Technical Report 27

Updating the HERC Average Cost Method
Use of 2009 Medicare Data and an Analysis of CABG Surgery

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Terms

CABG	Coronary Artery Bypass Graft
DRG	Diagnostic Related Group
DSS	Decision Support System
HCUP	Healthcare Cost and Utilization Project
HERC	Health Economics Resource Center
ICD-9	International Classification of Disease, 9th Revision
ICU	Intensive Care Unit
LOS	Length of Stay
MedPAR	Medicare Provider Analysis and Review File
OLS	Ordinary Least Squares
OR	Operating Room
RVUs	Relative Value Units
VA	U.S. Department of Veterans Affairs
VIREC	VA Information Resource Center

1. Introduction

The HERC Average Cost dataset for inpatient medical/surgical care is created annually by combining Medicare relative value units (RVUs) to estimate U.S. Department of Veterans Affairs (VA) costs for every VA encounter. These methods have been described in detail elsewhere.[1] In 2011, we updated the statistical model using Medicare data from 2009. This technical report describes the updated model and includes a more detailed examination of cardiac bypass surgery (CABG) average costs.

2. Methods

The VA Information Resource Center (VIREC) works with Medicare to create datasets for veterans who use Medicare. We requested the 2009 Medicare Provider Analysis and Report file (MedPAR), and received a file with 2,059,940 records. MedPAR exclusively reports payments to facilities (Medicare Part A); we did not attempt to estimate payments to providers, which would involve analyzing Part B claims and linking them to Part A. We focused on hospital claims in the 48 continental United States, dropping 6,210 records associated with care in Hawaii and Alaska. We excluded 442,000 long stay and skilled nursing facility records, focusing our analysis entirely on short stays.

Using the diagnostic related group (DRG) variable, we merged the file to the 2009 Medicare DRG weights, which Medicare uses to reimburse hospitals; 15 cases had a missing DRG weight and we gave them the weight of 1. We also merged the file to the Medicare Cost Report to obtain each facility's cost-to-charge ratio for 2007, 2008 and 2009. We excluded 24,583 records that did not merge with a facility cost-to-charge ratio, that had a large cost-to-charge ratio (>2), or that had large fluctuations in the cost-to-charge ratio over the three years. The final analytical sample included 1,586,785 records.

The MedPAR data reports payments and charges; charges frequently exceed payments by a factor of 3 and many researchers view charges with healthy skepticism.[2] We multiplied the reported charges by the cost-to-charge ratio (mean .303, SD .117, min .091, max 1.465), which typically deflates the charges. Although payments and charges are correlated (r=.67), we focused on charges because we wanted to estimate a relative value unit that was not constrained by the benefit limits imposed by Medicare.

We restricted our choice of independent variables to those from our prior model.[1] We included length of stay (LOS) and the calculated the difference between the actual LOS and the expected LOS for a given DRG. To allow for nonlinearities, positive and negative deviations in the actual and expected LOS were allowed to vary independently and in a nonlinear fashion (i.e., squared and cubic terms were included). We also included patient gender, age, whether they died in the hospital, and number of diagnoses. All costs represent 2009 dollars.

To demonstrate the changes in the average cost files we present a case study of CABG surgery (ICD 9 procedure 36.1x). We examined costs, payments, charges, and performance of the regression model. This procedure has been well studied and recent VA and non-VA cost data have been published on it.[3,4]

3. Results

3.1 Sample characteristics

The summary characteristics are presented in Table 1. 92% of the sample was male and the average age was 76. The average length of stay was 5.4 days, but the longest hospitalization was 850 days. People spent on average .27 days in the Intensive Care Unit (ICU) and 3.8 died while in the hospital. The average cost-adjusted charges, payments, and total charges were $10,396, $8,514 and $39,306, respectively.

Table 1. Sample Characteristics (n=1,586,785)

	Mean or %	Std. Dev.	Max
Female (%)	8.19%		
Age	76.28	10.55	109
Number of diagnoses	8.33	1.66	10
Length of stay	5.43	6.05	850
Surgery related DRG (%)	27.95%		
Days in the ICU	1.28	3.51	797
Died in the hospital (%)	3.84%		
Cost adjusted Charges	$10,396	$14,019	$2,460,774
Total Charges	$39,306	$58,153	$7,265,335
Payment Amount	$8,514	$11,752	$1,997,930

3.2 Overall Regression Results

Our ordinary least squares (OLS) regression model with 1996 Medicare data was preferred over semi-log and general linear model, and produced the best fit with an R^2 of 0.74. The same model with 2009 data accounted for 76% of the variance (see Table 2).

Table 2. Regression results from 2009 and 1996 MedPAR data

	2009 MedPAR		1996 MedPAR	
	Coef	*t stat*	*Coef*	*t stat*
Died in hospital	3076.68	103.74	2671.21	46.69
Sex (female = 1, male = 0)	-43.65	-2.28	32.91	0.54
Age in years	-40.79	-78.18	-34.22	18.48
Number of diagnoses	705.00	11.06	619.04	7.63
Number of diagnoses squared	-156.71	-14.72	-146.70	8.83
Number of diagnoses cubed	10.58	18.92	10.98	10.73
Length of stay (LOS) in days	-21.67	-4.97	104.26	11.48
Positive deviation from DRG-specific average LOS (POSLOS)	1072.46	196.51	670.95	66.39
Negative deviation from DRG-specific average LOS (NEGLOS)	600.65	40.36	182.50	6.15
NEGLOS squared	-114.80	-28.66	-109.89	13.77
POSLOS squared	0.19	6.16	-0.72	32.99
NEGLOS cubed	-3.58	-12.65	-4.59	8.36
POSLOS cubed	0.00	-10.05	0.00	0.17
1996 DRG weight	7381.10	303.59	4860.04	76.30
DRG weight squared	-273.52	-71.10	-255.16	23.11
DRG weight cubed	9.80	66.59	12.97	25.65
Surgical MDC	-237.30	-6.43	1069.88	13.68
Surgical MDC* LOS	68.17	13.58	-42.32	3.79
Surgical MDC* POSLOS	534.06	68.08	421.53	26.99
Surgical MDC* NEGLOS	-26.98	-1.45	328.30	9.06
Surgical MDC* POSLOS squared	0.43	5.99	-1.38	7.72
Surgical MDC* POSLOS cubed	0.00	-22.79	0.00	1.74
Surgical MDC* NEGLOS squared	17.70	4.13	47.50	5.64
Surgical MDC* NEGLOS cubed	2.08	7.28	3.64	6.59
Days in ICU	491.55	186.38	593.04	82.76
ICU days squared	6.04	82.55	10.27	37.86
ICU days cubed	0.00	-52.63	-0.03	18.24
Constant	760.84	5.99	413.77	2.28
R^2	0.76		0.74	

3.3 CABG patients

The model predicted an average cost for CABG patients of $38,121, while the cost adjusted charges were $38,941 and the Medicare payment averaged $30,726. As expected, the predicted amount was lower than the maximum cost-adjusted charges and was higher than the lowest cost-adjusted charges. Therefore, the variation in the predicted costs, as indicated by the standard deviation, was attenuated.

Table 3. Model fit among Veteran CABG patients in the MedPAR data (n=20,976)

	Mean	Std. Dev.	Min	Max
Length of stay	11	9	1	373
Days in the ICU	5	7	0	150
OR* cost adjusted charges	8,256	5,173	0	86,701
Total charges	149,816	128,857	4,200	4,286,700
Predicted costs from model	38,121	20,769	10,548	589,142
Medicare Payment amount	30,726	27,215	0	579,846
Cost adjusted charges	38,941	29,221	2,091	1,244,967

*OR stands for Operating Room

4. Discussion

Using methods based on our earlier work,[1] we developed a cost-regression that yielded an R^2 of .76 and shared many similarities with our earlier model. The model performed well with the overall sample (over 1.5 million records). This model is used for predicting medical/surgical costs in the VA, so the question about predictive power is paramount. To address that question, we examined cost estimates with CABG patients.

The model predicted an average cost for CABG patients of $38,121, while the cost adjusted charges reported in MedPAR were $38,941 and the Medicare payment averaged $30,726. We compared these cost estimates to publicly available data and published literature.

Based on the National Inpatient Sample, reported by the Agency for Healthcare Research and Quality, there were 207,226 CABG operations done in 2009.[4] The average length of stay for a CABG was 9.1 days and the average cost adjusted charges was $35,860. The Medicare veterans sample in our analysis had a slightly longer length of stay (10.7 days) higher average cost adjusted charges at $38,941 than the HCUP sample. The predicted costs, from our model, fit the data reasonably well except at the very tails of the distribution. Consistent with prior work,[1] we also found that the model attenuated the variation slightly.

As shown in Table 4, four previously published studies[5,6,7] reported the average cost of CABG surgeries. Brown[5] estimated costs of $32,201 by multiplying total charges from the MedPAR file by the appropriate hospital's overall cost-to-charge ratio from the fiscal year 2005 Medicare Cost Report. Birkmeyer[6] reported adjusted Medicare payments of $42,206, including physician payments. Chapman[7] reported cost data from the IMS LifeLink: US Health Plan Claims database (formerly the PharmMetrics Patient-Centric database). Wagner[3] reported VA costs of $47,234 to $49,051 for saphenous vein and radial artery bypass graph, respectively, from the Decision Support System (DSS).

In conclusion, we find sufficient evidence support to use the regression beta coefficients from this model in the HERC Average Cost dataset starting in 2011. Although the model performed well with CABG patients, the average cost method has limitations. Namely, it relies on relative value units (predominantly length of stay and DRG weight), which do not provide sufficient precision to differentiate surgical techniques (e.g., on pump versus off pump CABG).

Table 4. Summary of costs and length of stay in other reported CABG studies

| | Cost (SD) | | LOS (SD) | Physician Payment Included |
	As cited in literature[a]	*Cost adjusted to 2009 US dollars[b]*		
Brown (2008)[5]	$32,201 ($23,059)	$35,373 ($25,330)	9.9 (7.8)	Yes
Birkmeyer (2010)[6]	$42,206 (n/a)	$46,363 (n/a)	n/a	Yes
Chapman (2011)[7]	$56,024 ($33,207)	$59,619 ($35,338)	9.23 (3.65)	Yes
Wagner (2011)[2]	$47,234 - $49,051[c]	$47,234 - $49,051[c]	8.34-9.5	Yes

[a] Original recorded costs: Brown & Birkmeyer 2005 dollars; Chapman 2006 dollars
[b] Costs inflated using the US Bureau of Labor Statistics average Consumer Price Index
[c] VA Decision Support System costs reported separately for saphenous vein and radial artery bypass surgery, respectively

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