72)	7 (33.33)	0.91	0.34- 2.42
Congenital disorder				
Diabetes				
No	244 (89.71)	82 (33.61)	1	
Yes	28 (10.29)	9 (32.14)	0.94	0.41- 2.15
Hypertension				
No	167 (61.40)	56 (33.53)	1	
Yes	105 (38.60)	35 (33.33)	0.99	0.59-1.66
Dyslipidaemia				
No	258 (94.85)	90 (34.88)	1	
Yes	14 (5.15)	1 (7.14)	0.14**	0.02- 1.12
Myocardial infarction				
No	270 (99.63)	90 (33.33)	NA	NA
Yes	1 (0.37)	1 (100.00)		
History of smoking				
No	157 (57.93)	45 (28.66)	1	
Yes	114 (42.07)	46 (40.35)	1.68**	1.01-2.80
Functional Class				
Class 1, 2	167 (61.40)	38 (22.75)	1	
Class 3	86 (31.62)	36 (41.86)	2.44**	1.40-4.28
Class 4	19 (6.98)	17 (89.47)	28.86***	6.38-130.51
STS Score				
<4%	197 (72.43)	67 (34.01)	1	
≥4%	75 (27.57)	24 (32.00)	0.91	0.52-1.61
Ejection Fraction (EF)				
<55	104 (38.24)	35 (33.65)	1.01	0.60-1.70
≥55	168 (61.76)	56 (33.33)	1	
Albumin serum				
<3.5	75 (27.78)	43 (57.33)	4.12***	2.35-7.22
≥3.5	195 (72.22)	48 (24.62)	1	
HbA1C				
<6	108 (65.85)	31 (28.70)	1	
≥6	56 (34.15)	19 (33.93)	1.28	0.64-2.55
The cholesterol in the blood (LDL)				
<100	72 (44.17)	27 (37.50)	1	
≥100	91 (55.83)	24 (26.37)	0.60	0.31-1.16
Re-operation				
No	263 (96.69)	83 (31.56)	1	
Yes	9 (3.31)	8 (88.89)	17.35**	2.14-140.97
Postoperative sepsis				
No	243 (89.34)	72 (29.63)	1	
Yes	29 (10.66)	19 (65.52)	4.51***	2.00-10.18
Cardiac arrhythmia				
No	52 (19.12)	9 (17.31)	1	
Yes	220 (80.88)	82 (37.27)	2.84**	1.32-6.12

Baseline characteristics	Number (%)	Number of patients who had the length of hospital stay more than 14 days (%)	Crude OR	95%CI
Surgery time (min)				
<276	135 (49.63)	128 (24.33)	1	
≥276	137 (50.37)	101 (29.02)	1.61	0.97- 2.68
Median (Min: Max)	275(100,1000)			

* BMI (Body Mass Index) used criteria followed by Zierle-Ghosh and Jan [15]

** P-value < 0.05, *** P-value < 0.001, NA = Not Applicable

The proportion of patients who experienced a length of hospital stays longer than 14 days was 33.46%. The mean length of hospital stays among patients who have surgery by valve repair combined with heart valve replacement was 14.07 ± 8.00 days (Table 2).

Table 2: The length of hospital stays among cardiovascular patients with valve repair combined valve replacement in northeast Thailand.

Factors	Number of patients who had the length of hospital stay longer than 14 days (%)	Number of patients who had a length of hospital stays ≤ 14 days (%)	95%CI
Length of hospital stay	91 (33.46)	181 (66.54)	
Length of hospital stay (days) (mean ± SD)	14.07 ± 8.00		13.12-15.03

The factors associated with longer hospital stays included smoking history, level of heart abnormalities (functional Class) Class 4, albumin serum level (Alb) less than 3.5 g/dl, post-operative infection (Sepsis Post Operation), and cardiac arrhythmia (arrhythmia). The patients who had smoked had a likelihood 1.82 times to stay in the hospital for more than 14 days (Adjusted Odds Ratio (AOR) = 1.82; 95% CI: 1.01-3.27, P-value 0.046). The patients who had heart abnormality level (functional class) class 4 had a probability 21.32 times to long stay in the hospital (> 14 days) more than class 1 and class 2 (AOR = 21.32; 95% CI: 4.37 - 104.06, P-value <0.001). Furthermore, the patients who had a level of albumin serum < 3.5 g/dl had a likelihood 2.28 times to stay in the hospital for more than 14 days (AOR = 2.28; 95% CI: 1.16 - 4.48, P-value 0.016). The patients who had a post-operation infection had a likelihood of 3.25 times to long stay in the hospital (> 14 days) (AOR = 3.25; 95% CI: 1.23 - 8.58, P-value 0.017). Moreover, the patients who had cardiac arrhythmias (arrhythmia) after surgery had a probability 2.33 times to stay in the hospital for more than 14 days (AOR = 2.33; 95% CI: 1.01 - 5.37, P-value 0.048) (Table 3).

Table 3: Multivariable analysis of factors associated with the length of hospital stay among cardiovascular patients with valve repair combined valve replacement in Northeast Thailand using multiple logistic regressions (n=272)

Factors	Number of patients who had the length of hospital stay more than 14 days (%)	Crude OR	95% CI	Adj. OR	95% CI	P-value
The history of smoking						
No	45 (28.66)	1		1		0.046
Yes	46 (40.35)	1.68	1.01 - 2.8	1.82	1.01 - 3.27	
Functional Class						
1,2	8 (22.75)	1		1		<0.001
3	36 (41.86)	2.44	1.40 - 4.28	1.52	0.80 - 2.86	
4	17 (89.47)	28.86	6.38 - 130.51	21.32	4.37 - 104.06	
Albumin (Alb)						
<3.5	43 (57.33)	4.12	2.35 - 7.22	2.28	1.16 - 4.48	
3.5 - 5.2	48 (24.62)	1		1		0.016
Postoperative sepsis						
No	72 (29.63)	1		1		0.017
Yes	19 (65.52)	4.51	2.00 - 10.18	3.25	1.23 - 8.58	
Arrhythmia						
No	9 (17.31)	1		1		0.048
Yes	82 (37.27)	2.84	0.32 - 6.12	2.33	1.01 - 5.37	

4. Discussion

This study found that cardiovascular patients were male (54.41%) and the average age was 55.42 ± 12.61 years old. This finding was similar to a previous study that reported most CVD patients were male (60.0 to 69.0%) [16, 17]. Accordingly, males have risk behaviours (smoking, alcohol drinking, etc.) more than females [18, 19]. Patients who underwent combined valve repair and valve replacement had a mean length of hospital stay of 14.07 ± 8.00 days which was consistent with a prior study. The previous study reported a mean length of hospital stay was 11.8 ± 5.2 days [16]. In South Africa, the length of hospital stays ranged from 1 to 37 days [20]. The duration of hospitalization varied depending on many factors including age, gender, congenital disorders, post-operative infections, re-operations, and the length of cardiac surgery, etc. [21, 22]. This study found that the patients (80.88%) had cardiac arrhythmia after heart surgery which was consistent with previous studies. Previous studies found 30-50% of cardiac arrhythmia in patients after heart surgery [23]. Moreover, the patients (78.48 %) had cardiac arrhythmia after heart surgery and cardiac arrhythmia is a cause of death in patients [24].

Smoking history was a risk factor related to the length of hospital stays among CVD patients with combined valve repair and

valve replacement. This result was consistent with prior studies by *Ghotkar et al.* [18] and *Kao et al.* [19] which reported that patients who had smoked had a chance 4.8 times more likely to have a longer hospital stay compared to those who had not smoked. Smoking history is a cause of CVD and affects multiple surgical interventions, that are associated with an extended duration of stay in the Intensive Care Unit (ICU) [25]. Patients with heart abnormalities classified as functional class 4 were more likely to have a longer hospital stay (> 14 days) compared to those in class 1 and class 2 which is similar to previous studies. *Lei et al.* [26] reported that patients who had heart functional class 3 and class 4 had a chance of 2.68 times staying in the hospital. These patients had abnormal oxygen exchange, fatigued even when doing no activities, and subsequently developed heart failure [21, 26]. Furthermore, this study found that a level of albumin serum < 3.5 g/dl caused a long length of hospital stay, similar to the *Beydoun et al.* [27] and *Gassa et al.* [28] studies. Preoperative hypoalbuminemia can indicate malnutrition, acute kidney injury, and infection [28]. Consequently, preoperative hyperalbuminemia may confer a protective effect against complications and facilitate expedited recovery for patients, thereby diminishing the length of hospital admission [29].

Moreover, post-operative infection was a risk factor related to the length of hospital stays among CVD patients with combined valve repair and valve replacement. This finding was similar to previous studies [11, 13]. Post-operative infection is a significant complication that can occur following surgery, necessitating intensive antibiotic treatment, which can lead to extended hospital stays. Moreover, hypertension, diabetes, and obesity can increase the chance of post-operative infection in patients [11, 13]. However, the limitation of this study is that it is a retrospective study in which many patients' medical records are not completed. Furthermore, the next research should be a prospective study to obtain more comprehensive data and explore a wider range of factors.

5. Conclusion

The factors associated with long length of hospital stays included smoking history, level of heart abnormalities (functional Class) Class 4, albumin serum level (Alb) less than 3.5 g/dl, post-operative infection (Sepsis Post Operation), and cardiac arrhythmia (arrhythmia). These results can be used in

treatment plans. Therefore, hospitals should emphasize and empower patients to quit smoking and promote the nutritional status of patients before surgery. Moreover, the hospital should improve and develop the treatment service system to prevent long length of hospital stays, especially cardiac abnormalities class 4, post-operative infections, and cardiac arrhythmias issues.

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