Clinical Investigations

Hospitalization Costs for Acute Myocardial Infarction Patients Treated With Percutaneous Coronary Intervention in the United States Are Substantially Higher Than Medicare Payments

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ABSTRACT

Background: Acute coronary syndromes account for half of all deaths secondary to cardiovascular disease and represent a significant economic burden in the United States. Therefore, assessing hospitalization costs relative to Medicare reimbursement for these patients is important in understanding the impact of these patients on hospitals. We hypothesized that hospitalization costs for acute myocardial infarction patients treated with percutaneous coronary intervention (PCI) were higher than their associated Medicare payments.

Methods: Using the Nationwide Inpatient Sample, we evaluated hospitalization costs for patients treated with PCI from 2001 through 2009 by multiplying hospital charges by the group average cost-to-charge ratio for each patient's hospitalization. Primary end points examined were total hospital costs and trends over time, which were correlated with clinical outcomes and insurance payments. Costs were inflation adjusted with 2009 as the reference year.

Results: Median hospitalization costs of PCI increased from $15 889 (interquartile range [IQR] = $12 057–$21 204) in 2001 to $19 349 (IQR = $14 660–$26 282) in 2009. From 2004 to 2009, inflation-adjusted costs for PCI decreased at a rate of 0.3% per year. In 2009, a total of 265,531 patients received PCI for acute myocardial infarction. Of these, 143 654 were <65 years old, and 121 876 were ≥65 years old. Average 2009 Medicare payments ranged from $9303 to $17 500 depending on the Medicare Severity-Diagnosis Related Groups (MS-DRG) billed, leaving hospitals at a loss of anywhere from $4493 to $7940 per patient when comparing costs and reimbursements across all included MS-DRG codes.

Conclusions: Hospitalization costs for patients treated with PCI have been stabilizing over the last few years; however, there still remains a significant disparity between Medicare reimbursements and hospitalization costs, which has potential implications on patient outcomes, quality of care, and hospital sustainability.

Introduction

Although cardiovascular disease mortality rates have slowly declined in the United States, they still remain the leading cause of death in both men and women.[1] Acute coronary syndromes, which include unstable angina, non–ST-segment elevation myocardial infarction (NSTEMI), and ST-segment elevation myocardial infarction (STEMI), account for half of all deaths due to cardiovascular disease.[2] Given the large number of admissions for acute coronary syndromes, it is important to assess the economic impact these patients have on hospitals. Furthermore, it is essential to understand hospitalization costs, because Medicare payments may not be adequately reimbursing costs of treatment. Therefore, in this study, we used the Nationwide Inpatient Sample (NIS) data to describe recent hospitalization costs associated with percutaneous coronary intervention (PCI) for acute myocardial infarction (AMI), and examined the trends in these costs over time, along with the relationship between costs and Medicare payments in 2009.

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Methods

Patient Population

We collected and analyzed data from the NIS hospital discharge database for the period January 1, 2001 through December 31, 2009, which was acquired from the Healthcare Cost and Utilization Project of the Agency for Healthcare Research and Quality in Rockville, Maryland.[3] The NIS is a hospital discharge database that represents 20% of all inpatient admissions to nonfederal hospitals in the United

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States. Using the NIS for years 2001 through 2009, patients who underwent PCI were identified using the International Classification of Diseases, 9th Revision (ICD-9) procedure codes 0066, 3603, 3604, 3606, 3607, 3609. Of these patients, we selected those with a primary ICD-9 diagnosis code of NSTEMI (41070, 41071) or STEMI (41000, 41001, 41010, 41011, 41020, 41021, 41030, 41031, 41040, 41041, 41050, 41051, 41060, and 41061).

Cost Data

We determined an association between the following variables and total costs in the 2009 sample: age, gender, discharge status (home/short-term facility, long-term facility, and in-hospital death), primary payer (Medicare, Medicaid, private insurance, self-pay, no charge, other), race, patient household income quartile (based on the patients' home zip codes), Charlson Comorbidity Index (CCI), procedure type (drug-eluting stent, bare-metal stent, angioplasty without stenting), intensive care unit (ICU) stay, hospital region (Northeast, Midwest, South, West), hospital location/teaching status (rural, urban nonteaching, urban teaching), and hospital bed size (small, medium, large). Mechanical ventilation (ICD-9 procedure codes 9670-9672), was used as a surrogate for ICU stay. Hospitalization costs were determined by taking the total hospitalization charges and multiplying them by the group average cost-to-charge ratio (CCR) for each patient's hospitalization. Hospitalization charges and CCR were provided by the NIS database.

The NIS database provides data on the total hospitalization charges and the CCR. These charges represent the amount that hospitals billed for their services, but do not reflect how much the services actually cost or the specific amounts that hospitals received in payment. The CCR allows one to see how hospital charges translate into actual costs.[4] The CCRs provided are based on all-payer inpatient cost, which was obtained from accounting reports collected by the Centers for Medicare & Medicaid Services.

We examined trends in inflation-adjusted hospitalization costs of PCI for AMI from 2001 through 2009. To account for inflation we used the general consumer price index calculator (available at http://data.bls.gov/cgi-bin/cpicalc.pl) and converted all costs and charges to their dollar value in 2009.

Comparison With Medicare Reimbursements

For patients whose hospitalization was paid for by Medicare in 2009, we compared the cost of hospitalization to mean Medicare payments for the Medicare Severity-Diagnosis Related Groups (MS-DRG) of the hospitalization. Diagnosis Related Groups (DRGs) included in our study were 246 (percutaneous cardiovascular procedure with drug-eluting stent with major complication or comorbidity or 4+ vessels/stents), 247 (percutaneous cardiovascular procedure with drug-eluting stent without major complication or comorbidity), 248 (percutaneous cardiovascular procedure with non–drug-eluting stent with major complication or comorbidity or 4+ vessels/stents), 249 (percutaneous cardiovascular procedure with non–drug-eluting stent without major complication or comorbidity), 250 (percutaneous cardiovascular procedure without coronary artery stent with major complication or comorbidity), 251 (percutaneous cardiovascular procedure without coronary artery stent without major complication or comorbidity). These DRGs were applied only to patients who suffered from an AMI requiring PCI. Medicare payments are public information (http://www.cms.hhs.gov).

Statistical Analysis

We used the nonparametric Wilcoxon rank sum test to determine statistical significance, defined as a P value <0.05. We also present medians and interquartile ranges. Multivariate analysis to determine predictors of cost for patients in 2009 was performed using a standard least squares model. Variables included in the model were age, gender, race, discharge status, procedure type, NSTEMI vs STEMI, insurance status, zip income quartile, CCI, hospital region, hospital location/teaching status, hospital bed size, and ICU stay. All potential predictors of cost were forced into the model. Given that the study involved publically available, coded information that could not be linked to specific individuals directly or indirectly, this study was felt to be exempt from institutional review board approval. All statistical analysis was performed using the SAS-based statistical software JMP (www.jmp.com; SAS Institute Inc., Carey, NC).

Results

Patient Data

Cost data from 2009 were available for a total of 265 531 patients. Of these, 137 863 patients suffered a STEMI (51.9%) and 127 668 suffered a NSTEMI (48.1%). In terms of age, 143 654 (54.1%) were younger than 65 years, and 121 876 (45.9%) were $\geq$65 years. In regard to discharge status, 247 194 (93.1%) patients were discharged to home/short-term facility, 13 183 (5.0%) patients were discharged to long-term facilities, and 5055 (1.9%) patients suffered in-hospital mortality. There were 11 192 (4.2%) patients who required mechanical ventilation.

Hospital Data

Of the 265 531 hospitalizations for AMI, the majority of these were located in the Southern United States, in urban settings, and in large–bed-size hospitals. Specific details of hospital data can be seen in Table 1.

Hospitalization Costs in 2009

Cost data are also summarized in Table 1. The median cost for all patients hospitalized in 2009 was \$19 349 (interquartile range [IQR] = \$14 660–\$26 282). There was a significant difference in the median costs for patients <65 years old compared to $\geq$65 years old ($P < 0.0001$). Patients discharged to home or short-term facilities had significantly lower median costs when compared to those patients discharged to long-term facilities (\$18 949 vs \$30 007, $P < 0.0001$). Costs varied significantly by primary payer, with Medicare patients having the highest median costs compared to those with no charge or self-pay. Patients receiving drug-eluting stents had significantly higher costs than patients

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Table 1. Hospital Costs Data in 2009

Variable	No. (%)	Median Cost, US$	IQR, US$	*P*
All patients	265 531	19 349	14,660–26,282	—
Age				
<50 years	43 914 (16.5)	18 327	14,067–24,518	<0.0001
50–64 years	99 740 (37.5)	19 003	14,473–25,486	
65–80 years	81 987 (30.9)	19 875	14,956–27,187	
80+ years	39 889 (15.0)	20 625	15,358–28,361	
Gender				
Male	179 944 (67.8)	19 183	14,599–25,937	<0.0001
Female	85 582 (32.2)	19 670	14,791–27,010	
Discharge status				
Home/short term	247 194 (93.1)	18 949	14,470–25,396	<0.0001
Long term	13 183 (5.0)	30 007	20,736–46,577	
Death	5 055 (1.9)	27 882	18,519–45,589	
Insurance status				
Medicare	115 442 (43.5)	20 079	15,064–27,488	<0.0001
Medicaid	15 495 (5.8)	19 813	14,470–27,277	
Private insurance	99 497 (37.5)	18 987	14,544–25,463	
Self-pay	22 891 (8.6)	17 752	13,320–23,894	
No charge	2 057 (0.8)	17 583	14,608–22,008	
Other	9 469 (3.6)	19 228	14,985–25,927	
Race				
White	164 956 (62.1)	18 637	14,114–25,383	<0.0001
Black	18 258 (6.9)	18 228	13,693–25,145	
Hispanic	15 019 (5.7)	20 542	15,168–28,775	
Asian	4 770 (1.8)	24 476	16,492–35,643	
Income quartile[a]				
1 (lowest)	69 898 (26.3)	18 568	14,029–25,125	<0.0001
2	73 064 (27.5)	19 134	14,625–25,957	
3	64 847 (24.4)	19 713	14,871–26,905	
4 (highest)	50 985 (19.2)	20 439	15,597–27,881	
Charlson Comorbidity Index				
1	124 867 (47.0)	18 225	14,013–24,251	<0.0001
2	76 150 (28.7)	19 375	14,758–26,198	
3	36 221 (13.6)	21 052	15,660–28,820	
≥4	28 293 (10.7)	23 788	17,067–33,338	

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Table 1. Continued

Variable	No. (%)	Median Cost, US$	IQR, US$	P
STEMI vs NSTEMI				
STEMI	127 668 (48.1)	19 639	14,998–26,345	<0.0001
NSTEMI	137 863 (51.9)	19 087	14,341–26,216	
Procedure type				
Drug-eluting stent	169 073 (63.7)	20 016	15,250–26,898	<0.0001
Bare-metal stent	76 585 (28.8)	18 269	13,869–24,902	
Angioplasty, no stent	20 275 (7.6)	17 876	13,189–25,771	
ICU stay				
Yes	11 192 (4.2)	34 752	24,058–54,841	<0.0001
No	254 339 (95.8)	19 026	14,510–25,552	
Hospital region				
Northeast	31 654 (11.9)	18 232	12,743–25,389	<0.0001
Midwest	68 847 (25.9)	20 089	16,052–26,184	
South	117 079 (44.1)	17 695	13,487–23,862	
West	47 951 (18.1)	23 843	17,481–32,606	
Hospital location				
Rural	16 946 (6.4)	22 834	18,491–28,485	<0.0001
Urban nonteaching	109 007 (41.1)	19 421	15,041–26,458	
Urban teaching	139 578 (52.6)	18 769	13,903–25,799	
Hospital bed size				
Small	15 409 (5.8)	22 171	16,741–29,080	<0.0001
Medium	47 459 (17.9)	18 872	13,957–25,774	
Large	202 663 (76.3)	19 236	14,690–26,188	

Abbreviations: ICU, intensive care unit; IQR, interquartile range. NSTEMI, non–ST-segment elevation myocardial infarction; STEMI, ST-segment elevation myocardial infarction.
[a] Median household income quartiles for patient's zip codes are defined as: (1) $1–$38 999; (2) $39 000– $47 999; (3) $48 000–62 999; and (4) $63 000 or more.

receiving bare-metal stents and those receiving angioplasty without stenting. Hospital location, region, and bed size also showed differences in cost, with the Western United States region, rural locations, and small–bed-size hospitals having significantly higher costs ($P < 0.0001$).

Predictors of Cost With Multivariate Analysis

When performing our multivariate analysis, we found that age, female gender, discharge to long-term facility, insurance status (true for public insurance vs private insurance, and private insurance vs self-pay), race, income quartile, procedure type, hospital region, hospital location/teaching status, hospital bed size, and ICU stay were independent predictors of increased costs ($P < 0.0001$). Charlson Comorbidity Index was also an independent predictor of increased costs ($P = 0.0005$)

Medicare Population: Costs Compared With Reimbursement

For 2009, average Medicare payments for PCI for AMI were substantially lower than median hospitalization costs for Medicare patients for MS-DRGs 246–251. Differences in costs and reimbursement ranged from $4493 for MS-DRG 250 to $7940 for MS-DRG 247. Mean Medicare reimbursements were lower than the 25th percentile of costs for MS-DRGs 246, 247, 248, 249, and 251. These data are summarized in Table 2.

Cost Trends Over Time

Between 2001 and 2009, cost data were available for 2 148 861 patients. Trends in costs for treatment of AMI with PCI are summarized in Figure 1. Between 2001 and 2009, the inflation-adjusted cost for hospitalization for treatment of AMI with PCI increased from $15 889 (IQR = 12 057–21 204) to $19 349 (IQR = 14 659–26 281). Between 2001 and 2004,

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Table 2. Medicare Patients Costs vs Reimbursements in 2009

DRG	No.	Median Costs, US$	IQR, US$	Mean Medicare Reimbursement, US$	Difference Between Reimbursement and Costs, US$
246	22 829	25 000	18 614–33 751	17 500	7500
247	47 130	18 750	14 611–24 565	10 810	7940
248	12 316	23 038	16 919–32 288	16 066	6972
249	20 265	16 953	13 078–22 112	9520	7433
250	2919	20 066	14 643–27 946	15 573	4493
251	4755	15 609	11 956–20 382	9303	6306

Abbreviations: DRG, Diagnosis Related Group; IQR, interquartile range.

inflation-adjusted costs for PCI in AMI increased at an average rate of 7.4% per year. From 2004 to 2009, inflation-adjusted costs for PCI decreased at a rate of 0.3% per year.

Discussion

Overall, the median hospitalization costs for patients undergoing PCI for acute coronary syndromes have increased from $15 889 in 2001 to $19 349 in 2009, but costs were steady from 2004 to 2009 (Figure 1). Medicare payments have not been adequate in reimbursing hospitalization costs, rendering hospitals at an average loss of anywhere between $4493 (MS-DRG 250) and $7940 (MS-DRG 247) in 2009. Considering that Medicare was the primary payer for approximately 43.5% of patients in this study, it is clear that these losses create a significant economic burden on hospitals.

Riley et al recently assessed the trends in coronary revascularization over the 2001 to 2009 period and showed an average year-to-year increase in PCI volume of 1.3% per 1000 Medicare beneficiaries.[5] The increasing population of Medicare beneficiaries receiving PCI, along with systematic under-reimbursement, shall only further burden hospitals.

The increase in costs between 2001 and 2004 may be attributed to the advent of the drug-eluting stent. Drug-eluting stents have been widely popular since US Food & Drug Administration approval in early 2003. In our study we found that costs increased significantly between 2002 and 2003, when drug-eluting stents were starting to be widely utilized, and again between 2003 and 2004, when drug-eluting stents were first available for an entire year. The role of drug-eluting stents on increased costs is further supported by the fact that in 2009, patients receiving drug-eluting stents had significantly higher hospitalization costs than their bare-metal stent and balloon angioplasty counterparts. Our study demonstrated a decline in median hospitalization costs between 2004 and 2009.

Although not addressed in this study, other studies demonstrate that rehospitalizations during the 1-year follow-up after PCI also pose significant cost as well.[6] This could potentially add to the cost-payment discrepancies described in this study. Several studies have described the overall cost fluctuations to the Medicare program over the study period[7,8]; however, to the best of our knowledge,

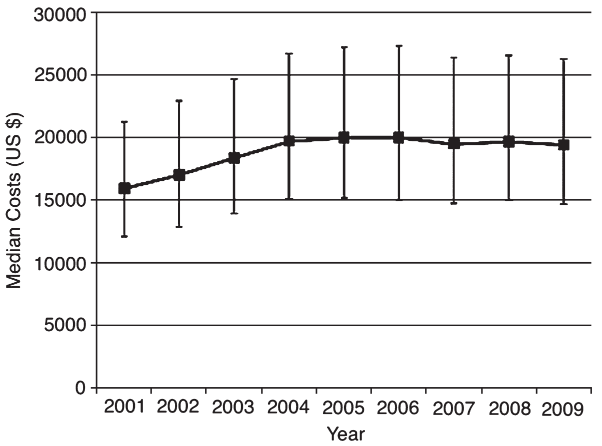

Figure 1. Median hospitalization cost trend from 2001 to 2009. Median hospitalization costs for patients undergoing PCI for acute coronary syndromes have increased from 2001 to 2009. Costs have been steady from 2004 to 2009. The confidence bands with each data point represent the 25th and 75th quartiles.

this present study represents the first examination of index hospitalization costs and payments for PCI in acute coronary syndromes. Similar cost studies analyzing endovascular treatments in patients with acute ischemic stroke and unruptured cerebral aneurysms have also shown that Medicare payments are not sufficiently meeting hospitalization costs,[9,10] a predicament that needs further attention.

In the era of dramatic changes to the healthcare economic landscape, such as the Balanced Budget Act (BBA) of 1997, and more recently the Affordable Care Act (ACA) of 2010, Medicare payment implications on hospital quality of care and patient outcomes has become a hot topic of discussion. Authors Shen and Wu have shown that hospitals facing large payment cuts experienced slower improvement in patient mortality rates in the post-BBA period with relation to AMI patient outcomes, relative to those facing small payment cuts, and that Medicare price cuts lead to reduced staffing and operating expenses, which they tied to increases in patient mortality rates.[11,12] Bazzoli et al have published several studies showing that BBA has adversely affected hospitals' financial conditions, and that hospitals with worse financial condition ultimately had to curtail investments in important areas, such as infrastructure, nursing staff, patient support and safety services, and quality-enhancing activities.[13–15] White and Wu performed a unique analysis looking at the long-term effect of BBA, studying the period of 1996 through 2009 and excluding small rural hospitals, allowing time to appropriately adjust to the Medicare payment changes. They concluded that hospitals' total revenues will drop under the ACA by more than expected based on just Medicare price changes, and that a significant percentage of lost revenues will be offset by reduced operating expenses, mainly via savings on personnel, but also nonpersonnel costs, along with delaying or forgoing capital improvements.[16] Volpp et al have previously shown that the BBA did not have a significant impact on 30-day mortality in AMI, but suggested that in the long run, reductions in margins could potentially translate into reductions in capital investments, infrastructure improvements, and quality-improvement initiatives that could reduce the rate of improvement in care.[17] These are important points to consider, as the BBA and ACA both lower hospital spending primarily by reducing DRG payment increases; however, the rate of payment reduction as part of the ACA is actually larger than the BBA, with the ACA reducing DRG payment by an estimated 1.1% per year indefinitely vs the BBA, which reduced Medicare inpatient payment by 5% between 1998 and 2000.[18,19]

We also demonstrated that insurance status was significantly associated with hospitalization costs when controlling for age, gender, comorbidities, and outcomes. Patients who had Medicare or Medicaid as the primary payer had significantly higher hospitalization costs than patients with private insurance, and privately insured patients had a higher cost than those who were uninsured. The significance of higher hospitalization costs for patients on public insurance is unclear. The association of higher cost with race may be related to other unmeasured comorbidities, whereas the association with income status remains unclear and requires further study and elucidation. This may be due to a number of factors including differences in resource utilization during the hospitalization based off of insurance status and income. We cannot exclude the interaction of other factors not measured in this database. Differences in costs and charges by insurance status have been demonstrated in previous studies.[20]

Although not the major focus of this current study, literature regarding performing transradial percutaneous coronary intervention (TRPCI) over transfemoral percutaneous coronary intervention (TFPCI) has been growing in interest.[21] A recent meta-analysis of randomized controlled trials comparing TRPCI vs TFPCI in STEMI patients showed that TRPCI had a statistically significant 48% reduced risk of major bleeding, 42% reduced risk of mortality, and a 33% reduced risk of major adverse cardiac event. This study also showed a significantly shorter hospital stay in the transradial group, but also higher frequency of access site crossover and a non–statistically significant longer time to reperfusion.[22] The implications of that meta-analysis can be considered in light of other recent studies that assess the hospitalization costs of TRPCI vs TFPCI, and have found that TRPCI was associated with lower average total costs of care, primarily driven by reduced length of stay and bleeding complications.[23] Recent work has estimated that TRPCI results in approximately $730 to $800 savings per PCI procedure, which when compared to TFPCI could amount to significant reductions in annual hospitalizations costs.[24,25] Although the transfemoral approach remains the most commonly used technique, further studies regarding transradial PCI could potentially help with the problem of determining ways of reducing hospitalization costs.

Coding errors are a potential limitation of this study, as they are with any study using a large administrative database. However, the very large numbers in this database should minimize that limitation. Another potential limitation is our use of CCRs in determining hospitalization costs. A hospital CCR is a reflection of a hospital's annual total costs divided by the annual total charges. The major components of hospital costs that can be included in a hospital CCR include the cost of devices and pharmaceuticals, employee costs (nurses, pharmacists, physicians, technologists), and malpractice insurance. Other ancillary costs that are components of CCR include building costs, maintenance costs, outpatient services, hospital investments, and loan repayments. Thus, some components of the cost of hospitalizations are not directly related to patient care but rather to institutional expenses, such as investments and loan repayments, that are distributed among the patient population.

In our study, we used average nationwide reimbursement rates for the 6 procedure-related DRG codes in calculating the disparities between costs and reimbursement. Hospitals receive different payments for DRGs depending on their location, teaching status, and case mix. We were able to show significant differences in costs based on hospital region, location/teaching status, and bed size; however, we could not obtain data on DRG reimbursement rates for specific hospitals, as these data are not available. Nonetheless, given the differences between hospitalization costs of Medicare patients in this study and the amount that Medicare reimbursed, on average, it is reasonable to assume that failure to reimburse for costs based on these CCRs caused hospitals to lose a considerable amount of money that could be invested into patient care. Furthermore, the costs and reimbursements addressed here refer specifically to index hospitalizations, and do not include out-of-hospital or follow-up costs for patients undergoing PCI, which can potentially contribute significantly to the overall costs of care. The costs of PCI also refer to all PCI procedures and do not differentiate between which access site was used. Cost trends discussed in this study were not compared with payment trends over the entire study period, as the most recent year included was felt sufficient to represent a clear disparity. Finally, the mean Medicare payments were reported rather than individual payments. This may affect the accuracy of the reported payments; however, the means should be a good reflection of general trends given the large sample size studied.

Conclusion

Our study of the NIS shows that not only have the hospitalization costs for PCI in acute coronary syndromes

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been stabilizing over the recent studied years, but more importantly, Medicare payments clearly have not been adequately reimbursing these hospitalizations. Therefore, for hospitals to maintain economic stability in caring for these patients, strident efforts should be made to both significantly reduce hospitalization costs and encourage Medicare to adequately reimburse hospitals for the services that they provide. Interesting nonclinical predictors of cost are noted and deserve further study and analysis. Furthermore, past experiences with the BBA of 1997 may help predict long-term implications of the ACA of 2010 on hospital outcomes, quality of care, and sustainability. Further analysis of the impact of the ACA on hospitals will be important to conduct, especially with common conditions that require hospitalizations such as AMI.

References

1. Kochanek KD, Xu JQ, Murphy SL, et al. Deaths: preliminary data for 2009. *Natl Vital Stat Rep.* 2011;59:1–51.
2. Kolansky DM. Acute coronary syndromes: morbidity, mortality, and pharmacoeconomic burden. *Am J Manag Care.* 2009;15:S36–S41.
3. Agency for Healthcare Research and Quality. Healthcare Cost and Utilization Project. Nationwide Inpatient Sample. 2001-2009. http://www.hcup-us.ahrq.gov/nisoverview.jsp. (accessed December 31, 2012).
4. Agency for Healthcare Research and Quality. Healthcare Cost and Utilization Project. Cost-to-charge ratio files. August 2011. http://www.hcup-us.ahrq.gov/db/state/costtocharge.jsp. (accessed December 31, 2012).
5. Riley RF, Don CW, Powell W, et al. Trends in coronary revascularization in the United States from 2001 to 2009: recent declines in percutaneous coronary intervention volumes. *Circ Cardiovasc Qual Outcomes.* 2011;4:193–197.
6. Zhao Z, Winget M. Economic burden of illness of acute coronary syndromes: medical and productivity costs. *BMC Health Serv Res.* 2011;11:35.
7. Ryan J, Linde-Zwirble W, Engelhart L, et al. Temporal changes in coronary revascularization procedures, outcomes, and costs in the bare-metal stent and drug-eluting stent eras: results from the U.S. Medicare program. *Circulation.* 2009;119:952–961.
8. Venkitachalam L, Lei Y, Stolker JM, et al. Clinical and economic outcomes of liberal versus selective drug-eluting stent use: insights from temporal analysis of the multicenter Evaluation of Drug Eluting Stents and Ischemic Events (EVENT) registry. *Circulation.* 2011;124:1028–1037.
9. Brinjikji W, Kallmes DF, Lanzino G, et al. Hospitalization costs for endovascular and surgical treatment of unruptured cerebral aneurysms in the United States are substantially higher than Medicare payments. *Am J Neuroradiol.* 2012;33:49–51.
10. Brinjikji W, Kallmes DF, Rabinstein AA, et al. Hospitalization costs for patients, with acute ischemic stroke treated with endovascular embolectomy in the United States. *Stroke.* 2011;42:3271–3273.
11. Shen YC, Wu VY. Reductions in Medicare payments and patient outcomes: an analysis of 5 leading Medicare conditions. *Med Care.* 2013;51:970–977.
12. Wu VY, Shen YC. The long-term impact of Medicare payment reductions on patient outcomes. National Bureau of Economic Research Working Paper. Cambridge, MA: National Bureau of Economic Research; 2011.
13. Bazzoli GJ, Lindrooth RC, Hasnain-Wynia R, et al. The Balanced Budget Act of 1997 and U.S. hospital operations. *Inquiry.* 2004;41:401–417.
14. Bazzoli G, Clement J, Lindrooth R, et al. Hospital financial condition and operational decisions related to the quality of hospital care. *Med Care Res Rev.* 2007;64:148–168.
15. Bazzoli G, Chen H, Zhao M, et al. Hospital financial condition and quality of patient care. *Health Econ.* 2008;17:977–995.
16. White C, Wu VY. How do hospitals cope with sustained slow growth in Medicare prices? *Health Serv Res.* 2014;49:11–31.
17. Volpp KG, Konetzka RT, Zhu J, et al. Effect of cuts in Medicare reimbursement on process and outcome of care for acute myocardial infarction patients. *Circulation.* 2005;112:2268–2275.
18. Seshamani M, Schwartz JS, Volpp KG. The effect of cuts in Medicare reimbursement on hospital mortality. *Health Serv Res.* 2006;41(3 part 1):683–700.
19. Committee on Energy and Commerce Subcommittee on Health. The estimated effect of the Affordable Care Act on Medicare and Medicaid outlays and total national health care expenditures. Washington, DC: US House of Representatives; 2011.
20. Thorpe KE, Howard D. Health insurance and spending among cancer patients. *Health Aff.* 2003;3:189–198.
21. Eleid M, Rihal C, Gulati R, et al. Systematic use of transradial PCI in patients with ST-segment elevation myocardial infarction: a call to "arms." *JACC Cardiovasc Interv.* 2013;6:1145–1148.
22. Komocsi A, Aradi D, Kehl D, et al. Meta-analysis of randomized trials on access site selection for percutaneous coronary intervention in ST-segment elevation myocardial Infarction. *Arch Med Sci.* 2014;10:203–212.
23. Safley DM, Amin AP, House JA, et al. Comparison of costs between transradial and transfemoral percutaneous coronary intervention: a cohort analysis from the Premier research database. *Am Heart J.* 2013;165:303–309.
24. Amin AP, House JA, Safley DM, et al. Costs of transradial percutaneous coronary intervention. *JACC Cardiovasc Interv.* 2013;6:827–834.
25. Applegate R, Sacrinty M, Schafer P, et al. Cost effectiveness of radial access for diagnostic cardiac catheterization and coronary intervention. *Catheter Cardiovasc Interv.* 2013;82:E375–E384.

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