Costs of Hospitalizations with a Primary Diagnosis of Acute Myocardial Infarction Among Patients Aged 18-64 Years in the United States

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1. Introduction

Acute Myocardial Infarction (AMI) is both a common and deadly type of cardiac event in the United States. Although the age-adjusted hospitalization rate for AMI and its in-hospital case fatality rates have both declined since the mid-1990s, there were still 634,000 inpatient admissions in 2009 for which AMI was listed as the primary diagnosis [1, 2]. Moreover, Americans suffered an estimated 610,000 first-time AMIs and 325,000 recurrent attacks, and 133,958 deaths in 2008 [2]. Because the declines in hospitalization and in-hospital mortality rates have been associated with more aggressive therapeutic interventions [1], it is important to evaluate the cost-effectiveness of these interventions.

To evaluate specifically the cost-effectiveness of various interventions against AMI, direct cost estimates of AMI are required [3-5]. Surprisingly, however, these cost estimates have not been comprehensively examined in the U.S. Many studies have investigated the economic burden of AMI, but all had some limitations [6-17]. Furthermore, in part because of limitations in available studies, the costs of coronary heart disease (CHD) were used in one study to represent the costs for AMI [6], albeit this is inappropriate. For example, a previous study of insured adults aged 18-64 years found that only about 30% of CHD cases represented AMI [9]. Moreover, the American Heart Association recently estimated that the total prevalence of CHD among persons aged ≥20 years was 7% but the AMI prevalence of AMI in this group was 3.1% [2]. In addition, in 2005, hospitalization costs for AMI admissions among adults aged 18-64 years were about $5000 more than those for CHD admissions of non-AMI [9]. Clearly, information on costs that does not clearly distinguish between AMI and non-AMI admissions is of little use in evaluating the cost-effectiveness of interventions to treat AMI [18].

In the present study we estimated AMI-specific costs by exploring the hospitalization costs of AMI while incorporating the impacts on costs of percutaneous coronary intervention (PCI), coronary artery bypass graft (CABG) surgery, comorbidities, complications, ST-elevation status, and length of stay (LOS) while controlling for age, sex, geographic regions, and urban versus non-urban location. Because PCI, CABG surgery, and LOS are likely to be the most influential factors on the costs and relevant factors for evaluating cost-effectiveness of AMI interventions, we also conducted multivariate logistic regressions to identify the factors predicting PCI, CABG surgery, and LOS.

2. Methods

2.1. Data source

The 2006-2008 MarketScan Commercial Claims and Encounter inpatient database was used for this study; this database contains information on patients up to age 64 years from approximately 40 privately insured employers, including state governments, with an average of nearly 21 million covered lives per year. In 2006-2008 the database had more than 2.4 billion service records representing commercially insured employees, qualified retirees and dependents from over 100 geographically diverse health insurance plans in all 50 U.S. states and the District of Columbia. The advantages of using the MarketScan database for economic studies include the large sample, detailed diagnosis codes for medical services, and hospitalization costs that are based on payment to providers [19]. Many researchers have used the MarketScan database to investigate medical costs associated with cardiovascular disease [9, 20, 21]

Using the International Classification of Diseases, 9th revision (ICD-9) codes, we identified hospitalizations with a primary diagnosis of AMI among patients aged 18-64 years who were enrolled in non-capitated health insurance plans. We further separated the hospitalizations into ST-elevated myocardial infarction (STEMI) and non-ST-elevated myocardial infarction (NSTEMI) cases. Based on secondary diagnosis codes, we identified major comorbidities, complications, and procedures for these hospitalizations (Table 1).

We excluded patients younger than 18 years because AMI is very uncommon in that group. We did not include patients in capitated health insurance plans because their costs of hospitalization would not reflect the medical services provided to them. We excluded hospitalizations with a LOS greater than 30 days because we determined that these hospitalizations (n=131, figure 1) would skew our results. To further limit the influence of extreme values on the cost estimates, we excluded all hospitalizations with a cost in the lowest or highest 1% of values (Figure 1). The costs in our study included all those for physician services, diagnostic tests, therapeutics, supplies, and room fees during the hospitalizations. These costs, as noted above, represented total payment to providers rather than hospital charges. Accordingly, we did not need to adjust charges into payments to reflect the true economic burden of hospitalizations, nor did we use unit cost per bed day or an expert panel's suggested cost as in many other studies [5, 11, 7, 22, 23]. We expressed the costs in 2008 dollars by adjusting the 2006 and 2007 value by the consumer price index (CPI) provided by the Bureau of Labor Statistics [24].

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AMI, comorbidity, complication, or procedure	ICD-9 or CPT-4 code
AMI STEMI NSTEMI	410.xx 410.01, 410.11. 410.21. 410.31 410.71
Congestive heart failure	402.01, 402.11, 402.91, 404.01, 404.03,404.11, 404.13, 404.91, 404.93,428.xx
Hypertension	401.xx-405.xx
Diabetes	250.xx
Hyperlipidemia	272.xx
Kidney disease	403.xx, 404.xx, 582.xx, 583.xx, 585.xx, 586.xx, 587.xx
Stroke	430.xx-438.xx
Cardiogenic shock	785.51
Ventricular tachycardia	427.1
Ventricular fibrillation	427.41, 427.42
Atrial tachycardia	427.0
Atrial fibrillation	427.31, 427.32
PCI	92980-92982, 92984, 92995, 92996, 00.66, 36.01-36.09
CABG surgery	33510-33519, 33521-33523, 33533-33536, 36.10-36.19

AMI: Acute myocardial infarction.

ICD-9: International classification of disease, 9th revision.

CPT-4: Current procedural terminology, 4th revision.

STEMI: ST-elevated myocardial infarction.

NSTEMI: Non-ST-elevated myocardial infarction.

PCI: Percutaneous coronary intervention.

CABG: Coronary artery bypass graft.

Table 1. Diagnostic codes for acute myocardial infarction (AMI) and selected comorbidities and procedures

2.2. Statistical analysis

After deriving the sample means of the costs for different population groups, AMI types, comorbidities, complications, and procedures, we specified various versions of multivariate regression models to examine the factors influencing the costs while controlling for demographic variables and Charlson comorbidity index (CCI) [25]. We used CCI as a comprehensive measure of disease severity. It measures the likelihood of death or serious disability in the subsequent year by diagnosis codes of up to 18 different diseases. In addition to estimating the various versions of regression for the whole study sample, we ran a regression on the costs for STEMI and NSTEMI patients separately. Because PCI, CABG surgery and LOS were major factors determining the costs, we used logistic regression to investigate the predictors of these three factors. For the regression estimation, we used mixed-effects models with a repeated measures approach to account for the fact that a single patient might have multiple admissions during the 3-year period. All tests of statistical significance were 2-tailed, and a p<0.001 was considered significant. All statistical analyses were performed using SAS version 9.1 [26].

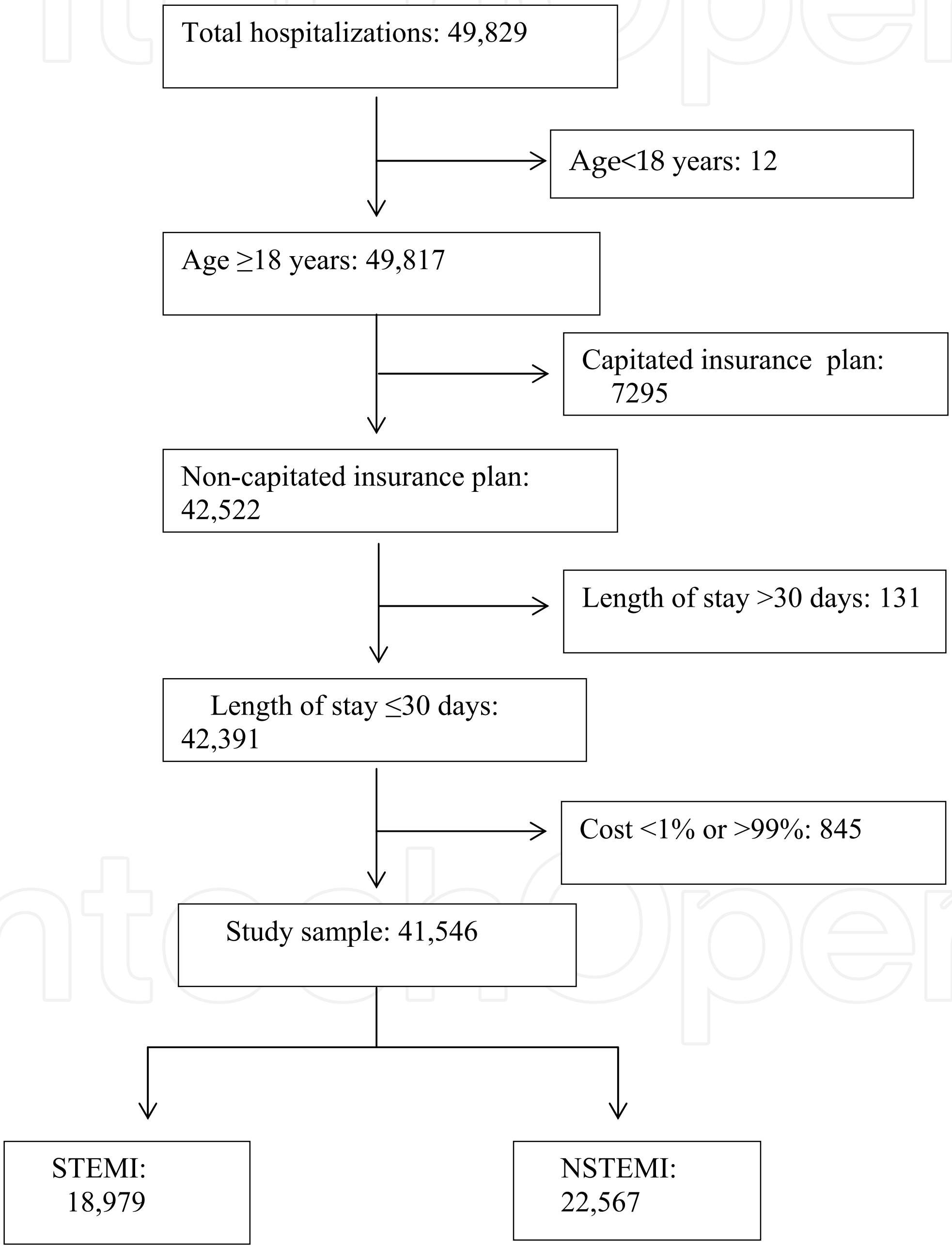

Figure 1. Diagram showing how the study sample was selected from all patients with a primary diagnosis of AMI in the 2006-2008 MarketScan Commercial Claims and Encounters inpatient database. STEMI: ST-elevated myocardial infarction. NSTEMI: non-ST-elevated myocardial infarction.

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		N	Mean costs (± SD)
Total sample		41,546	29,840.2 ± 22,900.6
Age group (year)			
	18-44	4671	27,537.1 ± 20,693.3
	45-54	13,991	29,661.7 ± 22,073.7
	55-64	22,884	30,419.4 ± 23,778.6
Sex			
	Female	10,874	27,102.7 ± 22,110.1
	Male	30,672	30,810.7 ± 23,096.9
MSA			
	Yes	31,511	29,639.3 ± 22,661.9
	No	10,035	30,471.0 ± 23,624.5
Region			
	Northeast	3296	27,623.5 ± 22,012.1
	North Central	13,051	29,452.9 ± 21,927.1
	South	20,992	29, 637.4 ± 23,020.8
	West	4207	33,790.2 ± 25,373.3
AMI type			
	STEMI	18,979	32,030.3 ± 22,282.8
	NSTEMI	22,567	27,998.3 ± 23,248.8
Hypertension			
	Yes	16,020	29,403.5 ± 21,868.0
	No	25,526	30,114.3 ± 23,521.8
Congestive Heart Failure			
	Yes	4813	36,758.5 ± 29,163.4
	No	36,733	28,933.7 ± 21,786.3
Cancer			
	Yes	551	29,024.5 ± 23,356.1
	No	40,995	29,851.2 ± 22,894.5
Hyperlipidemia			
	Yes	14,075	29,375.3 ± 20,655.4
	No	27,471	30,078.4 ± 23,966.5
Peripheral vascular disease			
	Yes	296	34,324.6 ± 26,393.2

		N	Mean costs (± SD)
	No	41,250	29,808.0 ± 22,870.8
Diabetes			
	Yes	7367	31,917.7 ± 24,735.0
	No	34,179	29,392.4 ± 22,460.8
Obesity			
	Yes	2944	28,862.3 ± 21,845.5
	No	38,602	29,914.8 ± 22,977.6
Stroke			
	Yes	1739	42,133.5 ± 30,090.3
	No	39,807	29,303.2 ± 22,381.4
Kidney disease			
	Yes	1584	33,499.2 ± 27,595.5
	No	39,962	29,695.2 ± 22,682.8
PCI			
	Yes	27,062	30,960.8 ± 19,564.6
	No	14,484	27,746.5 ± 27,972.1
CABG			
	Yes	3879	63,105.9 ± 26,886.0
	No	37,667	26,414.5 ± 19,450.5
Cardiogenic shock			
	Yes	1135	53,016.1 ± 32,754.6
	No	40,411	29,189.3 ± 22,216.0
Ventricular tachycardia			
	Yes	2170	37,306.5 ± 27,619.9
	No	39,376	29,428.7 ± 22,540.5
Atrial tachycardia			
	Yes	299	29,365.2 ± 25,149.5
	No	41,247	29,843.6 ± 22,883.8
Ventricular fibrillation			
	Yes	1286	43,165.1 ± 29,468.8
	No	40,260	29,414.6 ± 22,530.4
Atrial fibrillation			
	Yes	1975	38,109.7 ± 28,974.3

		N	Mean costs (± SD)
	No	39,571	29,427.5 ± 22,475.5
Charlson comorbidity index		41,456	1.55 ± 1.39
Length of stay (days)		41,456	4.66 ± 3.16

MSA: Metropolitan statistical area (resided in).

AMI: Acute myocardial infarction.

STEMI: ST-elevated myocardial infarction.

NSTEMI: Non-ST-elevated myocardial infarction.

PCI: Percutaneous coronary intervention.

CABG: Coronary artery bypass graft.

Table 2. Sample characteristics and mean costs (ages 18-64 years), 2006-2008 MarketScan inpatient database

3. Results

During 2006-2008, there were 41,546 hospitalizations with a primary diagnosis of AMI; their mean cost was $29,840 (± 22,901) (Table 2). Mean cost increased with age, but just marginally. Male patients cost more than female patients ($30,811 vs. $27,103, p<0.001), and the cost of STEMI exceeded that of NSTEMI ($32,030 vs. 27,998, p<0.001). Major comorbidities that increased the cost were stroke, heart failure, peripheral vascular disease, kidney disease, and diabetes. All of the complications except atrial tachycardia increased the cost greatly. Hospitalizations in which CABG surgery was performed cost a mean of $63,106, more than twice as high as the mean of $26,415 for those without CABG surgery. PCI increased the cost marginally.

The regression results indicated that age influenced the cost marginally after controlling for procedures, comorbidities, complications, LOS, and ST-elevation status, as well as other demographic variables (Model 6, Table 3). Hospitalizations of male patients had about $3350-$4000 higher costs than those of their female counterparts in Model 1-4, but the differences by sex dropped to $1437 when all the procedures and complications were considered (Model 6). The cost in the West was $5608 to $6530 higher than in any other regions in the fully adjusted model. The cost of hospitalization for STEMI was higher than that for NSTEMI, but the difference decreased from about $3776 (model 2) to $1003 with adjustment for all of the comorbidities, LOS, procedures, and complication (Model 6). CCI increased the cost by $2362 (Model 3), but this increase largely disappeared after adding the LOS, procedures, and complications (Model 6). Longer LOS increased the cost by about $2941 (p<0.001) per day (Model 6). After controlling for all other factors, PCI increased the cost by about $12,546, and CABG surgery increased the cost by about $28,406. These two procedures were the biggest factors influencing the cost of AMI hospitalizations. Complications increased the cost by $4669 in the fully adjusted model.

Independent variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	STEMI	NSTEMI
Age								
18-44 vs. 55-64	-2895.2 ±366.3 (<. 0001)	-3068.7 ±365.2 (<0.0001)	2278.4 ±362.4 (<0.0001)	64.9 ±307.7 (0.8329)	643.8 ±282.1 (0.0225)	808.3 ±281.0 (0.0040)	554.9 ± 420.3 (0.1868)	955.6 ±376.9 (0.0112)
45-54 vs. 55-64	-848.5 ±244.7 (0.0005)	-1024.1 ±244.13 (<0.0001)	564.5 ±242.1 (0.0197)	998.0 ±205.6 (<0.0001)	722.3 ±188.5 (0.0001)	817.3 ±187.8 (<0.0001)	502.8 ±283.7 (0.0763)	1069.4 ±249.6 (<0.0001)
Male	3720.4 ±254.5 (<0.0001)	3356.3 ±254.5 (<0.0001)	3804.2 ±252.4 (<0.0001)	3995.7 ±213.9 (<0.0001)	1574.6 ±198.0 (<0.0001)	1437.1 ±197.3 (<0.0001)	1046.8 ±316.9 (<0.0001)	1428.8 ±250.0 (<0.0001)
MSA	-829.5 ±262.0 (0.0015)	-834.6 ±261.1 (0.0014)	-805.1 ±258.5 (0.0018)	-1060.3 ±219.0 (<0.0001)	-1224.5 ±201.0 (<0.0001)	-1213.0 ±200.1 (<0.0001)	-1495.5 ±306.2 (<0.0001)	-903.1 ±263.2 (0.0006)
Region								
Northeast vs. West	-6009.0 ± 530.3 (<0.0001)	-5843.0 ±528.6 (<0.0001)	-6190.7 ±523.4 (<0.0001)	-7760.0 ±443.7 (<0.0001)	-6469.4 ±406.9 (<0.0001)	-6529.9 ±405.2 (<0.0001)	-7584.1 ±603.2 (<0.0001)	-5640.7 ± 546.4 (<0.0001)
North Central vs. West	-4235.0 ±404.0 (<0.0001)	-4045.4 ±402.8 (<0.0001)	-4349.7 ±398.8 (<0.0001)	-5570.7 ±338.1 (<0.0001)	-5693.6 ±309.9 (<0.0001)	-5735.1 ±308.6 (<0.0001)	-5444.2 ±454.0 (<0.0001)	-5894.0 ±420.8 (<0.0001)
South vs. West	-3980.0 ±385.3 (<0.0001)	-3771.9 ±384.2 (<0.0001)	-4291.2 ±380.7 (<0.0001)	-5985.3 ±322.9 (<0.0001)	-5561.9 ±296.0 (<0.0001)	-5608.2 ±294.8 (<0.0001)	-5959.2 ±431.8 (<0.0001)	-5266.7 ±403.3 (<0.0001)
STEMI	---	3775.6 ±224.8 (<0.0001)	4116.3 ±222.8 (<0.0001)	3654.9 ±188.9 (<0.0001)	1335.6 ±182.3 (<0.0001)	1002.8 ±182.4 (<0.0001)	---	---
Charlson comorbidity index	---	---	2361.8 ±80.3 (<0.0001)	-257.9 ±71.0 (0.0003)	169.1 ±65.3 (0.0085)	169.7 ±65.0 (0.0091)	361.6 ±11067 (0.0011)	80.9 ±79.5 (0.3091)
Length of stay	---	---	---	3974.8 ±31.1 (<0.0001)	3044.0 ±32.3 (<0.0001)	2940.7 ±32.6 (<0.0001)	3061.7 ±51.6 (<0.0001)	2865.5 ± 41.8 (<0.0001)
PCI	---	---	---	---	12490.0 ±204.5 (<0.0001)	12546.1 ±203.7 (<0.0001)	10169.0 ±366.5 (<0.0001)	13657.1 ±241.1 (<0.0001)

CABG	---	---	---	---	28189.4 ±352.7 (<0.0001)	28405.6 ±351.5 (<0.0001)	26476.2 ±599.8 (<0.0001)	29395.9 ±431.8 (<0.0001)
Complications	---	---	---	---	---	4669.1 ±252.5 (<0.0001)	4803.8 ±350.6 (<0.0001)	4498.8 ±368.0 (<0.0001)

Model 1: Age, sex, MSA, and region;

Model 2: Model 1 + STEMI;

Model 3: Model 2 + comorbidities;

Model 4: Model 3 + length of stay;

Model 5: Model 4 + PCI, CABG surgery;

Model 6: Model 5 + complications;

MSA: Metropolitan statistical area (resided in).

STEMI: ST-elevated myocardial infarction.

NSTEMI: Non-ST-elevated myocardial infarction.

PCI: Percutaneous coronary intervention.

CABG: Coronary artery bypass graft.

Table 3. Coefficient estimates of hospitalization costs for patients with acute myocardial infarction

PCI and CABG surgery increased the cost for both the STEMI and NSTEMI groups, with both procedures increasing the cost more for the NSTEMI group than for STEMI. LOS, in contrast, increased the cost more for the STEMI than the NSTEMI group, while living in an urban area (MSA in Table 3) decreased cost by $1496 for STEMI and $903 for NSTEMI.

Logistic regression indicated that patients aged 18-44 years were less likely than those aged 55-64 to undergo PCI or to have CABG surgery, and they were more likely to have a shorter LOS (i.e., <5 days) (Table 4). Patients in urban area were more likely to have PCI, but less likely to have CABG. Men were more likely to undergo PCI or to have CABG surgery than were women, but their odd of a short LOS was greater. Versus patients who did not live in urban areas, urban patients were more likely to have PCI, but they were less likely to undergo CABG surgery. Compared with patients in the West, patients in other regions were more likely to have a long LOS (i.e., ≥5 days), but they were usually less likely to have PCI and CABG surgery, with PCI in the North Central region the exception. STEMI patients were more likely than NSTEMI patients to undergo PCI and CABG surgery, and they were more likely to have a long LOS. Patients with comorbidities or complications were more likely to have a long LOS, but they were less likely to have PCI or CABG surgery. Patients undergoing PCI were more likely to have a short LOS, while patients undergoing CABG surgery were far more likely to have a long LOS.

Independent variable	PCI (yes vs. no)	CABG (yes vs. no)	Length of stay (<5 vs. ≥5)
Age 18-44 vs. 55-64 years	0.877 (0.814, 0.944)	0.718 (0.616, 0.836)	0.706 (0.651, 0.765)
Age 45-54 vs. 55-64 years	1.170 (1.112, 1.232)	1.010 (0.921, 1.107)	0.807 (0.767, 0.851)
Male	1.813 (1.724, 1.907)	2.776 (2.502, 3.081)	0.760 (0.721, 0.801)
MSA	1.249 (1.184, 1.317)	0.905 (0.824, 0.995)	1.044 (0.988, 1.104)
Region			
Northeast vs. West	0.792 (0.711, 0.884)	0.488 (0.391, 0.608)	1.560 (1.392, 1.747)
North Central vs. West	1.153 (1.059, 1.256)	0.969 (0.830, 1.132)	1.267 (1.158, 1.387)
South vs. West	0.884 (0.815, 0.959)	0.934 (0.806, 1.081)	1.486 (1.364, 1.620)
STEMI vs. NSTEMI	4.514 (4.293, 4.746)	1.337 (1.219, 1.467)	1.333 (1.267, 1.402)
Charlson comorbidity index	0.890 (0.876, 0.905)	0.887 (0.862, 0.913)	1.432 (1.408, 1.457)
Length of stay (days)	0.981 (0.973, 0.990)	1.405 (1.388, 1.422)	---
PCI	---	0.060 (0.053, 0.067)	0.819 (0.776, 0.866)
CABG	0.062 (0.056, 0.069)	---	47.992 (41.288, 55.785)
Complications	0.894 (0.834, 0.959)	0.863 (0.771, 0.966)	2.621 (2.460, 2.793)

PCI: Percutaneous coronary intervention.

CABG: Coronary artery bypass graft.

MSA: Metropolitan statistical area (resided in).

STEMI: ST-elevated myocardial infarction.

NSTEMI: Non-ST-elevated myocardial infarction.

Table 4. Coefficient estimates of logistic regression of PCI, CABG, and length of stay

4. Discussion

The large number of hospitalizations in our economic study of inpatients who had suffered an AMI enabled us to explore a variety of factors that influenced their costs. The results suggest that CABG and PCI are the biggest drivers of hospital costs for AMI patients, adding, respectively, $12,546 and $28,406 to the cost of a stay. The cost effects of PCI and CABG in our study were comparable to the $15,089 and $28,974 additional costs, respectively, found in a Medicare population [7]. Another study reported similar costs for PCI and CABG [17]. In an earlier study using MarketScan data from 2003 to 2006, Zhao and Winget found that the total hospitalization costs of PCI and CABG surgery patient costs were, respectively,

$31,379 and $63,909 [10]. Unfortunately, Zhao and Winget did not explore the effects of PCI and CABG on the costs of stay, as we did in our study. Such information is needed to evaluate the cost-effectiveness of AMI interventions [4].

Two other significant drivers of cost in our study were complications and LOS. Having one or more complications increased the cost by over $4600, and LOS increased the cost by over $2900 per day. LOS was highly correlated with CABG surgery and with complications, as indicated in our logistic models (Table 4). Thus, interventions aiming to prevent or better manage the complications of AMI patients might be cost-effective in reducing the hospitalization costs of this group.

Hospitalizations with STEMI had, on average, higher costs than NSTEMI hospitalizations, but after including PCI and CABG surgery as well as complications, comorbidities, and LOS in the regression model, the magnitude of the effect became much smaller. This may be because of differences in treatment approaches and in complications between the two kinds of hospitalizations. For example, over 80% of STEMI hospitalizations had a PCI while only about 51% in the NSTEMI group did. However, the NSTEMI group had a higher rate of CABG surgery than did STEMI (12% vs. 8%) (not shown in tables). On the other hand, compared with NSTEMI cases, the STEMI group had a higher rate of cardiogenic shock, ventricular tachycardia, and ventricular fibrillation, but it had a lower rate of heart failure, atrial tachycardia, and atrial fibrillation. All of these factors would affect the cost differences between STEMI and NSTEMI hospitalizations. The fact that STEMI cost more than NSTEMI was consistent with the literature; in Mexico, for example, STEMI cost nearly $2800 more than NSTEMI [11].

The predictors of PCI, CABG surgery, and LOS that we set forward in this study provide important information for secondary cost-effectiveness analyses of AMI interventions. We found that male patients were more likely than females to have PCI and CABG surgery, but their odds of a shorter LOS (<5 days) were greater. STEMI status greatly increased the probability of having PCI (coefficient estimate of 4.514) and significantly increased the probability of CABG surgery (coefficient estimate of 1.337), and it was associated with greater odds of a longer LOS (≥5 days). Patients with comorbidities and complications were relatively less likely to undergo PCI and CABG surgery, but they were more likely to have a longer LOS. All of these results could be used as inputs in cost-effectiveness evaluations of AMI interventions.

The numerous strengths of this study notwithstanding, several limitations should be considered when interpreting our results. First, all of our patients were covered by non-capitated private insurance plans. Although the costs of these patients accurately reflect the true economic burden imposed by their hospitalizations, the special population may have limited the generalizability of our results to the broader U.S. population. Second, all of our patients were 18-64 years old. The elderly population (aged >64 years) has much higher incidence and prevalence of AMI and its related comorbidities and complications [1, 2]; as a consequence, the total costs of AMI should be higher in this population than among those 18-64. Although many studies have focused on the cost of AMI among the elderly [4, 5, 8], new estimation methods are needed along with high-quality data to develop better cost estimates for this population. Unfortunately, our data would not be appropriate for an analysis of costs among the elderly population for AMI hospitalization. A third limitation is that we estimated the costs of hospitalizations only. With survival rates increasing because of advances in technology [1], AMI patients are living longer. Correspondingly, the lifetime costs of outpatient care and medications for afflicted patients should be increasing. Additionally, productivity losses from the morbidity and premature mortality associated with AMI are also high [10] and should be considered in any comprehensive economic evaluations.

Given all of these factors, the hospitalization costs presented in our report should be treated as a conservative estimate of the economic burden associated with AMI. Moreover, we should note the limitation that we analyzed the costs of hospitalizations with AMI as a *primary* diagnosis. Although this decision let us cover the majority of AMI cases, there may be substantial additional hospitalizations in which AMI is a secondary diagnosis [9]. These hospitalizations should certainly be included in any complete analysis of the costs of hospitalizations of AMI patients. Because examining the costs of AMI as a secondary diagnosis would require a different analytical framework from the one we used, it would have been beyond the scope of our analysis.

5. Conclusion

Using a large set of claims data, we estimated the hospitalization costs of patients with a primary diagnosis of AMI and identified the main cost drivers of this important problem. Because most previous studies did not provide any information on the predictors of the costs of AMI hospitalizations [27], we hope that the present study has to some degree filled this gap in the literature. The high costs of AMI could be an economic justification for policy makers to support efforts to prevent AMI. In addition, the detailed information presented herein about the impact of various factors on the costs, procedures, and LOS associated with hospitalizations having a primary diagnosis of AMI can be used to evaluate and support health economic research such as studies on the cost-effectiveness of interventions to control this problem.

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References

[1] Fang J, Alderman MH, Keenan NL, Ayala C. Acute myocardial infarction hospitalization in the United States, 1979 to 2005. Am J Med 2010; 123: 259-66.

[2] American Heart Association. Heart disease and stroke statistics – 2012 update: a report from the American Heart Association. Circulation 2012; 125: e2-e220.

[3] Ioannides-Demos LL, Makarounas-Kirchmann K, Ashton E, Stoelwinder J, McNeil JJ. Cost of myocardial infarction to the Australian community: a prospective, mutlticentre survey. Clin Drug Investig 2010; 30: 533-43.

[4] Sloss EM, Wickstrom SL, McCaffrey DF, et al. Direct medical costs attributable to acute myocardial infarction and ischemic stroke in cohorts with atherosclerotic conditions. Cerebrovasc Dis 2004; 18: 8-15.

[5] Krumholz HM, Chen J, Murillo JE, Cohen DJ, Radford MJ. Clinical correlates of in-hospital costs for acute myocardial infarction in patients 65 years of age and older. Am Heart J 1998; 135: 523-31.

[6] Turpie AG. Burden of disease: medical and economic impact of acute coronary syndromes. Am J Manag Care 2006; 12: S430-4.

[7] Kugelmass AD, Cohen DJ, Brown PP, Simon AW, Becker ER, Culler SD. Hospital resources consumed in treating complications associated with percutaneous coronary interventions. Am J Cardiol 2006; 97: 322-7.

[8] Tiemann O. Variations in hospitalisation costs for acute myocardial infarction – a comparison across Europe. Health Econ 2008; 17: S33-45.

[9] Wang G, Zhang Z, Ayala C, Dunet D, Fang J. Inpatient costs associated with ischemic heart disease among adults aged 18-64 years in the United States. In: Lakshmanados U, Ed. Novel strategies in ischemic heart disease. Rijeka, Croatia: InTech 2012; pp. 319-32.

[10] Zhao Z, Winget M. Economic burden of illness of acute coronary syndromes: medical and productivity costs. BMC Health Serv Res 2011; 11: 35. http://www.biomedcentral.com/1472-6963/11/25.

[11] Reynales-Shigematsu LM, Campuzano-Rincon JC, Sesma-Vasquez S, et al. Costs of medical care for acute myocardial infarction attributable to tobacco consumption. Arch Med Res 2006; 37: 871-9.

[12] Eisenstein EL, Shaw LK, Anstrom KJ, et al. Assessing the clinical and economic burden of coronary artery disease: 1986-1998. Med Care 2001; 39: 824-35.

[13] Etemad LR, McCollam PL. Total first-year costs of acute coronary syndrome in a managed care setting. J Manag Care Pharm 2005; 11: 300-6.

[14] McCollam P, Etemad L. Cost of care for new-onset acute coronary syndrome patients who undergo coronary revascularization. J Invasive Cardiol 2005; 17: 307-11.

[15] Menzin J, Wygant G, Hauch O,Jackel J, Friedman M. One-year costs of ischemic heart disease among patients with acute coronary syndromes: findings from a multi-employer claims database. Curr Med Res Opin 2008; 24): 461-8.

[16] Russell MW, Huse DM, Drowns S, Hamel EC, Hartz SC. Direct medical costs of coronary artery disease in the United States. Am J Cardiol 1998; 81: 1110-5.

[17] Kauf TL, Velazquez EJ, Crosslin DR, et al. The cost of acute myocardial infarction in the new millennium: evidence from a multinational registry. Am Heart J 2006; 151: 206-12.

[18] Luengo-Fernandez R, Gray AM, Rothwell PM. Costs of stroke using patient-level data: a critical review of the literature. Stroke. 2009; 40: e18-23.

[19] Adamson DM, Chang S, Hansen LG. Health research data from the real world: the MarketScan database (white paper). 2008. Available from http://thomsonreuters.com. Requested May 2010.

[20] Wang G, Zhang Z, Ayala C. Hospitalization costs associated with hypertension as a secondary diagnosis among insured patients aged 18-64 years. Am J Hypertens 2010; 23: 275-81.

[21] Kahende JW, Woollery TA, Lee CW. Assessing medical expenditures on 4 smoking-related diseases, 1996-2001. Am J Health Behav 2007; 31: 601-11.

[22] Ringborg A, Yin DD, Martinel M, Stalhammar J, Linggren P. The impact of acute myocardial infarction and stroke on health care costs in patients with type 2 diabetes in Sweden. Eur J Cardiovasc Prev Rehabil 2009; 16: 576-82.

[23] Wang G, Dietz WH. Economic burden of obesity in youths aged 6 to 17 years: 1979-1999. Pediatrics 2002; 109: e81. http://www.pediatrics.org/cgi/content/full/109/5/e81.

[24] Bureau of Labor Statistics (BLS). Consumer price index (CPI). Available from ftp://ftp.bls.gov/pub/special.requests/cpi/cpiai.txt. Accessed March 16, 2012.

[25] Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and evaluation. J Chronic Dis 1987;40:373-383.

[26] SAS. SAS/STAT User's Guide. Cary NC: SAS Institute Inc.; 2007.

[27] Tarride JE, Lim M, DesMeules M, et al. A review of the cost of cardiovascular disease. Can J Cardiol 2009; 25: e195-202.