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Brief communication (Original)

Estimating uncompensated medical care cost as a result of adverse events in a university hospital in Thailand

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Background: The impact of adverse events on costs of medical care in developing countries is more limited than in developed countries.
Objectives: To estimate uncompensated medical care costs as a result of adverse events in hospitalized patients.
Methods: Retrospective study based on a panel reviews of the medical records and hospital charges relating to 574 inpatients in the electronic database of a tertiary-care university hospital in Bangkok, Thailand, of which 138 were identified to have adverse events in 2009. The main outcome measure was hospital charges for medical care standardized by Thai diagnosis-related groups (Thai-DRGs).
Results: After controlling for personal and clinical factors, the average medical cost of an adverse event was estimated at US $128.98 per adjusted relative weight of Thai-DRGs, equivalent to 52% of the standard payment rate paid to the hospital set by a Universal Coverage Scheme.
Conclusions: Adverse events in the hospital increased the cost of medical care despite adjustment for the case-mix based on DRG. Under the close-ended DRG-based payments for hospitals in Thailand, this meant that adverse events resulted in significant amounts of uncompensated care.

Keywords: Adverse events, costs, hospital, medical care, Thailand

Adverse events (AEs) in hospitals compromise patient safety worldwide. They occur in around 4%–13.5% of hospital admissions [1-7], and among these, 40%–70% were found preventable [5-7]. Many studies in developed countries found that AEs were associated with increased length of stay and, thus, costs of medical care. For example, in public hospitals in Victoria, Australia, an AE added an extra Australian $460.31, or 15.7% of total direct medical cost [1]. However, the impact of AEs on costs of medical care in developing countries is much more limited. While AEs in developing countries might occur in around 2.5%–18.4% of hospital admissions [8], a study in a tertiary-care hospital in Thailand using the Institute for Healthcare Improvement Global Trigger Tool (IHI-GTT) revealed that AEs are found up to 41 events per 100 patients [9]. However, no financial impact of AEs was reported. In light of international movements towards universal healthcare coverage (UHC) and increasing use of close-ended hospital payments among developing countries, including Thailand [10], any cost implication of AEs could raise concerns over the financial sustainability of public hospitals, and even UHC programs. Although any treatment complications during hospital stay might increase relative weights for inpatient reimbursement under the Thai diagnosis-related-group (Thai-DRG) system, there was no evidence for whether any additional payments would be adequate for compensating the increased costs resulting from AEs. Therefore, the present study aimed to explore whether there might be any uncompensated costs of medical care associated with AEs in a hospital, using standardized cost based on Thai-DRGs. Insights into the cost of AEs might help demonstrate cost implications of patient safety, and thus implications for the financial sustainability of hospitals. It might also highlight the important roles of hospital quality improvement among policy makers and administrators of health security schemes in the country.

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Methods

After review and approval of the study protocol by the Institutional Review Board of the Faculty of Medicine, Chulalongkorn University (approval No. 146/2012, IRB No. 020/55) and permission from the King Chulalongkorn Memorial Hospital, we conducted a retrospective review of the medical records and hospital administrative database for discharge bills related to a previously published AE study of 576 inpatients in a tertiary-care, university-affiliated hospital in Bangkok, Thailand in 2009 [9]. To protect patients' rights and ensure confidentiality, the researchers were blinded to all patient identifiers. Using systematic random sampling and precalculated sample sizes by subgroups, the sample was selected from patients admitted to 5 major departments of the hospital—including obstetrics and gynecology, surgery, pediatrics, internal medicine, and orthopedics—during January 1–31, 2008. The first case was randomly selected, and the rest of the cases were subsequently chosen by the calculated interval. The selected cases were screened with predetermined inclusion criteria, including being admitted for at least 24 h and discharged from the hospital for at least 30 days by the time of data extraction. Nevertheless, 2 records were excluded from this study because of incomplete data for specifying diagnosis-related group (DRG) and calculating the relative weight, reducing the total number of records included to 574.

In brief, the sampled inpatient records had been reviewed by two trained registered nurses using the IHI-GTT [11]. The reviews were then focused on trigger-positive cases. A physician consultant was available to assist the reviewers. Other methodological details and the nature of the events have been described previously [9]. Based on identification of AEs in the study, we divided the sample into two groups: the AE-positive group consisting of 138 cases with identified AEs, and the AE-negative group of 436 cases without an adverse event.

Cost of medical care, the main outcome variable, was approximated by the total hospital charges for each case, retrieved from the hospital database using the admission numbers (AN). They included charges for diagnostic services—such as pathology, laboratory, and radiology services—medications and medical supplies, surgical or medical procedures, nursing services, and room and meal charges. Doctor fees were not applicable because hospital physicians were all on salary, not being charged to the patients. All charge information was originally in baht. However, an exchange rate at the end of year 2007–2008, 33.0 Baht per US dollar, was used for international presentation [12].

Other relevant patient characteristics were gathered from the hospital's electronic discharge summary databases and the patients' paper-based medical records. They included age, sex, insurance status, type of admission, length of stay, admitting department, and clinical diagnoses and relevant procedural information.

Patients' case mix information was gathered based on the assigned DRG of each inpatient admission using the Thai DRG system, version 4, used by the Central office for Healthcare Information (CHI) for inpatient reimbursement in the Universal Coverage (UC) scheme and the Civil Servant Medical Benefit Scheme (CSMBS) [13]. A relative weight (RW) was assigned to each Thai-DRG group, indicating the amount of resources used in treating patients in that group relative to the reference group. For the insured patients under Thai health security schemes, the RW was adjusted for a patient's length of stay (adj. RW) determined remuneration to the hospital for inpatient care.

Data analysis

After data checking and verification, the data were analyzed separately for the AE-positive group and the AE-negative group using descriptive statistics, including percentage, mean and standard deviation. For comparability across patients, the costs of medical care of the patients was standardized by dividing the hospital-charge figures with their corresponding Thai-DRGs adj. RW values. As each Thai-DRG group assumed a similar level of resources, any significant difference in cost per adj. RW between the AE-positive and AE-negative groups would indicate increased burden. Multiple linear regression models were deployed to control for possible confounders. Possible interaction or effect modification between covariate predictors were explored, and then excluded from the model unless significant effects were found. Because the distributions of model residuals were left-skewed, bootstrapping was applied for estimating standard errors and confidence intervals of the model coefficients. All analyses were conducted using STATA software, version 11.0.

Results

Certain differences regarding personal and clinical characteristics were identified between the AE-positive group and the AE-negative group (**Table 1**). The AE-positive group tended to be in the older age groups, paid by insurance, more likely to be admitted from the emergency department and less likely from the outpatient department, and be surgical cases.

Bivariate comparisons of the key, outcome-related variables between the AE-positive group and the AE-negative group can be found in **Table 2**, including average adjusted case-mix indices based on Thai-DRGs, average length of stay, average medical care costs per case, and standardized medical care costs per adjusted relative weight (adj. RW). The differences between the two groups were statistically significant for all of the variables. Compared with the AE-negative group, the AE-positive group had a much higher case-mix index (5.18 vs 1.96; $P < 0.001$) and longer average length of stay (17.40 vs 4.99; $P < 0.001$). The unstandardized hospital charges of the AE-positive group averaged at US $2,785.73 per case, more than 3.23 times the AE-negative figure ($P < 0.001$). After standardization with the case-mix Thai-DRGs adj. RW value, the mean medical cost of the AE-positive group was US$525.11 per adj. RW, whereas the mean cost of the AE-negative group was US $391.79 per adj. RW. For reference, the standard payment rate paid by the UC scheme during the study period was US $245.45 per adj. RW.

As we found significant bivariate analyses between the patient characteristics—except for sex—and the costs of medical care, a multiple regression model was then used to analyze the relationship between the standardized cost per adj. RW and the presence of adverse events. As shown in **Table 3**, after controlled for patient characteristics and clinical characteristics, the presence of AEs (AE-positive vs. AE-negative) was the only significant predictor of the standardized medical-care cost. The other covariates no longer showed significant association. Neither was there any potential effect modifier. The model estimated that, on average, patients with identified AEs in the AE-positive group would have significantly higher cost per adj. RW than those without AE in the AE-negative group (US $128.94; 95%confidence interval (CI) 30.65–227.23).

Table 1. Patient characteristics of the adverse event (AE)-positive and the AE-negative groups

Patient characteristics	Number (percentage) of patients		*P*[a]
	AE-positive group (n = 138)	AE-negative group (n = 436)	
Mean age (standard deviation)	42.6 (24.5)	33.2 (26.6)	<0.001[¶]
Age group			
New born–1 year	18 (13.0)	90 (20.1)	0.002*
1–25 years	14 (10.1)	85 (19.5)	
26–59 years	62 (44.9)	168 (38.5)	
60 years up	44 (31.9)	93 (21.3)	
Sex			
Male	42 (30.4)	180 (41.3)	0.023*
Female	96 (69.6)	256 (58.8)	
Type of admission			
Newborn	32 (23.2)	89 (20.4)	0.045*
Emergency	94 (68.1)	271 (62.2)	
Outpatient department	12 (8.7)	76 (17.4)	
Insurance status			
Pay out of pocket	43 (31.2)	208 (47.7)	0.001*
Pay by insurance	95 (68.8)	228 (52.3)	
Clinical characteristics			
Surgical	128 (92.8)	327 (75.0)	<0.001*
Nonsurgical	10 (7.3)	109 (25.0)	
Department			
Surgery	56 (40.6)	98 (22.5)	<0.001*
Obstetric	33 (23.9)	105 (24.1)	
Pediatric	22 (15.9)	126 (28.9)	
Internal medicine	18 (13.0)	95 (22.0)	
Orthopedic	9 (6.5)	12 (2.8)	

[a]Chi-square test, [¶]*t* test

Table 2. Bivariate analyses of adjusted Thai- diagnosis-related groups (DRGs) case-mix index, length of stay, medical care costs per case, and standardized medical care costs per relative weight adjusted for a patient's length of stay (adj. RW)

	Mean (standard error)		*P*[a]
	AE-positive group (n = 138)	AE-negative group (n = 436)	
Adjusted Thai-DRGs case-mix index	5.18 (0.62)	1.94 (0.16)	< 0.001*
Length of stay (days)	17.40 (2.24)	4.99 (0.38)	< 0.001*
Medical care cost per case (US$)	2,785.73 (417.46)	861.41 (203.00)	0.015*
Medical care costs per adj. RW (US$)	525.11 (44.93)	391.79 (27.10)	< 0.001*

[a] *t* test. The average reimbursement rate of the Universal Coverage scheme in 2009 was US$245.45 per adj. RW. AE = adverse event

Table 3. Multiple linear regression analysis of the standardized medical care cost per relative weight adjusted for a patient's length of stay (adj. RW) on the presence of adverse events (AE positive vs. AE negative) controlling for patient characteristics and clinical characteristics (n = 574)

Outcome variable Medical care cost per adj. RW	Coefficient estimate	Standard error	95% confidence interval
Presence of adverse events			
AE-negative group			ref
AE-positive group	128.94*	50.14	30.65, 227.23
Clinical characteristics			
Nonsurgical			ref
Surgical	–45.67	64.14	–171.38, 80.02
Department			
Pediatrics			ref
Surgery	194.10	165.16	–129.60, 517.81
Obstetrics and gynecology	168.76	130.22	–86.47, 423.98
Internal medicine	274.07	240.47	–198.24, 745.38
Orthopedics	98.86	137.60	–170.82, 368.56
Personal Characteristics			
Age group			
New born–1 year			ref
1–25 years	126.47	78.62	–27.63, 280.56
26–59 years	15.29	159.44	–297.21, 327.80
60 years up	125.34	184.39	–236.07, 486.74
Sex			
Male			ref
Female	–44.16	50.34	–142.82, 54.51
Type of admission			
Newborn			ref
Emergency	57.96	79.39	–97.63, 213.56
Outpatient department	–33.46	67.44	–165.66, 98.72
Insurance status			
Pay out of pocket			ref
Pay by insurance	134.71	2380.86	–4531.68, 4801.10

With the average Thai-DRGs case-mix index of 2.70, the average incremental cost of an adverse event for this particular hospital would be approximately US $734.64 per case. Based on our sample, the highest estimate would be among inpatients of the Department of Internal Medicine (US $973.11 per case), followed by those of the Department of Surgery (US $941.68 per case).

Discussion

The major findings of this study were not only the demonstration of the higher cost of medical care as a result of AEs, but also the evidence that the cost of AEs was uncompensated under the case-based payment based on Thai-DRGs. In the study-site hospital, an AE could result in an average increased amount of US $128.94 per adj. RW of Thai-DRG in treatment cost. The use of relative cost (cost per adj. RW) assumed increased cost by AEs could vary with patient severity as measured by Thai-DRGs. A subgroup analysis indicated that patients with 3 events in one admission could cost US $2,068 more than those with only one event. In addition, our findings were consistent with those in British hospitals in which the average cost was highest in internal medicine. However, events related to medication safety were only 26.8%, by contrast with studies from developed countries, such as by Levinson et al. [14], which usually found medication-related events predominated.

The increased cost could be a result of additional hospital stay and medical treatment. We found that AEs, on average, increased patients' length of stay by 12.4 days, in line with previous studies (8.5–13.1 days) [1, 15, 16]. Managing AEs might also require antibiotics, blood transfusion, or interventions. For example, in managing an AE found in one of the patients with ventral hernia without obstruction or gangrene, the patient needed computed tomography of the whole abdomen, antibiotics, medication for pain, and an exploratory laparotomy with a repair of a perforated bowel. Unfortunately, our data could not provide adequate details on which type of AEs in which groups of patient would cost more or less. A future study is recommended to determine these factors. Nevertheless, avoiding AEs would reduce hospital stays, along with the costs [17]. Saving the hospital bed-days also indirectly helped decrease the need for expanding hospital beds and free more beds for the hospital to accept patient referrals — the key role of public tertiary-care medical centers in Thailand.

Our regression model also showed that adverse events, when occurred, might have bigger impacts on cost of care than other patient and clinical factors. We hypothesize that once AEs were taken into account, they dominated other patient and clinical characteristics in determining patients' length of stay and costs of treatment for those particular hospital stays. Patients with adverse events, on average, would cost an extra 52.5% of the paid amount per one adj. RW set by the Thai National Health Security Office at US $245.45.

More importantly, as we had hypothesized, AEs in this hospital led to uncompensated cost under the closed-ended payment mechanisms used by the Thai national health security schemes because AEs significantly increased the cost per adj. RW of Thai-DRGs. Thus, for this particular tertiary-care hospital with around 50,000 admissions a year with an average Thai-DRGs case-mix index of 2.71, we might expect the AE incidents to cost around US $4.2 million annually. Assuming that all admissions were paid under the UC scheme the hospital would get paid around US $33.3 million, avoiding half of the events [9] and would practically save the hospital a large sum of expenses (6.3% of the expected inpatient income). If we generalize our findings to regional tertiary-care public hospitals of the Ministry of Public Health, the AEs could cost up to 40.7% of their average unit cost of inpatient care (US $306.67 per adj. RW) [18]. This finding has a considerable implications for patient safety towards hospital financial sustainability under the prospective payment schemes, such as those used in the universal coverage (UC) scheme, or the 30-baht scheme, in Thailand.

Nevertheless, certain limitations of our study should be addressed. The use of hospital charges as proxies of actual costs to patient care might overestimate the actual cost. However, the study hospital is a not-for-profit institution, setting service charges with a very small range of margins. We were informed that some might even be below actual cost. In addition, the cost estimate was based on how costs associated with AEs were identified and how the regression model was formulated. It was possible that choosing different approaches might yield different numbers of cost estimates. However, there was no criterion standard [19]. We sampled a few AE-positive cases from our sample for detailed medical record review to identify specific activities or treatments for managing adverse events. On a case-by-case basis, there were quite considerable disagreements between

physician reviewers on what services and medical items were attributable to adverse events. These discrepancies require another systematic study for clarification. We also realized that certain costs of AEs might by incurred after patient discharge, which could be accounted for [20]. Furthermore, we did not include any damage liability paid to patients, if any. Lastly, it might be difficult to generalize the result to estimate the cost of AEs nationwide. Owing to the higher patient severity in a tertiary-care setting, we anticipated that AEs in our study cost more than those occurring in general or community hospitals. Generalizing our cost figure might overestimate the overall national cost.

Conclusions

Patient safety has implications beyond effects on health and welfare of patients. Unsafe care can post significant financial burden on providers, particularly when a health system applies close-ended prospective payment mechanisms. We recommend patient safety programs in developing countries not only to improve the quality of care, but also to increase financial sustainability of healthcare providers and, thus, health coverage or insurance programs.

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Conflict of interest statement

The authors declare that there is no conflict of interest in this research.

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