

Appendix

Methods for estimating standardized costs

Carrier file utilization

Under the prospective payment system, for each calendar year Medicare establishes a base payment for each item of outpatient utilization, called a conversion factor. (Medicare Advisory Payment Commission (MedPAC), 2012) Medicare assigns each unit of service a different Healthcare Common Procedure Coding System (HCPCS) code, and a Relative Value Unit (RVU) to that code that reflects the intensity of resources necessary to deliver that unit of service. (Glass and Anderson 2002a, 2002b, 2002c)

The RVUs are divided into three components:

1. The work RVU value that reflects the extent of work and level of skill required for the physician to provide that service;
2. The practice expense RVU value reflecting the required capital and other labor inputs for that service; and
3. The malpractice RVU value.

Medicare adjusts the component RVU values are adjusted for local geographic differences in capital and labor price inputs, and malpractice insurance costs. (Medicare Payment Advisory Commission (MedPAC), 2012) For a minority of HCPCS codes, Medicare assigns different practice expense (RVU) values according to whether or not the outpatient service was provided in certain facilities such as hospitals, or in physician offices. The total payment to the provider (Medicare payment plus patient copayment and deductible) is the

sum of the three geographically adjusted component RVU values multiplied by the conversion factor for that calendar year.

On its website, CMS has RVU value files for each calendar year from 2003 onward that provide the component RVU values before geographic adjustment for each HCPCS code.(Centers for Medicare and Medicaid Services 2012b) We calculated the standardized cost for each Carrier items of utilization as the sum of the three unadjusted RVU values for the relevant HCPCS code for that calendar year multiplied by the conversion factor.

Medicare pays for outpatient laboratory tests under the Clinical Laboratory Fee Schedules, which lists the national standardized cost for each laboratory HCPCS code.(Centers for Medicare and Medicaid Services 2013) We used these to assign standardized costs to each unit of utilization representing a clinical laboratory test. Medicare pays for ambulance services under a different fee schedule that reflects the distance over which the patient had to be transported. A geographic adjustment factor (GAF) is applied by CMS to 70% and 50%, respectively, of the unadjusted payment total for ground and air ambulances.(Centers for Medicare and Medicaid Services 2014a) Therefore, we calculated the standardized costs for ground and air ambulance services, respectively, to be;

$$\text{Standardized Cost} = \text{Payment}_{\text{ADJUSTED}} / (0.7 * \text{GAF} + 0.3); \quad [\text{Equation 1}]$$

and;

$$\text{Standardized Cost} = \text{Payment}_{\text{ADJUSTED}} / (0.5 * \text{GAF} + 0.5). \quad [\text{Equation 2}]$$

Ambulance fee schedules are available on the CMS website for each calendar year 2004 through 2010 that list the GAF for all carriers and locality codes in the United States.

Outpatient Standard Analytic File (SAF)

Under the Hospital OPPS, Medicare assigns each of the HCPCS codes into one of several hundred ambulatory payment classifications (APC), and assigns standard Medicare payment and patient co-insurance amounts for the entire United States for each APC. (Medicare Payment Advisory Commission (MedPAC), 2011) Hospital OPPS files with the relative weights, Medicare standard payment, and patient co-insurance payment amounts (before geographic adjustment) are available on the CMS website from 2004 onward. (Centers for Medicare and Medicaid Services 2014b)

Medicare pays for some ambulatory surgery center claims in the Outpatient SAF under yet a different mechanism, and CMS ambulatory surgery center payment files list standard payment amounts before geographic adjustment. (Centers for Medicare and Medicaid Services 2012a) Medicare pays for laboratory test claims in the Outpatient SAF using the Clinical Laboratory Fee schedule. For each item of utilization in the Outpatient SAF, we estimated standardized costs to be the nationally assigned price from the appropriate reference file (Hospital OPPS, Ambulatory Surgery Center, or Clinical Laboratory Fee Schedule).

Additional Results

Although we found spearman rank correlations of standardized costs with allowable charges and billed charges to be high in all calendar years (**Appendix Figure 1**), scatterplots showed some discordant Outpatient SAF high standardized costs and allowable charges

(Appendix Figure 1B). Billed charges were nearly always higher than standardized costs (shown for calendar year 2005 in **Appendix Figure 1C and 1D**).

The differences between standardized costs and allowable charges, and between standardized costs and billed charges are consistent across all calendar years 2004 through 2010 for total outpatient costs (**Appendix table 2a**), Carrier file costs, (**Appendix table 2b**), and OP-SAF costs (**Appendix table 2c**). In each calendar year, we found Carrier file costs to be roughly twice what they are in the OP-SAF, and billed charges to be more than twice allowable charges. We found the change in rank order quintile when using standardized costs instead of allowable charges or billed charges to be consistent across all seven calendar years for both Carrier file and OP-SAF utilization (**Appendix tables 3a, 3b, and 3c**). The change in rank order quintile when using Outpatient SAF standardized costs rather than allowable charges (20 to 25% change rank order) is in between what we saw with Carrier file utilization (7% to 8% change rank order) and inpatient utilization (50% change rank order). (Schousboe 2014a).

Appendix References

Centers for Medicare and Medicaid Services. 2012a. "ASC Payment Rates Archive Page" [accessed on Jan 31, 2014, 2012a]. Available at: <http://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/ASCPayment/archive.html>.

Centers for Medicare and Medicaid Services. 2012b. "PFS Relative Value Files" [accessed on December 1, 2012b]. Available at: <http://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/PhysicianFeeSched/PFS-Relative-Value-Files.html>.

Centers for Medicare and Medicaid Services. 2013. "Clinical Laboratory Fee Schedule" [accessed on 2/1/2014, 2013]. Available at: <http://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/ClinicalLabFeeSched/index.html>.

Centers for Medicare and Medicaid Services. 2014a. "Ambulance Fee Schedule" [accessed on Mar 1, 2014, 2014a]. Available at: <http://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/AmbulanceFeeSchedule/index.html>.

Centers for Medicare and Medicaid Services. 2014b. "Hospital Outpatient PPS" [accessed on February 1, 2014, 2014b]. Available at: <http://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/HospitalOutpatientPPS/index.html>.

Medicare Advisory Payment Commission (MedPAC), 2012. "Physicians and Other Health Professionals Payment System." Washington, D.C.

Glass, K. P. and J. R. Anderson. 2002a. "Relative value units and cost analysis, Part 3 of 4." *J Med Pract Manage* 18(2): 66-70.

Glass, K. P. and J. R. Anderson. 2002b. "Relative value units and productivity: Part 2 of 4." *J Med Pract Manage* 17(6): 285-90.

Glass, K. P. and J. R. Anderson. 2002c. "Relative value units: from A to Z (Part I of IV)." *J Med Pract Manage* 17(5): 225-8.

Medicare Payment Advisory Commission (MedPAC), 2011. "Outpatient Hospital Services Payment System." Washington, D.C.

Appendix Table 1a: Total Allowable Charges and Standardized Costs (Carrier plus OP-SAF) for 2004 through 2010

Year	Standardized Costs Median (IQR)	Provider Payments* Median (IQR)	Billed Charges^ Median (IQR)	Difference Std Costs vs. Allowed Chrgs Median (IQR)	Difference Standard Costs vs. Billed Charges Median (IQR)
2004 (n=3096)	\$2,276 (887 – 4643)	\$2,205 (861 – 4504)	\$4,591 (1727 – 10005)	\$28 (-67 to 256)	-\$2,211 (-5272 to -695)
2005 (n=2623)	\$2,243 (882 to 4469)	\$2,248 (871 to 4473)	\$4,963 (1869 to 10462)	\$23 (-92 to 223)	-\$2,552 (-5894 to -873)
2006 (n=2560)	\$2,194 (888 – 4508)	\$2,185 (883 – 4466)	\$4,788 (1855 – 10430)	\$16 (-113 to 194)	-\$2,393 (-5772 to -815)
2007 (n=2298)	\$2,396 (981 – 4897)	\$2,333 (936 – 4599)	\$5,288 (2031 – 1193)	\$74 (-18 to 337)	-\$2,689 (-6142 to -922)
2008 (n=2033)	\$2,283 (1011 – 4667)	\$2,191 (941 – 4531)	\$5,188 (2108 – 11263)	\$80 (-10 to 307)	-\$2,769 (-6347 to -968)
2009 (n=1761)	\$2,242 (953 – 4809)	\$2,361 (939 – 5068)	\$5,229 (2059 – 11602)	-\$0 (-226 to 85)	-\$2,736 (-6441 to -966)
2010 (n=1571)	\$2,323 (906 – 5036)	\$2,476 (920 – 5270)	\$5,512 (2145 – 12020)	\$2 (-238 to 79)	-\$2,844 (-7009 to -940)

Appendix Table 1b: Carrier Allowable Charges and Standardized Costs for 2004 through 2010

Year	Standardized Costs Median (IQR)	Provider Payments* Median (IQR)	Billed Charges^ Median (IQR)	Difference Standard Costs vs. Payments Median (IQR)	Difference Standard Costs vs. Billed Charges Median (IQR)
2004 (n=2885)	\$1,604 (695 – 3,262)	\$1,587 (682 – 3,132)	\$3,170 (1273 – 6881)	-\$9 (-70 to 37)	-\$1,484 (-3667 to -485)
2005 (n=2623)	\$1,696 (711 – 3353)	\$1,683 (693 – 3353)	\$3,404 (1319 – 7221)	-\$9 (-69 to 41)	-\$1,627 (-3833 to -562)
2006 (n=2323)	\$1,662 (677 – 3375)	\$1,673 (666 – 3356)	\$3,456 (1325 – 7401)	-\$5 (-67 to 52)	-\$1,723 (-3924 to -591)
2007 (n=2084)	\$1,844 (748 – 3712)	\$1,738 (688 – 3483)	\$3,708 (1435 – 7750)	-\$79 (-234 to -10)	-\$1,762 (-4083 to -640)
2008 (n=1831)	\$1,733 (769 – 3487)	\$1,599 (716 – 3278)	\$3,610 (1511 – 7294)	-\$89 (-251 to -23)	-\$1,764 (-3850 to -604)
2009 (n=1577)	\$1,732 (756 – 3584)	\$1,743 (756 – 3649)	\$3,590 (1514 – 7616)	-\$7 (-62 to 50)	-\$1,741 (-3981 to -657)
2010 (n=1414)	\$1,790 (777 – 3881)	\$1,784 (761 – 3920)	\$3,594 (1558 – 8210)	-\$14 (-77 to 41)	-\$1,684 (-4182 to -658)

*Spearman rank correlation with standardized costs is 0.99 in all years.

^Spearman rank correlation with standardized costs is 0.98 in years 2004 thru 2006, and 0.97 in years 2007 through 2010.

Appendix Table 1c: OP-SAF Allowable Charges and Standardized Costs for 2004 through 2010*

Year	Standardized Costs Median (IQR)	Allowable Charges* Median (IQR)	Billed Charges^ Median (IQR)	Difference Standard Costs vs. Payments Median (IQR)	Difference Standard Costs vs. Billed Charges Median (IQR)
2004 (n=2445)	\$804 (243 – 1,823)	\$711 (224 – 1,690)	\$1,629 (540 – 4069)	-\$37 (-271 to 36)	-\$654 (-2156 to -151)
2005 (n=2235)	\$722 (226 – 1822)	\$681 (225 – 1,725)	\$981 (104 to 3567)	-\$31 (-232 to 47)	-\$437 (-2066 to 0)
2006 (n=1967)	\$770 (248 – 1728)	\$758 (255 – 1723)	\$1,656 (564 – 4180)	-\$18 (-185 to 87)	-\$779 (-2466 to -182)
2007 (n=1782)	\$782 (240 – 1897)	\$790 (257 – 1874)	\$1,807 (587 – 4914)	-\$19 (-185 to 82)	-\$865 (-3036 to -203)
2008 (n=1568)	\$790 (245 – 1947)	\$785 (256 – 1929)	\$2,065 (689 – 5344)	-\$11 (-137 to 110)	-\$1,047 (-3247 to -261)
2009 (n=1370)	\$761 (240 – 1809)	\$848 (253 – 2050)	\$1,981 (619 – 11797)	\$1 (-57 to 252)	-\$1,104 (-3379 to -231)
2010 (n=1230)	\$723 (219 – 1776)	\$789 (223 – 2079)	\$2,090 (647 to 5652)	\$1 (-40 to 273)	-\$1,216 (-3768 to -277)

*Spearman rank correlation between provider payments and standardized costs is 0.96 in all years

Appendix Table 2a: Change of Rank Order (Quintile) When Ranking by Standardized Costs instead of Allowable or Billed Charges (Total Outpatient Costs)

	Calendar Year	Change of Quintile (percent)				
		-2	-1	No Change	+1	+2
Standardized Costs vs. Allowable Charges	2004 (n=3096)	0.1%	6.2%	87.4%	6.2%	0.0%
	2005 (n=2623)	0.2%	5.7%	88.1%	5.9%	0.1%
	2006 (n=2560)	0.1%	6.6%	86.4%	6.8%	0.0%
	2007 (n=2298)	0.1%	5.7%	88.2%	6.0%	0.0%
	2008 (n=2033)	0.2%	5.6%	88.1%	6.0%	0.0%
	2009 (n=1761)	0.0%	6.0%	88.0%	5.9%	0.1%
	2010 (n=1571)	0.1%	5.7%	88.3%	5.9%	0.0%
Standardized Costs vs. Billed Charges	2004 (n=3096)	0.8%	12.9%	72.7%	13.4%	0.1%
	2005 (n=2623)	0.6%	11.8%	74.8%	12.7%	0.1%
	2006 (n=2560)	0.6%	11.3%	75.3%	12.8%	0.0%
	2007 (n=2298)	0.7%	11.7%	74.4%	13.0%	0.2%
	2008 (n=2033)	0.7%	12.1%	73.0%	13.8%	0.1%
	2009 (n=1761)	1.4%	13.8%	70.8%	15.4%	0.0%
	2010 (n=1571)	1.8%	12.2%	69.1%	16.6%	0.0%

Appendix Table 2b: Change of Rank Order (Quintile) When Ranking by Standardized Costs instead of Allowable or Billed Charges (Carrier File)

	Calendar Year	Change of Quintile (percent)				
		-2	-1	No Change	+1	+2
Standardized Costs vs. Allowable Charges	2004 (n=2885)	0.0%	3.5%	93.0%	3.5%	0.0%
	2005 (n=2623)	0.0%	3.7%	92.5%	3.7%	0.0%
	2006 (n=2323)	0.0%	3.9%	92.2%	3.9%	0.0%
	2007 (n=2084)	0.1%	4.0%	91.6%	4.2%	0.0%
	2008 (n=1831)	0.0%	3.8%	92.5%	3.8%	0.0%
	2009 (n=1577)	0.0%	3.2%	93.5%	3.2%	0.0%
	2010 (n=1414)	0.0%	4.0%	92.1%	4.0%	0.0%
Standardized Costs vs. Billed Charges	2004 (n=2885)	0.2%	10.3%	79.1%	10.3%	0.1%
	2005 (n=2623)	0.0%	10.3%	79.2%	10.4%	0.0%
	2006 (n=2323)	0.2%	9.9%	79.5%	10.4%	0.0%
	2007 (n=2084)	0.1%	11.4%	76.9%	11.6%	0.1%
	2008 (n=1831)	0.2%	11.1%	77.3%	11.4%	0.0%
	2009 (n=1577)	0.2%	11.8%	75.6%	12.3%	0.0%
	2010 (n=1414)	0.2%	11.5%	76.4%	11.9%	0.0%

Appendix Table 2c: Change of Rank Order (Quintile) When Ranking by Standardized Costs instead of Allowable or Billed Charges (OP-SAF)

	Calendar Year	Change of Quintile (percent)				
		-2	-1	No Change	+1	+2
Standardized Costs vs. Allowable Charges	2004 (n=2445)	0.8%	10.6%	76.8%	11.7%	0.1%
	2005 (n=2235)	0.8%	10.6%	76.4%	11.9%	0.1%
	2006 (n=1967)	1.1%	11.2%	74.3%	12.9%	0.2%
	2007 (n=1782)	1.1%	10.3%	75.8%	12.6%	0.1%
	2008 (n=1568)	0.7%	9.2%	78.6%	11.1%	0.1%
	2009 (n=1370)	1.0%	8.8%	79.9%	10.0%	0.2%
	2010 (n=1230)	1.0%	9.8%	77.7%	11.3%	0.1%
Standardized Costs vs. Billed Charges	2004 (n=2445)	2.5%	18.6%	59.5%	16.7%	1.8%
	2005 (n=2235)	1.7%	16.9%	61.7%	17.8%	1.6%
	2006 (n=1967)	2.3%	17.2%	60.4%	18.3%	1.6%
	2007 (n=1782)	1.7%	18.0%	59.8%	18.5%	1.8%
	2008 (n=1568)	1.7%	19.2%	56.2%	20.8%	1.6%
	2009 (n=1370)	1.8%	17.7%	59.6%	19.8%	0.9%
	2010 (n=1230)	0.1%	2.4%	56.0%	21.5%	1.1%

Table 3a: Associations of Predictors with Carrier Standardized Costs and Allowable Charges for 2005 (n = 1388)

Predictor	(Mean [sd] or N (%))	Parameter Estimates		Parameter difference, p-value ^{&}
		Log Standardized Costs	Log Allowable Charges	
Age	85.7 years (3.6)	-0.058* (-0.136 to 0.020)	-0.061* (-0.139 to 0.017)	0.35
Race	Black: 181 (13.0%) White: 1,207 (87.0%)	-0.031^ (-0.199 to 0.137)	-0.030^ (-0.200 to 0.139)	0.91
Femoral Neck BMD	0.639 g/cm ² (0.122)	0.032** (-0.024 to 0.088)	0.032** (-0.024 to 0.089)	0.75
GDS Score (0-15)	2.23 (2.92)	0.095** (0.042 to 0.147)	0.091** (0.038 to 0.144)	0.13
Prior Clinical Fracture	No: 629 (45.3%) Yes: 759 (54.7%)	0.119^^ (0.010 to 0.228)	0.121^^ (0.011 to 0.230)	0.71

*Number log(costs) standard deviation changes per 5 year increase in age

^Number log(costs) standard deviation changes black compared to white

**Number of log(costs) standard deviation changes per standard deviation increase of predictor

^^Number of log(costs) standard deviation changes prior fracture compared to no prior fracture

&Wald Chi test of hypothesis that the parameter coefficients for that predictor or the same; considering all parameters together, $\chi^2 = 4.72$, p-value=0.45

Appendix Table 3b: Associations of Predictors with Carrier Standardized Costs and Billed Charges for 2005 (n = 1388)

Predictor	(Mean [sd] or N (%))	Parameter Estimates		Parameter difference, p-value ^{&}
		Log Standardized Costs	Log Billed Charges	
Age	85.7 years (3.6)	-0.058* (-0.136 to 0.020)	-0.080* (-0.157 to -0.002)	0.002
Race	Black: 181 (13.0%) White: 1,207 (87.0%)	-0.031^ (-0.199 to 0.137)	0.028^ (-0.140 to 0.196)	0.001
Femoral Neck BMD	0.639 g/cm ² (0.122)	0.032** (-0.024 to 0.088)	0.042** (-0.014 to 0.098)	0.04
GDS Score (0-15)	2.23 (2.92)	0.095** (0.042 to 0.147)	0.089** (0.036 to 0.141)	0.90
Prior Clinical Fracture	No: 629 (45.3%) Yes: 759 (54.7%)	0.119^^ (0.010 to 0.228)	0.138^^ (0.029 to 0.247)	0.03

*Number log(costs) standard deviation changes per 5 year increase in age

^Number log(costs) standard deviation changes black compared to white

**Number of log(costs) standard deviation changes per standard deviation increase of predictor

^^Number of log(costs) standard deviation changes prior fracture compared to no prior fracture

&Wald Chi test of hypothesis that the parameter coefficients for that predictor or the same; considering all parameters together, $\chi^2 = 38.4$, p-value= <0.001

Table 4a: Associations of Predictors with OP-SAF Standardized Costs and Allowable Charges for 2005* (n=1208)

Predictor	Distribution of Predictor, (Mean [SD] or N (%))	Parameter Estimates (95% C.I.)		Parameter difference, p-value ^{&}
		Log Standardized Costs	Log Allowable Charges	
Age	85.9 years (3.6)	-0.140* (-0.225 to -0.056)	-0.138* (-0.221 to -0.055)	0.90
Race	Black: 153 (12.7%) White: 1,055 (87.3%)	0.093 (-0.089 to 0.275)	0.138 (-0.042 to 0.317)	0.10
Femoral Neck BMD	0.642 g/cm ² (0.125)	0.026 (-0.032 to 0.084)	0.040 (-0.017 to 0.098)	0.07
GDS Score (Scale 0-15)	2.30 (2.61)	0.044 (-0.012 to 0.100)	0.034 (-0.021 to 0.089)	0.22
Prior Clinical Fracture	No: 534 (44.2%) Yes: 674 (55.8%)	0.172 (0.055 to 0.288)	0.174 (0.059 to 0.290)	0.81

*Number log(costs) standard deviation changes per 5 year increase in age

^Number log(costs) standard deviation changes black compared to white

**Number of log(costs) standard deviation changes per standard deviation increase of predictor

^^Number of log(costs) standard deviation changes prior fracture compared to no prior fracture

&Wald chi² for test of hypothesis that the parameter coefficients for that predictor are the same; considering all parameters together, chi² = 7.52, p-value=0.18

Appendix Table 4b: Associations of Predictors with OP-SAF Standardized Costs and Billed Charges for 2005 (n = 1208)

Predictor	(Mean [sd] or N (%))			Parameter difference, p-value ^{&}
		Log Standardized Costs	Log Billed Charges	
Age	85.9 years (3.6)	-0.140* (-0.225 to -0.056)	-0.132 (-0.22 to -0.05)	0.79
Race	Black: 153 (12.7%) White: 1,055 (87.3%)	0.093 (-0.089 to 0.275)	0.132 (-0.050 to 0.315)	0.28
Femoral Neck BMD	0.642 g/cm ² (0.125)	0.026 (-0.032 to 0.084)	0.030 (-0.28 to 0.89)	0.68
GDS Score (0-15)	2.30 (2.61)	0.044 (-0.012 to 0.100)	0.065 (0.01 to 0.12)	0.06
Prior Clinical Fracture	No: 534 (44.2%) Yes: 674 (55.8%)	0.172 (0.055 to 0.288)	0.131 (0.014 to 0.250)	0.13

*Number log(costs) standard deviation changes per 5 year increase in age

^Number log(costs) standard deviation changes black compared to white

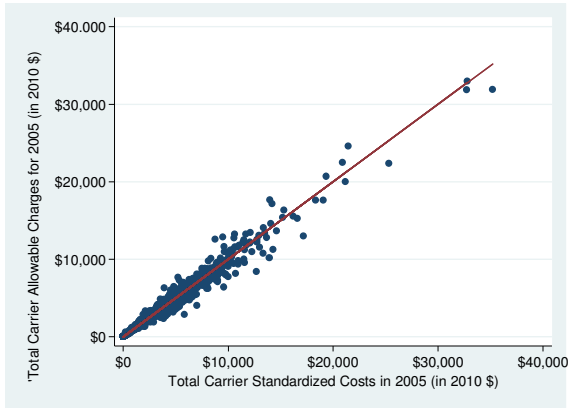
**Number of log(costs) standard deviation changes per standard deviation increase of predictor

^^Number of log(costs) standard deviation changes prior fracture compared to no prior fracture

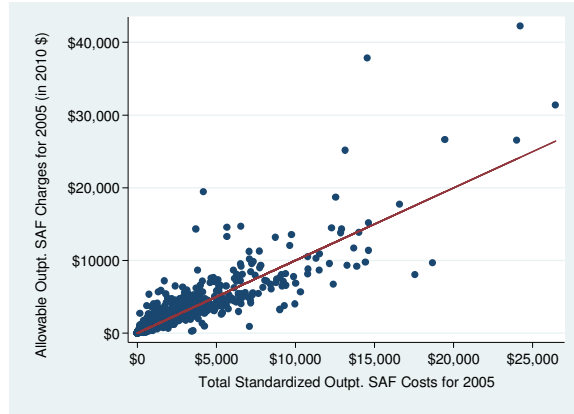
&Wald Chi test of hypothesis that the parameter coefficients for that predictor or the same; chi2 8.74, p-value=0.12

Appendix Figure 1: Scatterplots of Standardized Costs, Provider Payments, and Billed Charges in Carrier File and Outpatient SAF for Calendar Year 2005

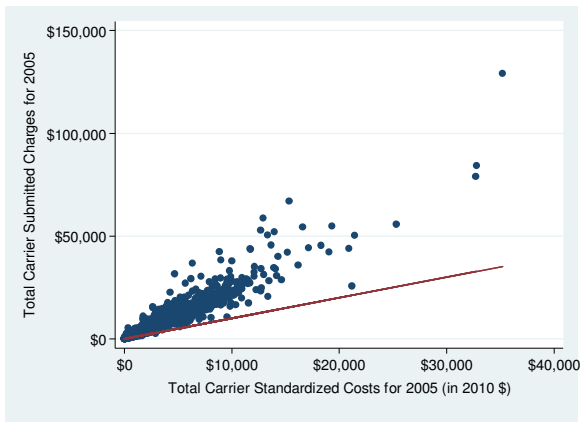
A. Carrier Standardized Costs and Provider Payments



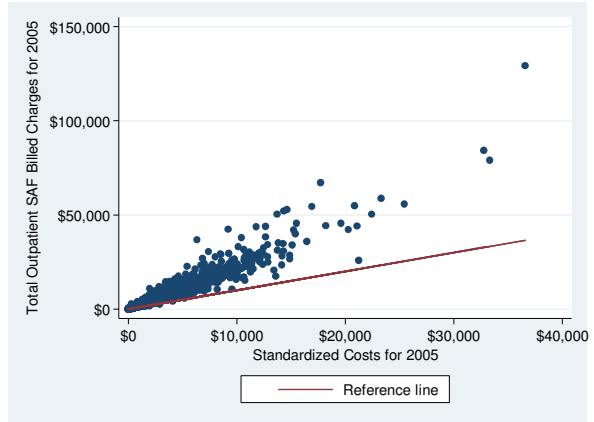
B. Outpatient SAF Standardized Costs and Provider Payments



C. Carrier File Standardized Costs and Billed Charges



D. Outpatient SAF Standardized Costs and Billed Charges



***Individual SOF participants are the unit of analysis. Dots may represent more than one individ**