

WORKING P A P E R

Evaluation of Severity- Adjusted DRG Systems

Addendum to the Interim Report

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PREFACE

The Centers for Medicare and Medicaid Services (CMS), the federal agency responsible for administering the Medicare program, has proposed to adopt Medicare-Severity (MS) diagnosis-related groups (DRGs) in fiscal year 2008 to account for differences in patient mix in its inpatient hospital payment system for Medicare patients. In March 2007, RAND released an interim report evaluating five other severity-adjusted DRG systems that the agency was considering. This addendum reports our findings with respect to the MS-DRGs. While some comparative information is presented for the other severity-adjusted DRGs, readers should refer to the interim report for a more complete assessment of those systems.¹

This project is funded by CMS under contract no. 500-2005-000281. The research was conducted in 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).

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/).

1. PURPOSE

The Centers for Medicare & Medicaid Services (CMS) asked RAND to evaluate "off-the-shelf" severity-adjusted DRG systems that might be considered for Medicare's inpatient prospective payment system (PPS). The focus of the study was on five DRG systems maintained by the following vendors:

3M/Health Information Systems (3M/HIS)

- CMS-DRGs modified for AP-DRG Logic (CMS+AP-DRGs)
- Consolidated Severity-Adjusted DRGs (Con-APR-DRGs) (i.e., All-Patient Refined DRGs with Medicare modifications)

Health Systems Consultants (HSC)

- Refined DRGs (HSC-DRGs)

HSS/Ingenix

- All-Payer Severity DRGs with Medicare modifications (MM-APS-DRGs)

Solucient

- Solucient Refined DRGs (Sol-DRGs)

RAND released an interim report evaluating the five systems as a working paper in March 2007. Shortly thereafter, CMS proposed in the Fiscal Year 2008 (FY08) proposed rule to adopt a different system (Medicare-Severity or MS-DRGs). CMS developed the MS-DRG system in response to comments and issues raised during the FY07 rulemaking process. This addendum reports our findings with respect to the MS-DRGs. While some comparative information is presented for the other severity-adjusted DRGs, readers should refer to the main body of the interim report for a more complete assessment of those systems.²

² 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. DATA AND METHODS

The analyses reported in this addendum use the same data and methods that were used to evaluate the other severity-adjusted DRG systems. These methods are described in the main body of the report. In our comparison of the severity-adjustments, we wanted to use a consistent set of base CMS-DRGs. All the severity-adjusted DRG systems other than the Con-APR-DRG system use the base CMS-DRGs and are likely to incorporate refinements in the CMS-DRGs when those systems are updated. In addition to proposing the MS-DRGs in FY08, CMS proposed to make a few refinements to the base CMS-DRGs that are reflected in the proposed FY08 MS-DRGs. CMS supplied us with the FY08 MS-DRG assignments that would have applied to FY05 Medicare discharges from acute-care hospitals. Where feasible, we "mapped" the affected records back to the base DRG assignments that would have applied using the FY07 CMS-DRG classification logic.³ We then repeated the earlier quantitative analyses using this version of the MS-DRG assignments. The results presented in the remainder of this addendum add the findings for the MS-DRGs to the findings for the other severity-adjusted systems.

3. OVERVIEW OF MS-DRG SYSTEM

The MS-DRG system builds on the DRG refinements that CMS developed but did not adopt in 1994. The system utilizes the CMS-DRGs as the foundation for its grouping logic. 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. In particular:

- CMS collapsed the paired DRGs (with and without CC) and DRGs with age splits (0-17, >age 17) into base DRGs. CMS-DRGs that split based on the presence of a major cardiovascular condition,

³ For example, the FY08 rule proposes to reassign spinal fusions involving nine or more vertebrae (procedure code 81.64) from MS-DRGs 459 and 460 (Spinal Fusion Except Cervical With and Without MCC) to proposed MS-DRGs 456-458 (Spinal Fusion Except Cervical With Curvature of the Spine or Malignancy With MCC, With CC and Without CC). Because we evaluated the other CMS-based systems using the FY07 base CMS-DRGs, we reassigned these discharges from MS-DRGs 456-458 to MS-DRGs 459 and 460.

AMI with and without major complications, or cardiac catheterization with and without complex diagnoses were also collapsed. CMS also consolidated three pairs of burn DRGs that are distinguished based on the presence of CC or a significant trauma. Further, 34 current base CMS-DRGs with low Medicare volume (e.g., pediatric or primarily outpatient procedures) were consolidated with clinically similar proposed base MS-DRGs. A new base DRG was created for cranial-facial bone procedures.

- The general structure of the MS-DRG logic establishes three severity levels for each base DRG: With MCC, With CC, and Without CC. However, CMS consolidated severity levels for the same base DRG if the following criteria for a subgroup were not met:
 - At least a 3 percent reduction in variance would result.
 - At least 5 percent of discharges would be assigned to the subgroup.
 - At least 500 discharges would be assigned to the subgroup.
 - There would be at least a 20% difference in average charges between subgroups.
 - There would be a \$4,000 difference in average charges between subgroups.
- When the criteria for a subgroup were not met, the MCC and CC severity levels may have been collapsed, resulting in a With CC/MCC DRG and a Without CC/MCC DRG; alternatively, the no CC and CC severity levels may have been collapsed, resulting in a With MCC DRG and a Without MCC DRG. Some base MS-DRGs were not subdivided because there was not sufficient difference between the subgroups.
- CMS assigned each diagnosis code a uniform CC-severity level across all base DRGs (in conjunction with CC exclusion logic) based on an evaluation of the impact of the condition on cost. Because of the small number of cases, CMS used the APR-DRG assignments for newborn, obstetric and congenital anomaly diagnoses. Thirteen percent of diagnoses are MCCs, 27.2 percent are CCs, and 59.8 percent are non-CC. Imprecise codes (Not Otherwise Specified or NOS) and E-codes (causes of injury) are

generally categorized as non-CCs. Diagnoses that are closely associated with mortality are assigned differently depending on whether the patient is discharged alive (MCC) or dies (non-CC). 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 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.

Table 1 summarizes how the MS-DRG system logic compares to the other severity-adjusted systems along key dimensions.

Table 2 shows the distribution of DRGs by severity subgroups. There are 335 base DRGs, 53 of which are not divided into severity subgroups and 152 of which are divided into all three severity subgroups. There are 106 base DRGs that are divided into two subgroups: 63 split based on the presence or absence of a CC and 43 split based on the presence or absence of a MCC. The MDC 14 groups are shown separately because they are unchanged from the CMS-DRGs. In total, there are 745 proposed MS-DRGs.

Table 2 Number of Base MS- DRGs and Severity-Adjusted MS-DRGs

Severity Subgroups	Number of Base MS-DRGs	Number of MS-DRGs
No Subgroups	53	53
3 subgroups	152	456
2 subgroups: major CC and CC; non-CC	63	126
2 subgroups: non-CC and CC; major CC	43	86
Subtotal	311	721
MDC 14	22	22
Error DRGs	2	2
Total	335	745

Source: HHS, 2007.

Table 1 Logic of Alternative DRG Systems

	CMS-DRG	CMS+AP-DRG	HSC-DRG	Sol-DRG	MM-APS-DRG	Con-APR-DRG	MS-DRG
Number of MDCs	25	25	25	25	25	25	25
Number of base DRGs	379	379	391	393	328	270	335
Total number of DRGs	538	602	1,293	1,261	915	863	745
Number of DRGs < 500 discharges	97 (18%)	97 (16%)	374 (29%)	474 (38%)	115 (13%)	113 (13%)	38 (5.2%)
Number of CC (severity) subclasses	2	3	3 (med) or 4(surg)	3 (med) or 4 (surg)	3	4	3
CC subclasses	Without CC, With CC for selected base DRGs	Without CC, With CC for selected base DRGs and Major CC across DRGs within MDC	No CC, Class C CC, Class B CC, Class A CC (Surgical only)	Minor/no substantial CC, Moderate CC, Major CC, Catastrophic CC (Surgical only)	Without CC, With CC, With Major CC with collapsing within base DRGs	Minor CC, Moderate CC, Major CC, Severe CC with collapsing within base DRG and across base DRGs	Without CC, With CC, With Major CC with collapsing with base DRGs
Multiple CCs recognized	No	No	No	No	Yes (in weight computation)	Yes	No
CC assignment logic	Presence / absence	Presence / absence	Presence / absence	Presence / absence	Presence / absence	18-step process	Presence / absence
MDC assignment	Principal diagnosis	Principal diagnosis	Principal diagnosis	Principal diagnosis	Principal diagnosis	Principal diagnosis with rerouting	Principal diagnosis
Death used in DRG assignment	Yes (in selected DRGs)	Yes (in selected DRGs)	Yes ("early death" DRGs)	Yes ("early death" DRGs)	Yes (in selected DRGs)	No	Yes (in selected DRGs and CC assignments)

To facilitate comparisons across the severity-adjusted DRG systems, we assigned a severity level to each MS-DRG consistent with the method used for the other DRG systems. The severity level is based on the lowest severity-level of any CCs assigned to that DRG. We assigned a 0 to the lowest level. If a base MS-DRG divides into two DRGs, one for both discharges with no CC and discharges with CCs and the other for discharges with MCCs, we assigned Level 0 to the DRG for discharges with no MCC and Level 2 to the DRG for discharges with MCCs. We also assigned severity level 0 to base DRGs that do not split by CC level.

Table 3 summarizes the distribution of DRGs and discharges across severity levels by classification system, exclusive of MDC 15, ungroupable discharges, and statistical outliers. In comparison to the other severity-adjusted systems, the MS-DRGs have a much higher percentage of discharges assigned to the lowest severity level. This includes base DRGs that are not divided into severity subgroups, the no CC severity level, and the no MCC severity level in those base DRGs that are split based on the presence of a MCC only. Sixty percent of discharges are assigned to Severity Level 0 DRGs compared to only 20 percent in the Con-APR DRG system. There are several reasons for the higher percentage, including the re-assessment of CC assignments, the collapsing of the no CC and CC severity levels in 43 base MS-DRGs, and no severity subgroups in 53 base MS-DRGs.

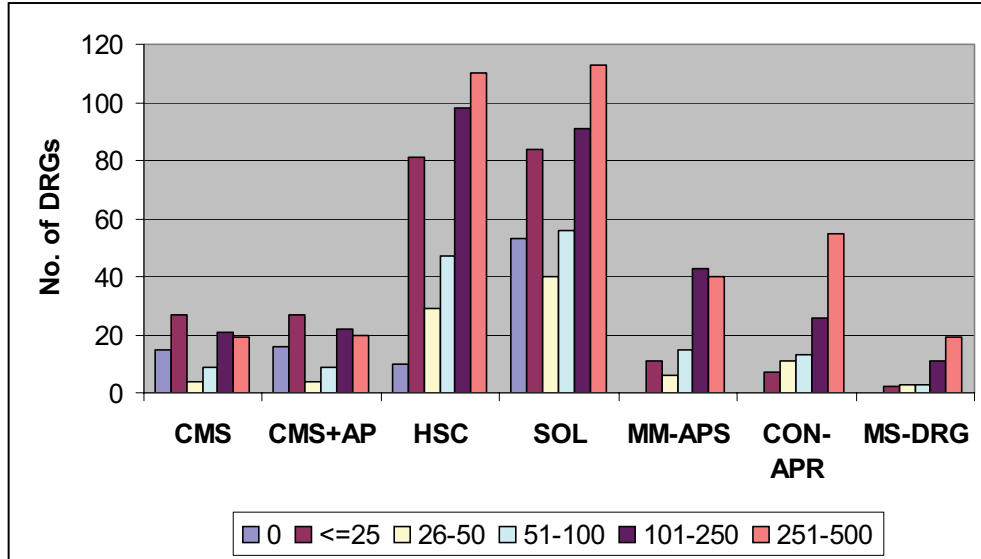
Table 3: Distribution of DRGs and Discharges by Severity-Level Assignments

CMS DRGs						
	SOI Level 0	SOI Level 1	SOI Level 2	SOI Level 3	Age 0-17 DRGs	Total
N DRGs	358	128			25	511
N Discharges	6,782,845	5,074,736			278,401	12,135,982
% Discharges	56%	42%			2%	100%
CMS+AP DRGs						
	SOI Level 0	SOI Level 1	SOI Level 2	SOI Level 3	Age 0-17 DRGs	Total
N DRGs	358	128	64		25	575
N Discharges	5,842,981	3,933,710	2,262,260		97,030	12,135,981
% Discharges	48%	32%	19%		1%	100%
HSC-DRGs						
	SOI Level 0	SOI Level 1	SOI Level 2	SOI Level 3	Age 0-17 DRGs	Total
N DRGs	373	349	348	175		1245
N Discharges	2,788,346	5,501,541	3,145,959	700,136		12,135,982
% Discharges	23%	45%	26%	6%		100%
SoI-DRGs						
	SOI Level 0	SOI Level 1	SOI Level 2	SOI Level 3	Age 0-17 DRGs	Total
N DRGs	368	336	331	169		1204
N Discharges	2,923,930	6,609,026	2,113,606	489,520		12,136,082
% Discharges	24%	54%	17%	4%		100%
MM-APS-DRGs						
	SOI Level 0	SOI Level 1	SOI Level 2	SOI Level 3	Age 0-17 DRGs	Total
N DRGs	325	316	265			906
N Discharges	3,892,398	6,283,024	1,960,560			12,135,982
% Discharges	32%	52%	16%			100%
Con-APR-DRGs						
	SOI Level 0	SOI Level 1	SOI Level 2	SOI Level 3	Age 0-17 DRGs	Total
N DRGs	261	262	263	59		845
N Discharges	2,475,008	5,588,117	3,308,104	764,821		12,136,050
% Discharges	20%	46%	27%	6%		100%
MS-DRGs						
	SOI Level 0	SOI Level 1	SOI Level 2	SOI Level 3	Age 0-17 DRGs	Total
N DRGs	325	196	215			736
N Discharges	7,308,649	2,847,838	1,979,495			12,135,982
% Discharges	60%	23%	16%			100%

Figure 1 shows the distribution of low-volume DRGs in each system in FY05, exclusive of MDC 15 newborns and ungroupable discharges. Because the MS-DRGs combine low-volume severity classes (and several low-volume base DRGs) and do not have separate DRGs for age 0-17, there are fewer low-volume DRGs than in the other systems. In total, there were 38 MS-DRGs with 500 or fewer discharges, 19 of which had more than 250 discharges. In comparison, because the current CMS-DRG system has age splits and has not consolidated low-volume base DRGs, it has 95 DRGs with 500 or fewer FY05 discharges.

Figure 1

Number of Low-Volume DRGs (500 or Fewer FY 05 Discharges)



WITHIN-DRG COST VARIATION IN DRG SYSTEMS

Severity-adjusted DRGs are designed to reduce the amount of cost variation within DRGs. To compare how much within-DRG variation occurs in each DRG system, we computed the mean standardized cost, standard deviation, and coefficient of variation (CV) for each DRG across the various systems.⁴ Figure 2 shows the distribution of CVs across the DRG systems, exclusive of MDC 15 newborns, ungroupable discharges, and statistical outliers. Each severity-adjusted system has a smaller proportion of DRGs with a CV > 100 percent than the CMS-DRGs. Seventeen percent of the 511 CMS-DRGs to which Medicare patients were assigned in 2005 had a CV > 100 percent. In contrast, 8 percent of the 736 MS-DRGs have a CV > 100 percent. This is a slightly lower percentage than in the CMS+AP DRGs but slightly higher percentage than the other four severity-adjusted DRG systems. Only 1.7 percent of discharges are

⁴ The CV is the standard deviation divided by the mean. We report the CV as a percentage by multiplying the above calculation by 100.

assigned to MS-DRGs with a CV > 100 percent, which is comparable to the percentage of discharges assigned to DRGs with a CV > 100 percent in the Con-APR DRGs and the CMS+AP DRGs (Figure 3). The MM-APS DRGs and CMS+AP DRGs have slightly lower and higher percentages, respectively, of discharges assigned to DRGs with a CV > 100 percent.

Figure 2: Proportion of DRGs, by Magnitude of CV

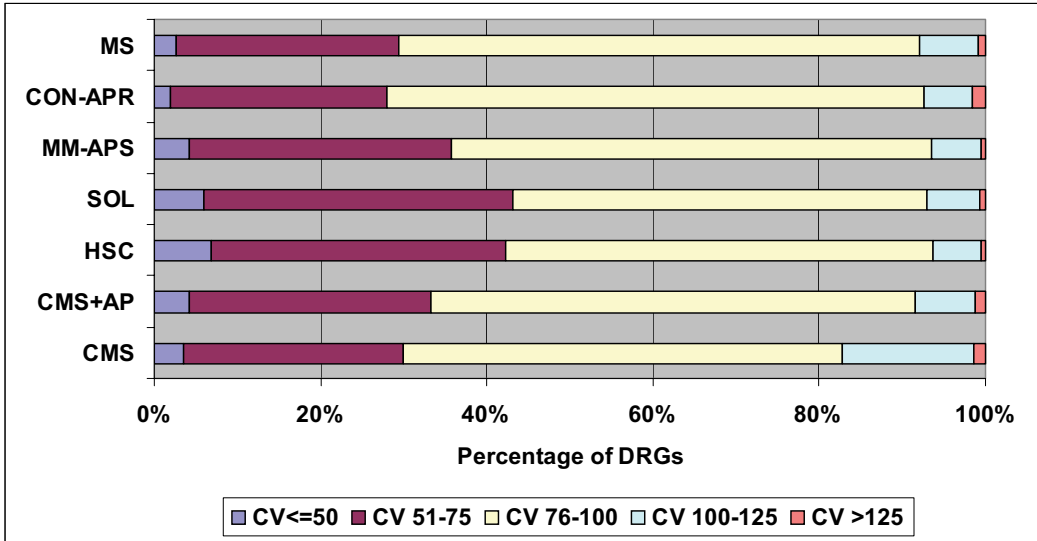
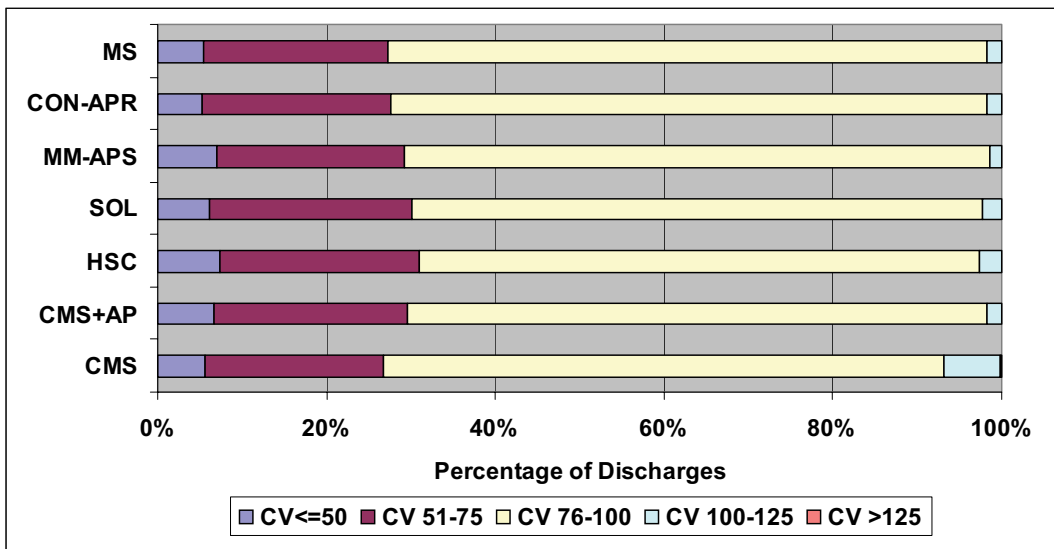


Figure 3: Proportion of Discharges Assigned to DRGs, by Magnitude of CV



4. COMPARATIVE PERFORMANCE IN EXPLAINING VARIATION IN COSTS

We used a log-linear regression model to compare the ability of DRG systems to explain differences in cost across Medicare discharges. We defined the FY05 log-standardized cost for each discharge as the dependent variable in the regressions. Our independent variable was a dummy variable for the DRG number (including severity level) assigned to the discharge. We excluded discharges assigned to MDC 15, ungroupable discharges, and statistical outliers. We created MDC 00 for the pre-MDC assignments. We also created MDC 26 for the DRGs to which surgical discharges with no surgical procedure related to the principal diagnosis are assigned. The distribution of discharges and the number of DRGs in each MDC are shown in Table 4.

We report in this section the results from four regression models:

- Model 1 examined the overall explanatory power of each DRG system.
- Model 2 examined the explanatory power of each DRG system by MDC.
- Model 3 examined the explanatory power of each DRG system by the relative costliness of base DRGs.
- Model 4 examined the contribution of each severity level to the overall explanatory power of each DRG system.

4.1 Assessment of Performance, Overall and By MDC

We report the results for the Model 1 regression on overall performance and the Model 2 regression on performance by MDC in Table 5. The Model 1 regression results show that all six severity-adjusted systems predict cost better than the CMS-DRGs do. The adjusted R-squared value for the MS-DRGs is .4300, a 9.1 percent improvement over the CMS-DRGs. The R-squared value is higher than the CMS+AP DRGs, but lower than the other systems. This is also the predominate pattern at the MDC level; however, the MS-DRGs have the lowest adjusted R-squared values among the severity-adjusted systems in seven MDCs. In three of these MDCs, the R-squared values are actually lower than under the current CMS-DRGs: MDC 19 (Mental Diseases and Disorders), MDC 20 (Alcohol/Drug Use and Alcohol/Drug Induced Organic Mental Disorders) and MDC 22(Burns). MDCs 19 and 20 have low explanatory power and the reduction is minimal. However, there is a 4 percent reduction in the explanatory power for MDC 22 that may be attributable to how the CMS-DRGs were

collapsed to form the base DRGs. The three pairs of burn CMS-DRGs that were defined based on the presence of a CC or a significant trauma were consolidated. There are eight CMS-DRGs in MDC 22 compared to 6 MS-DRGs.

Table 4: FY05 Distribution of Discharges and DRGs, by MDC

MDC**	CMS-DRG		CMS+AP DRG		HSC-DRG		SOL-DRG		MM-APS DRG		Con-APR DRG*		MS-DRG	
	N Discharges	N DRGs	N Discharges	N DRGs	N Discharges	N DRGs	N Discharges	N DRGs	N Discharges	N DRG	N Discharges	N DRGs	N Discharges	N DRGs
0	54,989	9	54,989	9	54,988	29	54,988	24	54,999	16	31,654	19	55,026	13
1	914,600	44	914,600	48	914,600	90	914,600	92	914,600	90	916,073	78	914,600	75
2	14,525	11	14,525	13	14,525	37	14,525	37	14,525	17	13,764	14	14,525	10
3	110,288	29	110,288	31	110,288	79	110,288	79	110,288	41	120,721	41	110,288	25
4	1,828,135	30	1,828,135	35	1,828,135	51	1,828,135	51	1,828,135	44	1,812,316	51	1,828,132	40
5	3,310,026	54	3,310,026	63	3,310,011	158	3,310,092	138	3,310,026	126	3,233,387	97	3,310,026	87
6	1,296,899	44	1,296,899	49	1,296,899	69	1,296,899	72	1,296,899	69	1,330,895	75	1,296,899	61
7	342,584	20	342,584	24	342,584	48	342,584	48	342,574	29	345,721	36	342,555	36
8	1,386,779	57	1,386,779	63	1,386,779	153	1,386,779	157	1,386,779	110	1,439,888	80	1,386,779	99
9	300,256	27	300,256	31	300,256	58	300,256	58	300,256	34	311,494	32	300,256	29
10	473,540	17	473,540	19	473,540	48	473,540	50	473,540	28	415,684	32	473,540	26
11	697,529	32	697,529	35	697,529	60	697,529	60	697,529	46	756,521	48	697,529	43
12	97,787	16	97,787	18	97,787	45	97,787	45	97,787	25	100,198	23	97,782	21
13	125,316	17	125,316	19	125,316	52	125,316	52	125,316	37	125,300	35	125,316	25
14	16,510	15	16,510	15	16,510	48	16,510	48	16,510	20	16,435	22	16,510	15
16	157,689	8	157,689	10	157,615	18	157,615	18	157,689	18	157,965	20	157,689	15
17	103,747	17	103,747	21	103,747	41	103,747	39	103,747	28	105,083	24	103,747	27
18	417,815	11	417,814	14	417,815	20	417,815	22	417,815	23	424,053	23	417,815	17
19	121,261	9	121,261	9	121,261	29	121,261	12	121,261	19	120,162	16	121,261	9
20	59,298	4	59,298	4	59,298	10	59,317	4	59,298	9	59,396	6	59,298	4
21	132,951	15	132,951	17	132,946	32	132,951	33	132,951	25	110,994	17	132,951	20
22	4,902	8	4,902	8	4,902	23	4,902	18	4,902	13	5,008	11	4,902	6
23	53,901	7	53,901	7	53,901	17	53,901	17	53,901	11	53,037	14	53,901	10
24	12,043	4	12,043	7	12,040	16	12,043	16	12,043	12	13,093	10	12,043	8
25	19,913	3	19,913	3	19,988	11	19,988	11	19,913	7	22,978	10	19,913	6
26	82,699	3	82,699	3	82,722	3	82,714	3	82,699	9	94,229	11	82,699	9
Total	12,135,982	511	12,135,981	575	12,135,982	1,245	12,136,082	1,204	12,135,982	906	12,136,049	845	12,135,982	736

Discharge count is adjusted for short-stay transfers to acute care hospitals. Count excludes statistical outliers, MDC 15 discharges, and ungroupable discharges.

* Con-APR-DRG MDC 24 and MDC 25 have been relabeled to be consistent with other classification systems.

**MDC 0 consists of pre-MDCs. MDC 26 contains surgical discharges with no surgical procedure related to the principal diagnosis.

Table 5: Comparative Performance of Severity-Adjusted DRGs in Explaining Cost Variation Overall and by MDC

MDC**	CMS-DRG		CMS+AP DRG		HSC-DRG		SOL-DRG		MM-APS DRG		Con-APR DRG*		MS-DRG	
	Adj R Sq	Inter-cept.	Adj R Sq	Dep. Mean	Adj R Sq	Dep. Mean	Adj R Sq	Dep. Mean	Adj R Sq	Dep. Mean	Adj R Sq	Dep. Mean	Adj R Sq	Dep. Mean
0	0.3348	10.75	0.3348	10.75	0.3478	10.75	0.3377	10.75	0.3465	10.75	0.1451	10.82	0.3460	10.75
1	0.2086	8.39	0.2516	8.39	0.2791	8.39	0.2764	8.39	0.2634	8.39	0.2895	8.39	0.2592	8.39
2	0.0636	8.06	0.0906	8.06	0.1138	8.06	0.1082	8.06	0.0988	8.06	0.1091	8.06	0.0925	8.06
3	0.1049	7.98	0.1340	7.98	0.1567	7.98	0.1484	7.98	0.1571	7.98	0.2703	8.04	0.1404	7.98
4	0.2456	8.43	0.2751	8.43	0.2959	8.43	0.2907	8.43	0.2806	8.43	0.2987	8.43	0.2805	8.43
5	0.5036	8.57	0.5270	8.57	0.5445	8.57	0.5358	8.57	0.5423	8.57	0.5590	8.57	0.5365	8.57
6	0.3516	8.41	0.3904	8.41	0.3868	8.41	0.3801	8.41	0.3949	8.41	0.4255	8.40	0.3847	8.41
7	0.2032	8.57	0.2700	8.57	0.2800	8.57	0.2704	8.57	0.2700	8.57	0.3186	8.57	0.2691	8.57
8	0.4491	8.81	0.4753	8.81	0.4865	8.81	0.4830	8.81	0.4836	8.81	0.4748	8.82	0.4795	8.81
9	0.1321	8.20	0.1652	8.20	0.1704	8.20	0.1570	8.20	0.1661	8.20	0.1749	8.20	0.1500	8.20
10	0.1364	8.09	0.1802	8.09	0.1904	8.09	0.1815	8.09	0.1852	8.09	0.1935	8.08	0.1776	8.09
11	0.1468	8.33	0.1980	8.33	0.2192	8.33	0.2063	8.33	0.2112	8.33	0.2376	8.36	0.2106	8.33
12	0.1734	8.23	0.2105	8.23	0.2367	8.23	0.2309	8.23	0.2139	8.23	0.2462	8.24	0.2042	8.23
13	0.1619	8.35	0.1902	8.35	0.2333	8.35	0.2256	8.35	0.2207	8.35	0.2482	8.35	0.2119	8.35
14	0.2098	7.84	0.2098	7.84	0.2506	7.84	0.2455	7.84	0.2462	7.84	0.2794	7.84	0.2108	7.84
16	0.0752	8.16	0.1144	8.16	0.1288	8.16	0.1152	8.16	0.1349	8.16	0.1837	8.17	0.1183	8.16
17	0.1503	8.66	0.2325	8.66	0.2541	8.66	0.2496	8.66	0.2372	8.66	0.2878	8.67	0.2484	8.66
18	0.2226	8.72	0.2646	8.72	0.2978	8.72	0.3063	8.72	0.2729	8.72	0.2745	8.73	0.2722	8.72
19	0.0370	8.05	0.0370	8.05	0.0549	8.05	0.0374	8.05	0.0532	8.05	0.0722	8.05	0.0369	8.05
20	0.1082	7.79	0.1082	7.79	0.1424	7.79	0.1083	7.79	0.1383	7.79	0.1314	7.79	0.1069	7.79
21	0.2247	8.20	0.3139	8.20	0.3120	8.20	0.3058	8.20	0.3207	8.20	0.3476	8.15	0.3152	8.20
22	0.3678	8.63	0.3678	8.63	0.4173	8.63	0.4079	8.63	0.3933	8.63	0.4716	8.69	0.3532	8.63
23	0.1395	8.01	0.1395	8.01	0.1676	8.01	0.1576	8.01	0.1636	8.01	0.1935	8.01	0.1574	8.01
24	0.2363	9.27	0.3321	9.27	0.3477	9.27	0.3486	9.27	0.3483	9.27	0.4244	9.36	0.3175	9.27
25	0.1034	8.59	0.1034	8.59	0.1683	8.59	0.1842	8.59	0.1983	8.59	0.2044	8.56	0.1437	8.59
26	0.1354	9.33	0.1354	9.33	0.1354	9.33	0.1354	9.33	0.2843	9.33	0.3612	9.38	0.2816	9.33
Overall	0.3942	8.49	0.4243	8.49	0.4388	8.49	0.4326	8.49	0.4348	8.49	0.4458	8.49	0.4300	8.49
Discharges	12,135,982		12,135,981		12,135,982		12,136,082		12,135,982		12,136,050		12,135,982	

Discharge count is adjusted for short-stay transfers to acute care hospitals. Count excludes statistical outliers, MDC 15 discharges, and ungroupable discharges.

*Con-APR DRG MDC 24 and MDC 25 have been renumbered consistent with other systems.

**MDC 0 consists of pre-MDCs. MDC 26 contains surgical discharges with no surgical procedure related to the principal diagnosis.

4.2. Assessment of Performance, by Relative Costliness of Base DRGs

We performed the Model 3 regressions to compare the performance of the severity-adjusted systems in explaining the costs of inexpensive base DRGs relative to more expensive base DRGs. We collapsed the DRGs into base DRGs, which we assigned to deciles on the basis of their log mean standardized cost per discharge. We then assigned the decile to each record. We first performed a discharge-level regression using log-standardized cost as the dependent variable and decile as the explanatory variable to determine how much explanatory power is created by simply dividing the base DRGs into cost deciles (Table 6). The results for the six CMS-DRG-based systems are quite similar (R-squared values of 0.362 to 0.368) because most discharges are assigned to the same base DRGs in these systems. The R-squared value for the decile assignments for the Con-APR DRGs (which have different base DRGs) is 0.352.

Table 6: Results from Discharge-Level Regressions Using Cost Decile as the Explanatory Variable

	CMS-DRG	CMS+AP	HSC	Sol	MM+APS	Con-APR	MS-DRGs
Adj. R-squared	0.362	0.362	0.366	0.365	0.368	0.352	0.365
N Discharges	12,135,982	12,135,981	12,135,982	12,136,082	12,135,982	12,136,050	12,135,982

We then performed separate regressions by cost decile to determine the contribution of the DRGs to explaining cost variation within each decile. Our dependent variable was log-standardized cost and our explanatory variable was the DRG (including severity level). As seen in Table 7, the CMS-DRGs add only a small amount of explanatory power until Decile 7, and the most additional explanatory power occurs in Decile 10. The MS-DRG system provides more explanatory power in all deciles than does the CMS-DRGs, but the most explanatory power occurs in the top three deciles. For most cost deciles, the MS-DRGs provide less additional explanatory power than the other severity-adjusted systems.

Table 7: Results from Regressions by Base DRG Cost Decile, Using DRG as the Explanatory Variable

Base DRG Cost Decile	CMS-DRG			CMS+AP-DRG*			HSC-DRG			Sol-DRG		
	N DRGs	N Discharges	Adj. R sq	N DRGs	N Discharges	Adj. R sq	N DRGs	N Discharges	Adj. R-sq	N DRGs	N Discharges	Adj. R-sq
1	43	625,032	0.022	55	625,032	0.039	75	433,293	0.040	69	424,220	0.035
2	55	1,274,845	0.029	72	1,274,845	0.066	112	597,661	0.061	100	577,480	0.041
3	52	1,476,494	0.027	71	1,476,494	0.065	115	2,085,490	0.078	112	1,954,055	0.064
4	55	1,125,647	0.023	76	1,125,647	0.068	130	1,362,633	0.077	124	1,520,423	0.064
5	57	2,125,839	0.021	78	2,125,839	0.084	127	2,212,077	0.090	129	2,210,063	0.074
6	47	1,243,085	0.018	66	1,243,085	0.092	126	1,167,796	0.117	123	1,112,163	0.104
7	55	1,344,747	0.065	75	1,344,746	0.107	139	1,343,285	0.120	131	985,748	0.100
8	47	702,821	0.039	67	702,822	0.108	143	676,515	0.135	140	1,113,323	0.146
9	57	1,458,415	0.060	82	1,458,414	0.129	140	1,529,064	0.161	138	1,492,356	0.168
10	43	759,057	0.297	58	759,057	0.342	138	728,168	0.336	138	746,251	0.336
Base DRG Cost Decile	MM-APS			Con-APR-DRGs *			MS-DRGs					
	N DRGs	N DRGs	Adj. R sq	N DRGs	N Discharges	Adj. R sq	N DRGs	N Discharges	Adj. R-sq			
1	86	748,140	0.062	88	1,060,257	0.085	45	717,895	0.035			
2	93	1,907,587	0.073	97	1,609,288	0.110	61	1,790,892	0.055			
3	93	1,603,069	0.072	96	1,819,102	0.116	67	1,652,007	0.062			
4	91	2,130,807	0.086	98	1,950,986	0.134	82	2,204,178	0.088			
5	93	1,093,131	0.105	98	891,144	0.133	78	681,990	0.120			
6	88	999,546	0.102	95	1,188,375	0.139	80	1,211,536	0.105			
7	92	890,344	0.106	98	939,809	0.165	85	1,011,400	0.091			
8	94	854,166	0.114	89	856,658	0.158	84	779,523	0.133			
9	98	1,423,088	0.190	98	1,252,229	0.234	92	1,537,187	0.174			
10	78	486,104	0.336	94	568,202	0.363	62	549,374	0.340			

*Deciles were assigned by Base DRG. CMS+AP-DRGs and Con-APR-DRGs that are consolidated across base DRGs are included in the cost deciles applicable to each base

4.3. Assessment of Severity-Level Contributions to Explanatory Power

We performed the Model 4 regressions to compare the contribution that each severity level makes to the overall explanatory power of the DRG systems. To make this comparison, we performed a series of discharge-level regressions that added severity-level distinctions in successive steps until all severity levels in each classification system were accounted for in the DRGs.

- Step 1 used base DRGs as the explanatory variable.
- Step 2 measured the explanatory power of creating two severity levels by using DRGs with SOI Level 0 as the explanatory variable for discharges assigned to those DRGs and the base DRGs as the explanatory variable for the remaining discharges. This had the

effect of combining SOI Levels 1 through 3 as applicable into a single variable.

- Step 3 measured the explanatory power of creating three severity levels by using DRGs with SOI Level 0 or 1 as the explanatory variable for discharges assigned to those DRGs and the base DRGs as the explanatory variable for the remaining discharges. This had the effect of combining SOI Levels 2 and 3 as applicable into a single variable. This was the last step for the MM-APS-DRGs and the MS-DRGs because the remaining discharges were all assigned to SOI Level 2.
- Step 4 measured the explanatory power of creating four severity levels in the HSC-DRGs and Sol-DRGs for surgical discharges and four severity levels for both surgical and medical discharges in the Con-APR-DRGs. For the CMS+AP-DRGs, the results measured the explanatory power of adding a third severity level (MCCs) to the CMS-DRG CC, along with age splits.

The results from the Model 4 regressions (Table 8) show that the base MS-DRGs have a higher explanatory power than the CMS+AP-DRGs and the Con-APR-DRGs. The MS-DRGs add more explanatory power than the other systems with the creation of two severity levels, which may be attributable to the reassessment of the CC list. The second severity level (CC or MCC) added 10 percent to the explanatory power for the MS-DRGs. Adding the third severity level (MCC) increased the explanatory power 3.5 percent. This is less than the additional explanatory power provided by the third severity level of the CMS+DRGs and the MM-APS-DRGs and may again be attributable to the reassessment of the CC list. With only substantially more costly conditions qualifying as a CC, we would expect less average cost differences between CCs and MCC subgroups.

Table 8: Model 4 Regression Results Showing Increase in Explanatory Power Provided by Adding Severity Levels to Base DRGs

N SOI Levels	CMS+AP DRGs			HSC-DRGs			Sol-DRGs			MM-APS-DRGs			Con-APR-DRGs			MS-DRGs		
	N DRG	Adj. r-sq	% Inc.	N DRG	Adj. r-sq	% Inc.	N DRG	Adj. r-sq	% Inc.	N DRG	Adj. r-sq	% Inc.	N DRG	Adj. r-sq	% Inc.	N DRG	Adj. r-sq	% Inc.
Base	362	0.377		378	0.383		377	0.382		325	0.380		272	0.362		326	0.378	
2 Levels	494	0.394	4.5	722	0.405	5.8	705	0.404	5.9	641	0.408	7.3	531	0.389	7.6	585	0.416	10.1
3 Levels	511	0.394	0.0	1071	0.433	7.0	1036	0.427	5.7	906	0.435	6.5	791	0.431	10.7	736	0.430	3.5
4 Levels	575	0.424	7.6	1245	0.439	1.3	1204	0.433	1.3				845	0.446	3.5			

Note: CMS+AP-DRG 3-level DRG split is age 0-17 DRGs. 4-level split adds the MCCs.

4.4. VALIDITY OF THE SEVERITY-ADJUSTED DRGS

In addition to explaining cost variation, severity-adjusted DRGs should have validity as a measure of resource costs. For a given base DRG, the SOI levels should be monotonic; that is, the mean cost per discharge should increase as the severity level increases. Further, the severity levels within base DRGs should discriminate between discharges with substantially different treatment costs. CMS incorporated these principles into the criteria that the agency used to determine whether to establish MS-DRG subgroups. To compare how the MS-DRG severity levels discriminate between discharges with different treatment costs relative to the other severity-adjusted DRG systems, we examined both the percentage differences and the absolute differences in cost between the severity levels within base DRGs.

Table 9 shows the percentage difference between the mean standardized cost for discharges with SOI Levels 1 through 3 as applicable to the adjacent lower SOI within the base DRG (e.g., Base DRG 1 SOI Level 1 compared with Base DRG 1 SOI Level 0). The first column of the table shows the number of DRGs with SOI Level 0 and the proportion of discharges assigned to those DRGs. The "Other DRGs" column, which is not applicable to the MS-DRGs, includes DRGs for age 0-17 and any DRGs for which there was no base DRG with SOI 0 that could be used in the comparison, e.g., no Medicare discharges were assigned to the base DRG SOI Level 0. For SOI Level 1 and higher, we computed the ratio of the mean cost for that level to the mean cost for the adjacent lower level (e.g., $\text{mean cost}_{\text{DRG Level 2}} / \text{mean cost}_{\text{DRG Level 1}}$) and report the results by the magnitude of the ratio. We used the number of discharges assigned to the higher severity level to calculate the percentage of discharges assigned to each ratio category.

Medicare beneficiaries were assigned to 325 MS-DRGs with SOI Level 0. These DRGs represented 44 percent of the severity-adjusted DRGs and 60 percent of the Medicare discharges. As previously noted, this is a higher percentage of discharges assigned to SOI Level 0 than under the current CMS-DRGs or any of the other severity-adjusted DRG systems. The remaining Medicare discharges were assigned to 411 DRGs with SOI Levels 1 or 2, of which 387 were on average at least 30 percent more costly than the discharges in the adjacent lower-severity DRG. Unlike the other systems, all SOI Level 1 or 2 DRGs were monotonic and at least 20 percent more costly than the adjacent lower-severity DRG.

Table 10 shows the distribution of the absolute dollar differences in the mean standardized costs between discharges assigned to DRG SOI Levels 1 through 3 (as applicable) and those assigned to the adjacent lower severity level in the same base DRG. Consistent with Table 9, the discharge counts are based on the discharges assigned to the DRG with the higher severity level in the comparison. Of the discharges assigned to the MS-DRGs SOI Levels 1 and 2, 58 percent were assigned to DRGs that were at least \$2,000 more costly than the adjacent lower severity level. This is a higher percentage than any other severity-adjusted DRG system.

Table 9: Ratio of the Mean Standardized Cost of a Higher Severity Level to That of the Adjacent Lower Severity Level Within the Same Base DRG

Level 0 DRGs		DRGs with Severity Level 1-3 (as applicable)					Other DRGs	Total
CMS DRGs								
		<1.0	1.0 to 1.1	1.1 to 1.2	1.2 to 1.3	> 1.3		
N DRGs	358	0	0	1	7	118	27	511
% DRGs	70%	0%	0%	0%	1%	23%	5%	100%
% Discharge	56%	0%	0%	1%	2%	39%	2%	100%
% SOI 1-3 Discharges		0%	0%	2%	4%	94%		
CMS+AP DRGs								
	Level 0 DRGs	<1.0	1.0 to 1.1	1.1 to 1.2	1.2 to 1.3	> 1.3	Other DRGs	Total
N DRGs	358	4	0	12	30	366	29	799
% DRGs	45%	1%	0%	2%	4%	46%	3%	100%
% Discharge	48%	1%	0%	2%	8%	39%	1%	100%
% SOI 1-3 Discharges		3%	0%	4%	16%	77%		
HSC-DRGs								
	Level 0 DRGs	<1.0	1.0 to 1.1	1.1 to 1.2	1.2 to 1.3	> 1.3	Other DRGs	Total
N DRGs	373	33	53	101	144	536	5	1245
% DRGs	30%	3%	3%	8%	12%	43%	0%	100%
% All Disch	23%	1%	4%	8%	13%	52%	0%	100%
% SOI 1-3 Discharges		1%	6%	10%	17%	67%		
Sol-DRGs								
	Level 0 DRGs	<1.0	1.0 to 1.1	1.1 to 1.2	1.2 to 1.3	> 1.3	Other DRGs	Total
N DRGs	368	25	47	77	114	564	9	1204
% DRGs	31%	2%	4%	6%	9%	47%	1%	100%
% Discharge	24%	0%	3%	5%	10%	58%	0%	100%
% SOI 1-3 Discharges		0%	4%	7%	13%	76%		
MM-APS-DRGs								
	Level 0 DRGs	<1.0	1.0 to 1.1	1.1 to 1.2	1.2 to 1.3	> 1.3	Other DRGs	Total
N DRGs	325	2	6	30	70	473	0	906
% DRGs	36%	0%	1%	3%	8%	52%	0%	100%
% Discharge	32%	0%	2%	4%	11%	51%	0%	100%
% SOI 1-3 Discharges		0%	3%	6%	16%	75%		
Con-APR-DRGs								
	Level 0 DRGs	<1.0	1.0 to 1.1	1.1 to 1.2	1.2 to 1.3	> 1.3	Other DRGs	Total
N DRGs	261	3	7	39	81	642	11	1044
% DRGs	25%	0%	1%	4%	8%	61%	1%	100%
% Discharge	20%	0%	1%	8%	16%	54%	1%	100%
% SOI 1-3 Discharges		0%	2%	10%	20%	69%		
MS-DRGs								
	Level 0 DRGs	<1.0	1.0 to 1.1	1.1 to 1.2	1.2 to 1.3	> 1.3	Other DRGs	Total
N DRGs	325	0	0	1	22	388		736
% DRGs	44%	0%	0%	0%	3%	53%	0%	100%
% Discharge	60%	0%	0%	0%	4%	36%	0%	100%
% SOI 1-3 Discharges		0%	0%	0%	9%	91%		

Table 10: Difference in Mean Standardized Cost Between Severity Levels 1 Through 3 (as applicable) and an Adjacent Lower Severity Level

CMS DRGs								
	Base and Other DRGs	Negative	0-\$500	\$500-999	\$1000-1999	\$2000-4999	≥ \$5000	Total
N DRGs	385	0	1	8	34	58	25	511
% DRGs	75%	0%	0%	2%	7%	11%	5%	100%
% Discharges	59%	0%	1%	2%	14%	20%	4%	100%
% SOI 1-3 Discharges		0%	2%	5%	35%	49%	9%	
CMS+AP DRGs								
	Base and Other DRGs	Negative	0-\$500	\$500-999	\$1000-1999	\$2000-4999	=>\$5000	Total
N DRGs	387	4	4	22	79	189	114	799
% DRGs	48%	1%	1%	3%	10%	24%	14%	100%
% Discharges	0.49258	0.0149301	0.00781	0.067193	0.19371545	0.18005343	0.04372	100%
% SOI 1-3 Discharges		3%	2%	13%	38%	35%	9%	
HSC-DRGs								
	Base and Other DRGs	Negative	0-\$500	\$500-999	\$1000-1999	\$2000-4999	=>\$5000	Total
N DRGs	378	33	46	122	239	303	124	1245
% DRGs	30%	3%	4%	10%	19%	24%	10%	100%
% Discharges	23%	1%	3%	16%	33%	18%	6%	100%
% SOI 1-3 Discharges		1%	5%	20%	43%	23%	8%	
SoI-DRGs								
	Base and Other DRGs	Negative	0-\$500	\$500-999	\$1000-1999	\$2000-4999	=>\$5000	Total
N DRGs	377	25	39	85	211	290	177	1204
% DRGs	31%	2%	3%	7%	18%	24%	15%	100%
% Discharges	24%	0%	3%	7%	39%	20%	7%	100%
% SOI 1-3 Discharges		0%	4%	10%	51%	27%	9%	
MM-APS-DRGs								
	Base and Other DRGs	Negative	0-\$500	\$500-999	\$1000-1999	\$2000-4999	=>\$5000	Total
N DRGs	325	2	4	54	140	233	148	906
% DRGs	36%	0%	0%	6%	15%	26%	16%	100%
% Discharges	32%	0%	0%	11%	30%	21%	5%	100%
% SOI 1-3 Discharges		0%	0%	17%	44%	31%	8%	

Con-APR-DRGs								
	Base and Other DRGs	Negative	0-\$500	\$500- 999	\$1000- 1999	\$2000- 4999	=>\$5000	Total
N DRGs	272	3	10	72	164	226	297	1044
% DRGs	26%	0%	1%	7%	16%	22%	28%	100%
% Discharges	21%	0%	2%	18%	33%	19%	7%	100%
% SOI 1-3 Discharges		0%	2%	23%	41%	24%	9%	
MS-DRGs								
	Base and Other DRGs	Negative	0-\$500	\$500- 999	\$1000- 1999	\$2000- 4999	=>\$5000	Total
N DRGs	325	0	0	2	79	217	113	736
% DRGs	44%	0%	0%	0%	11%	29%	15%	100%
% Discharges	60%	0%	0%	0%	17%	18%	5%	100%
% SOI 1-3 Discharges		0%	0%	1%	42%	46%	12%	

4.5 Stability of the Severity-Adjusted DRG Relative Weights

In the main body of the interim report, we compared the FY04 and FY05 relative weights for the five proprietary severity-adjusted systems to assess the year-to-year stability in the DRG relative weights. We found that no system assigned more than a small percentage of discharges to DRGs with a greater than five percent change in relative weights. We have not repeated this analysis for the MS-DRGs; however, we have no reason to expect that the results would be substantially different for this system.

5. Changes in Relative Weights

In Chapter 5 of the interim report, we explored the impact of the alternative severity-adjusted systems on the relative weights and hospital case mix indices (average relative weights). We repeated the Chapter 5 analyses for the MS-DRGs in order to have a comparison of the impact of the MS-DRGs to the other severity-adjusted systems.

Table 11 arrays Medicare discharges into deciles based on standardized cost per discharge and summarizes the changes in relative weight by cost decile. The purpose of this analysis is to compare the potential redistribution of payments across systems assuming no change in coding behavior. We separately summarized the change in relative weight by those discharges that would have a lower relative weight

(losers) and those that would have a higher relative weight (gainers). We estimated the impact on aggregate payments by multiplying the estimated FY07 average payment per Medicare discharge⁵ by the mean gain (or loss) in each decile and the number of discharges that were gainers (or losers). The result provides a rough estimate of the payment impact when the hospital payment factors and outliers are comparable across the cost deciles. Because case mix is positively correlated with IME, DSH and outlier payments, it is likely that the amount of redistribution is understated but the relative relationships across the severity-adjusted DRG systems should be the same.

Each severity-adjusted DRG system improves payment accuracy by redistributing payment from lower-cost discharges to higher-cost discharges.⁶ For example, in the MS-DRG system, there is an estimated net loss of more than \$334 million in Decile 1 and more than a \$1.4 billion estimated net increase in payments for discharges in Decile 10. The total payment redistribution from the losers to the gainers is \$9.7 billion, or 8.4 percent of the total payment. The redistribution is less than the Con-APR-DRG system, the same as the HSC-DRG system, and more than in the other systems even though some of these systems have higher explanatory power.

⁵ We used \$9,601 as our estimated average FY07 PPS payment. This figure is based on the impact statement published in the FY07 PPS final rule, which estimated that the average per-discharge payments for operating costs and capital costs were \$8,830 and \$771, respectively.

⁶ The net gains do not equal the net losses because a slightly different set of providers were used to develop the relative weights.

Table 11: Changes in Relative Weights, by Cost Deciles of Discharges

Decile	CMS+AP-DRG						HSC-DRG					
	N losers		% Change	\$ Impact (Millions)	N Gainers		N losers		% Change	\$ Impact (Millions)	N Gainers	
1	828,633	-11.21	-\$549	362,549	13.68	\$249	822,329	-16.42	-\$803	369,797	13.34	\$244
2	857,947	-11.51	-\$617	343,163	16.81	\$325	817,112	-15.40	-\$797	384,412	17.06	\$362
3	855,227	-11.77	-\$660	349,595	18.30	\$394	804,686	-15.13	-\$813	400,351	19.31	\$462
4	840,558	-12.04	-\$703	366,339	19.24	\$472	789,729	-14.95	-\$837	417,311	21.09	\$568
5	825,750	-12.21	-\$758	382,521	20.17	\$565	775,205	-14.68	-\$872	433,131	22.69	\$696
6	810,343	-11.93	-\$815	399,265	21.07	\$679	758,051	-14.10	-\$914	451,508	23.87	\$853
7	806,186	-11.03	-\$866	404,490	22.18	\$810	742,954	-13.17	-\$957	467,602	24.18	\$1,023
8	795,886	-10.41	-\$925	415,594	22.86	\$983	712,968	-12.66	-\$1,005	498,384	23.60	\$1,236
9	741,641	-10.72	-\$1,048	470,339	22.64	\$1,338	644,836	-13.40	-\$1,147	567,091	22.65	\$1,613
10	550,104	-11.76	-\$1,277	662,156	15.55	\$2,413	489,245	-15.56	-\$1,550	723,051	16.16	\$2,652
Payment Redistribution			-\$8,218			\$8,225	-\$9,694					\$9,709
% of Payments			-7.1%			7.1%	-8.4%					8.4%
Decile	Sol-DRG						MM-APS-DRG					
	N losers		% Change	\$ Impact (Millions)	N Gainers		N losers		% Change	\$ Impact (Millions)	N Gainers	
1	738,767	-13.58	-\$623	452,616	8.04	\$171	781,620	-13.93	-\$662	410,618	13.58	\$268
2	757,894	-12.17	-\$606	443,205	10.48	\$242	801,741	-13.57	-\$704	399,957	15.80	\$333
3	759,591	-11.93	-\$624	445,186	12.31	\$311	802,725	-13.45	-\$735	402,511	17.30	\$397
4	753,690	-11.97	-\$655	453,151	14.03	\$395	795,854	-13.42	-\$771	411,378	18.56	\$473
5	745,211	-12.12	-\$702	463,017	15.63	\$502	787,309	-13.41	-\$824	421,234	19.81	\$567
6	729,538	-12.26	-\$764	479,964	17.08	\$652	775,285	-13.23	-\$890	434,479	20.75	\$690
7	713,598	-12.16	-\$839	496,928	18.18	\$835	758,853	-12.77	-\$958	451,866	20.86	\$834
8	688,489	-12.22	-\$925	522,830	19.23	\$1,079	728,537	-12.58	-\$1,032	482,941	20.86	\$1,038
9	636,296	-13.37	-\$1,112	575,571	20.56	\$1,513	673,445	-12.90	-\$1,161	538,511	21.94	\$1,466
10	519,662	-15.30	-\$1,614	692,601	17.51	\$2,771	530,441	-12.64	-\$1,318	681,756	18.85	\$3,006
Payment Redistribution			-\$8,464			\$8,474	-\$9,055					\$9,073
% of Payments			-7.3%			7.3%	-7.8%					7.8%
Decile	Con-APR-DRGs						MS-DRGs					
	N losers		% Change	\$ Impact (Millions)	N Gainers		N losers		% Change	\$ Impact (Millions)	N Gainers	
1	824,179	-18.81	-\$907	368,985	20.31	\$388	676,544	-16.98	-\$712	514,960	14.98	\$379
2	801,229	-19.05	-\$961	400,927	21.71	\$489	696,588	-17.18	-\$782	504,912	15.59	\$428
3	774,654	-19.41	-\$1,005	430,929	22.53	\$583	691,122	-17.35	-\$821	514,033	16.12	\$488
4	746,332	-19.83	-\$1,060	461,106	23.47	\$693	678,431	-17.46	-\$860	528,758	16.75	\$565
5	717,822	-20.23	-\$1,137	490,818	24.53	\$831	666,923	-17.34	-\$910	541,581	17.60	\$662
6	688,466	-20.15	-\$1,227	521,320	25.33	\$1,005	657,572	-16.56	-\$963	552,177	18.75	\$795
7	658,400	-19.39	-\$1,307	552,282	25.57	\$1,216	660,777	-14.94	-\$1,008	549,958	19.79	\$940
8	626,685	-18.89	-\$1,411	584,713	26.48	\$1,514	665,086	-13.75	-\$1,073	546,402	21.07	\$1,133
9	590,010	-18.85	-\$1,633	621,802	30.62	\$2,149	636,426	-13.76	-\$1,214	575,563	22.32	\$1,530
10	537,096	-21.66	-\$3,174	675,055	42.48	\$4,978	504,129	-13.75	-\$1,428	708,099	17.92	\$2,865
Payment Redistribution			-\$13,821			\$13,845	-\$9,771					\$9,785
% of Payments			-11.9%			11.9%	-8.4%					8.4%

Changes in the Case-Mix Index

Table 12 compares the CMI for categories of hospitals across the DRG systems studied, assuming no behavioral changes in coding practices or types of patients. On average, the CMI for urban hospitals increases under the severity-adjusted systems, and that for rural hospitals decreases. The change is greatest in the Con-APR DRGs, where the CMI for rural hospitals is 2.4 percent lower than that under the CMS-DRGs. The CMI for large urban hospitals (those located in metropolitan areas with more than 1 million population) and other urban hospitals is 0.6 and 0.1 percent higher, respectively, under the Con-APR-DRGs. Under the MS-DRGs, there is a slightly larger increase in the average CMI for large urban hospitals (0.7 percent), a reduction in the CMI for other urban hospitals (-0.3 percent), and a smaller reduction for rural hospitals (-1.7%).

Consistent with the other severity-adjusted systems, the MS-DRG system would reduce the CMI for smaller hospitals and increase the CMI for larger hospitals. Larger hospitals tend to have more complex and severely ill patients than smaller hospitals do. Teaching hospitals also tend to treat more complex cases. The CMI for non-teaching hospitals under the MS-DRGs would be lower(-0.4 percent) and the CMI for major teaching hospitals would increase more (0.6 percent) than the CMI for hospitals with small teaching programs (0.2 percent). Other than the Con-APR-DRGs, the other severity-adjusted systems would have a similar impact. Under the Con-APR-DRGs, the CMI for hospitals with large teaching programs would be about the same, but that for hospitals with smaller teaching programs would increase 0.7 percent relative to the CMS-DRGs.

Table 12: CMI Change in Alternative DRG Systems Relative to the CMS-DRG CMI

	N Hospitals	N Discharges	CMS- DRG CMI	Percentage Change from CMS-DRG CMI					
				CMS+ AP- DRG	HSC- DRG	Sol- DRG	MM- APS- DRG	Con- APR- DRG	MS- DRG
ALL	3,890	12,165,763	1.00	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
By Geographic Location:									
Large urban areas (pop>1	1,485	5,715,356	1.02	0.5%	0.4%	0.3%	0.6%	0.6%	0.7%
Other urban areas (pop<1	1,186	4,578,447	1.04	-0.2%	-0.2%	-0.1%	-0.2%	0.1%	-0.3%
Rural hospitals	1,219	1,871,960	0.84	-1.3%	-0.9%	-1.0%	-1.4%	-2.4%	-1.7%
Bed Size (Urban):									
0-99 beds	685	611,139	0.91	-1.0%	-1.1%	-1.1%	-1.3%	-1.6%	-1.2%
100-199 beds	875	2,346,922	0.93	0.0%	0.1%	0.0%	0.1%	0.0%	0.0%
200-299 beds	511	2,446,737	1.00	0.1%	0.2%	0.3%	0.3%	0.6%	0.3%
300-499 beds	433	2,965,216	1.08	0.3%	0.3%	0.3%	0.4%	0.8%	0.4%
500 or more beds	167	1,923,789	1.17	0.6%	0.3%	0.2%	0.4%	0.4%	0.5%
Bed Size (Rural):									
0-49 beds	543	330,242	0.73	-2.5%	-2.1%	-2.2%	-2.7%	-5.0%	-3.0%
50-99 beds	398	595,599	0.80	-1.4%	-1.0%	-1.1%	-1.6%	-2.7%	-2.0%
100-149 beds	160	415,367	0.85	-1.1%	-0.7%	-0.8%	-1.2%	-2.0%	-1.5%
150-199 beds	69	260,910	0.91	-0.8%	-0.6%	-0.7%	-0.8%	-1.5%	-1.0%
200 or more beds	49	269,842	0.99	-0.6%	-0.1%	-0.1%	-0.6%	-0.5%	-0.9%
Urban by Region:									
New England	129	541,471	0.99	0.1%	-0.2%	-0.5%	-0.5%	-0.6%	-0.5%
Middle Atlantic	370	1,621,488	1.00	0.0%	-0.4%	-0.5%	-0.3%	-1.5%	-0.1%
South Atlantic	432	2,208,336	1.04	0.5%	0.7%	0.7%	0.7%	1.4%	0.7%
East North Central	410	1,856,164	1.03	0.6%	0.7%	0.6%	0.8%	1.5%	0.6%
East South Central	168	696,943	1.06	-0.2%	-0.2%	-0.2%	-0.2%	-0.3%	-0.4%
West North Central	164	657,322	1.08	-0.3%	-0.3%	0.0%	-0.3%	0.3%	-0.3%
West South Central	369	1,115,411	1.05	0.1%	0.0%	0.1%	0.3%	0.5%	0.3%
Mountain	153	465,093	1.08	0.4%	0.2%	0.5%	0.4%	1.0%	0.7%
Pacific	423	1,016,135	1.03	0.0%	-0.2%	-0.1%	-0.1%	0.2%	0.3%
Puerto Rico	53	115,440	0.87	-1.1%	-1.4%	-0.1%	-1.2%	-5.1%	-1.3%
Rural by Region:									
New England	34	49,842	0.90	-0.6%	-0.6%	-0.5%	-1.1%	-0.6%	-1.1%
Middle Atlantic	68	139,639	0.85	-1.1%	-0.7%	-0.7%	-1.3%	-1.5%	-1.4%
South Atlantic	191	409,116	0.82	-0.8%	-0.4%	-0.5%	-0.9%	-1.8%	-1.2%
East North Central	163	290,069	0.87	-1.1%	-0.7%	-0.9%	-1.3%	-1.8%	-1.6%
East South Central	201	328,326	0.82	-1.5%	-0.9%	-1.1%	-1.4%	-3.2%	-1.9%
West North Central	184	240,449	0.87	-1.6%	-1.2%	-1.1%	-1.8%	-2.5%	-2.0%
West South Central	227	266,419	0.80	-2.1%	-1.8%	-1.9%	-2.0%	-4.3%	-2.5%
Mountain	91	80,219	0.85	-1.2%	-1.0%	-0.4%	-1.3%	-1.2%	-1.1%
Pacific	60	67,881	0.86	-0.9%	-1.0%	-1.1%	-1.4%	-1.6%	-1.6%

	N Hospitals	N Discharges	Percentage Change from CMS-DRG CMI						
			CMS- DRG CMI	CMS+ AP- DRG	HSC- DRG	SoI- DRG	MM- APS- DRG	Con- APR- DRG	MS- DRG
By Payment Classification:									
Teaching Status:									
Non-teaching	2,791	6,115,193	0.92	-0.4%	-0.2%	-0.2%	-0.4%	-0.5%	-0.4%
Fewer than 100 Residents	853	4,061,451	1.04	0.1%	0.2%	0.2%	0.2%	0.7%	0.2%
100 or more Residents	246	1,989,119	1.16	0.8%	0.3%	0.1%	0.5%	0.0%	0.6%
Urban DSH:									
Non-DSH	778	2,574,640	1.02	-0.1%	0.0%	0.1%	-0.2%	0.5%	0.0%
100 or more beds	1,541	7,378,095	1.05	0.3%	0.2%	0.2%	0.4%	0.4%	0.4%
Less than 100 beds	352	341,068	0.82	-0.9%	-0.8%	-1.0%	-1.1%	-2.0%	-1.1%
Rural DSH:									
Non-DSH	238	300,747	0.87	-1.4%	-1.0%	-0.9%	-1.7%	-1.9%	-1.7%
SCH	402	599,823	0.83	-1.3%	-1.0%	-1.0%	-1.4%	-2.4%	-1.8%
RRC	132	466,395	0.92	-0.8%	-0.3%	-0.5%	-0.7%	-1.4%	-1.1%
Other Rural:									
100 or more beds	60	135,146	0.80	-0.9%	-0.8%	-1.2%	-1.3%	-2.0%	-1.5%
Less than 100 beds	387	369,849	0.74	-2.1%	-1.6%	-1.7%	-2.2%	-4.3%	-2.6%
Urban teaching and DSH:									
Both teaching and DSH	829	4,705,476	1.09	0.5%	0.3%	0.3%	0.5%	0.5%	0.5%
Teaching and no DSH	204	1,108,092	1.06	0.0%	0.1%	0.0%	-0.1%	0.4%	0.1%
No teaching and DSH	1,064	3,013,687	0.95	-0.1%	0.1%	0.0%	0.1%	0.1%	0.1%
No teaching and no DSH	574	1,466,548	1.00	-0.2%	-0.1%	0.1%	-0.3%	0.5%	0.0%
Rural Hospital Types:									
RRC	145	519,808	0.92	-0.8%	-0.4%	-0.5%	-0.7%	-1.4%	-1.1%
SCH	423	457,119	0.79	-1.6%	-1.2%	-1.2%	-1.7%	-3.0%	-2.1%
MDH	180	164,453	0.75	-2.1%	-1.7%	-1.7%	-2.3%	-4.1%	-2.7%
SCH and RRC	76	266,027	0.92	-0.9%	-0.7%	-0.7%	-1.1%	-1.3%	-1.3%
MDH and RRC	8	19,746	0.85	-1.4%	-0.6%	-0.8%	-1.6%	-1.9%	-1.7%
Other Rural:	387	444,807	0.77	-1.6%	-1.2%	-1.4%	-1.8%	-3.3%	-2.1%

5.4. CODING IMPROVEMENT UNDER SEVERITY-ADJUSTED DRGS

A concern with implementing severity-adjusted DRGs is that the incentives for more-complete and accurate coding may lead to CMI increases that do not reflect actual changes in patient mix. The case-mix information presented in the preceding tables assumes no changes in coding behavior. However, the experience under the Medicare PPS has been that each time the payment system has changed to consider new factors in the DRG logic, providers have responded by improving their coding of these factors in order to optimize payments. Thus, the case-mix-change information in the tables is likely to be affected by coding improvement. Because we worked with FY05 data only in evaluating the MS-

DRGs, we do not repeat using the MS-DRGs the analysis in Chapter 5 of the interim report on case mix change. The reader is referred to the FY08 proposed rule for a detailed analysis by CMS and 3M/HIS concerning the likely impact of introducing the MS-DRGs.

6. OTHER ISSUES

6.1 How Understandable Are the Severity-Adjusted DRGs?

The DRG grouping logic should be understandable to clinicians and others desiring to use the system for benchmarking and other activities related to assessing the cost and quality of care. Features of the grouping logic that make the classification system easier to understand include:

- Uniform rules for assignments to MDCs, DRGs, and severity levels. The MS-DRG classification logic relies on uniform hierarchical rules for assigning discharges to their respective MDCs, base DRGs, and severity levels. Except for the Con-APR-DRGs, the other severity-adjusted systems also use uniform hierarchical rules for DRG assignment based on the CMS-DRGs.
- Standard DRG severity levels. The underlying logic of the MS-DRG system uses standard severity levels, but the criteria for establishing severity subgroups results in severity levels that vary by base DRG. Because the severity levels are often collapsed and the resulting subgroups depend on the particular DRG, it is a more complicated system to understand than those systems that uniformly define subgroups, namely the HSC-DRGs, Sol-DRGs and CMS+AP-DRGs. The MM-APS-DRGs and Con-APR-DRGs also collapse severity levels to eliminate low-volume and monotonicity issues.
- Standard severity-level assignments for diagnoses. The MS-DRG system assigns a standard severity level to each CC (coupled with a CC exclusions list). The CMS+AP DRGs and the MM-APS-DRGs also use standard severity-level assignments. The remaining systems use more complex logic that makes severity-level assignments by categories of base DRGs or diagnoses.

A transition issue is how easily discharges can be cross-walked between the current CMS-DRGs and the MS-DRGs. Although the MS-DRGs are based on the CMS-DRGs, there are challenges in cross-walking discharges between the two systems because of the revisions in the CC list and the sequential renumbering of the DRGs. The revisions in the CC list mean that it is not possible to crosswalk groups of discharges from paired CMS-DRGs to the corresponding MS-DRG. Because a discharge that is assigned to a CMS-DRG With CC cannot be assumed to crosswalk to the corresponding MS-DRG With CC, the crosswalk must be done on discharge-specific CCs. Further, crosswalking between collapsed MS-DRG subgroups for no CC/With CC to the corresponding CMS-DRG cannot be done without knowing the secondary diagnoses.

6.2 Does the Grouper Logic Reflect Current Patterns of Care?

DRG classification logic should be periodically reviewed and updated to reflect changes in patient mix and patterns of care. The MS-DRGs are the most updated of the severity-adjusted DRG systems. CMS reviewed the CC list and severity-level assignments in developing the MS-DRGs. The other CMS-based systems use CC lists and severity-level assignments that are based on outdated analyses of the effect on a condition on treatment costs from either the 1988 Yale study or the 1994 CMS refinement study. Further, the MS-DRGs incorporate recent refinements in the CMS-DRGs to account for complexity as well as severity. The APR-DRG system has not been reviewed for several years and is not as current as the MS-DRG system.

6.3 Does the Public Have Access to the System Logic and Software?

The classification logic for the MS would be in the public domain and, as is the case with the current CMS-DRGs, the source code, logic, and documentation are available for purchase through the National Technical Information Service. Each of the other severity-adjusted systems evaluated in this report is maintained as a proprietary system, although 3M/HIS has indicated that it would put the CMS+AP-DRGs in the public domain should CMS decide to adopt that system.

6.4 What Are the Operational Implications of the System?

Two aspects of the severity-adjusted DRG system have the most implications for administrative costs. First, increased emphasis on complete coding is likely to lead to implementation costs for training coders and ongoing costs for additional coding staff. Some hospitals have been coding "efficiently," that is, they have not been coding more than necessary to assign the patient to the highest possible DRG. In theory, "efficient" coding practices could continue under MS-DRGs and the other systems that assign patients based on the highest severity level of any CCs, but it would still require training to make sure coders were sensitive to the severity-level assigned to various CCs. Because of the revised CC list, more training may be needed for the MS-DRGs than for the other CMS-based systems.

Systems modifications represent the second major category of costs of implementing a severity-adjusted DRG system. These costs are likely to be less expensive for the MS-DRGs. Most importantly, because the MS-DRGs are in the public domain, there should be less disruption to existing arrangements for acquiring and installing the grouper software and integrating that software with other hospital systems. Also, because the 3-digit numbering convention is retained, the more extensive systems modifications required for the 4-digit systems (HSC-DRG and Sol-DRG) are not an issue.

6.5. How Applicable Is Each System to Other Payers and Purposes?

The current CMS-DRGs are used by other payers and for benchmarking and quality-assessment purposes. All else being equal, adopting a system that can be used by other payers has considerable benefits. All five proprietary severity-adjusted systems that we review in the interim report were initially developed as all-payer systems. Two (HSC-DRG and Sol-DRG) have retained their all-payer focus, while the others have modified the all-payer structure to address low-volume Medicare DRGs and reduce the total number of DRGs. Except for MDC 15 (Newborns) where the current CMS DRGs were retained, the MS-DRGs also consolidate base DRGs, eliminate the age splits, and collapse severity levels. This is likely

to diminish the utility of the MS-DRG system for other payers and for quality assessment.

7. SUMMARY OF FINDINGS AND DISCUSSION

Each of the severity-adjusted DRG systems improves upon the explanatory power of the CMS-DRGs. The MS-DRGs explain 43 percent of the cost variation, which is a 9.1 percent improvement over the CMS-DRGs. The explanatory power of the MS-DRGs is higher than the CMS+AP DRGs, but lower than the other systems. This is also the predominate pattern at the MDC level; however, the MS-DRGs have the lowest adjusted R-squared values among the severity-adjusted systems in seven MDCs. In three of these MDCs, the R-squared values are actually lower than under the current CMS-DRGs: MDC 19 (Mental Diseases and Disorders), MDC 20 (Alcohol/Drug Use and Alcohol/Drug Induced Organic Mental Disorders) and MDC 22 (Burns). MDCs 19 and 20 have low explanatory power and the reduction is minimal. However, there is a 4 percent reduction in the explanatory power for MDC 22. This may be attributable to how the CMS-DRGs were collapsed to form the base DRGs and warrants further examination. The MS-DRGs have fewer DRGs (745) than any of the systems other than CMS-DRGs and CMS+AP-DRGs. The lower explanatory power relative to the systems with more DRGs reflects a tradeoff between explanatory power and the criteria used to establish the severity-level groupings, i.e., the minimum volume and cost differential requirements.

Using the FY05 MedPAR data and FY07 average payment rates, we estimate that the MS-DRGs are likely to redistribute less Medicare payments than the Con-APR-DRGs but more payments than the other systems. Our analysis was based on FY05 MedPAR data and FY08 average payments per discharge and assumed no changes in coding behavior. Readers are referred to the CMS FY08 proposed rule for an analysis of estimated FY08 impact derived through a payment simulation that accounts for coding improvement and the transition to cost-based relative weights as well as implementation of the MS-DRGs.

As discussed in the interim report, the Con-APR-DRG system explains more cost variation than the other systems but is also the most complex and is likely to impose the highest implementation and ongoing costs.

Three CMS-based systems have higher explanatory power than the MS-DRGs: the HSC-DRGs, MM-APS-DRGs, and the Sol-DRGs. The strengths and weaknesses of these systems are discussed in the interim report. The MS-DRGs have two important advantages over the other systems:

- The CC list and severity-level assignments reflect current Medicare data.
- The classification logic is in the public domain and, as a result, systems implementation and on-going costs are likely to be less than with the other CMS-based systems.

Limitations

Our focus was on the overall performance of the MS-DRG system relative to the five proprietary systems that we had evaluated in the March 2006 report. We used the same general methodological approach and the limitations noted in Chapter 6 of the interim report apply to our evaluation of the MS-DRGs. Most importantly, we did not assess how specific elements of the classification logic, such as the updating of the CC list and the consolidation of severity levels within base DRGs, affect clinical coherency and cost homogeneity. We used only the FY05 MedPAR file and, as a result, did not explore the stability of the MS-DRGs or the likely impact of coding improvement on case mix change.

The FY08 proposed rule contains an impact analysis for the MS-DRGs derived through payment simulation. This is a more precise methodology than the methodology that we used in the report and we refer the reader to the proposed rule for a better estimation of the impact of moving from the CMS-DRGs to the MS-DRGs.

REFERENCES

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