ORIGINAL ARTICLE

In-Hospital Costs of Hemiarthroplasty in Patients with Osteoporotic Femoral Neck Fracture at Faculty of Medicine Siriraj Hospital

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Background: The medical cost of osteoporotic hip fracture has become a great burden for the healthcare system. In Thailand, studies on the costs of bipolar hemiarthroplasty treatment for osteoporotic femoral neck fractures are limited and not up to date.

Objective: To evaluate the in-hospital costs of treating the elderly with osteoporotic femoral neck fractures receiving hemiarthroplasty treatment.

Materials and Methods: Patients with hip fractures who were 60 years or older and underwent bipolar hemiarthroplasty were prospectively observed. All patients were managed according to the Siriraj hip fracture fast-track and Fracture Liaison Service protocols. The authors collected details of the in-hospital costs incurred during the admission period and identified factors associated with an increasing in these costs.

Results: Between February 1 and July 31, 2020, 50 patients were enrolled in the present study. Their average age was 78.3 years, and most had a Charlson comorbidity index of more than 5. The median total in-hospital costs for treatment were 5,013.25 USD with a range of 3,695.05 to 13,193.77 USD. Most of the total in-hospital costs occurred intraoperatively, with 29% of the total costs related to the cost of a prosthesis. The factors associated with an increase in costs were the length of stay (probability $p<0.001$) and postoperative pneumonia ($p=0.038$).

Conclusion: In-hospital costs of hip fracture have become a great burden for patients and caregivers. Strategies to reduce total costs during hospitalization should focus on early surgery coupled with rehabilitation, which results in shorter stays.

Keywords: Cost analysis; Femoral neck fracture; Hemiarthroplasty; In-hospital costs

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Since the beginning of this century, there have been substantial changes in the demography of the human population, with a marked increase in the number of older people. This growth in the proportion of older adults in the population profoundly affects all regions of the world, especially Asian countries[1]. In 2015, Thailand became an "aging society" with 16.2% of the national population aged older than 60 years[2]. The proportion is predicted to grow to 20% in 2021, which will make Thailand a full-fledged aging or aged society[3]. Due to the considerable rise in the proportion of older people, the incidence of age-related diseases including osteoporosis, will inevitably rise. The resulting heavy burden on healthcare systems will be a major challenge.

Osteoporosis is the most common chronic metabolic bone disease. It is characterized by a reduction in bone mass and an alteration of the bone microarchitecture, leading to bone fragility[4]. Osteoporotic fractures occur in the spine and metaphyseal regions of long bones. However, osteoporotic hip fracture such as femoral neck or intertrochanteric femoral fracture, is considered the most serious fragility fracture, with reported 1-year mortality rates ranging from 15% to 36%[5]. In addition, more than half of older individuals with a hip fracture are unable to walk independently and require long-term care[6]. The incidence of hip

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fracture varies widely around the world, depending on local population demographics, influences of ethnicity, latitude, and environmental factors[7]. In 2018, there were an estimated 42,000 hip fracture cases in Thailand[8]. Since people with a hip fracture often require surgical intervention, the socioeconomic impact of hip fractures has increased markedly throughout the world.

The medical costs of hip fracture have become a great burden for healthcare systems due to its high morbidity and treatment expenses. In the United States, expenditure on hip fractures is projected to be in the order of 18.2 billion USD in 2025[9], and it may reach 131.5 billion USD in 2050[10]. Most of the costs occur in an acute hospital setting, and they represent around 16% to 23% of the annual costs associated with hip fractures[11,12]. To the authors' knowledge, only two studies have evaluated the costs of hip fractures in Thailand, with one conducted in 2005 and the other in 2015[13,14]. However, there have since been improvements in case management in acute hip fracture settings, such as the establishment of a hip fracture fast-track protocol and the fracture liaison service (FLS) at the authors' hospital. In addition, new prosthetic designs have emerged, and there have been advances in perioperative care for hip fracture patients. It is, therefore, important to reevaluate all costs that occur during the hospitalization period.

The objective of the present study was to determine the in-hospital costs associated with treating older adults with osteoporotic femoral neck fractures who received surgical intervention in the form of hemiarthroplasty. This information is crucial and can be used as reference data for further health economic studies.

Materials and Methods

The study protocol, questionnaire, and consent forms used in the present study prospective cohort study were approved by the Siriraj Institutional Review Board of the Faculty of Medicine Siriraj Hospital (IRB number: 822/2562), Mahidol University, Bangkok, Thailand (COA number: 081/2020). The present study was registered with the Thai Clinical Trials Registry (TCTR number: 20201116001). Each participating patient signed a detailed informed consent form, and all patient information was kept confidential. The study design and reporting format followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) principles.

All adults 60 years or older who underwent hemiarthroplasty for a femoral neck fracture at the Faculty of Medicine Siriraj Hospital, Mahidol University between February 1 and July 31, 2020, were eligible for enrollment. Patients with one or more of the following conditions were excluded: femoral neck fracture caused by high-energy trauma, complex hemiarthroplasty such as structural bone grafting or osteotomy, pathological fracture, and multiple fractures. Patients were also excluded if they declined to participate or died before hospital discharge.

Siriraj hip fracture protocol

All hip fracture patients were treated according to the Siriraj hip fracture fast-track protocol and FLS protocol. Once a patient was admitted to the hospital, an anesthesiologist performed a fascia iliaca compartment block in the emergency room to provide early and effective pain control. Both an orthopedic surgeon and a geriatrician conducted a comprehensive medical evaluation as part of the preoperative planning. If necessary, additional consultations were undertaken for patient-specific medical problems. The goal was to surgically treat all hip fractures within 48 hours of admission if there were no contraindications. All surgeries used a posterolateral approach, and they were conducted by either arthroplasty or orthopedic trauma surgeons. A cementless femoral component was initially chosen. However, if stability of the stem could not be obtained, a cemented stem was selected. Postoperatively, physical therapists encouraged patients to walk as soon as possible, with weight bearing as tolerated. In general, each patient received a 45-minute session of physical therapy every day during the hospitalization period. Prophylaxis for deep vein thrombosis was initiated using the mechanical prophylaxis protocol, with medical prophylaxis used when indicated. In general, medical prophylaxis was considered in patients with an elevated risk of venous thromboembolism beyond surgery itself, such as those with a history of venous thromboembolism[15]. Drug therapy for deep venous thrombosis (DVT) prophylaxis with low-molecular-weight heparins or adjusted-dose warfarin was administered for 35 days after hip fracture surgery.

After fracture treatment, a video-based learning tool related to osteoporosis education was given to all patients and their families or caregivers. An osteoporosis booklet was also provided as supplementary reading material after the osteoporosis education. Basic metabolic laboratory tests were

Table 1. Details of in-hospital costs (direct medical, direct nonmedical, and indirect medical) for hip fracture patients

Direct medical costs	Direct nonmedical costs	Indirect medical costs
• Preoperative laboratory tests	• Transportation cost*	• Cost from work absenteeism*
• Surgical and anesthetic procedure costs	• Medical assistive device cost	• Work replacement cost*
• Prostheses	• Food	• Cost of productivity loss*
• Physical therapy session	• Payment for a paid caregiver	
• Osteoporosis assessment		
• Nursing care		
• Medical treatment and supplies at ward and ICU		
• Essential medication during hospitalization		
• Hospital room charge		

ICU=intensive care unit

* Data were obtained from patients, families and/or caregivers

performed once the patients were medically stable. Serum calcium, serum phosphate, serum 25-hydroxyvitamin D, renal function, and liver function were tested. In addition, all patients were scheduled for a bone mineral density test using a dual-energy X-ray absorptiometry scan as an outpatient visit. All patients received calcium and vitamin D supplementation. The goal was to keep serum 25-hydroxyvitamin D greater than 30 ng/mL. An anti-osteoporosis drug was initiated, depending on the national guidelines for osteoporosis treatment[16] and the health insurance coverage of each patient. A multidisciplinary team provided a fall prevention protocol, which included home modifications. The team typically consisted of a physical medicine and rehabilitation clinician, a geriatrician, an occupational therapist, and a physical therapist. Once a patient was deemed fit to be discharged, an FLS nurse coordinator transferred the postoperative care plan, including osteoporosis treatment, to the treating physicians who had taken care of the patient.

Cost assessment

The total costs of hip fracture treatment during hospitalization were calculated for each patient. Costs were classified into three groups, direct medical, direct non-medical, and indirect medical. "Direct medical costs" were defined as the costs of all interventions directly attributed to patient care during admission. These were obtained from the hospital's finance department and the final hospitalization bills[17]. The costs comprised preoperative laboratory tests, medical care costs during admission to an inpatient unit or intensive care unit (ICU), and nursing care costs. As nursing care costs were based on a fixed average charge per day, they did not vary with the level of severity of the patient. Direct medical costs also included surgical and anesthetic procedure costs such as preoperative fascia iliaca compartment block and prosthesis, osteoporotic assessment, physical therapy once daily until discharge, and hospital room charges.

"Direct non-medical costs" were defined as expenditures relating to hip fracture that did not involve the direct purchase of medical services[18]. These expenditures were related to items such as transportation, medical assistive devices such as a walker or wheelchair, food, and payments to hired caregivers. "Indirect medical costs" were defined as expenses arising from cessation or reduction of work due to morbidity and mortality associated with femoral neck fracture. More specifically, they were the estimated costs incurred as a result of work absenteeism, work replacement, and loss of work productivity by patients and their family members or caregivers[19]. Calculations of the costs of work absenteeism were based on lost work time per day, and the salaries or wages of patients and their families or caregivers[20]. For unemployed patients or patients working as homemakers, the calculations of their income loss were based on the gross national income per capita for Thailand in 2019 at 331 Baht, or 10.96 USD, per day[21] (Table 1). The determination of equivalent amounts in U.S. dollars used the average exchange rate in 2020 financial year (1 USD=30.2 Baht).

Data collection

The authors collected demographic data from the patients. The data related to age, sex, body mass index, side of fracture, comorbidities, Charlson comorbidity index[22], the American Society of Anesthesiologists physical status classification, pre-fracture ambulatory status, length of hospital stay, time to surgery, type of prosthesis, and complications during hospital stay.

Table 2. Patient demographics and clinical characteristics

Clinical variables	Values (n=50)
Age (years); n (%)	
Mean±SD	78.3±8.9
<65	2 (4.0)
65 to 74	15 (30.0)
75 to 84	21 (42.0)
≥85	12 (24.0)
Sex: female; n (%)	35 (70.0)
Body mass index (kg/m^2); mean±SD	22.6±4.8
Right side; n (%)	25 (50.0)
ASA; n (%)	
1	1 (2.0)
2	28 (56.0)
3	21 (42.0)
Charlson comorbidity index; n (%)	
0 to 2	7 (14.0)
3 to 5	21 (42.0)
>5	22 (44.0)
Comorbidities; n (%)	
Essential hypertension	37 (74.0)
Dyslipidemia	24 (48.0)
Diabetes mellitus type 2	20 (40.0)
Chronic kidney disease	7 (14.0)
Old cerebrovascular accident	7 (14.0)
Atrial fibrillation	6 (12.0)
Thyroid disease	6 (12.0)
Coronary artery disease	4 (8.0)
Parkinson's disease	3 (6.0)

Clinical variables	Values (n=50)
Comorbidities; n (%)	
Alzheimer's disease	3 (6.0)
Dementia	1 (2.0)
Pre-fracture ambulatory status	
Without assistive device	30 (60.0)
With assistive device	20 (40.0)
• Single cane	6 (12.0)
• Tripod cane	7 (14.0)
• Walker	7 (14.0)
Time to surgery (days); n (%)	
Mean±SD	1.7±1.4
Within 48 hours of admission	44 (88.0)
More than 48 hours of admission	6 (12.0)
Type of bipolar hemiarthroplasty prosthesis; n (%)	
Cementless femoral component	40 (80.0)
Cemented femoral component	10 (20.0)
Length of hospital stay (days); mean±SD	9.5±4.7
Complications; n (%)	
Acute postoperative anemia	17 (34.0)
Urinary tract infection	11 (22.0)
Electrolyte imbalance	6 (12.0)
Pneumonia	4 (8.0)
Sepsis	2 (4.0)
Cerebrovascular accident	2 (4.0)
Upper gastrointestinal bleeding	1 (2.0)
Respiratory failure	1 (2.0)
Crystal-induced arthritis	1 (2.0)

ASA=American Society of Anesthesiologists physical status classification; SD=standard deviation

Data analyses

A descriptive analysis was performed. For continuous variables, the results were presented as the mean ± standard deviation or median and range, as appropriate. For categorical variables, the results were shown as frequencies and percentages. The Shapiro-Wilk test was used to differentiate normally distributed from nonnormally distributed quantitative data.

Following the initial analysis, a multivariate linear regression model with natural logarithmic transformation of cost was created. This evaluated the independent associations between each potential explanatory variable and the total in-hospital costs. Variables were eligible for inclusion in the model if they had a univariate significance level of 0.25 or less, or if they were thought to be clinically relevant. Using a forward stepwise procedure, variables that did not achieve a probability p-value of 0.25 or below were removed from the final model. Due to the explanatory nature of the analyses, 0.25 was chosen as the threshold for retention in the final model. However, the statistical significance was still set at p-value less than 0.05. Beta coefficients and their 95% confidence intervals were reported for the final regression model. All analyses were performed using Stata, version 14 (StataCorp LP, College Station, TX, USA).

Results

Of the 53 patients, three were excluded, two patients with multiple fractures and another with a pathological fracture. The demographic and clinical characteristics of the remaining 50 patients are summarized in Table 2. The mean age of the patients was 78.3 years. Most patients were female (70%), had a Charlson comorbidity index of more than 5 (44%), and were classified as American Society of Anesthesiologists Class 2 (56%). Thirty patients (60%) could ambulate preoperatively without the aid of any assistive device. Forty-seven patients (94%)

Table 3. Total in-hospital costs of hemiarthroplasty for femoral neck fracture

Cost variables	Baht		USD	
	Mean±SD	Median (range)	Mean±SD	Median (range)
Direct medical costs	164,918.99±60,177.08	142,727.25 (103,655.25 to 395,867.25)	5,460.89±1,992.62	4,726.07 (3,432.29 to 13,108.19)
Direct nonmedical costs	2,981.80±3,034.35	2,230.00 (600.00 to 13,500.00)	98.74±100.48	73.84 (19.87 to 447.02)
Transportation	1,727.80±2,675.44	145.00 (0.00 to 11,000.00)	57.21±88.59	4.80 (0.00 to 364.24)
Assistive device	1,086.00±1,920.25	600.00 (600.00 to 13,500.00)	35.96±63.58	19.87 (19.87 to 447.02)
Food	154.00±498.66	0.00 (0.00 to 2,400.00)	5.10±16.51	0.00 (0.00 to 79.47)
Payment for paid caregiver	14.00±70.02	0.00 (0.00 to 400.00)	0.46±2.32	0.00 (0.00 to 13.25)
Indirect medical costs	3,387.94±2,645.45	2,648.00 (184.62 to 11,380.62)	112.18±87.60	87.68 (6.11 to 376.84)
Work absenteeism	1,106.38±2,087.68	0.00 (0.00 to 11,380.62)	36.64±69.13	0.00 (0.00 to 376.84)
Work replacement	44.00±218.68	0.00 (0.00 to 1,200.00)	1.46±7.24	0.00 (0.00 to 39.74)
Productivity loss	2,237.56±2,246.50	1,986.00 (0.00 to 8,275.00)	74.09±74.39	65.76 (0.00 to 274.01)
Total cost	171,258.73±61,803.86	151,400.06 (111,590.37 to 398.451.87)	5,670.82±2,046.49	5,013.25 (3,695.05 to 13,193.77)

SD=standard deviation

Table 4. Direct medical cost of femoral neck fracture patients who underwent hemiarthroplasty

Cost variables	Baht		USD	
	Mean±SD	Median (range)	Mean±SD	Median (range)
Preoperative period				
Laboratory tests	4,996.50±1,625.37	4,667.50 (3,005.00 to 9,915.00)	165.45±53.82	154.55 (99.50 to 328.31)
Intraoperative period				
Surgical & anesthetic procedure	37,022.78±9,627.08	35,751.38 (24,423.50 to 74,508.50)	1,225.92±318.78	1,183.82 (808.73 to 2,467.17)
Prosthesis	49,089.78±11,004.06	44,116.50 (42,710.00 to 90,216.00)	1,625.49±364.37	1,460.81 (1,414.24 to 2,987.28)
Postoperative period				
Nursing care	26,203.40±17,931.80	21,695.00 (8,880.00 to 115,600.00)	867.66±593.77	718.38 (294.04 to 3,827.81)
Medical treatment & supplies	14,730.78±17,127.28	7,867.50 (1,520.00 to 94,595.00)	487.77±567.13	260.51 (50.33 to 3,132.28)
Medications	7,819.05±7,508.75	4,529.25 (1,318.00 to 38,959.00)	258.91±248.63	149.98 (43.64 to 1,290.03)
Osteoporotic assessment	1,920.00±0.00	1,920.00 (1,920.00 to 1,920.00)	63.58±0.00	63.58 (63.58 to 63.58)
Physical therapy	1,544.20±829.50	1,350.00 (380.00 to 3,880.00)	51.13±27.47	44.70 (12.60 to 128.50)
Hospital room charge	21,592.50±15,086.55	19,345.00 (4,250.00 to 68,920.00)	714.98±499.55	640.56 (140.73 to 2,282.12)
Total	164,918.99±60,177.08	142,727.25 (103,655.25 to 395,867.25)	5,460.89±1,992.62	4,726.07 (3,432.29 to 13,108.19)

SD=standard deviation

had at least one underlying disease, with essential hypertension being the most common comorbidity. The average time from admission to surgery was 1.7 days. Eighty-eight percent of the patients underwent surgery within 48 hours of the admission. The average length of hospital stay was 9.5 days. Postoperative complications occurred in 25 patients (50%). The three most frequent postoperative complications were acute postoperative anemia (34%), urinary tract infection (22%), and electrolyte imbalance (12%).

Table 3 details the overall in-hospital costs of the femoral neck fracture treatments. The mean and median total in-hospital costs per patient were 5,670.82 USD and 5,013.25 USD, respectively with a range of 3,695.05 to 13,193.77 USD. The median direct medical cost was 4,726.07 USD with a range of 3,432.29 to 13,108.19 USD and accounted for 96.3% of total in-hospital costs. More than half of the direct medical costs occurred during surgery (Table 4). These intraoperative expenses comprised two items, costs relating to the surgical and anesthetic procedures (22.4%) and the cost of the prosthesis (29.8%). The mean cost of the prosthesis was US $1,625.49. During the postoperative period, nursing care represented a small portion of the costs (Table 4).

When evaluating the relationship between each clinical variable and the total in-hospital cost, five variables were found to have a significance level of 0.25 or less or had clinical relevance to the total in-hospital cost. These included a body mass index greater than or equal to 19 kg/m², a Charlson comorbidity index greater than or equal to 5, time to surgery at more than 48 hours after admission, length of stay, and the presence of postoperative

Table 5. Univariate analysis and multivariate analysis identifying the factors affecting the total in-hospital costs for patients with femoral neck fracture and undergoing hemiarthroplasty

Factors	Univariate			Multivariate*		
	Beta coefficient	95% CI	p-value	Beta coefficient	95% CI	p-value
Age (ref., <80)	0.0066	−0.0075 to 0.0207	0.355			
Sex (ref., male)	0.0034	−0.0121 to 0.0189	0.658			
BMI (ref., >19)	−0.0116	−0.0332 to 0.0100	0.287	0.0049	−0.0076 to 0.0173	0.435
Prefracture ambulatory status (ref., without gaitaid)	0.0070	−0.0074 to 0.0214	0.331			
CCI (ref., <5)	0.0123	−0.0018 to 0.0264	0.085	−0.0004	−0.0089 to 0.0081	0.932
ASA						
1	1					
2	0.0081	−0.0412 to 0.0574	0.742			
3	0.0228	−0.0267 to 0.0724	0.359			
Time to surgery (days)						
Less than 48 hours	0.0380	0.0191 to 0.0570	<0.001	0.0058	−0.0085 to 0.0201	0.419
Type of prosthesis (ref., cemented)	−0.0008	−0.0186 to 0.0170	0.931			
Length of stay	0.0044	0.0035 to 0.0053	<0.001	0.0039	0.0028 to 0.0050	<0.001
Complication: pneumonia (ref., no)	0.0440	0.0210 to 0.0669	<0.001	0.0168	0.0009 to 0.0327	0.038

BMI=body mass index; CCI=Charlson comorbidity index; ASA=American Society of Anesthesiologists physical status classification; CI=confidence interval

* Adjusted R^2=0.6943

pneumonia (Table 5). These variables were included in the multiple regression models. Using a forward stepwise process, the authors found that length of stay had the strongest association with total in-hospital cost (β=0.0039; p<0.001). Another weakly correlated, but significant, factor was the presence of pneumonia after surgery. Collectively, the five factors explained 69.4% of the variance in total in-hospital costs (Table 5).

Discussion

Hip fracture is one of the most devastating complications of osteoporosis. Based on global trends and demographic shifts in recent decades, the number of hip fractures is projected to exceed 21.3 million worldwide in 2050. Demographic changes are expected to be more pronounced in Asian countries, and it is estimated that 45% of hip fractures will occur in this region[23]. The previous research in Thailand found that the incidence of hip fractures per 100,000 person-years increased from 7.45 in 1990, to 185.2 in 1998, and to 238.5 in 2017[24]. Hip fractures have an enormous economic impact on countries. Based on a recent analysis of Norwegian registry data, it has been predicted that hip fracture treatment costs will increase by 65% from 2020 to 2040[25]. However, in the case of Thailand, there are limited current data on the costs associated with hip fractures. The two Thai studies available reported treatment cost data from 13 to 17 years ago. Up-to-date data for hip fracture treatment in Thailand are essential.

Here, the authors report a median in-hospital cost for femoral neck fracture treatment of 5,013.20 USD per patient. The present study result is much higher than the medians reported previously at 3,157.00 USD per patient per year in 2004 and 4,210.60 USD per patient per year in 2008[13,14]. There are reasons for these differences. First, the present study enrolled patients who were older and had more comorbidities than other studies, reflecting the trend toward an aged society. Therefore, these older patients might have received more intensive preoperative medical evaluations and treatments during their hospitalization, resulting in a higher total in-hospital cost. Moreover, the present study included the cost of the hip fracture fast-track protocol and the FLS protocol. Neither of those programs were in place during the two previous studies. Furthermore, the authors used newer-generation prostheses. The prostheses used in the two previous studies were based on now-obsolete designs no longer used. Overall, the present study results reflect the actual and current in-hospital costs in Thailand for treating patients with femoral neck fractures who received treatment with hemiarthroplasty.

Most of the present study total in-hospital costs occurred intraoperatively, with 29% accounted for by the cost of the prosthesis. Since the prosthetic cost remains the main component of the total cost of hip fracture treatment, each hospital should develop

its own strategies to control the cost of the implants. An option to reduce the overall cost of treatment is to select a cheaper, but equally effective, prosthetic device or one that is locally made. Interestingly, the present study showed a very low mean indirect medical cost of 112.18 USD per patient. This could be explained by the extended Thai family culture. After hip fracture treatment, most patients were cared for by their family members. They were typically retirees or part-time workers. Thus, there was minimal financial impact from work absenteeism, work replacement, and productivity cost of these caregivers.

The total in-hospital cost incurred for hip fractures in Thailand was lower than the amounts reported from other countries in Asia and Europe. In those other regions, orthogeriatric care models have been incorporated into treatment pathways. For example, Tan et al.[26] reported a higher mean total in-hospital cost in Singapore of 10,251.60 USD in 2011. However, the higher cost was due to a longer hospitalization period, which was around 16 days, compared with 9.5 days in the present study. Another study from a hospital in Norway showed the mean total in-hospital cost for hip fracture treatment between 2011 and 2013 was 15,732.00 USD per patient[27]. Although the duration of hospital stay was only 6.4 days, most of the total in-hospital costs were related to nursing care, medical treatment, and medications. In marked contrast to the present study results, the prosthesis cost and the costs incurred during the operation represented only 3.5% and 12.3% of the total in-hospital cost, respectively. The differences between the present study findings and those of the other studies simply reflect the wide variety of healthcare and reimbursement policies that each country has adopted.

Multiple regression analysis showed that length of hospital stays, and the occurrence of postoperative pneumonia were significantly associated with total in-hospital cost. This finding is expected as a longer duration of hospitalization results in a higher utilization of medical supplies and other resources. Additionally, the rate of postoperative pneumonia of the present study subjects was approximately 4%, which was similar to the rates reported by the other studies[28,29]. Although early ambulation is one of the valuable strategies available to reduce postoperative pneumonia, this process remains suboptimal in some centers due to factors such as availability of physical therapists, patients' condition, the method of pain control, and patient attitudes. Based on the present study findings, efforts to reduce in-hospital costs should focus on provision of early surgery, prevention of respiratory complications via encouragement of early ambulation, and discharge of patients as soon as they meet hospital discharge criteria.

The strength of the present research is that it is the first prospective study to evaluate all costs incurred during hospitalization for hemiarthroplasty for a femoral neck fracture in Thailand. Unlike other cost analyses performed in Thailand, the author did not use the estimated costs available from the Health Intervention and Technology Assessment Program of Thailand (HITAP), Ministry of Public Health. This is because these costs may be under- or over-estimates of the actual costs of hip fracture treatment[30].

There are limitations to the present study. First, the sample size was small. However, as this was only a preliminary study, further investigation is warranted. Second, data were collected from the patients admitted to a university-based tertiary care medical center. Some of those patients were referred by local hospitals, where resources may be inadequate for the care of frail older patients. Consequently, the costs may be high due to the complexities of cases. This means that the present study results cannot be generalized to community hospitals, where cases are less complex. In addition, the authors only enrolled older patients with femoral neck fractures that underwent hemiarthroplasty. Therefore, the present study costs cannot be applied to patients receiving other surgical treatment such as multiple screw fixation or total hip arthroplasty or to those diagnosed with hip osteoarthritis. Furthermore, all costs presented in the present study were collected from a single high-volume medical center. Because such centers may have discount contracts with the manufacturers, there may be differences in the prosthesis costs incurred by high- and low-volume centers. One strategy that may reduce the variation in prosthesis costs is to form purchasing consortiums among low-volume hospitals to gain the financial benefits accruing from higher-volume purchases. Lastly, the authors only collected the costs during hospitalization. Since hip fracture treatment needs a long-term care program, a study evaluating the total cost of hip fracture treatment over the long term follow-up is warranted.

Conclusion

The mean and median total in-hospital costs for femoral neck fracture treatment with hemiarthroplasty were 5,670.82 USD and 5,013.25 USD, respectively. These costs represent current and actual data on

treatment in Thailand. They can be used as basic information for future cost-effectiveness or cost-utility analyses. Moreover, extended hospital stays and post operative pneumonia were identified as factors associated with the total costs. Thus, efforts to reduce hospitalization costs should focus on early surgery and rehabilitation. Since osteoporotic hip fractures can have a long-term impact on the quality of life of the patients and caregivers, studies that evaluate long-term treatment costs are essential.

What is already known on this topic?

Costs of hip fracture have become a great burden for healthcare systems due to its high morbidity and treatment expenses. Most of the costs occur in an acute hospital period. Previous studies about costs of bipolar hemiarthroplasty treatment for osteoporotic femoral neck fractures are limited and not up to date.

What this study adds?

The mean and median total in-hospital costs for femoral neck fracture treatment with hemiarthroplasty were 5,670.82 USD and 5,013.25 USD, respectively. Extended hospital stays and post operative pneumonia were identified as the factors associated with increase in the total costs. Efforts to reduce hospitalization costs should focus on early surgery and rehabilitation.

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Conflicts of interest

The authors declare no conflict of interest.

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