Cost Analysis of Osteoporotic Hip Fractures

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Objective: *To assess the total costs of hip fracture treatment subsequently incurred in 1 year.*
Material and Method: *A cohort study was conducted from January 1, 2002 to December 31, 2004. All new osteoporotic hip fracture patients were enrolled with informed consent. A total cost was estimated, and multivariate analysis was performed to determine factors related to costs.*
Results: *A total of 37 patients were included. Average age was 75 $\pm$ 11.8 years. Four of them (11%) died. Median total cost of hip fracture treatment in 1 year was 116,458.6 Baht (range 21,428.5-5,070,665.0). Median direct cost was 59,881.6 Baht (range 21,428.5-595,520.4). Direct cost per live-year saved was 118,168.3 Baht. Preoperative status was the only factor related to direct cost.*
Conclusion: *Cost incurred from hip fracture in 1 year was high. The appropriate solution to prevent hip fracture might bring about good health in the Thai elderly and reduce its cost in the future.*

Keywords: *Cost, Hip fracture, Osteoporosis*

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Hip fracture is an important cause of mortality and morbidity among the elderly, and contributes significantly to health care costs[1]. Following a hip fracture, there is a 10%-20% mortality over 6 months, 50% of patients are unable to walk without assistance, and 25% of them require long-term domiciliary care[2]. Nowadays, the incidence of osteoporotic hip fractures has increased worldwide especially in Asian countries[3-24]. It was estimated that there was a fourfold increase between 1990 and 2050 (from 1.7 million in 1990 to 6.3 million) because of the increase in the ageing population [25] while 50% of this fracture is predicted to occur in Asia by the next century[26].

About US$7,000 for the immediate hospital care and $21,000 in total costs for the first year after hip fracture was estimated. Based on today's currency values and a cost of $21,000 per patient, the total cost of hip fractures in the year 2050 will be $131.5 billion[27]. In Thailand, the incidence of hip fracture was 151 per 100000 from a hospital survey, and 185 per 100000 from a community survey [3]. The medical charge per case is 36,563 Baht, nearly one third of the national income per capita [28]. There is no study about the burden of hip fracture, in terms of cost analysis, in Thailand. Cost analysis might reveal how much hip fracture impacts the Thai people and has lead to develop an effective program for prevention. Therefore, the present study was conducted to estimate total costs of treatment for the first year after hip fracture.

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Material and Method

A cohort study was conducted in Ramathibodi Hospital from January 1, 2003 to December 31, 2004. All new osteoporotic hip fracture patients, age equal to or more than 51 years, admitted to orthopaedic wards were enrolled with informed consent. Osteoporotic hip fracture was defined as intertrochanter or femoral neck fracture (ICD-10 S72.1) which occurred under low-energy trauma. Patients with pathologic hip fracture from a tumor were excluded. All patients were treated based on orthopaedic standard treatment by orthopaedic surgeons in our institute. Internal fixation with angle blade plate or dynamic hip screws was used for intertrochanteric fracture. Internal fixation with multiple screws was used for femoral neck fracture. Hip fractures with poor

bone quality or delayed surgical treatment underwent hemiarthroplasty with Austin Moore prosthesis or bipolar arthroplasty with Monk prosthesis. If the patient's status could not tolerate major surgery, conservative treatment by traction or weight-bearing as tolerated was performed. The study was approved by the Institutional Review Board (IRB).

Study factors were demographic data, types of fracture, prefracture status, underlying diseases, age at menopause, types of treatment, types of implant, duration of admission, and complications. Outcome factors were postfracture status, and readmission. The main outcomes were costs and morbidity/mortality of hip fracture.

Cost of hip fracture

A total cost was composed of direct medical cost, direct non-medical cost, and indirect cost. It was estimated by using provider and patients' point of view. Cost of treatment included only the costs of hip fracture and its consequences from hospital admission to a total 1-year of follow-up. Direct medical costs consisted of hospital, physicians, nurses, anesthetic, laboratory, implant, operation which included overhead cost of fluoroscopy and surgical set, medications, rehabilitation, nursing home, and readmission. Costs of health personnel were calculated based on their salary and total hours of work per month. Direct non-medical cost included transportation, caretaker, food and clothes, traditional medicine, and absence from work (both patients and relatives). Indirect cost was estimated by using willingness to pay.

Overhead cost calculation

The cost of fluoroscopy and surgical set was calculated by using the formula below.

$E = [K - S/(1+r)^n]/ A(n,r)$

S = resale value

n = the useful life of the equipment

r = discount (interest rate)

A(n,r) = the annuity factor (n years at interest rate)

K = purchase price/initial outlay

E = equivalent annual cost

Unit cost and cost-effectiveness analysis

Unit cost was defined as the total cost of hip fracture treatment divided by the number of patients. Cost-effectiveness analysis was defined as a total cost of hip fracture treatment divided by the number of patients who survived after 1 year of follow-up.

Morbidity and mortality of hip fracture

Morbidity of hip fracture defined as complications occurred after and related to hip fracture, including surgical wound infection, urinary tract infection, pneumonia, pulmonary embolism, deep vein thrombosis, septic arthritis/osteomyelitis of the hip, refracture of the hip, nonunion and malunion. Mortality of hip fracture defined as a death occurred after and related to hip fracture.

Data collection

Study factors were collected from medical records and radiographs. All patients were followed up at 3, 6, and 12 months. The ability to perform physical activities, medication, rehabilitation, readmission, morbidity, mortality and its causes, and duration of follow-up were collected at each visit. If the patients could not come to the hospital, a well-trained nurse did a telephone survey.

Statistical analysis

Demographic data were analyzed as mean $\pm$ standard deviation (SD) for continuous data, and as percentage for categorical data. For the comparison between groups, unpaired t-test was used for continuous data and Fisher's exact test was used for categorical data. The costs were calculated as direct medical costs, direct non-medical costs, indirect costs, and total costs. Each cost was analyzed as median and range. Mann-Whitney U test was used for the comparison between the costs of femoral neck fracture and those of intertrochanteric fracture. Multivariate analysis was performed to determine the factors related to direct costs. Forward stepwise regression was used for the analysis. The significant level for removal factor from the model equaled to 0.2 and for addition to the model equaled to 0.05. All statistical analysis was performed by using STATA 8.0 (StataCorp, Texas). Significant p-value was set as equal to or less than 0.05.

Results

Forty patients with hip fractures were informed and willing to enroll in the present study. Three of them had inadequate data. A total of 37 patients were included in the analysis. Demographic data is shown in Table 1. Average age was 75 $\pm$ 11.8 years. Twenty-five patients (68%) were women. Average age at menopause was 48.9 $\pm$ 4.8 years. Twenty-two patients (60%) had underlying diseases, which were diabetes mellitus, hypertension, ischemic heart disease, cerebrovascular disease, Parkinsonism, and renal failure.

Table 1. Demographic data and study factors of femoral neck and intertrochanteric fracture

Baseline characteristics	Femoral neck fracture (n = 17)	Intertrochanteric fracture (n = 20)	p-value
Age (years), mean ± SD	74.2 ± 12.3	75.7 ± 11.6	0.7215
Age at menopause (years), mean ± SD	48.0 ± 4.2	50.3 ± 5.71	0.3307
Female (%)	14 (82.4)	1 (55)	0.0940[a]
Side, right (%)	5 (29.4)	9 (45)	0.4980[a]
Underlying diseases (%)	11 (64.7)	11 (55)	0.7380[a]
Preoperative status (%)			
- Independent	14 (82.4)	17 (85.0)	0.2780[a]
- Partially dependent	1 (5.9)	3 (15)	
- Totally dependent	2 (11.8)	0	
Discharge status (%)			
- Independent	11 (64.7)	4 (20)	0.0080[a]*
- Partially dependent	2 (11.8)	2 (10)	
- Totally dependent	4 (43.5)	14 (70)	
Last follow-up status (%)			
- Independent	6 (54.5)	4 (25)	0.2370[a]
- Partially dependent	2 (18.2)	8 (50)	
- Totally dependent	3 (27.3)	4 (25)	
Duration of admission (days), mean ± SD	10.0 ± 6.4	9.9 ± 4.2	0.5774
Duration of surgery (minutes), mean ± SD	115.9 ± 35.6	120.3 ± 43.6	0.7434
Implant (%)			
- Austin Moore	14 (82.4)	5 (77.8)	0.0010[a]*
- ABP	0	3 (16.7)	
- DHS	2 (11.8)	10 (55.6)	
- Bipolar (Monk)	1 (5.9)	0	
Blood loss (ml), median (range)	100 (20-400)	200 (100-1500)	0.1618[b]
Complications (%)			
- Death + sepsis	1 (5.9)	0	0.7330[a]
- Death + fasciitis	0	1 (5)	
- Death + UTI	1 (5.9)	1 (5)	
- UTI	0	2 (10)	

p-value from unpaired t-test, [a] p-value from Fisher's exact test, [b] p-value from Mann-Whitney U test, * significant p-value ≤ 0.05

Seventeen patients (46%) had femoral neck fracture and 20 patients (54%) had intertrochanteric fracture. There was no statistically significant difference in demographic data between each group of fracture except discharge status. Patients with intertrochanteric fracture had a higher proportion of dependent status when compared to patients with femoral neck fracture (p = 0.0080). Implant use showed statistically significant difference among types of hip fracture due to their indication and standard treatment. Most femoral neck fractures underwent surgery by using Austin Moore prosthesis while most intertrochanteric fractures were fixed with a dynamic hip screw. At the latest follow-up, an additional 2 patients with femoral neck fracture and 9 patients with intertrochanteric fracture were unable to walk independently. However, the status of patients in each fracture was not statistically significantly different between preoperative (p = 0.498) and immediately postoperative status (p= 0.163). Complications occurred in 6 patients (16%), including urinary tract infection, sepsis and fasciitis. Four of them (11%) died because of these complications. There was no statistically significant difference of morbidity and mortality between each type of fracture (p = 0.7330).

Costs of hip fracture in both provider and patient's perspectives were analyzed as a whole or separately according to types of fractures (Table 2). Median total cost of hip fractures was 116,458.6 Baht (range 21,428.5-5,070,665.0). Median total cost of femoral neck fracture was 123,249.5 Baht (range 21428.5-1,595,520.0) and median total cost of intertrochanteric fracture was 110,415.6 Baht (range 25031.5-5,070,665.0).

Table 2. Costs of hip fractures

Cost (Bahts), median (range)	Hip fracture (n = 37)	Femoral neck fracture (n = 17)	Intertrochanteric fracture (n = 20)	p-value [a]
Total	116458.6 (21428.5-5070665.0)	123249.0 (21428.5-1595520.0)	110415.6 (25031.5-5070665.0)	0.7146
Direct	59881.6 (21428.5-595520.4)	62504.5 (21428.5-595520.4)	52232.9 (25031.5-437240.7)	0.6476
Direct medical	44956.6 (21368.5-369040.7)	44956.6 (21368.5-234191)	39716.9 (25031.5-369040.7)	1.000
- Hospital	2000 (1000-7000)	1750 (1250-7000)	2250 (1000-5000)	0.4077
- Physicians	2196.8 (1368-5688.5)	2052 (1533.7-5688.5)	2456 (1368-4196.5)	0.4738
- Nurses	2542 (1364-7223)	2154.5 (1612-7223)	2642 (1364-5239)	0.4104
- Anesthetic	2484 (1428-4368)	2484 (1428-3426)	2484 (1542-4368)	0.9130
- Laboratory	3320	3320	3320	-
- Implant	8100 (5000-26800)	8100 (8000-26800)	8000 (5000-8100)	0.0001*
- Fluoroscopy & surgical set	478.0 (159.3-717.1)	478.0 (159.3-956.1)	478.1 (239.0-956.1)	0.9378
- Blood transfusion	0 (0-1200)	0 (0-600)	0 (0-1200)	0.0847
- Drugs (admit and discharge)	1691.5 (531.9-13030.44)	1691.5 (531.9-12544.9)	1513.5 (674.9-13030.4)	0.5026
- Drugs (F/U)	3200 (0-340000)	9000 (0-190000)	1600 (0-340000)	0.5109
- Rehabilitation (admit)	1992 (996-6972)	1743 (1245-6972)	2241 (996-4980)	0.4077
- Rehabilitation (F/U)	0 (0-34000)	0 (0-34000)	0 (0-2800)	0.8764
- Readmission				
- 1st	0 (0-150000)	0 (0-150000)	0 (0-60000)	0.5371
- 2nd	0 (0-45000)	0 (-)	0 (0-45000)	0.1862

[a] P-value from Mann-Whitney U test
* Significant p-value ≤ 0.05

Table 3. Direct non-medical cost and indirect cost

Cost (Bahts), median (range)	Hip fracture (n = 37)	Femoral neck fracture (n = 17)	Intertrochanteric fracture (n = 20)	p-value [a]
Direct non-medical	12400 (0-380000)	24600 (0-380000)	3750 (0-153200)	0.3846
- Transportation	180 (0-1000)	200 (60-600)	200 (40-100)	0.9408
- Caretaker	0 (0-102000)	0 (0-64600)	0 (0-102000)	0.2582
- Food, clothes	12000 (0-190000)	24000 (0-190000)	3000 (0-680000)	0.3360
- Traditional medicine	0 (0-2000)	0 (0-2000)	0 (0-180)	0.4210
- Absence from work (relatives)	0 (0-190000)	0 (0-190000)	0 (-)	0.2781
Indirect - Willingness to pay	50000 (0-5000000)	100000 (0-1000000)	35000 (0-5000000)	0.3535

[a] P-value from Mann-Whitney U test

Table 4. Multivariate analysis of factors related to direct cost

Factors	Beta coefficient	Standard error	95% Confidence interval	p-value
Preoperative status				
- Independent [a]				
- Partially dependent	27,948.9	58,459.6	- 90.855.3 – 147.531.4	0.636
- Totally dependent	310,674.9	80,277.5	147,531.4 – 125,741.8	< 0.0001**

[a] Reference group
** Significant p-value

There was no statistically significant difference between the costs of each type of hip fracture. However, costs of implant in femoral neck fracture were statistically significantly higher than those of intertrochanteric fracture due to their standard treatment.

Median direct cost for all fractures was 59,881.6 Baht (range 21,428.5-595,520.4). It was composed of direct medical cost and direct non-medical cost as shown in Table 2 and 3. Overall median direct medical cost was 44,956.6 Baht (range 21,368.5-369,040.7) and median direct non-medial cost was 12,400 Baht (range 0-380,000) with high variation. Most direct medical cost came from surgery and medication. There was no statistically significant difference between direct costs of each type of hip fractures. However, cost of implant for femoral neck fracture was statistically significantly higher than that of intertrochanteric fracture ($p = 0.0001$). Indirect cost was assessed on the basis of willingness to pay. Overall indirect cost was 50,000 Baht (0-5 million). There was no statistically significant difference between indirect costs in each group ($p = 0.3535$).

Unit cost (cost per patient) in 1-year follow-up was calculated. Unit cost of hip fracture was 428,514.9 Baht/patient. Unit cost of femoral neck fracture was 456,042.5 while unit cost of intertrochanteric fracture was 405,116.6 Baht/patient. Cost-effectiveness of hip fracture care was 480,456.2 Baht/patient. Cost-effectiveness of femoral neck fracture in 1 year of follow-up was 516,848.2 Baht/survival patients, and those of intertrochanteric fracture were 450,129.5 Baht/survival patient. However, total cost was affected by variation of indirect cost. So direct cost was calculated as cost-effectiveness and direct cost per live-year saved was 118,168.3 Baht.

When factors related to direct costs were taken into account, the univariate analysis was performed by using regression analysis. Age, sex, types of fracture, preoperative status, length of hospital stay, complications, and underlying disease was not statistically significantly related to direct costs of hip fracture treatment. Only preoperative status was statistically significantly related to direct costs (Table 4). It explained only 26% of direct costs (adjusted R-squared = 0.2653). When compared with independent patients, totally dependent patients increased direct costs about

310,674.9 Baht/1-year of follow up (95% CI: 147,531.4-473,818.4) significantly with p-value < 0.0001. Partially dependent patients increased direct costs about 27,948.9 Baht/1-year of follow up (95%CI: -90,855.3-146,753.1) when compared to independent patients. However, it was not statistically significant with p-value = 0.636.

Discussion

Hip fracture has a high impact on patients' quality of life and also to the society. The cost of hip fracture has been studied in many countries. The estimated cost of hip fracture was $21,000 per patient and the total cost in the year 2050 will be 131.5 billion. The cost per life-year saved is $30,600 per patient [27]. Direct cost of femoral neck fracture in 1 year was $13,363 – 17,257 according to type of fixation [29] compared with $6170 for the controls [30]. Cost of displaced femoral neck fracture in 2 years was $15,000 – 21,000 in Sweden [31]. Brainsky A, et al estimated incremental costs in the year after hip fracture compared with the costs in the year before the fracture, ranged between $16,322 – 18,727. It was lower than other studies [32]. From the study in Aberdeen, the cost of hip fracture ranged from 2,000-4,000 pounds [33]. While the study from London showed direct cost of femoral neck fracture was 4,884 – 5,606 pounds [34]. From the study of Lawrence TM, et al mean total hospital expenditure per patient was 12,163 pounds [35]. In Belgium, mean cost of the acute hospital study was 8,667 Euro, and the mean 1-year cost after hospitalization was 6,636 Euro [36]. While another study reported mean hospital inpatient costs were $8,977 and an annual $752 after hip fracture [37]. Direct cost of hip fracture in Latin America was $4,500-6,000 [38]. Overall direct costs incurred from hip fracture were $10,000 - 20,000 per 1-year period.

This is the first study about the cost of hip fracture in provider's and patient's perspective (point of view) and cost-effectiveness analysis in Thailand. Median total cost of hip fracture treatment in 1 year was 116,458.6 Baht (range 21,428.5-5,070,665.0). Median total cost of femoral neck fracture was 123,249.5 Baht (range 21428.5-1,595,520.0) and median total cost of intertrochanteric fracture was 110,415.6 Baht (range 25031.5-5,070,665.0). Nowadays, Thai Gross domestic product (GDP) per capita is less than $ 5000 per year [39]. The exchange rate this year was about 40 Baht per $1. The total cost of hip fracture from the present study was more than 58% of the Thai National GDP per capita. When compared to a previous study [28], the medical charge per case is 36,563 Baht, which is lower than the present study because it included only hospital charge on admission, and did not reveal the real burden of hip fracture. However, the indirect cost concealed in total cost correlated with the socioeconomic status and recent disability. Therefore, the figure of direct cost was more accurate. Median direct cost for all fractures was 59,881.6 Baht (range 21,428.5-595,520.4). It was about 30% of Thai National GDP. In comparison to the other studies, the direct cost of femoral neck fracture was 62,504.5 Baht (21,428.5-595,520.4), which was 10 times lower. However, the value of money for living in Thailand is about 10 times lower than US dollars. So the burden of hip fracture in Thailand did not differ from other countries.

From previous studies, the factors determined cost variation were the number of days spent during acute care, convalescence, rehabilitation, nursing home stay [30,32-34,36]. In the present study, only preoperative status was significantly related to direct costs. The worse the status, the more special care was needed after hip fracture. However, R-squared of preoperative status in the present model was low (26%). The explanation was the number of patients in the present study was too small to determine significant factors related to direct costs. Most of the direct costs were incurred from surgery, hospitalization and followed by medication. Length of hospital stay was not associated with direct costs. This result was supported by the study of Taheri PA et al. [40]. The cost of rehabilitation was very low. This may be explained in part by strong family support, and unavailability of rehabilitation personnel in Thailand.

The cost-effectiveness (cost per life year saved) was 480,456.2 Baht/patient in the present study, which was 2 times the Thai National GDP per capita. When direct cost was calculated as cost-effectiveness, direct cost per live-year saved was 118,168.3 Baht. After adjusting for value of money, it equaled the figure of Sweden [27]. Therefore, the burden of saving hip fracture patients is very high in Thailand.

Femoral neck fracture consumed a higher cost than intertrochanteric fracture. The former had a higher cost of implant, medication, and direct non-medical costs while the latter had a higher cost of hospitalization and rehabilitation due to difficulty in treatment of this fracture, and also higher impact on physical status. Nevertheless, there was no statistically significant difference between costs of each fracture. The explanation was too small a sample size to detect the difference. The mortality rate was 10.8% compared with 2.3-26% from other studies [38,41-42]. Schurch MA et al reported

prognostic factors for mortality were age, sex, consumption of cardiovascular drugs, and previous living circumstances. After fracture, 63% of patients had returned to their previous living circumstances, but 18% needed more care [41]. In the present study, prognostic factor for mortality could not be calculated because the number of patients was small. Ten patients (27%) returned to their previous status and 15 patients (41%) had poorer physical status. This might be the minimal concern and accessibility of rehabilitation programs after fracture. Only 9 patients (24%) were in a rehabilitation program after discharge.

The limitation of the present study was some costs were underestimated such as cost of transportation, family care, and home aids. Therefore, the total cost was underestimated. Also the willingness to pay, which depended on socioeconomics of the patients, had the highest variability giving the unreliable indirect and total cost. The sample size in the present study was small and only in our institute. It can be the small representative for hip fracture patients in our hospital and cannot be applied to Thailand.

Hip fracture in Thailand has a high impact on the society. The present study shows direct cost incurred from hip fracture in 1 year of period was 30% of the Thai National GDP per capita and cost-effectiveness to save 1 hip fracture patient was equal to the Thai National GDP per capita. The proper method to prevent hip fracture might bring about good health in the Thai elderly and reduce cost of hip fracture in the future. Also, a multicenter study will reveal the real impact of hip fracture in Thailand.

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การศึกษาต้นทุนในการรักษากระดูกตะโพกหัก

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การศึกษานี้มีวัตถุประสงค์เพื่อประเมินต้นทุนรวมในการรักษากระดูกตะโพกหักในระยะเวลา 1 ปี โดยศึกษาผู้ป่วยกระดูกตะโพกหักที่ยินยอมเข้าร่วมการวิจัยตั้งแต่ 1 มกราคม พ.ศ. 2545 ถึง 31 ธันวาคม พ.ศ. 2547 ทำการคำนวณต้นทุนรวมและวิเคราะห์หาปัจจัยที่มีผลต่อต้นทุนทางตรง จากการศึกษาพบว่าผู้ป่วย 37 คน อายุเฉลี่ย 75 $\pm$ 11.8 ปี เสียชีวิต 4 คน (ร้อยละ 11) การรักษากระดูกตะโพกหักเป็นระยะเวลา 1 ปี มีค่ามัธยฐานของต้นทุนรวม 116,458.60 บาท (พิสัย 21,428.50-5,070,665.00 บาท) ค่ามัธยฐานของต้นทุนทางตรง 59,881.60 บาท (พิสัย 21,428.50-595,520.40 บาท) ต้นทุนทางตรงของการรักษากระดูกตะโพกหักให้รอดชีวิต 118,168.3 บาทต่อคน ความสามารถในการช่วยเหลือตนเองก่อนผ่าตัดมีผลต่อต้นทุนทางตรง สรุปว่าต้นทุนของการรักษากระดูกตะโพกหักมีค่าสูง การป้องกันภาวะนี้อาจลดต้นทุนการรักษาในอนาคต