Memo

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From: Kevin Quinn
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Control No. W563

RE: Applicability of Hospital Specific Relative Value (HSRV) DRG Weights

All information in this memorandum is in the public domain and may be shared as appropriate.

Summary

This memo describes the purpose of DRG relative weights, the rationale for moving away from charge-based weights, the calculation of hospital specific relative value (HSRV) weights as a more accurate alternative, and adoption of HSRV weights by other payers. An appendix includes an example of HSRV calculations.

The Purpose of DRG Relative Weights

The essence of payment by diagnosis related groups is to set "a price for a product," where the "product" is hospital inpatient treatment for a medical or surgical condition.[1] For each DRG, the base payment equals:

DRG base rate x DRG relative weight = DRG base payment

Because the base payment does not depend on a hospital's own charges or cost, the hospital has an incentive to provide care efficiently. And because the relative weights are higher for patients who are likely to be more costly, DRG payment promotes access across the full spectrum of patients.

Ideally, relative weights and therefore base payment rates would be in perfect parallel with the hospital costs for each DRG, so that any particular DRG would be neither more nor less profitable than any other DRG. In practice, the challenge is to operationalize the calculation of relative weights.

DRG Relative Weights Used by Medi-Cal

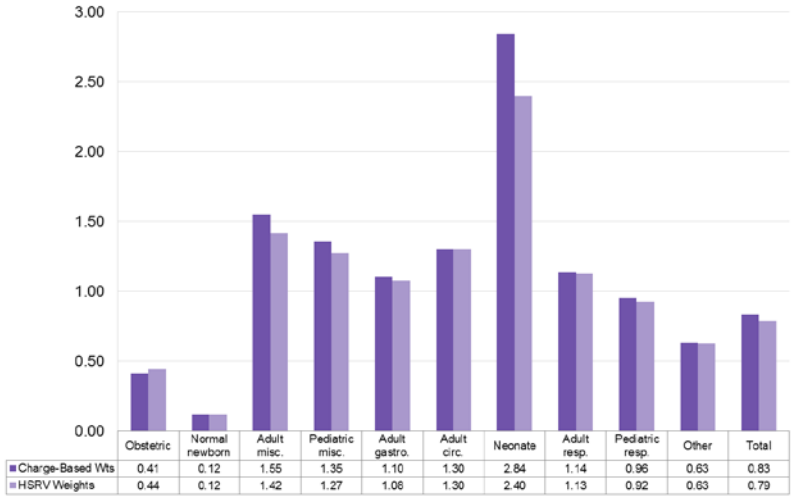
In FY 2013-14 and FY 2014-15, Medi-Cal used national charge-based APR-DRG weights as calculated by 3M Health Information Systems. The data source is the all-payer National Inpatient Sample (formerly the Nationwide Inpatient Sample) compiled by the Agency for Healthcare Research and Quality. The dataset for calculating relative weights includes 15 million hospital stays, including California discharge data from the Office for Statewide Health Policy and Development. In our earlier analysis, we found that the national weights fit the California data well.[2] Medi-Cal's use of the national weights obviates the need for the expensive and time-consuming process of calculating

state-specific weights. The national weights also display more statistical stability than would state-specific weights, even in a state the size of California.[3]

Effective October 1, 2012, 3M began releasing two sets of relative weights, one set calculated using charge-based weights and one set adjusted for differences in charge-setting practices.[4] The latter set is referred to as hospital-specific relative value (HSRV) weights. Note that the terminology can be confusing; despite the term "hospital-specific," there is just one single set of national HSRV weights. Different weights are not calculated for different hospitals.

Charge-based and HSRV weights are very similar in rank order and magnitude by DRG but the HSRV weights are more accurate reflections of relative cost. For Medicaid programs, the most important differences between the two sets of weights are that HSRV weights are higher than charge-based weights for obstetrics and normal newborns but lower than charge-based weights for the neonate (sick newborn) care category. See Chart 1, which uses Medi-Cal fee-for-service data for FY 2013-14 to show the differences in casemix by care category.

Chart 1
Casemix by Medicaid Care Category



	Obstetric	Normal newborn	Adult misc.	Pediatric misc.	Adult gastro.	Adult circ.	Neonate	Adult resp.	Pediatric resp.	Other	Total
Charge-Based Wts	0.41	0.12	1.55	1.35	1.10	1.30	2.84	1.14	0.96	0.63	0.83
HSRV Weights	0.44	0.12	1.42	1.27	1.06	1.30	2.40	1.13	0.92	0.63	0.79

For this chart, 403,927 Medi-Cal fee-for-service stays from FY 2013-14 were grouped first to APR-DRG V.31 using charge-based weights and then to V.32 using HSRV weights. Since the DRG grouping logic is identical between V.31 and V.32, the differences in

For FY 2015-16, DHCS has decided to adopt the national HSRV relative weights recently made available by 3M. This memo explains the background of HSRV weights, describes usage by other payers, and shows an example of HSRV calculation.

Calculation of Relative Weights

Ever since Medicare introduced DRG payment in 1983, the most common approach has been to calculate relative weights using hospital charges. Charges have the great advantage of being readily available on submitted claims for individual patients, without any need for compiling and auditing cost data or performing elaborate calculations. As well, in 1983 hospital charges and costs were much closer to each other than they are today, so relative charges were a more accurate proxy for relative costs than is true today.

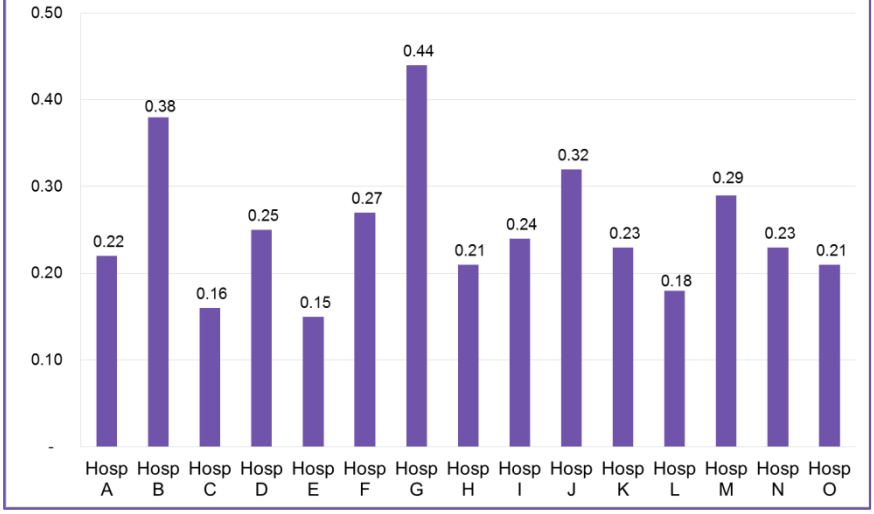
Trends in Hospital Charges

Over the past 35 years, one of the most pronounced trends in the hospital industry has been the decline in cost-to-charge ratios (CCRs). That is, hospitals nationwide have consistently increased charges faster than costs. Between 1994 and 2013, for example, the national CCR fell from 59% to 30%.[5] The CCR is the inverse of the charge-to-cost markup; in other words the typical hospital went from charging $168 for every $100 in cost in 1994 to charging $331 for every $100 in cost in 2013. For inpatient care specifically, California hospitals went from charging $203 for every $100 of cost in 1992 to charging $474 for every $100 in cost in 2011.[6] To its credit, the California Hospital Association has launched an initiative to assist hospitals that want to make their charges more reasonable and transparent.[7] Nevertheless, at the present time it is fair to conclude that hospital charges nationwide have lost credibility as a measure of what goes on within a hospital, as summarized in the title of an oft-cited *Health Affairs* article: "The Pricing of U.S. Hospital Services: Chaos Behind a Veil of Secrecy."[8]

Increased Variability in Charges

The CCR changes have not been uniform. Some hospitals have been much more aggressive in raising charges than others. Chart 2 shows CCRs for 15 large hospitals that serve Medi-Cal; the hospitals with the lowest CCRs have been the most aggressive in setting charges. Of these 15, the CCR at Hospital E is one-third that of Hospital G. (CCRs are public information, but we have not listed names in order to keep the focus on the issue of charge levels overall.) California is not unusual; the same chart looks much the same at the national level.[9]

Chart 2
Cost-to-Charge Ratios for 15 Large Medi-Cal DRG Hospitals



Distortions in Relative Weights

Hospitals can have very different CCRs. Moreover, these differences tend not to be random. Though there are many exceptions, as a general statement large urban hospitals that treat complex patients tend to have lower CCRs than smaller community hospitals that treat more typical patients. The use of charge-based weights therefore means that weights tend to be too high for DRGs that are more often treated in large urban hospitals and too low for DRGs that are treated in smaller community hospitals .

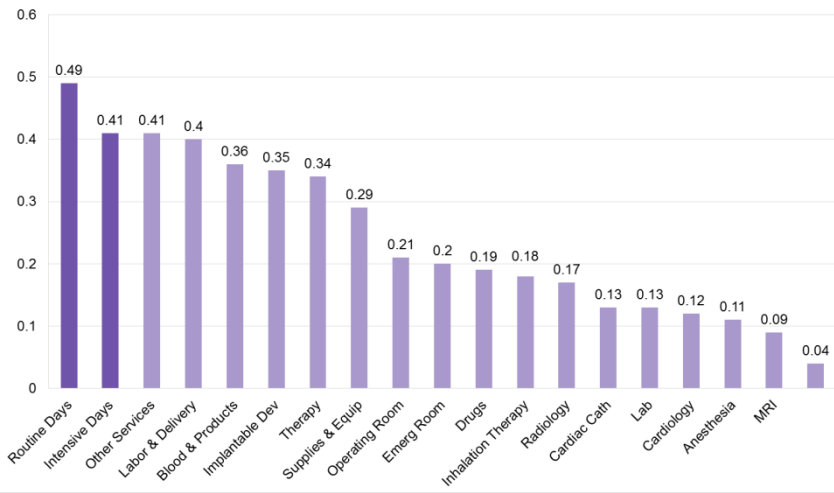
Section A of the Appendix shows 10 stays at three hospitals. By construction, the average cost of DRG 1 is $3,000 and the average cost of DRG 2 is $1,000. Since there are five stays for each DRG, the cost-based weights would be 1.50 for DRG 1 and 0.50 for DRG 2. Of the three hospitals, one has a low CCR (20%), one has a medium CCR

(30%) and one has a high CCR (40%). The charge-based weights end up being 1.62 for DRG 1 and 0.38 for DRG 2.

CCR Differences by Cost Center

As well, hospitals very typically have different CCRs for different services. Chart 3, drawing on national Medicare data, shows that CCRs for routine "room and board" services codes are much higher than CCRs for ancillary services. That is, hospital charges are twice as high as cost for routine bed services but 25 times higher than cost for CT scans. A hospital's overall CCR of, say 30%, therefore reflects a mix of high CCRs for routine services and low CCRs for ancillary services.

Chart 3
National CCRs by Hospital Cost Center



If all patients used the same mix of services, then differences in CCRs by revenue code would not matter. However, many medical and psychiatric patients predominantly use routine services, which means that using a single hospital-wide CCR underestimates the cost of their care. Many surgical patients, on the other hand, predominantly use ancillary services, which means that using a single hospital-wide CCR overestimates the cost of their care. Use of a single hospital-wide CCR remains a very useful way to estimate hospital cost and Medicaid pay-to-cost ratios, but the prevalence of different mixes of routine and ancillary revenue codes is a main reason why limited significance should be inferred from small differences in estimated cost between care categories.

Do Distortions in Relative Weights Matter?

Yes—especially over time. When distortions in relative weights cause profit margins to be noticeably and predictably higher for some DRGs than for others, some hospitals will tend to favor those DRGs. They will build capacity, recruit the relevant specialists, and advertise their expertise in the most profitable DRGs.[10] The most studied example is cardiac surgery. In the Medicare program – which is of course the single largest payer for cardiac care – the cardiac surgical patients were found to be much more profitable than medical cardiac patients and much more profitable than the average Medicare patient overall.[11] The impact of distorted DRG rates was considered more important than cost efficiencies in prompting the growth in specialty cardiac hospitals, which multiplied so quickly that in 2003 Congress established a moratorium on enrolling new cardiac specialty hospitals in Medicare.

For Medicare, the accuracy of relative weights is a particular concern in the care categories where hospitals are most likely to respond to Medicare payment incentives, such as cardiology, orthopedics, and gastroenterology. For Medicaid, the obvious analogues are obstetrics, sick babies, and complex pediatrics.

Options for Improvement

The problems with charge-based weights have been recognized since the beginnings of DRG payment[12] but have attracted more attention as the gaps between charges and cost have become larger and more variable.

Based in large part of its analysis of specialty hospitals, in 2005 the influential Medicare Payment Advisory Commission (MedPAC) recommended that Medicare move from its traditional charge-based relative weights to hospital-specific relative value (HSRV) weights.[13] CMS did not end up taking that recommendation. Effective October 1, 2007, Medicare instead moved from charge-based weights to calculating weights by multiplying line-level charges times a single set of national CCRs. To use the numbers in Chart 2 as an example, every hospital's routine bed charges would be multiplied by 49% and every hospital's CT charges would be multiplied by 4%. For each stay, the result would be an estimate of cost. The relative weight for any particular DRG would then be the average estimated cost for the stays in that DRG relative to the estimated cost for the average Medicare stay overall. The Medicare method is described in the DRG final rule published each August.[14]

Regardless of the merits of Medicare's decision, the Medicare model is not feasible for Medi-Cal and other Medicaid programs that use APR-DRGs. Using the Medicare DRG algorithm is demonstrably inappropriate for a Medicaid population.[15] For calculating APR-DRG relative weights, the National Inpatient Sample is by far the most appropriate source. The National Inpatient Sample, however, does not show charges at the line level. That is, it only shows charges for the whole stay, not charges broken out by the cost centers in Chart 2. Another possibility would be to multiply header-level charges by a hospital-specific CCR, but that would require matching NIS records to hospital cost reports, which is possible but challenging.

Instead, 3M has calculated HSRV relative weights as a way to control for differences in hospital-wide CCRs without the need for an outside data source such as hospital cost reports. Recall that the problem with charge-based weights is that a $15,000 charge at a hospital with high charges has more impact on a relative weight than a $10,000 charge at a hospital with low charges, even if the underlying cost of care was $3,000 at both hospitals. The essential idea behind HSRV is to calculate charge-based relative values within a hospital, then combine the hospital-specific relative values across different hospitals. That is, we look at the ratio of charges for DRG 1 to charges for DRG 2 for each hospital, regardless of the actual dollar values of charges.

If all hospitals had the same mix of DRGs, this would be a straightforward calculation. But they don't, of course. Casemix differs across hospitals, and some hospitals have higher average charges because they have higher casemix. We therefore "allow" higher average charges at hospitals with higher casemix. Now, circularity becomes a potential issue, because casemix is taken into account when calculating relative weights. (Casemix is a synonym for average relative weight.) Calculations of HSRV weights overcome this problem in one of two ways. The first method is to iterate toward a stable solution. The other is to estimate a regression equation. The calculations are most easily understood through a simple example, as shown in the appendix.

Conclusion

As noted above, absolute accuracy in calculation of relative weights is unachievable. However, relative weights can be more or less accurate in the extent to which they reflect hospital costs rather than more artificial magnitudes such as charges. The closer that Medi-Cal and other Medicaid programs can get to accurate relative weights, the more likely that hospital behavior will not be driven by differences in profitability across DRGs that were not intended by the payer.

HSRV weights are recommended by 3M (the developers of APR-DRGs and the Medicare contractor for DRG payment) and by Xerox. HSRV weights are currently used by Medicare for long-term acute care hospitals, by Maryland in its unique all-payer ratesetting system, and by the Medicaid programs in Mississippi, Montana, and New York. (Mississippi and Montana are also Xerox clients.)

We would be pleased to provide any further information you would like.

Notes

[1] Kevin Quinn, "After the Revolution: DRGs at Age 30," *Annals of Internal Medicine* 160:6 (March 18, 2014), pp. 426-429.
[2] Xerox State Healthcare, *Medi-Cal DRG Project Policy Design Document,* Report to the California Department of Health Care Services (West Sacramento, CA: Xerox, September 2013), p.40.
[3] *Policy Design Document,* §2.5.
[4] This memorandum draws on a technical memorandum by Richard Fuller of 3M, *Overview to the Design and Application of HSRV Log Weights*
[5] Xerox calculations from American Hospital Association, *Hospital Statistics,* 2000 and 2015 editions. The figures refer to inpatient and outpatient care combined, but the same trends have been observed for inpatient and outpatient care separately.
[6] Richard L. Fuller, *An Analysis of the Real Price Effects Resulting from Charge Setting Practices in the U.S. Hospital Sector,* Report to the Jayne Koskinas Ted Giovanis Foundation for Health and Policy, 2015.
[7] California Hospital Association, *Modern Pricing: Clarifying Hospital Charges for Consumers* (Sacramento, CA: CHA, May 2014).
[8] Uwe Reinhardt, "The Pricing of U.S. Hospital Services: Chaos Behind a Veil of Secrecy," *Health Affairs* 25:1 (January-February 2006), pp. 57-69.
[9] See the Medicare Inpatient Prospective Payment System Impact File at www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/AcuteInpatientPPS/index.html.
[10] Paul Ginsburg, "When the Price Isn't Right: How Inadvertent Payment Incentives Drive Medical Care," *Health Affairs* Web Exclusive August 9, 2005, pp. W5-376 to W5-384.
[11] Kevin J. Hayes, Julian Pettengill and Jeffrey Stensland, "Getting the Price Right: Medicare Payment Rates for Cardiovascular Services," *Health Affairs* 26:1 (January/February 2007), pp. 124-136.
[12] Julian Pettengill and James Vertrees, "Reliability and Validity in Hospital Case-Mix Measurement," *Health Care Financing Review* 4:2 (December 1982), pp. 101-128.
[13] Medicare Payment Advisory Commission, *Physician-Owned Specialty Hospitals,* Report to the Congress (Washington, DC: MedPAC, 2005).
[14] Centers for Medicare and Medicaid Services, "Medicare Program; Hospital Inpatient Prospective Payment Systems for Acute Care Hospitals," Final Rule, *Federal Register* 79:163 (August 22, 2014), pp. 49910-49915.
[15] Kevin Quinn, "New Directions in Medicaid Payment for Hospital Care," *Health Affairs* 27:1 (January/February 2008), pp. 269-80.

Appendix: Examples of HSRV Relative Weight Calculation

A. Baseline Data

We start with ten stays at three hospitals. There are two DRGs. As is typical, the mix of DRGs varies across hospitals. To keep the numbers simple and highlight the differences in how weights are calculated, the cost of DRG 1 is $3,000 at every hospital and the cost of DRG 2 is $1,000 at every hospital.

The hospitals, however, vary in how much they mark up charges over cost. High Hospital has high charges and a low cost-to-charge ratio of 20%. Its charges are five times higher than its cost. Medium Hospital has a CCR of 30% while Low Hospital has a CCR of 40%.

Note that the average cost per stay is $2,000 and the average charge per stay is $8,667.

BASELINE DATA		Stays	Cost	CCR	Charges	Avg Cost	Avg Chg	Rel Wt
High Hosp	DRG 1	1	$ 3,000	0.20	$ 15,000			
High Hosp	DRG 1	1	$ 3,000	0.20	$ 15,000			
High Hosp	DRG 1	1	$ 3,000	0.20	$ 15,000			
High Hosp	DRG 1	1	$ 3,000	0.20	$ 15,000			
High Hosp	DRG 2	1	$ 1,000	0.20	$ 5,000			
Med Hosp	DRG 1	1	$ 3,000	0.30	$ 10,000			
Med Hosp	DRG 2	1	$ 1,000	0.30	$ 3,333			
Med Hosp	DRG 2	1	$ 1,000	0.30	$ 3,333			
Low Hosp	DRG 2	1	$ 1,000	0.40	$ 2,500			
Low Hosp	DRG 2	1	$ 1,000	0.40	$ 2,500			
Total		**10**	**$ 20,000**	**0.23**	**$ 86,667**	**$ 2,000**	**$ 8,667**	
High Hosp		5	$ 13,000	0.20	$ 65,000	$ 2,600	$ 13,000	
Med Hosp		3	$ 5,000	0.30	$ 16,667	$ 1,667	$ 5,556	
Low Hosp		2	$ 2,000	0.40	$ 5,000	$ 1,000	$ 2,500	
DRG 1		5	$ 15,000	0.21	$ 70,000	$ 3,000	$ 14,000	
DRG 2		5	$ 5,000	0.30	$ 16,667	$ 1,000	$ 3,333	

B. Calculation of Cost-Based Weights

We want to come as close as possible to cost-based weights. If we have cost data, as in the table above, then the cost-based relative weight for DRG 1 is straightforwardly calculated as the average cost of DRG 1 divided by the average cost of all stays, e.g., $3,000 / $2,000 = 1.50.

DRG 1	1.5000
DRG 2	0.5000

Appendix: Examples of HSRV Relative Weight Calculation

C. Calculation of Charge-Based Weights

In the absence of cost data, the most obvious way to calculate relative weights is using charges, e.g., $14,000 / $8,667 = 1.6154.

Traditional Charge Based Weights

DRG 1	1.6154
DRG 2	0.3846

Note that charge-based weights are generally quite similar to, but not the same as, cost-based weights. In this example, the weight for DRG 1 is too high and the weight for DRG 2 is too low. The distortion occurs because the three hospitals each sets charges differently, so relative charges do not exactly track relative costs.

D. Calculation of Hospital-Specific Relative Value Weights -- Iteration Method

The essential idea in the HSRV calculation is that the relative values of charges within a hospital offer useful information, even if the charge levels are not directly comparable between hospitals. In High Hospital, for example, the average charge for DRG 1 ($15,000) is 1.1538 times the average charge for all stays ($13,000). In Medium Hospital, the average charge for DRG 1 ($10,000) is 1.7779 times the average charge for all stays ($5,556). We can therefore calculate an adjusted charge for each stay, where the adjusted charge equals the actual charges x (average charge for that hospital / average charge for all DRGs). That helps, but is not quite sufficient, because some hospitals have higher average charges because they treat sicker patients. We therefore "allow" higher charges for some hospitals by multiplying the adjustment factor times the hospital-specific casemix. But casemix is the same as the average relative weight, so there's a problem of potential circularity because we're using casemix to calculate the relative weights. This problem can be overcome through iteration. Start with the charge-based relative weights as shown in cells N46 and N47 and apply those to each stay, Then calculate the average casemix for each hospital, e.g., 1.3692 for High Hospital (cell H77).

For the first stay in the data table, the adjusted charge is then $15,000 x ($8,667 / $13,000) x 1.3692 = $13,692. Note that total charges for all stays remains $86,667 and the average charge remains $8,667. But the adjusted average charge for DRG 1 is now $13,434. The new relative weight for DRG 1 = $13,434 / $8,667 = 1.5501. The new weights for DRG 1 and DRG 2 are then used in Iteration 2.

Appendix: Examples of HSRV Relative Weight Calculation

ITERATION 1		Stays	Rel Wt	Avg Casemix	Adj Chg	Avg Chg	Rel Wt
High Hosp	DRG 1	1	1.6154		$ 13,692		
High Hosp	DRG 1	1	1.6154		$ 13,692		
High Hosp	DRG 1	1	1.6154		$ 13,692		
High Hosp	DRG 1	1	1.6154		$ 13,692		
High Hosp	DRG 2	1	0.3846		$ 4,564		
Med Hosp	DRG 1	1	1.6154		$ 12,400		
Med Hosp	DRG 2	1	0.3846		$ 4,133		
Med Hosp	DRG 2	1	0.3846		$ 4,133		
Low Hosp	DRG 2	1	0.3846		$ 3,333		
Low Hosp	DRG 2	1	0.3846		$ 3,333		
Total		**10**	**10.0000**		**$ 86,667**	**$ 8,667**	
High Hosp	Total Casemix	5	6.8462	1.3692	$ 59,333	$ 11,867	
Med Hosp	Total Casemix	3	2.3846	0.7949	$ 20,667	$ 6,889	
Low Hosp	Total Casemix	2	0.7692	0.3846	$ 6,667	$ 3,333	
DRG 1		5			$ 67,169	$ 13,434	1.5501
DRG 2		5			$ 19,497	$ 3,899	0.4499

We follow the same adjustment process in Iteration 2, again noting that total and average charges remain unchanged. The adjusted average charge for DRG 1 is $13,434 so its relative weight is now 1.5217. This weight and the new weight are then used in Iteration 3.

ITERATION 2		Stays	Rel Wt	Avg Casemix	Adj Chg	Avg Chg	Rel Wt
High Hosp	DRG 1	1	1.5501		$ 13,300		
High Hosp	DRG 1	1	1.5501		$ 13,300		
High Hosp	DRG 1	1	1.5501		$ 13,300		
High Hosp	DRG 1	1	1.5501		$ 13,300		
High Hosp	DRG 2	1	0.4499		$ 4,433		
Med Hosp	DRG 1	1	1.5501		$ 12,740		
Med Hosp	DRG 2	1	0.4499		$ 4,247		
Med Hosp	DRG 2	1	0.4499		$ 4,247		
Low Hosp	DRG 2	1	0.4499		$ 3,899		
Low Hosp	DRG 2	1	0.4499		$ 3,899		
Total		**10**	**10.0000**		**$ 86,667**	**$ 8,667**	
High Hosp	Total Casemix	5	6.6502	1.3300	$ 57,635	$ 11,527	
Med Hosp	Total Casemix	3	2.4499	0.8166	$ 21,233	$ 7,078	
Low Hosp	Total Casemix	2	0.8999	0.4499	$ 7,799	$ 3,899	
DRG 1		5			$ 65,941	$ 13,188	1.5217
DRG 2		5			$ 20,726	$ 4,145	0.4783

We repeat the process, noting that we the differences are becoming smaller and smaller. At some point (e.g., when the relative weights are unchanged to a specified number of decimal places), we truncate the iteration process.

Appendix: Examples of HSRV Relative Weight Calculation

ITERATION 3		Stays	Rel Wt	Avg Casemix	Adj Chg	Avg Chg	Rel Wt
High Hosp	DRG 1	1	1.5217		$ 13,130	$ 13,130	
High Hosp	DRG 1	1	1.5217		$ 13,130	$ 13,130	
High Hosp	DRG 1	1	1.5217		$ 13,130	$ 13,130	
High Hosp	DRG 1	1	1.5217		$ 13,130	$ 13,130	
High Hosp	DRG 2	1	0.4783		$ 4,377	$ 4,377	
Med Hosp	DRG 1	1	1.5217		$ 12,887	$ 12,887	
Med Hosp	DRG 2	1	0.4783		$ 4,296	$ 4,296	
Med Hosp	DRG 2	1	0.4783		$ 4,296	$ 4,296	
Low Hosp	DRG 2	1	0.4783		$ 4,145	$ 4,145	
Low Hosp	DRG 2	1	0.4783		$ 4,145	$ 4,145	
Total		**10**	**10.0000**		**$ 86,667**	**$ 8,667**	
High Hosp	Total Casemix	5	6.5652	1.3130	$ 56,898	$ 11,380	
Med Hosp	Total Casemix	3	2.4783	0.8261	$ 21,478	$ 7,159	
Low Hosp	Total Casemix	2	0.9566	0.4783	$ 8,290	$ 4,145	
DRG 1		5			$ 65,408	$ 13,082	1.5094
DRG 2		5			$ 21,258	$ 4,252	0.4906

ITERATION 4		Stays	Rel Wt	Avg Casemix	Adj Chg	Avg Chg	Rel Wt
High Hosp	DRG 1	1	1.5094		$ 13,057	$ 13,057	
High Hosp	DRG 1	1	1.5094		$ 13,057	$ 13,057	
High Hosp	DRG 1	1	1.5094		$ 13,057	$ 13,057	
High Hosp	DRG 2	1	0.4906		$ 4,352	$ 4,352	
Med Hosp	DRG 1	1	1.5094		$ 12,951	$ 12,951	
Med Hosp	DRG 2	1	0.4906		$ 4,317	$ 4,317	
Med Hosp	DRG 2	1	0.4906		$ 4,317	$ 4,317	
Low Hosp	DRG 2	1	0.4906		$ 4,252	$ 4,252	
Low Hosp	DRG 2	1	0.4906		$ 4,252	$ 4,252	
Total		**10**	**10.0000**		**$ 86,667**	**$ 8,667**	
High Hosp	Total Casemix	5	6.5283	1.3057	$ 56,578	$ 11,316	
Med Hosp	Total Casemix	3	2.4906	0.8302	$ 21,585	$ 7,195	
Low Hosp	Total Casemix	2	0.9812	0.4906	$ 8,503	$ 4,252	
DRG 1		5			$ 65,177	$ 13,035	1.5041
DRG 2		5			$ 21,490	$ 4,298	0.4959

Note that after five iterations the relative weights are 1.5018 and 0.4982, essentially identical to the cost-based weights of 1.5000 and 0.5000.

Appendix: Examples of HSRV Relative Weight Calculation

ITERATION 5		Stays	Rel Wt	Avg Casemix	Adj Chg	Avg Chg	Rel Wt
High Hosp	DRG 1	1	1.5041		$ 13,025	$ 13,025	
High Hosp	DRG 1	1	1.5041		$ 13,025	$ 13,025	
High Hosp	DRG 1	1	1.5041		$ 13,025	$ 13,025	
High Hosp	DRG 1	1	1.5041		$ 13,025	$ 13,025	
High Hosp	DRG 2	1	0.4959		$ 4,342	$ 4,342	
Med Hosp	DRG 1	1	1.5041		$ 12,979	$ 12,979	
Med Hosp	DRG 2	1	0.4959		$ 4,326	$ 4,326	
Med Hosp	DRG 2	1	0.4959		$ 4,326	$ 4,326	
Low Hosp	DRG 2	1	0.4959		$ 4,298	$ 4,298	
Low Hosp	DRG 2	1	0.4959		$ 4,298	$ 4,298	
Total		**10**	**10.0000**		**$ 86,667**	**$ 8,667**	
High Hosp	Total Casemix	5	6.5123	1.3025	$ 56,440	$ 11,288	
Med Hosp	Total Casemix	3	2.4959	0.8320	$ 21,631	$ 7,210	
Low Hosp	Total Casemix	2	0.9918	0.4959	$ 8,596	$ 4,298	
DRG 1		5			$ 65,077	$ 13,015	1.5018
DRG 2		5			$ 21,590	$ 4,318	0.4982

Appendix: Examples of HSRV Relative Weight Calculation

E. Calculation of Hospital-Specific Relative Value Weights -- Logarithmic Regression Method

An alternative calculation method that yields essentially the same result is through a regression model. This method is more tractable for extremely large datasets, such as the 15 million records used by 3M Health Information Systems in setting APR-DRG HSRV relative weights.

The data from Part A above are reorganized for use in a regression. The left-hand variable is the natural logarithm of charges, that is, ln(chg). right-hand variables are dummy variables indicating which DRG and which hospital the record applies to.

Hosp	DRG	Chg	ln(chg)	DRG1	DRG2	High Hosp	Med Hosp	Low Hosp
High Hosp	DRG 1	$15,000	9.6158	1	0	1	0	0
High Hosp	DRG 1	$15,000	9.6158	1	0	1	0	0
High Hosp	DRG 1	$15,000	9.6158	1	0	1	0	0
High Hosp	DRG 1	$15,000	9.6158	1	0	1	0	0
High Hosp	DRG 2	$5,000	8.5172	0	1	1	0	0
Med Hosp	DRG 1	$10,000	9.2103	1	0	0	1	0
Med Hosp	DRG 2	$3,333	8.1117	0	1	0	1	0
Med Hosp	DRG 2	$3,333	8.1117	0	1	0	1	0
Low Hosp	DRG 2	$2,500	7.8240	0	1	0	0	1
Low Hosp	DRG 2	$2,500	7.8240	0	1	0	0	1

Population model: $y = B_0 + B_1X_1 + B_2X_2 + B_3X_3 + B_4X_4 + E$

where y is our dependent variable, B_0 is our intercept, B_1-B_4 is the slope, X_1-X_4 are independent variables and E is the error (natural variation in the real world).

Using our sample, the model looks like this:

$\ln(Chg) = B_1\,DRG1 + B_2 DRG2 + B_3 HighHosp + B_4 MedHosp$

The intercept is irrelevant and therefore the constant is set to zero.

One hospital is not included in the model, in this example Low Hospital. It would not change the results if another hospital were dropped.

Appendix: Examples of HSRV Relative Weight Calculation

SUMMARY OUTPUT

Regression Statistics	
Multiple R	1.00
R Square	1.00
Adjusted R Square	0.83
Standard Error	0.00
Observations	10.00

ANOVA

	DF	SS	MS	F	Significance F
Regression	4	781	195	5.19181E+32	9.955E-82
Residual	6	2.25719E-30	3.762E-31		
Total	10	781.2594667			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	0							
DRG1	8.92	6.66782E-16	1.338E+16	0.0000	8.92	8.92	8.92	8.92
DRG2	7.82	4.33704E-16	1.804E+16	0.0000	7.82	7.82	7.82	7.82
Hosp1	0.69	6.53833E-16	1.06E+15	0.0000	0.69	0.69	0.69	0.69
Hosp2	0.29	5.84806E-16	4.919E+14	0.0000	0.29	0.29	0.29	0.29

Using the coefficients from the regression model, we can calculate the weights for each DRG.

Cases: number of DRG cases
Wt (Unscaled) row: We have to apply the EXP to each DRG coefficient. The exponent is the inverse of the natural logarithm.
For DRG 1, for example, EXP(8.92) = 8.92 to the power e, where e = 2.71828. The result is 7,500.
Total Wt row: multiply the number of DRGs by their unscaled weight.
Avg Wt row: Total Wt divided by total DRGs
Wt (Scaled) row: unscaled weight for each DRG divided by the overall average weight

	DRG 1	DRG 2	Total
Cases	5	5	10
Wt (Unscaled)	7,500	2,500	
Total Wt	37,500	12,500	50,000
Avg Wt			5,000
Wt (Scaled)	1.5000	0.5000	

For DRG 1, for example, 7,500 / 5,000 = 1.5000.

We see that the HSRV relative weights are virtually identical under both methods.

Notes

[1] Kevin Quinn, "After the Revolution: DRGs at Age 30," *Annals of Internal Medicine* 160:6 (March 18, 2014), pp. 426-429.
[2] Xerox State Healthcare, *Medi-Cal DRG Project Policy Design Document,* Report to the California Department of Health Care Services (West Sacramento, CA: Xerox, September 2013), p.40.
[3] *Policy Design Document,* §2.5.
[4] This memorandum draws on a technical memorandum by Richard Fuller of 3M, *Overview to the Design and Application of HSRV Log Weights*
[5] Xerox calculations from American Hospital Association, *Hospital Statistics,* 2000 and 2015 editions. The figures refer to inpatient and outpatient care combined, but the same trends have been observed for inpatient and outpatient care separately.
[6] Richard L. Fuller, *An Analysis of the Real Price Effects Resulting from Charge Setting Practices in the U.S. Hospital Sector,* Report to the Jayne Koskinas Ted Giovanis Foundation for Health and Policy, 2015.
[7] California Hospital Association, *Modern Pricing: Clarifying Hospital Charges for Consumers* (Sacramento, CA: CHA, May 2014).
[8] Uwe Reinhardt, "The Pricing of U.S. Hospital Services: Chaos Behind a Veil of Secrecy," *Health Affairs* 25:1 (January-February 2006), pp. 57-69.
[9] See the Medicare Inpatient Prospective Payment System Impact File at www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/AcuteInpatientPPS/index.html.
[10] Paul Ginsburg, "When the Price Isn't Right: How Inadvertent Payment Incentives Drive Medical Care," *Health Affairs* Web Exclusive August 9, 2005, pp. W5-376 to W5-384.
[11] Kevin J. Hayes, Julian Pettengill and Jeffrey Stensland, "Getting the Price Right: Medicare Payment Rates for Cardiovascular Services," *Health Affairs* 26:1 (January/February 2007), pp. 124-136.
[12] Julian Pettengill and James Vertrees, "Reliability and Validity in Hospital Case-Mix Measurement," *Health Care Financing Review* 4:2 (December 1982), pp. 101-128.
[13] Medicare Payment Advisory Commission, *Physician-Owned Specialty Hospitals,* Report to the Congress (Washington, DC: MedPAC, 2005).
[14] Centers for Medicare and Medicaid Services, "Medicare Program; Hospital Inpatient Prospective Payment Systems for Acute Care Hospitals," Final Rule, *Federal Register* 79:163 (August 22, 2014), pp. 49910-49915.
[15] Kevin Quinn, "New Directions in Medicaid Payment for Hospital Care," *Health Affairs* 27:1 (January/February 2008), pp. 269-80.