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Inpatient Costs Associated with Ischemic Heart Disease Among Adults Aged 18-64 Years in the United States

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1. Introduction

Ischemic heart disease (IHD) is both the most common and the most costly form of cardiovascular disease (CVD) in the United States (US).[1-2] In 2010, the estimated prevalence of IHD among American adults aged ≥20 years was 7.9% (9.1% in men and 7.0% in women),[1] and the aging of the US population should drive prevalence even higher in the future. Fortunately, the IHD death rate has declined in recent decades, but it remains the leading cause of hospital admissions and the single largest killer of American men and women, causing 1 of every 6 deaths.[1-3] Not surprisingly, spending to treat IHD has increased more than 40% over the past 25 years.[4] For 2010, the total economic burden of IHD was estimated to be $177 billion, $96 billion in direct medical costs and $81 billion in indirect costs. Well over half of the direct costs ($57 billion) were for inpatient care.[1] Thus, information on the costs of hospitalizations involving IHD may be helpful in developing strategies to contain the growth in the disease's economic burden.

To date, researchers have used a variety of approaches in investigating the health care costs of IHD.[4-15] For example, in the US, Hodgson and Cohen used a prevalence-based approach to demonstrate that IHD accounted for just over one half of health care expenditures for heart disease in 1995 ($38.7 billion of $75.9 billion.)[5] Russell et al., using a variety of data sources and a Markov model, estimated incidence-based first-year treatment costs of IHD in the US for that same year at $5.54 billion.[6] More recently, Menzin and coworkers estimated the average cost (in 2005 dollars) of initial hospitalization for acute coronary syndromes to be $22,921, and their estimate for re-hospitalization for IHD was $28,637.[7] In other industrialized countries, the economic burden of IHD has also been very high. For example, in the United Kingdom (UK), Liu and associates estimated the total 1-year cost (1999) of IHD to be £7.06 billion, the highest of any disease in the UK. The total direct health care costs of IHD were £1.73 billion, of which £917 million (53%) was for inpatient care.[8] Unfortunately, these earlier studies either did not use detailed diagnostic codes for IHD, did not address diagnostic status and issues of comorbidity, or focused exclusively on older population. Thus, their results have limited implications for deciding how to allocate resources and, similarly, for evaluating the cost-effectiveness of prevention programs at the community level.

To address these gaps, we used a large administrative dataset to explore the cost of hospitalization for patients with IHD; to make this a valuable exercise we classified the

patients in several different ways by IHD diagnosis and also examined the apparent effects of sex, age, and a variety of comorbidities as well as 2 procedures. The estimated costs of hospitalization should provide some insights on why the inpatient costs of IHD have been so high and how the increases in costs can be contained.

2. Methods

The study population was selected from the 2005 MarketScan Commercial Claims and Encounters inpatient dataset, which contains over 1 million records for patients aged 64 or younger from self-insured employers, including state governments. The advantages of using data from MarketScan are the large samples, the detailed diagnostic codes for medical services, and the listings of hospitalization costs that are based on payment to providers.[16] The MarketScan dataset has been used by many other researchers investigating the health and economic burden of CVD.[7, 17-21]

Using codes from the International Classification of Diseases, 9th revision (ICD-9) (Table 1), we identified hospitalizations with a primary or secondary diagnosis of IHD among patients aged 18 to 64 years enrolled in non-capitated health insurance plans. We excluded patients younger than 18 because of the low prevalence of IHD in that age group. We excluded patients in capitated health insurance plans because their costs of hospitalization would not reflect the medical services provided to them. To limit the influence of extreme values for hospitalization costs we also excluded those hospitalizations with costs below the 1st or above the 99th percentile.

IHD Classification, Comorbidity, or Procedure	ICD-9 code
Ischemic heart disease, all	410.xx - 414.xx
Acute myocardial infarction Other coronary heart disease	410.xx 411.xx - 414.xx
Heart failure	40201, 40211, 40291, 40401, 40403, 40411, 40413, 40491, 40493, 4280, 4281, 4289, 42820, 42821, 42822, 42823, 42830, 42831, 42832, 42833, 42840, 42841, 42842, 42843
Stroke	430.xx - 438.xx
Diabetes	250.xx
Symptoms involving respiratory system and other chest symptoms	786.xx
Cardiac dysrhythmias	427.xx
Hypertension	401.xx, 402.xx, 403.xx, 404.xx, 405.xx
Hyperlipidemia	272.xx
Percutaneous coronary intervention	00.66, 36.01−36.09 plus CPT-4 codes 92980−92982, 92984, 92995, 92996
Coronary artery bypass graft	36.10−36.19 plus CPT-4 codes 33510−33519, 33521−33523, 33533−33536

IHD: ischemic heart disease; ICD-9, International Classification of Diseases, Ninth Revision; CPT: Current Procedural Terminology.

Table 1. Diagnostic codes for ischemic heart disease and selected comorbidities and procedures

For all the hospitalizations in the study we further identified whether the IHD was an acute myocardial infarction (AMI) or not (non-AMI). The comorbidities used for our analyses (expressed as diagnoses in Tables 2 and 3) were heart failure, stroke, diabetes, cardiac dysrhythmias, hypertension, hyperlipidemia, and symptoms involving the respiratory system and other chest symptoms. In addition to these health conditions, we identified hospitalizations with a percutaneous coronary intervention (PCI) or a coronary artery bypass graft (CABG) because these procedures were (and remain) quite expensive.

We analyzed the costs for 3 groups of hospitalizations: 1) those with either a primary or secondary diagnosis of IHD; 2) those with a primary diagnosis of IHD, including those in which there was also a secondary diagnosis of IHD; and 3) hospitalizations with a secondary diagnosis of IHD in which the primary diagnosis was not IHD. For each study sample, we calculated the costs by various diagnosis classifications in four subgroups: men, women, patients aged 18-44, and patients aged 45-64.

Hospitalization costs were considered to be total payments to providers rather than hospital charges to reflect the true economic burden of hospitalizations. In this study we included all costs for physician services, all diagnostic tests, therapeutics, supplies, and room fees.

For cost comparisons, we used the Wilcoxon 2-sample test for the analysis, and a Bonferroni correction to protect against inflation of the type I error rate due to multiple testing was made for costs. Significance was assumed when the 2-tailed probability value was <0.001. For the regression analysis, we used the PROC GLM (General linear model) procedure for the cost regression model and PROC GENMOD (General model) for logit estimation. The regression model was run for the 3 groups of hospitalizations previously defined: 1) those with either a primary or secondary diagnosis of IHD; 2) those with a primary diagnosis of IHD, including those in which there was also a secondary diagnosis of IHD; and 3) hospitalizations with a secondary diagnosis of IHD in which the primary diagnosis was not IHD. We also ran a logit regression for IHD as the primary diagnosis versus IHD as the secondary diagnosis. The logit model was used to investigate the factors potentially influencing the probability of having a primary diagnosis of IHD (versus a secondary diagnosis of IHD). All the statistical analyses were performed using SAS, version 9.2.

3. Results

Among the 63,864 cases of IHD we identified, 33,316 (52%) hospitalizations had a primary diagnosis of IHD and their average costs were $24,079, 30,548 cases (48%) had a secondary diagnosis of IHD (their primary diagnosis was not IHD) and their average costs were $16,113 (Table 2 and Table 3). In both of these major diagnostic status groups, the costs were higher for AMI than for non-AMI, higher for men than for women, and increased with age.

Overall, 31% (n=10,261) of the hospitalizations in which the primary diagnosis was IHD were AMI, with the costs averaging $27,507 (Table 2). This cost was $4,954 higher (p <0.001) than the average for non-AMI cases ($22,553). The cost differences between the AMI and non-AMI cases were similar among each of the 4 subgroups defined by sex or age. For both AMI and non-AMI cases the costs were $4.1-4.5 thousand higher in men than in women. Costs increased with age, but the increase was small for AMI cases.

Among the hospitalizations with a primary diagnosis of IHD, 82.5% also had a secondary diagnosis of IHD; 58.4% had symptoms involving the respiratory system and other chest

Classification (n)	Overall	Men	Women	Age 18-44	Age 45-64
Total IHD (33,316)	24,079.1 ± 19,774.6	25,371.8 ± 20,148.9	20,876.4 ± 18,429.6	22,373.6 ± 19,347.5	24,225.1 ± 19,804.2
AMI (10,261)	27,507.3 ± 21,055.9	28,622.0 ± 21,408.1	24,541.4 ± 19,788.9	27,109.1 ± 20,749.2	27,553.1 ± 21,091.6
Non-AMI (23,055)	22,553.4 ± 18,979.2	23,882.7 ± 19,364.1	19,360.6 ± 17,617.1	19,175.3 ± 17,641.6	22,799.9 ± 19,050.0
Secondary diagnosis					
IHD					
Yes (27,487)	25,466.0 ± 20,295.2	26,633.1 ± 20,632.7	22,447.6 ± 19,068.3	24,545.8 ± 20,043.0	25,543.1 ± 20,314.7
No (5,829)	17,539.4 ± 15,519.7	18,983.8 ± 16,039.6	14,587.4 ± 13,944.9	13,156.1 ± 12,387.1	17,951.6 ± 15,720.6
Symptoms involving respiratory system and other chest symptoms					
Yes (19,451)	23,249.7 ± 20,312.6	24,857.3 ±20,899.5	19,752.9 ± 18,498.7	21,626.4 ± 19,677.7	23,417.3 ± 20,370.2
No (13,865)	25,242.8 ± 18,933.7	26,030.3 ±19,126.0	22,869.1 ± 18,138.6	24,058.9 ± 18,482.5	25,315.9 ± 18,959.5
Cardiac dysrhythmias					
Yes (4,660)	31,259.1 ± 23,890.2	32,268.7 ± 23,850.7	27,535.7 ± 23,677.8	29,263.1 ± 24,127.4	31,408.3 ± 23,868.5
No (28,656)	22 911.5 ±18,763.8	24 112.0 ±19,130.5	20 105.5 ± 17,561.3	21 404.4 ±18,376.9	23 043.3 ± 18,791.9
Heart failure					
Yes (2,750)	32,076.2 ± 25,616.2	34,404.3 ± 26,437.6	27,593.4 ± 23,322.6	34,363.9 ± 27,188.6	31,961.8 ± 25,535.1
No (30,566)	23,359.7 ± 18,998.1	24,626.1 ± 19,352.8	20,145.6 ± 17,664.6	21,744.3 ± 18,641.8	23,503.3 ± 19,023.1
Stroke					
Yes (1,334)	34,977.5 ±25,870.1	37, 228.6 ± 26,078.1	29,721.0 ±24,619.4	34,306.5 ± 25,772.7	34,999.8 ± 25,883.0
No (31,982)	23,624.6 ± 19,346.5	24,886.1 ± 19,717.6	20,491.0 ± 18,015.1	22,175.0 ± 19,166.3	23,752.0 ± 19,357.4
Diabetes					
Yes (5,283)	28,342.2 ± 22,410.2	29,612.4 ±22,916.8	25,577.1 ± 21,008.3	25,607.7 ± 20,614.9	28,549.3 ± 22,528.7
No (28,033)	23,275.7 ± 19,131.9	24,608.7 ± 19,512.4	19,889.0 ± 17,683.9	21,840.1 ± 19,082.5	23,401.3 ± 19,131.4

Classification (n)	Overall	Men	Women	Age 18-44	Age 45-64
Hypertension					
Yes (10,841)	26,049.1 ± 20,883.6	27,513.0 ± 21,382.4	22,294.1 ± 19,041.5	24,166.9 ± 20,508.9	26,195.2 ± 20,906.3
No (22,475)	23,128.9 ± 19,144.9	24,323.8 ± 19,431.6	20, 217.1 ± 18,101.6	21,614.9 ± 18,788.9	23,264.4 ± 19,171.1
Hyperlipidemia					
Yes (8,723)	26,111.3 ± 19,182.2	27,800.9 ± 20,381.2	22,904.6 ± 18,464.6	24,855.3 ± 19,093.2	26 807.6 ± 20,133.8
No (24,593)	22,553.6 ± 18,495.0	24,429.9 ± 19,979.4	20,310.1 ± 18,381.1	21,275.2 ± 19,362.8	23,327.3 ± 19,609.2
PCI					
Yes (17,444)	24,596.8 ± 16,125.4	24,890.3 ± 16,309.2	23,22.9 ± 15,534.1	27,269.3 ± 17,312.0	24,379.3 ± 16,005.8
No (15,872)	23,510.2 ± 23,117.6	25,960.5 ± 24,012.0	18,472.8 ± 20,251.7	17,481.6 ± 20,031.4	24,054.4 ± 23,300.1
CABG					
Yes (5,472)	46,757.2 ± 21,858.9	46,801.0 ± 21,848.1	46,559.1 ± 21,907.8	49,378.4 ± 22,220.7	46,636.4 ± 21,836.7
No (27,844)	19,622.4 ± 15,907.8	20,601.9 ± 16,282.1	17,365.9 ± 14,765.9	19,646.0 ± 16,772.9	19,620.2 ± 15,824.7

Data are means expressed in U.S. dollars +/- standard deviation. N = 33,316. IHD: ischemic heart disease; AMI: acute myocardial infarction; PCI: percutaneous coronary intervention; CABG: coronary artery bypass graft surgery.

Table 2. Mean costs of hospitalizations for patients with primary diagnosis of ischemic heart disease, by sex and age

Classification (n)	Overall	Men	Women	Age 18-44	Age 45-64
Total IHD (30,548)	16,112.9 ± 19,735.1	17,016.6 ± 20,554.8	14,753.3 ± 18,350.6	13,059.5 ± 17,449.8	16,433.5 ± 19,933.1
AMI (2,435)	24,280.9 ± 27,298.5	24,866.8 ± 27,509.5	23,438.7 ± 26,983.7	20,211.1 ± 25,183.3	24,881.2 ± 27,551.5
Non-AMI (28,113)	15,405.4 ± 18,772.6	16,350.1 ± 19,710.1	13,978.4 ± 17,162.8	12,195.2 ± 16,060.8	15,731.2 ± 18,996.2
Primary diagnosis					
Symptoms involving respiratory system and other chest symptoms					
Yes (6,588)	7,452.3 ± 6,52.5	7,423.3 ± 6,381.5	7,481.9 ± 5,911.0	7,640.1 ± 7,002.4	7,413.2 ± 5,959.9
No (23,960)	18,494.2 ± 21,444.5	19,138.6 ± 21,956.6	17,410.1 ± 20,509.9	16,548.6 ± 20,928.1	18 649.0 ± 21,478.0

Classification (n)	Overall	Men	Women	Age 18-44	Age 45-64
Cardiac dysrhythmias					
Yes (1,840)	18,124.4 ± 22,317.4	18,717.3 ± 23,145.7	16,544.0 ± 19,877.5	15,102.2 ± 21,319.11	18,342.8 ± 22,377.9
No (28,708)	15,984.0 ± 19,551.4	16,882.8 ± 20,331.7	14,676.4 ± 18,279.2	12,968.3 ± 17,255.9	16,307.2 ± 19,754.6
Heart failure					
Yes (2,084)	21,762.3 ± 25,688.6	22,823.3 ± 26,615.2	19,739.4 ± 23,709.1	20,527.8 ±23,046.3	21,829.1 ± 25,827.5
No (28,464)	15,699.3 ± 19,162.2	16,549.2 ± 19,914.7	14,441.9 ± 17,918.3	12,773.7 ± 17,140.3	16,018.0 ±19,343.3
Stroke					
Yes (1,383)	15,425.7 ± 17,204.0	14,920.7 ± 16,102.0	16,309.3 ± 18,963.1	14,997.5 ± 16,269.7	15,443.5 ± 17,247.1
No (29,165)	16,145.5 ± 19,846.8	17,122.2 ± 20,748.6	14,686.4 ± 18,321.7	13,022.0 ± 17,472.3	16,483.5 ± 20,058.1
Diabetes					
Yes (559)	17,980.1 ± 23,291.7	18,973.5 ± 23,901.0	16,569.4 ± 22,373.6	14,960.6 ± 25,210.6	18,356.7 ± 23,040.6
No (29,989)	16,078.1 ± 19,661.5	16,981.0 ± 20,487.8	14,718.2 ± 18,263.6	13,018.0 ± 17,245.6	16,398.3 ± 19,870.5
Hypertension					
Yes (652)	13,559.3 ± 17,880.3	15,454.2 ± 20,077.9	11,010.1 ± 14,041.7	8,683.1 ± 6,657.4	14,090.1 ± 18,626.1
No (29,896)	16,168.6 ± 19,770.3	17,049.1 ± 20,563.9	14,840.6 ± 1,8 430.5	13,158.1 ± 17, 605.0	16,484.5 ± 19,957.8
Hyperlipidemia					
Yes (13)	20,917.9 ±19,047.4	24,389.9 ± 20,399.4	9344.7 ± 6,559.5	32,121.5 ± 34,424.1	18,880.9 ± 16,946.8
No (30,535)	16,110.9 ± 19,735.5	17,012.6 ± 20,554.7	14, 754.6 ±18 352.5	13,046.3 ± 17,436.9	16,432.6 ±19,934.4
PCI					
Yes (909)	28,966.3 ± 23,297.8	29,823.0 ± 23,887.1	27,286.4 ± 22,038.1	28,777.8 ± 23,750.8	28,980.8 ± 23,276.8
No (29,638)	15,718.7 ± 19,482.5	16,582.2 ± 20,291.8	14,429.7 ± 18,132.3	12,699.5 ± 17,115.9	16,038.4 ± 19,689.7
CABG					
Yes (402)	60,281.3 ± 29 757.2	59,987.2 ± 29,250.9	60,972.4 ± 31,028.9	51,054.4 ± 41, 641.3	60,764.4 ±28,996.5
No (30,146)	15,523.9 ± 18,882.0	16,345.9 ± 19,660.0	14,294.0 ± 17,583.1	12,795.9 ±16,884.6	15,12.4 ± 19,058.4

Data are means expressed in U.S. dollars +/- standard deviation. N = 30,548. IHD:ischemic heart disease; AMI: acute myocardial infarction; PCI: percutaneous coronary intervention; CABG: coronary artery bypass graft

Table 3. Mean costs of hospitalizations for patients with ischemic heart disease as a secondary but not a primary diagnosis, by sex and age

symptoms; 32.5%, hypertension; 26.2%, hyperlipidemia; 15.9%, diabetes; 14.0%, cardiac dysrhythmias; 8.3%, heart failure; and 4.0%, stroke (Table 2). All the co-morbidities except symptoms involving the respiratory system/chest were associated with increased inpatient costs. Among these 6 secondary diagnoses (comorbidities) the cost was the highest for stroke ($34,978) and lowest for hypertension ($26,049). This pattern held for the male and female groups and for those aged 45-64, but in the 18-44 group the cost for heart failure was marginally higher than that for stroke.

Overall, a hospitalization with PCI had a cost approximately $1,100 greater than one without that procedure, but there were large differences in cost between the PCI and "no PCI" groups for women and the younger age group (18-44). The costs of hospitalizations with CABG averaged $46,757, more than twice the average for stays without CABG ($19,622). This pattern held true for all groups delimited by sex or age.

Among hospitalizations with a secondary but not a primary diagnosis of IHD (Table 3), the mean cost was about $8,900 higher for an AMI stay ($24,281) than for a non-AMI hospitalization ($15,405). Similar patterns were seen for the 4 groups defined by sex or age, and the costs were higher for men and those aged 45-64 than for women and the younger group, respectively. Among the 8 subgroups defined by AMI status and either sex or age, the highest costs were $24,881(45-64, AMI) and $24,867 (men, AMI), and the lowest was $12,195 (18-44, non-AMI).

Overall, having a primary diagnosis of cardiac dysrhythmias, heart failure, or diabetes increased costs (Table 3), while primary diagnoses of hypertension, respiratory/chest symptoms, and stroke were associated with lower costs. Stroke, however, was associated with higher costs in women and the younger population. The cost of hospitalization with PCI averaged $28,966, almost twice the cost of cases without PCI ($15,719). Hospitalizations with CABG cost $60,281, essentially 4 times the cost of hospitalizations without CABG. The cost differences between CABG and no CABG were similar across all 4 groups defined by sex or age.

The regression analysis indicated that the cost of hospitalization increased significantly with age ($p = 0.01$ for age 18-39, $p < 0.001$ for age 40-54) for IHD as a secondary diagnosis, but analyses of IHD as either the primary or secondary diagnosis or as the primary diagnosis did not find a significant age gradient ($p > 0.01$) (Table 4). Costs were always higher for men than for women ($p < 0.001$), especially for hospitalizations with a primary diagnosis of IHD with a cost difference of $4,822. After controlling for age, sex, urbanization, geographic region, and the Charlson Comorbidity Index, the cost of hospitalizations with the primary diagnosis of IHD was $7,319 higher than for those with a secondary diagnosis of IHD. For hospitalizations with a primary diagnosis of IHD, all the comorbidities increased the costs except for respiratory/chest symptoms, albeit the findings for diabetes and heart failure were not statistically significance at the 0.001 level.

Cardiac dysrhythmias and stroke were the most expensive comorbidities for hospitalizations with the primary diagnosis of IHD, and heart failure was the most expensive for hospitalizations when IHD was listed as a secondary diagnosis. Both PCI and CABG were associated with higher costs, especially CABG, which was the largest contributor to costs for both IHD as the primary and as a secondary diagnosis. The logit results revealed that after controlling for Charlson comorbidity index and region, in a comparison with patients aged 55-64 years, patients aged 18-39 were less likely and those aged 40-54 more likely to have a primary diagnosis of IHD rather than a secondary diagnosis of that disease. Men had a higher probability than women of having the diagnosis of IHD be primary (last column of table 4).

Characteristic	Primary or Secondary Diagnosis N=63,864	Primary Diagnosis N=33,316	Secondary Diagnosis N=30,548	Primary Diagnosis Versus IHD as the Secondary Diagnosis N=63,864
Age (years)				
18-39	-2,802.4 (0.0678)	-2,513.7 (0.0617)	-2,650.7 (0.0178)	-0.5393 (<0.0001)
40-54	-1,097.5 (0.0502)	-251.8 (0.5582)	-1,807.9 (<0.0001)	0.0832 (<0.0001)
55-64	Ref	Ref	Ref	Ref
Male	3,326.5 (<0.001)	4,822.2 (<0.001)	2,110.5 (<0.001)	0.5367 (<0.0001)
Urban	-189.9 (0.7537)	-83.1 (0.8573)	566.94 (0.2595)	-0.1511 (<0.0001)
Region				
Northeast	-3,229.4 (<0.0189)	-4,204.17 (<0.0001)	-1,784.6 (0.1137)	0.0081 (0.8546)
North Central	-3,570.6 (0.0004)	-3,584.5 (<0.0001)	-3,324.9 (<.0001)	0.0243 (0.4515)
South	-1,443.9 (0.1353)	-821.7 (0.2730)	-2,006.1 (0.0110)	-0.0164 (0.5947)
West	Ref	Ref	Ref	Ref
Charlson Comorbidity Index	2,065.2 (<0.0001)	2,850.4 (<0.0001)	1,749.7 (<0.0001)	-0.0893 (<0.001)
IHD primary vs. secondary	7,318.8 (<0.0001)	-	-	-
Secondary IHD	-	5,926.2 (<0.0001)	-	-
Heart failure	-	1,747.0 (0.0246)	5,127.7 (<0.0001)	-
Stroke	-	7,054.2 (<0.0001)	2,698.0 (0.0091)	-

Characteristic	Primary or Secondary Diagnosis N=63,864	Primary Diagnosis N=33,316	Secondary Diagnosis N=30,548	Primary Diagnosis Versus IHD as the Secondary Diagnosis N=63,864
Diabetes	-	306.2 (0.6758)	291.1 (0.8559)	-
Hypertension	-	1,294.3 (0.0036)	3,252.8 (0.0275)	-
Symptoms involving respiratory system and other chest symptoms	-	-3.015.7 (<0.0001)	-10,016.0 (<0.0001)	-
Cardiac dysrhythmias	-	7,583.9 (<0.0001)	2,571.2 (0.0044)	-
Hyperlipidemia	-	2,471.1 (<0.0001)	2,142.2 (<0.0001)	-
PCI	-	1,527.3 (0.0002)	13,140.0 (0.0002)	-
CABG	-	26,164.0 (<0.0001)	44,053.0 (<0.0001)	-

Values in parentheses are p values. IHD: ischemic heart disease; PCI: percutaneous coronary intervention; CABG; coronary artery bypass graft; Ref: reference; All the comorbidities (heart failure, stroke, diabetes, hypertension, symptoms involving respiratory system and other chest symptoms, cardiac dysrhythmias, and hyperlipidemia) refer to the secondary diagnosis for hospitalizations with the primary diagnosis of IHD, and refer to the primary or secondary diagnosis for hospitalizations with a secondary diagnosis of IHD.

Table 4. Coefficient estimates of hospitalization costs and diagnosis status for patients with a diagnosis of ischemic heart disease

4. Discussion

Using a large administrative dataset, we analyzed the costs of hospitalizations in patients diagnosed with IHD and obtained detailed information on a variety of measures. Our cost information on IHD classified by AMI, primary and secondary diagnosis statuses, and

comorbidities is the first of its kind to be reported. More important, while many authors have detailed the costs of CABG and PCI procedures over the years, our study is unique in reporting the costs of hospitalization for IHD patients who underwent these procedures by age, sex, and diagnostic status and controlling several major comorbidities of IHD.

We used ICD-9 codes to define IHD; earlier investigations by other researchers were hampered by not clearly defining this disease, and few considered IHD as a secondary diagnosis. We found, as expected, that the hospitalizations in which IHD was the primary diagnosis were far more expensive, on average, than the cases in which IHD was only a secondary diagnosis, but we found that the latter accounted for 48% of the hospital stays of interest. Thus, there is considerable merit in examining these hospitalizations in terms of their economics. More broadly, the information set forth in the present report should be valuable for identifying with greater precision the drivers of costs incurred by patients hospitalized with IHD.

Our cost estimates for hospitalizations with a primary diagnosis of IHD ($24,079 on average, $27,507 for AMI and $22,553 for non-AMI) are comparable to those in the literature. In a study that used data from 1995, Russell and associates estimated the cost of fatal AMI at $17,532 and nonfatal AMI at $15,540.[6] More recently, Menzin and coworkers estimated the cost of IHD at just under $23 thousand for initial hospitalization but about $5,700 higher for re-hospitalization in 2005.[7] Our finding that costs were higher for AMI hospitalizations than for those classified as non-AMI, while expected, adds further to the literature; of additional interest was the fact that the cost gap between AMI and non-AMI hospitalizations when IHD was the primary diagnosis was much larger for those aged 18-44 than it was for the other major subgroups (men, women, and those aged 45-64).

Our findings that stroke, heart failure, and cardiac dysrhythmias drive up the costs of hospitalization when IHD is the primary diagnosis are consistent with the literature but still of great interest. We also found that hyperlipidemia was associated with higher costs as expected. Patients with hyperlipidemia were often referred for lipid-lowering therapy, which incurred costs from medication, clinical visits, and lab tests. As for diabetes, in a study in the UK, Currie and coworkers found that 16.9% of IHD admissions (primary diagnosis) had a secondary diagnosis of diabetes and accounted for 16% of the costs of the disease.[10] Our results were somewhat similar: 15.9% of IHD admissions (primary diagnosis) had diabetes; we also found that those with diabetes had costs $5,067 higher than those who did not. Perhaps surprisingly, in our regression analysis, diabetes did not drive up the cost of IHD hospitalization significantly when IHD was a secondary diagnosis or even when it was the primary diagnosis. This finding deserves more exploration, as diabetes is a risk factor for many kinds of vascular disease and a known predictor of poorer outcomes for CABG surgery.

Nichols and Brown, who also explored the costs associated with a combination of CVD and diabetes, found higher costs in patients with diabetes than in those without that disease, and they reported that diabetes patients with CVD incurred more costs earlier in life than patients with diabetes but no CVD.[22] Elsewhere, Rosen and colleagues found that for patients with IHD in 2000-2002, costs when they also had hypertension were an additional $1,900 (our result was $2,920 for 2005), and when they had diabetes in addition to IHD they

were $3,300 more (our result was $5,067 for 2005). These authors also found that the annual costs attributable to IHD were an additional $30,000 in the year an AMI occurred, and $4,000 in each subsequent year (in large part due to revascularization procedures).[4]

In our study, PCI increased the costs dramatically for patients with a secondary (but not a primary) diagnosis of IHD, and CABG increased the costs by 10s of thousands of dollars regardless of whether the IHD diagnosis was primary or secondary. Our mean cost for IHD as a primary diagnosis was $46,757 when there was CABG surgery, $19,622 when there was not. Wittels and coworkers, reporting more than 2 decades ago, found that the 5-year cost per case was $32,465 for CABG surgery and $26,916 for angioplasty. Researchers have investigated the factors influencing the high costs of CABG and have concluded that length of stays, race, age, prescription are the major factors.[23-25] Given the high cost of CABG surgery, reducing the number of procedures and/or lowering the unit costs might be cost-effective strategies in containing the overall costs associated with IHD.

Our finding in the logit model that men were more likely than women and patients aged 40-54 more likely than those either 18-39 or 55-64 to have IHD as the primary diagnosis rather than a secondary diagnosis is of great interest and adds to the literature on IHD among American adults. We found that the economic burden of IHD was higher among men than women, and this finding about the likelihood of primary versus secondary diagnosis would be consistent with that. Further, because men and persons aged 40-54 are major participants in the workforce, these results may suggest high indirect costs associated with IHD for these subpopulations.

The variety of new findings from the present study notwithstanding, several limitations should be considered in interpreting the results. First, the costs reported for IHD with a specific comorbidity could not be allocated explicitly into the cost of IHD and the cost of the comorbidity, and the causal relationships between IHD and its comorbidities were unknown. Thus, the estimated costs for IHD with a comorbidity should be interpreted as the costs associated with IHD when that comorbidity was present rather than the costs of IHD plus the costs of that comorbidity. Fortunately, researchers have proposed ways of attributing hospitalization costs to specific diseases when the comorbidity issues are significant,[26] and such research in the case of IHD should be conducted.

Second, our sample population was of patients aged 18-64 years, while most previous studies focused on persons aged 65 years or older because of the higher prevalence of IHD and the greater costs for this age group. However, our results showed that although there was a tendency toward increased costs with greater age, the cost differences between age groups were not large, and our cost estimates were comparable with those in the literature. Third, the hospitalization costs were direct medical costs only, while the literature has shown that about half of the total economic burden of IHD is represented by indirect costs such as those for informal care and loss of productivity. Thus, the hospitalization costs were very conservative estimates of the total economic burden of IHD. Quantifying the costs of informal care and productivity loss associated with IHD is needed to have a better understanding of the full economic burden of IHD. Fourth, our data did not allow us to identify the hospitalizations as an initial admission or a readmission. Thus, we were unable to investigate the cost relationship between IHD initial admissions and readmissions. Finally, all of the patients had insurance coverage and thus were not representative of the

broad US population, a good portion of which has no health insurance. All of these factors may limit the generalization of our results to the general population.

5. Conclusions

Inpatient costs for IHD in the US are high, especially for hospitalizations among patients who had an AMI. Cardiac dysrhythmias, heart failure, and stroke are major factors associated with increased costs for patients with IHD. CABG surgery greatly increases the cost of IHD hospitalization, as does PCI if IHD is a secondary diagnosis only. The high costs we report here provide economic justifications for the development of more effective programs to prevent CVD. New strategies for the comprehensive prevention and control of IHD and its associated comorbidities such as cardiac dysrhythmias, heart failure, and stroke could curb hospitalizations and decrease the use of cardiac procedures for IHD and thereby control the associated medical costs.

6. Acknowledgement

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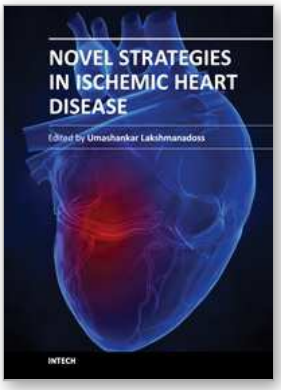

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