

WORKING P A P E R

Comparative Performance of the MS-DRGS and RDRGS in Explaining Variation in Cost for Medicare Hospital Discharges

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PREFACE

Health Systems Consultants, Inc. asked RAND to assess the comparative ability of two severity-adjusted patient classification systems to explain variation in Medicare costs per discharge. The two systems evaluated in the study are the Medicare-severity adjusted DRG (MS-DRG) system that Medicare adopted effective October 1, 2007 and Health System Consultants, Inc.'s Refined-DRGs (RDRGs), version 21.0/24.0. The results should be of interest to parties who use a classification system to assign hospital inpatients to groupings based on expected resource needs.

The research was conducted by RAND Health, a division of the RAND Corporation. A profile of RAND Health, abstracts of its publications, and ordering information can be found at www.rand.org/health. Comments on this report should be directed to Barbara Wynn, the principal investigator (wynn@rand.org).

PURPOSE

In 2007, the RAND Corporation evaluated for the Centers for Medicare and Medicaid Services (CMS) alternative patient classification systems that might be used in Medicare's prospective payment system (PPS) for hospital inpatient services to assign discharges to severity-adjusted diagnosis-related groups (DRGs).¹ One classification system that RAND evaluated was Health System Consultants, Inc.'s Refined-DRGs (RDRGs), version 19.0/23.0. Effective October 1, 2007, CMS developed and implemented Medicare-Severity Adjusted DRGs (MS-DRGs), version 25.0 and HSC updated the RDRG system to version 21.0/24.0. Health Systems Consultants, Inc. asked RAND to assess the comparative ability of the MS-DRGs and the updated RDRGs to explain variation in Medicare costs per discharge. This paper reports the results of our analysis.

OVERVIEW OF THE MS-DRG AND RDRG CLASSIFICATION SYSTEMS

MS-DRGs. The MS-DRG version 25.0 system utilizes the CMS-DRGs version 24.0 as the foundation for its grouping logic.² The logic collapses any paired DRGs (DRGs distinguished by the presence or absence of complications or comorbidities (CCs) and/or age) into base DRGs and then splits the base DRGs into CC-severity levels. The general structure of the MS-DRG logic establishes three severity levels for each base DRG: With Major CC, With CC, and Without CC. However, CMS consolidated severity levels for the same base DRG if the severity levels were low volume, did not have a significant difference in average charges, or did not reduce charge variance at least three percent. CMS assigned each diagnosis code a uniform CC-severity level across all base DRGs based on an evaluation of the impact of the condition on cost. A CC exclusions list is used to exclude clinical situations in which the condition should be a non-CC. Each discharge is assigned to the highest severity

¹ See Wynn et al., Evaluation of Severity-adjusted DRG Systems: Interim Report. RAND: Santa Monica, CA, WR-434-CMS, 2007 (available at www.rand.org/pubs/working_papers/WR434/).

² For a general explanation, see Barbara O. Wynn and Molly M. Scott, Evaluation of Severity-Adjusted DRG Systems: Addendum to the Interim Report. Santa Monica: RAND, WR-434/1-CMS, 2007a (available at www.rand.org/pubs/working_papers/WR434/1). For a detailed explanation, see 3M, Medicare Severity Diagnosis Related Groups (MS-DRGs). Definitions Manual, Version 25.0. 2007.

level of any secondary diagnosis. Generally, there is no adjustment in the severity-level for additional factors or CCs. However, discharges with no CC but certain high cost devices are assigned to a CC severity level. In total, the MS-DRG version 25.0 has 335 base DRGs and 745 MS-DRGs.

RDRGs. The current version of the RDRGs maintained by Health Systems Consultants, Inc. applies the same general logic for severity classifications adjustments developed by Yale researchers in the early 1980's to version 24.0 of the CMS-DRGs.³ The RDRG system uses the CMS-DRGs hierarchical logic to assign discharges to pre-Major Diagnostic Categories (pre-MDCs) and MDCs, and surgical DRGs. Medical cases involving death within two days of admission are assigned to a unique "early death" Refinement Group DRG (RGN). For other discharges, CMS-DRG version 24.0 paired groupings (DRGs with and without CCs or distinguished solely by age or discharge status) are collapsed into adjacent DRGs (ADRGs which are comparable to base CMS-DRGs).⁴ Informed by the updated CC exclusions lists and CC/MCC listings developed for the MS-DRGs, version 25.0, the ADRGs are then divided into three (for medical cases) or four (for surgical cases) severity levels or RGNs. Unlike the MS-DRGs, severity levels are not collapsed within an ADRG if they are low-volume or have similar resource use. Severity levels are not assigned to the early death medical DRGs and certain other ADRGs, including:

- three ADRGs for discharges involving solely surgical procedures unrelated to the principal diagnosis (ADRG 468, 476, and 477)
- ADRGs for a principal diagnosis that is invalid for a discharge diagnosis (ADRG 469) and ungroupable discharges (ADRG 470)
- pre-MDC ADRGs 541 and 542 (Tracheostomy with Mechanical Ventilation + 96 Hours or Principal Diagnosis Excluding Face, Mouth, and Neck with and without Major O.R. Procedure).

³ For a detailed explanation of the grouping logic, see Health Systems Consultants, Inc., RDRG®: A Severity Classification System, Version 21.0/24.0 Including Updates from the MS-DRGs 25.0. Definitions Manual. New Haven, CT, 2007.

⁴ In developing the MS-DRGs, CMS collapsed CMS-DRGs that split based on the presence of a major cardiovascular condition, AMI with and without major complications, or cardiac catheterization with and without complex diagnoses. The RDRGs retain the splits as separate ADRGs.

As is the case with the MS-DRGs, a discharge is assigned to the severity level corresponding to the highest severity level of any secondary diagnosis in the case. There are 372 ADRGs and 1,315 RGNs in version 21.0/24.0 of the RDRGs. In contrast, there were 1,293 RGNs in version 19.0/23.0 of the RDRGs. There are two important differences between the two versions. First, the earlier version did not reflect the version 24.0 DRG refinements that CMS adopted in October 2006 as a first step towards severity-adjusted DRGs. Second, the CC severity-level assignments in the version 21.0/24.0 RDRGs were informed by the CC assignments made in the MS-DRG version 25.0.

DATA AND METHODS

Our study is focused on a single research question: how well does each classification system explain variation in resource usage? To answer this question, we repeated analyses using log-linear regression models from our earlier study (Wynn et al., 2007). The R-squared statistic resulting from the regression measures the proportion of cost variation within a population that is explained by the regression model. R-squared is a descriptive measure between 0 and 1. An R-squared of 0.35 means that the model explains 35 percent of the cost variation for a sample of discharges. The closer the value is to 1.0, the better the model is at explaining the variation.

For our analyses, we used the March 2007 update of Medicare Payment and Analysis Review (MedPAR) data for FY06 acute-care hospital discharges. The file contains records for Medicare beneficiaries discharged from general acute care hospitals during FY06 (discharges occurring on or after October 1, 2005 and before October 1, 2006). The file contained 11,823,246 records for acute care hospital stays (exclusive of PPS-exempt hospitals and critical access hospitals). This is the same database that we used in a CMS-funded evaluation of alternative methodologies to establish DRG relative weights.⁵ We eliminated records for Indian Health Service hospitals and hospitals

⁵ Barbara O. Wynn and Molly Scott, "Evaluation of Alternative Methods to Establish DRG Relative Weights," Santa Monica: RAND, WR-560-CMS, 2008 (available at http://www.rand.org/pubs/working_papers/WR560/).

that use all-inclusive rate charging practices. Consistent with CMS practice, we included Maryland hospitals that have a PPS waiver. We eliminated individual records that did not pass edits for data consistency or were missing variables needed to determine standardized costs.

Each MedPAR record had already been assigned to the FY08 MS-DRG version 25.0 in our earlier study. We used software supplied by Health Systems Consultants to assign each record to the RDRG version 21.0/24.0.⁶ We eliminated discharges assigned to MDC 15 (Newborns) and those assigned to the error DRGs for discharges with invalid principal diagnoses or otherwise ungroupable. The same discharges were assigned to the error DRGs under both systems.

For our regressions, we needed a measure of cost for each discharge as our dependent variable. Based on earlier work, we decided to use two different cost measures. We selected the first cost measure in order to compare our results with those from our earlier evaluation of severity-adjusted DRGs (Wynn et al., 2007). Consistent with that study, we estimated the cost of a discharge by applying the national cost-to-charge ratios to charges on the MedPAR record.⁷ To derive the second measure, we applied hospital-specific cost-to-charge ratios to charges on the MedPAR record. We had used the second measure as our "gold standard" in our evaluation of alternative relative weight methodologies (Wynn and Scott, 2008). We then standardized the cost estimates for differences in hospital characteristics using the hospital payment factor approach. See Wynn and Scott (2008) for a detailed explanation of our methodology to estimate and standardize cost.

Next, we determined the geometric mean standardized cost per discharge for each MS-DRG. We defined statistical outliers as discharges with a standardized cost per case that is more than three standard

⁶ This version is based on ICD-9-CM diagnosis and procedure codes version 24.0 and the MedPAR records contain version 23.0 codes. We used the standard conversion table published by the National Center for Health Statistics available at <http://www.cdc.gov/nchs/datawh/ftp/ftp9/icd9/icd9nv07.pdf> to map the diagnosis and procedure codes that were deleted between the two versions.

⁷ There are some differences in the national CCR approach between the two studies. Wynn et al. (2007) used national cost-to-charge ratios for 13 revenue center groupings from the FY07 proposed rule. The current study used national cost-to-charge ratios for 15 revenue center groupings from the FY08 final rule. This method is described in detail in Wynn and Scott (2008).

deviations from the geometric mean cost per discharge for the relevant MS-DRG. There were 71,581 statistical outliers using national cost-to-charge ratios to estimate cost and 71,616 using hospital-specific cost-to-charge ratios. Model 1 regressions included statistical outliers and Model 2 regressions excluded them.

Table 1
Reconciliation of the Number of Discharges and DRGs Used in the Regression Analyses, by DRG System

	Discharges	MS-DRG	RDRG
Total	11,804,971	745	1,315
Indian Health Service hospitals	9,697	0	0
All-inclusive rate hospitals	38,376	0	0
Unused DRGs	-	4	41
Error DRGs	53,909	1	1
MDC 15 discharges	2	2	2
Total charges \neq summed charges	10	0	0
No standardization data	21,161	0	0
N used in Model 1 regressions with outliers	11,681,816	736	1,271
N used in Model 2 regressions without outliers using national cost-to-charge ratios	11,610,235	736	1,271
N used in Model 2 regressions without outliers using hospital-specific cost-to-charge ratios	11,610,200	736	1,271

Table 1 summarizes the numbers of records and DRGs that are affected by the exclusion policies and the number of discharges that were used in the regressions. Table 2 summarizes by MDC the number of MS-DRGs, RDRGs, and discharges with and without statistical outliers using hospital-specific cost-to-charge ratios to estimate cost. Consistent with the approach taken in Wynn et. al (2007), we created MDC 00 for the pre-MDC assignments and MDC 26 for the DRGs to which surgical discharges with no surgical procedure related to the principal diagnosis are assigned. We assigned a discharge to a MDC based on its MS-DRG assignment.⁸ We performed both an overall regression and regressions by

⁸ We found that 753 discharges in certain RGNs in MDCs 01-25 were assigned to MDC 26 under the MS-DRGs and some discharges assigned to MDC 26 under the MS-DRGs were assigned to a RGN in MDCs 01-25 under the RDRG logic. The redesignation of circumcision from an operating procedure in CMS-DRG version 24 to a non-operating procedure in MS-DRG version 25 is an example of why this occurs. We have not included the RGNs for these discharges in the RGN count for MDCs so that the RGN count reflects the actual number of RGNs assigned by the RDRG grouper logic to a given MDC.

MDC using each of our standardized cost measures as the dependent variable and the MS-DRG or RGN number as the independent variable.

Table 2 Distribution of DRGs and Discharges with and without Statistical Outliers Using

Hospital-Specific Cost-to-Charge Ratios to Estimate Cost By MDC

MDC	Description	N MS DRGs	N RDRGs	N Discharges With Outliers	N Discharges Without Outliers
00	Pre-MDC DRGs	13	30	55,656	54,661
01	Diseases and Disorders of the Nervous System	75	92	892,293	886,338
02	Diseases and Disorders of the Eye	10	35	13,951	13,855
03	Diseases and Disorders of the Ear, Nose, Mouth, and Throat	25	81	99,557	99,084
04	Diseases and Disorders of the Respiratory System	40	54	1,669,611	1,661,252
05	Diseases and Disorders of the Circulatory System	87	158	3,154,417	3,135,135
06	Diseases and Disorders of the Digestive System	61	83	1,284,132	1,277,339
07	Diseases and Disorders of the Hepatobiliary System and Pancreas	36	48	328,805	327,129
08	Diseases and Disorders of the Musculoskeletal System and Connective Tissue	99	153	1,378,217	1,366,271
09	Diseases and Disorders of the Skin, Subcutaneous Tissue and Breast	29	58	293,206	291,378
10	Endocrine, Nutritional and Metabolic Diseases and Disorders	26	45	420,627	418,426
11	Diseases and Disorders of the Kidney and Urinary Tract	43	64	728,665	724,557
12	Diseases and Disorders of the Male Reproductive System	21	45	91,383	90,532
13	Diseases and Disorders of the Female Reproductive System	25	51	119,037	118,052
14	Pregnancy, Childbirth, and the Puerperium	15	47	17,025	16,841
16	Diseases and Disorders of the Blood and Blood Forming Organs and Immunological I	15	21	132,599	132,066
17	Myeloproliferative Diseases and Disorders and Poorly Differentiated Neoplasms	27	39	90,699	90,281
18	Infectious and Parasitic Diseases (Systemic or Unspecified Sites)	17	27	437,758	435,467
19	Mental Diseases and Disorders	9	29	120,190	119,478
20	Alcohol/Drug Use and Alcohol/Drug Induced Organic Mental Disorders	4	10	53,725	53,495
21	Injuries, Poisonings, and Toxic Effects of Drugs	20	32	131,634	131,059
22	Burns	6	22	4,525	4,503
23	Factors Influencing Health Status and Other Contacts with Health Services	10	17	51,909	51,495
24	Multiple Significant Trauma	8	16	12,220	12,164
25	Human Immunodeficiency Virus Infections	6	11	19,317	19,252
26	Surgical procedures Unrelated to Principal Diagnosis	9	3	80,658	80,125

RESULTS

Cost Estimated Using National Cost-to-Charge Ratios

Table 3 summarizes the regression results using the cost measure derived from national cost-to-charge ratios. Overall, the RDRG system performs better than the MS-DRG system in both regression models. The R-squared value under Model 1 (including statistical outliers) is 0.4390 for the RDRG system compared to 0.4194 for the MS-DRG system, a 4.7 percent increase in explanatory power. With few exceptions, the RDRG system has a higher adjusted R-squared value within each MDC. The percentage improvement is particularly notable in the MDCs with low explanatory power, such as MDCs 19 (Mental Diseases and Disorders) and 20 (Alcohol/Drug Use and Alcohol/Drug Induced Organic Mental Disorders). The R-squared values for MDC 19 and 20 are 49.0 percent and 33.1 percent higher, respectively, under the RDRG system than the MS-DRG system. The MS-DRGs have higher R-squared values in MDC 25 (Human Immunodeficiency Virus Infections) and MDC 26 (Surgical Procedures Unrelated to Principal Diagnosis). The adjusted R-squared value for MDC 26 is 0.2782 in the MS-DRG system, which subdivides the three base DRGs assigned to this MDC by severity levels, compared to 0.1328 for the RDRG system, which does not assign severity levels to the comparable ADRGs.

Under both systems, the adjusted R-squared values for the Model 2 regression (excluding statistical outliers) are slightly higher but the general pattern is unchanged. For example, the overall adjusted R-squared value for the RDRG system increases from 0.4390 to 0.4537. RAND's earlier evaluation (Wynn and Scott, 2007) using FY 2005 discharges found that the MS-DRGs had an adjusted R-squared value of 0.4300 when statistical outliers were excluded. The adjusted R-squared value for the MS-DRGs using FY2006 discharges is 1.5 percent higher (0.4363). In addition to more recent discharge data, the later regression reflects improvements in the method to estimate cost (an increase from 13 to 15 revenue center groupings) and the changes made between the proposed and final MS-DRGs, version 25. In the earlier RAND evaluation, the RDRG version 19.0/23.0 had an adjusted R-squared value of 0.4388 in explaining overall cost variation. The adjusted R-squared value from the Model 2 regression using the FY2006 discharges is 3.4

percent higher (0.4537) and in addition to the more recent discharges and refinement in the cost estimate reflects the refinements made to the RDRG version 21.0/24.

Table 3 Comparative Performance of MS-DRGs and RDRGs in Explaining Cost Derived from National Cost-to-Charge Ratios

MDC	Model 1: Including Outliers			Model 2: Excluding Outliers		
	N=11,681,816	Adj R Sq		N=11,610,200	Adj R Sq	
	Dep Mean	MS-DRG	RDRG	Dep Mean	MS-DRG	RDRG
00	10.79	0.3267	0.3302	10.81	0.3659	0.3687
01	8.47	0.2607	0.2846	8.47	0.2758	0.2966
02	8.12	0.0962	0.1286	8.12	0.1008	0.1273
03	8.06	0.1393	0.1645	8.05	0.1449	0.1683
04	8.52	0.2728	0.3060	8.51	0.2854	0.3157
05	8.65	0.5203	0.5360	8.64	0.5394	0.5533
06	8.49	0.3724	0.3894	8.48	0.3859	0.4009
07	8.64	0.2626	0.2825	8.64	0.2735	0.2915
08	8.91	0.4708	0.4763	8.91	0.4903	0.4939
09	8.28	0.1470	0.1740	8.27	0.1543	0.1783
10	8.17	0.1784	0.1985	8.16	0.1875	0.2054
11	8.42	0.2058	0.2402	8.42	0.2160	0.2482
12	8.33	0.2151	0.2490	8.32	0.2286	0.2584
13	8.44	0.2030	0.2387	8.43	0.2092	0.2394
14	7.98	0.2049	0.2577	7.96	0.2233	0.2672
16	8.22	0.1020	0.1356	8.21	0.1064	0.1386
17	8.77	0.2442	0.2750	8.77	0.2520	0.2798
18	8.83	0.2667	0.3357	8.83	0.2785	0.3433
19	8.11	0.0376	0.0560	8.10	0.0406	0.0568
20	7.91	0.1134	0.1509	7.90	0.1199	0.1545
21	8.29	0.3041	0.3188	8.28	0.3167	0.3287
22	8.76	0.3654	0.4283	8.74	0.3932	0.4478
23	8.09	0.1481	0.1647	8.08	0.1667	0.1812
24	9.36	0.3409	0.3682	9.35	0.3506	0.3750
25	8.67	0.1866	0.1678	8.67	0.1925	0.1706
26	9.42	0.2637	0.1240	9.42	0.2782	0.1328
All	8.58	0.4194	0.4390	8.58	0.4363	0.4537

Cost Estimated from Hospital-Specific Cost-to-Charge Ratios

Table 4 summarizes the regression results using the cost measure derived from hospital-specific cost-to-charge ratios. The adjusted R-squared values from these regressions are higher than those resulting from the regressions using national cost-to-charge ratios to estimate

cost. For example, the Model 1 adjusted R-squared value for the RDRG system increases from 0.4390 to 0.4903, or 11.8 percent with the change in the method used to estimate cost. The Model 1 adjusted R-squared values for the MS-DRG system increases nearly as much (11.4 percent). Hospital-specific cost-to-charge ratios take into account systematic differences across hospitals in overall charging practices and reduce the amount of within-DRG variation in most MDCs. With the exception of MDC 14 (Pregnancy, Childbirth and Puerperium), a Medicare low-volume DRG, the adjusted R-squared values are higher across MDCs under both systems.

Table 4 Comparative Performance of MS-DRGs and RDRGs in Explaining Cost Derived from Hospital-Specific Cost-to-Charge Ratios

MDC	Model 1: Including Outliers			Model 2: Excluding Outliers		
	N=11,681,816	Adj R Sq		N=11,610,235	Adj R Sq	
	Dep Mean	MS-DRG	RDRG	Dep Mean	MS-DRG	RDRG
00	10.87	0.3675	0.3718	10.89	0.4196	0.4233
01	8.60	0.3087	0.3391	8.60	0.3260	0.3526
02	8.22	0.1016	0.1484	8.22	0.1082	0.1496
03	8.18	0.1666	0.2017	8.18	0.1716	0.2043
04	8.67	0.3156	0.3589	8.67	0.3287	0.3675
05	8.75	0.5587	0.5784	8.75	0.5762	0.5939
06	8.62	0.4307	0.4513	8.62	0.4440	0.4624
07	8.76	0.3007	0.3251	8.76	0.3131	0.3353
08	9.02	0.5156	0.5224	9.02	0.5382	0.5428
09	8.40	0.1776	0.2125	8.40	0.1861	0.2177
10	8.30	0.2098	0.2359	8.30	0.2184	0.2424
11	8.55	0.2427	0.2852	8.55	0.2533	0.2936
12	8.41	0.2684	0.3115	8.41	0.2910	0.3302
13	8.53	0.2673	0.3143	8.53	0.2817	0.3213
14	7.99	0.1812	0.2478	7.98	0.1956	0.2522
16	8.34	0.1249	0.1658	8.33	0.1281	0.1674
17	8.87	0.2857	0.3205	8.87	0.2958	0.3270
18	8.94	0.2954	0.3813	8.94	0.3083	0.3886
19	8.26	0.0330	0.0593	8.25	0.0353	0.0598
20	8.02	0.1475	0.2052	8.02	0.1561	0.2105
21	8.41	0.3395	0.3588	8.41	0.3509	0.3675
22	8.84	0.3909	0.4620	8.83	0.4102	0.4758
23	8.28	0.2577	0.2808	8.28	0.2854	0.3054
24	9.49	0.3736	0.4094	9.48	0.3829	0.4154
25	8.72	0.2199	0.1859	8.72	0.2283	0.1899
26	9.51	0.3077	0.1431	9.52	0.3253	0.1534
Overall	8.70	0.4661	0.4903	8.70	0.4828	0.5044

As was the case with the first set of regressions, with the exception of MDCs 25 and 26, the RDRG system performs better than the MS-DRG system in both the Model 1 and Model 2 regressions. The adjusted R-squared value under Model 1 (including statistical outliers) is 0.4903 for the RDRG system compared to 0.4661 for the MS-DRG system, a 5.2 percent improvement in explanatory power. (The RDRG system had a 4.7 percent higher adjusted R-squared value in the regressions using national cost-to-charge ratios to estimate cost). The percentage improved in the MDCs with low explanatory power is more marked using the hospital-specific cost-to-charge ratios to estimate cost. For example, the adjusted R-squared values for MDC 19 (Mental Diseases and Disorders) and 20 (Alcohol/Drug Use and Alcohol/Drug Induced Organic Mental Disorders) are 79.7 percent and 39.1 percent higher, respectively, under the RDRG system than the MS-DRG system. Under both systems, the adjusted R-squared values for the Model 2 regression (excluding statistical outliers) are higher. The overall adjusted R-squared value for the RDRG system increases from 0.4903 to 0.5044 while the value for the MS-DRG system increases from 0.4661 to 0.4828. The overall improvement seen in the RDRG system over the MS-DRG system is 4.4 percent in the Model 2 regression compared to 5.2 percent in the Model 1 regression.

Discussion

This study focused on the comparative ability of the RDRG and MS-DRG systems to explain cost variation using Medicare discharge data. Both systems are based on CMS-DRG version 24 but take different strategies with respect to how discharges are assigned severity levels. One would expect the RDRGs to have higher explanatory power than the MS-DRGs in that the RDRG logic has more severity levels across all surgical DRGs and most medical DRGs. The MS-DRGs collapse severity levels within base MS-DRGs for low Medicare-volume DRGs and DRGs that do not have substantial variation between severity levels. While this still enables the MS-DRGs to explain about 96 percent of the cost variation across Medicare discharges as the RDRGs, this might not be the case for non-Medicare discharges. For base DRGs that are more common in the non-Medicare population, the RDRG system's larger number of severity levels and CC assignments based on all-patient data may result in comparatively

higher explanatory power than found in this analysis using Medicare data. While the overall pattern is similar across the various regressions performed for this study, two other findings are noteworthy. First, by having more severity levels, the RDRGs have slightly better comparative performance when statistical outliers (defined using the MS-DRGs) are included than when they are excluded. Second, both systems perform considerably better in explaining cost estimated using hospital-specific cost-to-charge ratios than cost estimated using national cost-to-charge ratios.