WORKING
P A P E R

Evaluation of Severity-Adjusted DRG Systems: Interim Report

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RAND HEALTH

PREFACE

The Centers for Medicare and Medicaid Services (CMS),the federal agency responsible for administering the Medicare program, is considering major refinements in the methodologies used to account for differences in patient mix in its prospective payment system (PPS) for acute-care inpatient hospital services. CMS asked the RAND Corporation to evaluate alternative systems that might be used by the PPS to classify discharges into severity-adjusted diagnosis-related groups (DRGs). This interim report presents the preliminary results of analyses that address three questions:

- How well does each classification system explain variation in resource usage?
- How would the classification system affect a hospital's patient mix?
- Are the groupings manageable, administratively feasible, and understandable?

The final report will expand on these analyses where appropriate and will also evaluate alternative methods to determine DRG relative weights. The final report will be submitted by September 1, 2007.

This project is funded by CMS under contract no. 500-2005-000281. This interim report should not be interpreted as being indicative of decisions CMS may make concerning the hospital inpatient PPS. 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).

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SUMMARY

The Centers for Medicare & Medicaid Services (CMS), the federal agency responsible for administering the Medicare program, is considering major refinements in the methodologies used to account for differences in patient mix in its prospective payment system (PPS) for acute-care hospital services. The purpose of the refinements is to improve payment accuracy and equity so that hospitals do not avoid treating expensive cases or are advantaged by treating less costly conditions. The refinements would reduce payments for less expensive cases and increase payments for more expensive cases.

To support the agency's assessment of potential refinements, this report evaluates alternative systems that might be used under the PPS to classify discharges into severity-adjusted diagnosis-related groups (DRGs). The analyses in this report focus on three key questions:

- How well does each classification system explain variation in resource usage?
- How would the classification system affect a hospital's patient mix?
- Are the groupings manageable, administratively feasible, and understandable?

The report presents the preliminary results of our evaluation of the alternative severity-adjusted DRG systems and takes into account comments from CMS and a technical expert panel. The final report will expand on these analyses where appropriate. It will also evaluate alternative methods to determine DRG relative weights and assess the payment impact of the alternative methodologies. The final report will be submitted by September 1, 2007.

STUDY APPROACH

The study compares alternative severity-adjusted DRG classification systems to the DRGs established by CMS in the fiscal year 2007 (FY07) PPS final rule. Based on the responses that CMS received from vendors with severity-adjusted DRG systems, the report evaluates the 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)[1]

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)

The analyses in this report rely on quantitative methods and systematic review of the DRG classification logic used by each DRG system.

OVERVIEW OF SEVERITY-ADJUSTED DRG SYSTEMS

Four of the severity-adjusted patient classification systems utilize the CMS-DRGs as the foundation for their grouping logic. The HSC-DRGs, Sol-DRGs, and MM-APS-DRG system start with the CMS-DRGs but collapse any paired DRGs (DRGs distinguished by the presence or absence of complications or comorbidities (CCs) and/or age) into base DRGs and then split the base DRGs into CC-severity levels. A discharge is assigned to the highest severity level of any secondary diagnosis. The CMS+AP-DRG system follows the basic CMS-DRG logic but creates separate DRGs within major diagnostic categories (MDCs) for cases with the most resource-intensive or catastrophic CCs.

The fifth severity-adjusted DRG system included in this evaluation, the Con-APR-DRG system, involves a different approach to grouping logic. The system uses base APR-DRGs that are similar but not identical to base CMS-DRGs. In determining severity levels, the classification logic takes the presence of multiple CCs and other factors into account.

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[1] CMS called this system Consolidated-Severity DRGs or CS-DRGs during the FY07 rulemaking process. We have chosen to use the Con-APR-DRG acronym in this report to keep the connection with the APR-DRG system.

Table S.1 summarizes key differences in how the systems classify patients into base DRGs and severity levels.

- Both the Con-APR-DRGs and the MM-APS-DRGs collapse some base DRGs with low Medicare volume; the remaining systems have not been modified to address low volume issues.
- The HSC-DRGs and the Sol-DRGs use uniform severity levels for each base DRG (3 for medical and 4 four surgical). The general structure of the MM-APS-DRG logic establishes three severity levels for each base DRG, but some severity levels for the same base DRG are consolidated to address Medicare low-volume DRGs and monotonicity issues. The general structure of the Con-APR-DRGs establishes four severity levels for each base DRG, but severity level consolidations occur to address Medicare low-volume DRGs and monotoncity.
- Under the CMS+AP-DRGs and MM-APS DRGs, each diagnosis is assigned a uniform CC-severity level across all base DRGs (in conjunction with CC exclusion logic). The remaining systems assign diagnoses to CC-severity level classifications by groups of DRGs.
- Under the grouping logic used by all systems other than the Con-APR DRGs, each discharge is assigned to the highest severity level of any secondary diagnosis. The Con-APR-DRG system adjusts the initial CC-severity level assignment based on other factors, including the presence of additional CCs. None of the other systems adjust the severity-level classification for additional factors or CCs, but the MM-APS-DRG system handles independent coexisting conditions through an enhanced relative weight.
- The HSC-DRGs and the Sol-DRGs have a medical “early death” within each MDC.
- The Con-APR-DRG system does do not use death in the grouping logic. In addition, most complications of care do not affect the DRG assignment.

Table S.1 Logic of CMS and Alternative DRG Systems

	CMS-DRG	CMS+AP-DRG	HSC-DRG	Sol-DRG	MM-APS-DRG	Con-APR-DRG
Number of MDCs	25	25	25	25	25	25
Number of base DRGs	379	379	391	393	328	270
Total number of DRGs	538	602	1,293	1,261	915	863
Number of DRGs < 500 discharges	97 (18%)	97 (16%)	374 (29%)	474(38%)	115 (13%)	113 (13%)
Number of CC (severity) subclasses	2	3	3 (med) or 4(surg)	3 (med) or 4 (surg)	3	4
CC subclasses	With CC, without 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 CCs, Moderate CCs, Major CCs, Catastrophic CCs (Surgical only)	Without CC, With CC, With Major CC with some collapsing at base DRG level	Minor, Moderate, Major, Severe with some collapsing at DRG level
Multiple CCs recognized	No	No	No	No	Yes (in computation of weight)	Yes
Logic of CC subdivision	Presence/ absence	Presence/ absence	Presence/ absence	Presence/ absence	Presence/ absence	18-step process
Logic of MDC assignment	Principal diagnosis	Principal diagnosis	Principal diagnosis	Principal diagnosis	Principal diagnosis	Principal diagnosis with rerouting
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
Complications of care are CCs ?	Yes	Yes	Yes	Yes	Yes with some downgrading	No

COMPARATIVE PERFORMANCE IN EXPLAINING VARIATION IN RESOURCE USE

We used FY04 and FY05 data to analyze the performance of the severity-adjusted DRGs along several dimensions.

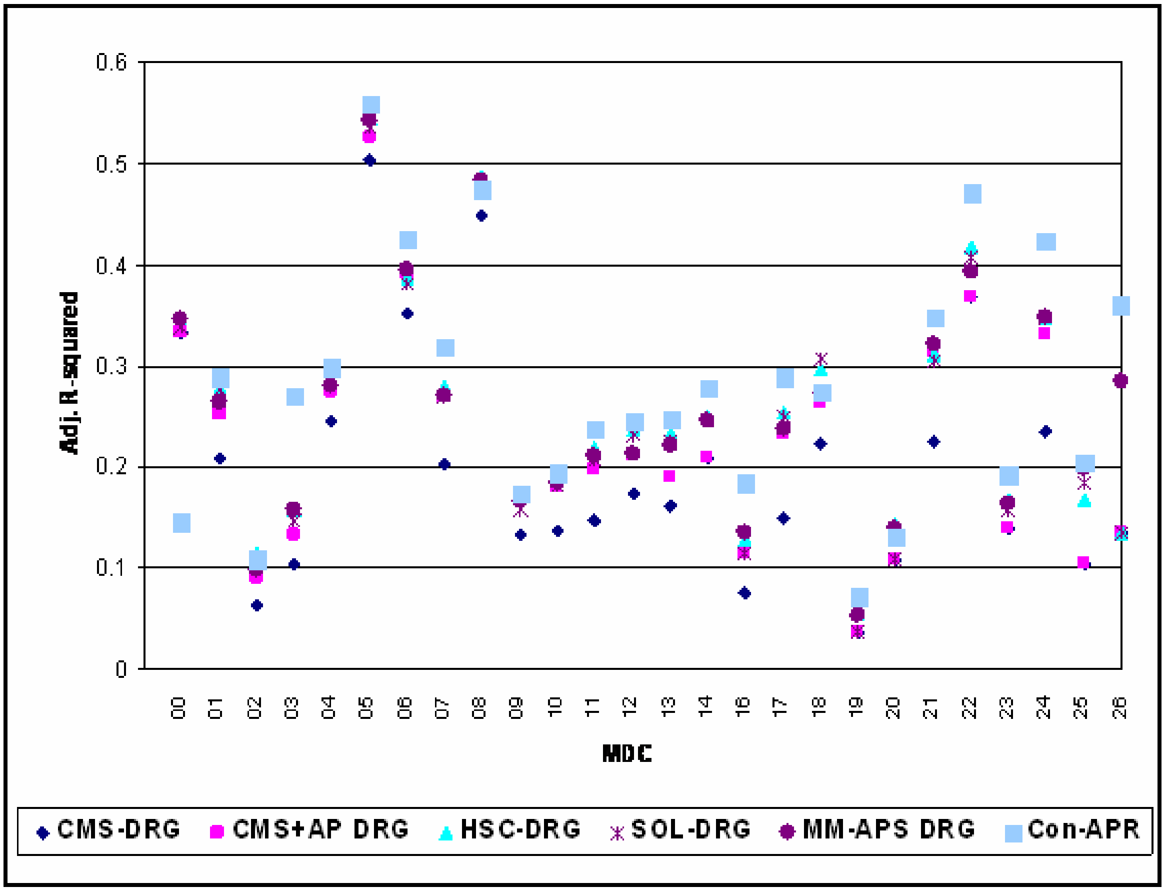
Within-DRG variation. The goal for the severity-adjusted DRGs is to reduce the amount of cost variation within DRGs. All five severity-adjusted systems reduce the amount of variation, with the MM-APS DRGs, Con-APR-DRGs, and CMS+AP-DRGs having a lower percentage of discharges assigned to DRGs with substantial variation than the HSC-DRGs and Sol-DRGs.

Explanatory power. An important evaluation question is how well each DRG system explains differences in cost across Medicare discharges. All five severity-adjusted systems have higher explanatory power than the CMS-DRGs. The Con-APR-DRGs explain 45 percent of the cost variation, which is a 13 percent improvement over the CMS-DRGs. The other systems show the following improvement: HSC-DRGs, 11 percent; MM-APS-DRGs and Sol-DRGs, 10 percent; and, CMS+AP DRGs, 8 percent. The Con-APR-DRGs had the highest explanatory power in most MDCs (Figure S.1).

Validity. Another important question is whether severity of illness is a valid measure for treatment costs. For a given base DRG, the average cost per discharge should increase as the severity levels increase and the severity levels should discriminate between discharges with substantially different treatment costs. Across the DRG systems, costs increase as the severity level increases except for a few DRGs with only a small number of discharges. The number of DRGs and severity levels affects the amount of cost discrimination seen between severity levels.

Stability. It is important that the DRG system used in the Medicare PPS result in DRG relative weights that have year-to-year stability. We found only minor differences in stability between FY04 and FY05 relative weights across the systems. About five percent of FY05 discharges were assigned to DRGs with more than a five percent change in relative weights from FY04.

Figure S.1
Comparison of R-Squared Values by MDC Using Standardized Cost as the Dependent Variable and DRG as the Explanatory Variable



IMPACT ON PATIENT MIX

The differences in explanatory power affect how Medicare payments are distributed across discharges and hospitals. The total payment redistribution across systems differs and reflects the impact of the improvement in explanatory power. The CMS+AP-DRGs showed the least improvement and also would lead to less payment redistribution than the other systems (about $8.2 billion or 7.1 percent of total payments). The Con-APR-DRGs, with the most improvement would entail more payment redistribution than the other DRG systems ($13.8 billion, or 11.9 percent of the total payments). The Sol-DRG and MM-APS-DRGs would redistribute about $8.5 and $9.1 billion, respectively while the HSC-DRGs would redistribute about $9.7 billion.

The case mix index for urban hospitals and larger hospitals increases, while that for rural hospitals and smaller hospitals decreases across the systems. This is consistent with a severity-adjusted DRG system shifting payment from less-expensive cases to more-expensive cases.

The above estimates assume no changes in coding practices; actual impacts under any of the systems will depend on hospital efforts to improve coding practices in response to the specific incentives of the selected system. One of the challenges facing CMS will be to develop an equitable policy for addressing case mix increases attributable to coding improvement. The amount of coding improvement is likely to vary across hospitals, depending on how strong their current coding practices are and the resources they are able to devote to improving them.

OTHER ISSUES: COMPLEXITY AND ADMINISTRATIVE BURDEN

The DRG grouping logic should be understandable to clinicians and others desiring to use the system for benchmarking and assessing the cost and quality of care. Although the Con-APR-DRG system explains the most cost variation, it is also the most complex to understand. The CMS-based systems have lower explanatory power but are easier to understand, largely because they build on the existing system and rely on uniform hierarchical rules for assigning discharges to base DRGs and severity levels. The Con-APR DRG system has a unique grouping logic that takes into account multiple CCs and other factors.

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. Because the Con-APR-DRG system determines the final severity level based on multiple CCs and requires more precise coding for higher severity levels, the Con-APR DRG system is likely to require more investment in coding staff than the other systems. More-complete coding, however, has benefits for other uses of the clinical information, such as quality-monitoring activities.

Systems modifications represent the second major category of costs of implementing a severity-adjusted DRG system. In addition to acquiring and installing the software for assigning patients to DRGs, hospitals would have to integrate that software with other hospital systems, including encoders and financial systems. The ease with which this could be accomplished will depend on the arrangements that CMS and the selected vendor negotiate.

Under the current CMS-DRG system, the classification logic is in the public domain. The source code, logic, and documentation are available for purchase through the National Technical Information Service. Each severity-adjusted system evaluated in this report is maintained as a proprietary system. Accessibility to the DRG classification logic and software was raised as an issue during the FY07 rulemaking process when CMS proposed adopting the Con-APR-DRG system in FY08. Concerns were raised with respect to both sufficient access to evaluate the impact of adopting the system and on-going access by hospital consultants and vendors in order to integrate the grouper software with other hospital systems. If CMS decides to implement one of the severity-adjusted DRG systems evaluated in this study, we assume that negotiations would occur between the vendor and CMS regarding the specifics of arrangements for maintaining the classification system and public accessibility to the grouping logic and software. It will be important for CMS to control future revisions in the classification logic for purposes of the Medicare PPS and for the logic and software to be readily available to the public at a reasonable cost.

LIMITATIONS

Our general approach to evaluating the performance of the alternative DRG systems was to use the “off-the-shelf” versions of the groupers that did not control for differences such as the older grouper versions of the HSC-DRG and Sol-DRG systems, the precise coding rules and treatment of complications of care in the Con-APR-DRGs and, to a lesser extent, the MM-APS-DRGs. We also did not evaluate the add-on for independent CCC conditions used by the MM-APS-DRGs as part of this evaluation but will as part of our evaluation of relative weight methdologies in the final report.

Our focus was on the overall performance of the systems; our evaluation of how specific elements of the classification logic affect clinical coherency and cost homogeneity was limited to one major diagnostic category. We also did not decompose the elements accounting for case mix change across the systems but believe that it would be important to do so in the future.

The DRG classification system is only one factor that affects payment accuracy and equity. The method used to derive the relative weights, including how case-level costs are estimated, and the method used to estimate case-level costs for purposes of assessing payment accuracy are critical components of the payment system. Other policies, such as those that would be adopted for post-acute care transfers and high cost outlier cases need development before the impact of implementing a severity-adjusted DRG system can be determined. It was premature for us to examine hospital-level payment impacts of the severity-adjusted DRG classification systems without considering the relative weight methodologies. For the final report, we will examine different approaches to estimating costs and developing relative weights and the payment impacts of the alternative methodologies.

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ACRYONYMS AND ABBREVIATIONS

3M/HIS	3M/Health Information Systems
ADRG	adjacent diagnosis-related group
AP-DRGs	all-patient diagnosis-related groups
APR-DRGs	all-patient refined diagnosis-related groups
APS-DRGs	all-patient severity-adjusted diagnosis-related groups
CC	complication or comorbidity
CCR	cost-to-charge ratio
CDRG	consolidated diagnosis-related group
CMS	Centers for Medicare & Medicaid Services
Con-APR-DRGs	consolidated all-patient refined DRGs
DRG	diagnosis-related group
DSH	disproportionate share hospital
FY	fiscal year
HCFA	Health Care Financing Administration
HIV	human immunodeficiency virus
HSC	Health Systems Consultants
IME	indirect medical education
MCC	major complication or co-morbidity
MCV	Major cardiovascular (diagnosis)
MDC	major diagnostic category
MedPAC	Medicare Payment Advisory Commission
MedPAR	Medicare Payment and Analysis Review
pdx	principal diagnosis
O.R.	operating room
PPS	prospective payment system
RGN	refinement group number
sdx	secondary diagnosis
SOI	severity of illness
TEP	technical expert panel

1. INTRODUCTION

1.1. PURPOSE OF THIS STUDY

The Centers for Medicare & Medicaid Services (CMS), the federal agency responsible for administering the Medicare program, is considering major refinements in the methodologies used to account for differences in patient mix in its prospective payment system (PPS) for acute-care hospital services. To support the agency’s assessment of potential refinements, this study evaluates alternative systems that might be used by the PPS to classify discharges into severity-adjusted diagnosis-related groups (DRGs) and to measure the average resource requirements of discharges assigned to a given DRG relative to all discharges. CMS has asked RAND to examine the following areas:

Severity-adjusted DRG classification systems

- How well does each classification system explain variation in resource usage?
- How would the classification system affect a hospital’s patient mix?
- Are the groupings manageable, administratively feasible, and understandable?

Alternative relative-weight methodologies

- What is the effect of using alternative methods for deriving relative weights?

This interim report presents the preliminary results of our findings with respect to the severity-adjusted DRG classification systems. The final report will expand on these analyses where appropriate. It will also evaluate alternative methods to determine DRG relative weights and assess the hospital-level payment impacts of the classification systems and relative weight methodologies. The final report will be submitted by September 1, 2007.

1.2. THE ROLE OF DRGS IN MEDICARE'S PROSPECTIVE PAYMENT SYSTEM

The Social Security Amendments of 1983 (P.L. 98-21) established a per-discharge PPS to encourage acute-care hospitals to provide services to Medicare beneficiaries more efficiently. Previously, payments for inpatient discharges were based on the reasonable costs of providing services to Medicare patients. Under PPS, each inpatient discharge is assigned to a DRG that includes patients expected to have similar resource use and clinical patterns of care. The Medicare payment is based on a standard payment rate adjusted by the relative weight of the DRG and for facility-level characteristics. The relative weight represents the average cost of caring for discharges in a specific DRG relative to the average costs for all Medicare discharges. Facility-level geographic adjustments take into account the wage index for the geographic area and, for hospitals in Alaska and Hawaii, the cost of living. Additional adjustments are made for indirect medical education (IME) costs and for serving a disproportionate share of low-income patients. Separate payment rates apply to operating and capital costs, and hospital-specific rates affect payments for sole community and Medicare dependent hospitals. Special payment policies apply to transfer cases and to extraordinarily high-cost cases.

DRGs are intended to distinguish discharges that are clinically similar and require comparable resources. Resource use is defined as relative volume and types of diagnostic, therapeutic, and nursing services required for treatment of a given illness or injury and is measured by the estimated cost for the discharge. Severity of illness (SOI) is defined by a patient's medical condition, or the extent of physiologic decompensation or organ system loss of function. While resource use and SOI are highly correlated, a very resource-intensive case does not always reflect a high level of severity (CMS, 2007).

The Medicare law requires that the DRGs be updated annually. The updating process includes:

- Accounting for annual changes in the *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) diagnosis and procedure codes used in the DRG grouping logic.

- Refinements in the logic used to assign patients to DRGs that reduce the amount of resource variation among cases assigned a given DRG.
- Recalibration of the DRG relative weights based on more-recent Medicare claims data that reflect changes in patterns of care and use of new technology.

A proposed notice of the annual changes in the PPS is published each spring in the *Federal Register* for public comment. The final rule setting forth the changes effective for discharges in the upcoming federal fiscal year (FY) is announced around August 1 each year.

During the FY07 rulemaking process, CMS proposed two substantial changes affecting the DRG classification system and relative weights. The proposals were based on recommendations made by the Medicare Payment Advisory Commission (MedPAC) to improve the accuracy of the payment system. The first proposal called for adoption a severity-adjusted DRG system to reduce cost variance within DRGs in FY08. Specifically, a consolidated version of the all-patient refined DRGs (Con-APR-DRGs) developed and owned by 3M/HIS was proposed for adoption. Responding to public comment in the FY07 final rule, CMS indicated that an independent contractor would conduct an evaluation of alternative severity-adjusted DRG systems for possible FY08 implementation. In addition, CMS created 20 new DRGs and modified 32 others in the FY07 rule as an interim step to increase recognition of SOI in the patient classification system.

The second proposal in the FY07 proposed rule called for changing the method used to calculate the DRG relative weights, which were based on average charges for Medicare discharges assigned to a given DRG relative to the average charges for all Medicare discharges. The final rule provided for a three-year transition from charge-based to cost-based relative weights and indicated that the method of establishing relative weights would be further evaluated in another study to be funded by CMS.

1.3. STUDY APPROACH

In this interim report, we compare alternative severity-adjusted DRG classification systems with the DRGs established by CMS in the FY07 PPS final rule. Based on the responses that CMS received from vendors with severity-adjusted DRG systems, we evaluated the 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)[2]

Health Systems Consultants (HSC)

- Refined DRGs (HSC-DRGs)

HSS/Ingenix

- All-payer severity DRGs with Medicare modifications (MM-APS-DRGs)

Solucient

- Refined DRGs (Sol-DRGs)

The analyses in this interim report rely on quantitative methods. Using vendor-supplied software for each DRG system, we assigned FY04 and FY05 Medicare discharges from acute-care hospitals to the FY07 CMS-DRGs and to DRGs in each of the alternative severity-adjusted systems. We estimated the cost of each discharge and standardized for the PPS payment factors. We used regression analysis to examine the power of each severity-adjusted DRG system to explain variation in standardized costs per discharge. We then created relative weights and measured the amount of change in the case mix index (CMI), or average relative weight, across groups of hospitals. The data used for these analyses are described in greater detail in Appendix A. The specific methods for each set of analyses are described at the beginning of each section to which they pertain.

We supplemented the quantitative analyses with a review of recent literature, CMS rulemaking documents, and other reports. We prepared a draft report that was submitted to CMS, the vendors, and a technical expert panel for review and comment. We have taken their comments into consideration in this report. The final report will include an evaluation of alternative methods to determine DRG relative weights and will examine the payment impacts of the alternative methodologies.

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[2] CMS called this system Consolidated-Severity DRGs or CS-DRGs in the FY07 proposed rule. We have chosen to use the Con-APR-DRG acronym in this report to keep the connection with the APR-DRG system.

1.4. ORGANIZATION OF THIS REPORT

The remainder of this report is organized as follows.

Chapter 2 provides background information on the grouping logic used by the CMS-DRGs and the alternative severity-adjusted DRG systems.

Chapter 3 presents the overall findings from our analysis of the ability of the alternative DRG systems to explain cost variation. Issues examined in this chapter include the amount of variation within the severity-adjusted DRG systems, the explanatory power of the DRG systems and their comparative ability to discriminate between discharges with substantial cost differences, and the year-to-year stability of the groupings.

Chapter 4 uses major diagnostic category (MDC) 5, Diseases and Disorders of the Circulatory System, to highlight selected differences in the logic used to group discharges in each DRG system and the implications that these differences have for clinical coherency and the explanatory power of the DRGs.

Chapter 5 summarizes the impact of the different DRG classification systems on a hospital’s CMI, and discusses the potential for increases in case mix attributable to coding improvement and not to actual changes in patient mix.

Chapter 6 addresses other issues that CMS might consider in deciding whether to adopt an existing severity-adjusted DRG system, including how understandable the system is and how easily the CMS-DRGs can be cross-walked to the severity-adjusted DRGs, whether the classification logic and grouper software will be reasonably accessible to users, and whether the classification system has other applications. CMS will need to take these issues as well as our quantitative findings into account in determining the degree to which any of these classification systems might meet the needs of the Medicare program.

Chapter 6 concludes with an overall summary of the strengths and weaknesses of the severity-adjusted systems.

2. OVERVIEW OF DRG CLASSIFICATION SYSTEMS

This chapter provides background information on the patient classification systems that are evaluated in this report (the systems are listed in Table 2.1). Section 2.1 provides a brief overview of the development of DRGs and the severity-adjusted DRG systems. Section 2.2 describes the logic that each system uses to group patients into DRGs, the updating process used to maintain each system, and the way each system is currently used. Section 2.3 summarizes key differences in the way the various systems classify patients into severity-adjusted DRGs.

2.1. OVERVIEW OF ALTERNATIVE DRG CLASSIFICATION SYSTEMS

Under the Medicare PPS, each discharge is assigned to a DRG, using "grouper" software that contains the logic used for the assignment. The logic takes into consideration the information reported on the billing form (UB-92): the principal diagnosis and up to eight secondary diagnoses, up to six procedures, age, length of stay, and discharge destination.

The original DRG system was developed at Yale in the 1960s (Fetter, 1983) for utilization review purposes rather than for payment. It was intended to be a comprehensive patient classification system covering the newborn, pediatric, adult, and elderly populations. The structure and logic of the original DRG system, adopted during the 1980s, persists in the system used today in the Medicare PPS (CMS-DRGs). With the implementation of the PPS in 1983, CMS (formerly the Health Care Financing Administration, HCFA) assumed ownership of the DRG system and consequent responsibility for maintaining, recalibrating, and updating it. Modifications since 1983 have focused primarily on the elderly population (Averill et al., 1998) and on improving the explanatory power of the DRGs to describe differences in resource use among Medicare patients.

Table 2.1 CMS-DRGs and Alternative DRG Systems Evaluated in This Study

	CMS-DRGs	CMS + All-Patient Severity DRGs	HSC Refined DRGs	Solucient Refined DRGs	Medicare-Modified All-Patient Severity DRGs	Consolidated All-Patient Refined DRGs
Abbreviation[a]	CMS-DRG	CMS +AP – DRG	HSC-DRG	Sol-DRG	MM-APS-DRG	Con-APR-DRG
ICD-9/CMS-DRG Version[b]	24	24	23	23	24	23
Ownership	CMS	3M/HIS	Health Systems Consultants, Inc.	Solucient	HSS/ Ingenix	3M/ HIS
Updating frequency	Annual	Annual for codes; every 1-2 years for clinical logic	Annual for codes and CMS-DRG changes	Annual for codes and CMS-DRG changes	Annual for codes and CMS-DRG changes	Major clinical updates every 3-5 years. Annual update for ICD-9-CM changes.
Updating process	Clinical judgment and statistical analysis of data.	Statistical and clinical judgment; consult with New York State.	Panel of physicians incorporate DRG and ICD-9-CM changes.	Statistical results primarily used to incorporate DRG and ICD-9-CM changes, with some clinical input.	Incorporate DRG and ICD-9-CM changes into grouper logic. Statistical and clinical judgment of impact on CDRG.	Statistical and clinical judgment.

[a] The abbreviations are those used in this report to distinguish one system from another and may differ from the abbreviation used by a vendor for its classification system.

[b] The version number is the version of ICD-9-CM codes and, where applicable, CMS-DRGs that are used in the grouper logic. The vendor may assign a different version number to its severity-adjusted system.

The original DRGs were formed by a team of clinical panels through statistical and clinical analysis of diagnoses, procedures, patient characteristics, and clinically recommended groupings. An ongoing CMS concern has been whether the CMS-DRGs adequately capture the range of SOI among patients that affects resource use. In the late 1980s, HCFA asked the researchers at Yale who developed the original DRG system to develop an advanced severity-adjustment methodology to reduce the variation in resource use within DRGs. That effort produced the first refined DRG (R-DRG) system that categorized all secondary diagnoses that were considered complications or comorbidities (CC) into severity levels. Two patient classification systems evaluated in this report closely follow the logic of the Yale R-DRGs in establishing severity levels for CMS-DRGs: the HSC-DRGs of Health Systems Consultants, Inc., and the Sol-DRGs of Solucient. These systems start with the CMS-DRGs but collapse any paired DRGs (i.e., those that are split by CC or patient characteristic) into adjacent DRGs or ADRGs and then establish CC-severity-level groupings by base ADRG. To standardize terminology across the systems, we shall refer to collapsed DRGs as base DRGs. Ingenix's MM-APS-DRG system also establishes separate severity-level classes by base DRG, but it diverges from the R-DRG logic by combining certain CMS-DRGs and CC-severity levels. The logic follows the severity-adjusted DRG system that HCFA developed but did not adopt in 1994 (HCFA, 1994). The two systems developed by 3M/HIS also consider CC-severity levels, but they use different logic to establish the severity levels, and as a result, they have unique DRG structures. The CMS+AP-DRG system follows the CMS-DRG logic but at the MDC level creates separate DRGs within MDCs for discharges with the most resource-intensive or catastrophic CCs and non-operating-room (O.R.) procedures. The Con-APR-DRG system accounts for multiple CCs and takes non-CC factors into account in assigning SOI levels to a set of base DRGs that are similar but not always identical to base CMS-DRGs.

2.2. DESCRIPTION OF PATIENT CLASSIFICATION SYSTEMS EVALUATED

2.2.1. CMS-DRGs

We begin by describing the current grouper methodology used by CMS (CMS-DRGs). All other grouper methodologies have elements in common with this methodology.

Logic

Discharges are assigned to DRGs in hierarchical order. As summarized in Figure 2.1 for CMS-DRGs, the assignment process first allocates all ICD-9 principal diagnoses into one of 25 mutually exclusive principal diagnosis areas, or MDCs (Table 2.2). Diagnoses within each MDC are intended to correspond to a single organ system or etiology and a particular medical-specialty focus (Averill, Goldfield, Hughes, Bonazelli, et al., 2003). Since not all cases correspond to a single--or any--organ system, a set of residual MDCs were created (e.g., MDC 17, Myeloproliferative Diseases and Disorders and Poorly Differentiated Neoplasms). In addition, drawing on refinements originating in the 3M/HIS AP-DRG system, the CMS-DRG classification system has separate MDCs for multiple significant trauma and human immunodeficiency virus (HIV) infections.

Table 2.2 Major Diagnostic Categories[a]

MDC Number	Major Diagnostic Categories (MDCs)
1	Diseases and Disorders of the Nervous System
2	Diseases and Disorders of the Eye
3	Diseases and Disorders of the Ear, Nose, Mouth, and Throat
4	Diseases and Disorders of the Respiratory System
5	Diseases and Disorders of the Circulatory System
6	Diseases and Disorders of the Digestive System
7	Diseases and Disorders of the Hepatobiliary System and Pancreas
8	Diseases and Disorders of the Musculoskeletal System and Connective Tissue
9	Diseases and Disorders of the Skin, Subcutaneous Tissue and Breast
10	Endocrine, Nutritional and Metabolic Diseases and Disorders
11	Diseases and Disorders of the Kidney and Urinary Tract
12	Diseases and Disorders of the Male Reproductive System
13	Diseases and Disorders of the Female Reproductive System
14	Pregnancy, Childbirth, and the Puerperium
15	Newborns and Other Neonates with Conditions Originating in the Perinatal Period
16	Diseases and Disorders of the Blood and Blood Forming Organs and Immunological Disorders
17	Myeloproliferative Diseases and Disorders and Poorly Differentiated Neoplasms
18	Infectious and Parasitic Diseases (Systemic or Unspecified Sites)
19	Mental Diseases and Disorders
20	Alcohol/Drug Use and Alcohol/Drug Induced Organic Mental Disorders
21	Injuries, Poisonings, and Toxic Effects of Drugs
22	Burns
23	Factors Influencing Health Status and Other Contacts with Health Services
24	Multiple Significant Trauma
25	Human Immunodeficiency Virus Infections

[a] The MDC numbers are those used by the CMS-DRGs and all systems evaluated in this study except the Con-APR-DRGs. The Con-APR-DRGs reverse the order for multiple significant trauma and HIV infections (i.e., multiple significant trauma is 25 in the Con-APR DRG system).

Table 2.3
Comparison of Pre-MDC DRGs in Alternative DRG Systems

CMS-DRG	HSC-DRG	Sol-DRG	MM-APS-DRG	CMS+AP-DRGs	Con-APR-DRG
103- Heart	103 (4 levels)	103 (4 levels)	001,002	SAME AS CMS-DRG	4,5,6 (combined with lung)
541-ECMO or Trach>96 hrs. and Pdx ≠ Face, Mouth or Neck with Major O.R.	541	541	024		11,12,13
542- Trach>96 hrs. and Pdx ≠ Face, Mouth or Neck without Major O.R.	542	542	025		14,15,16
480- Liver and/or Intestine Transplant	480 (4 levels)	480 (4 levels)	012		1,2,3
495- Lung Transplant	495 (4 levels)	495 (4 levels)	018,019		4,5,6 (combined with heart)
512- Simultaneous Pancreas/Kidney	512 (4 levels)	512 (4 levels)	020,021		
481- Bone Marrow Transplant	481 (4 levels)	481 (4 levels)	013,014		7,8,9,10
513- Pancreas Transplant	513 (4 levels)	513 (4 levels)	022,023		17,18,19
482- Trach with Pdx = Face, Mouth or Neck Dx or Complete Laryngectomy	482 (4 levels)	482	015,016, 017		
Total- 9 DRGs	9 HSC-ADRG; 30 total	9 Sol-ADRG; 27 total	9 CDRG; 16 total	9 DRGs	7 APR-DRGs;

In general, a discharge is assigned to an MDC on the basis of the principal diagnosis.[3] However, nine pre-MDC DRGs related to organ transplants and tracheostomies are assigned directly on the basis of ICD-9-CM procedure codes (pre-MDC DRGs) because these procedures, rather than the reason for admission, account for resource use in such discharges. Pre-MDC DRGs are recognized in some form in each of the alternative DRG systems, although the total number of pre-MDC DRGs varies across systems (as summarized in Tables 2.3 and 2.4). Next, patients are assigned to MDC 24 (Multiple Significant Trauma) on the basis of both the principal and secondary diagnoses and to MDC 25 (HIV Infections) on the basis of a principal diagnosis of either HIV infection or a significant HIV-related condition. Discharges that are not assigned to a pre-MDC-DRG, MDC 24, or MDC 25 are assigned to one of the remaining MDCs on the basis of their principal diagnosis.

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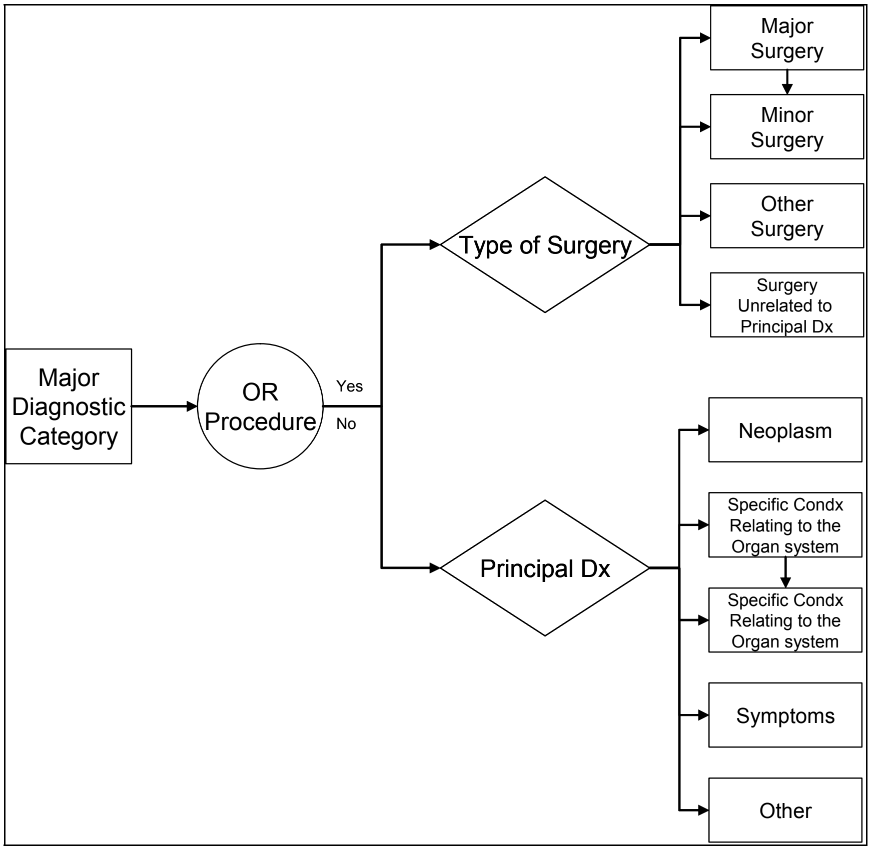
[3] The principal diagnosis is defined in the Uniform Hospital Discharge Data Set (UHDDS) as "that condition established after study to be chiefly responsible for occasioning the admission of the patient to the hospital for care."

Figure 2.1
Generic CMS-DRG Structure for a Major Diagnostic Category


Major Diagnostic Category
OR Procedure
Yes
No
Type of Surgery
Major Surgery
Minor Surgery
Other Surgery
Surgery Unrelated to Principal Dx
Principal Dx
Neoplasm
Specific Condx Relating to the Organ system
Specific Condx Relating to the Organ system
Symptoms
Other

Source: 3M/HIS, 2006.

Within MDCs, DRGs are generally distinguished as surgical or medical DRGs based on the presence of an O.R. procedure. Assignment to surgical DRGs within an MDC occurs in hierarchical order so that discharges with multiple surgical procedures are assigned to the DRG for the procedure with the highest relative weight. Some DRGs are further distinguished by age (0-17 and >17 years) and/or the presence of one or more secondary diagnoses that are CCs. The partition by age and/or presence of a CC is not uniform across DRGs; some DRGs divide on age, some divide on the presence or absence of a CC, and some divide first on age and then further subdivide based on the presence or absence of a CC.

A secondary diagnosis is considered a CC if its presence along with a specific principal diagnosis is expected to have a substantial effect on resource use. The CMS-DRG grouper logic uses the same list of CCs across DRGs; however, when clinicians have deemed that a CC is closely related to the principal diagnosis, the CC may be excluded for that principal diagnosis. In other words, a secondary diagnosis that is defined as a CC is treated as a CC throughout the CMS-DRG classification system except in those DRGs for which the particular secondary diagnosis adds no new information about resource use beyond what is already present in the principal diagnosis. Complications are treated the same as comorbidities, and no distinction is made between (1) diagnoses present at admission and those that occur during the course of treatment, (2) the severity of the secondary diagnoses that are on the CC list (except in the severity-adjusted DRGs that CMS has adopted in the past few years), or (3) the presence of multiple CCs. Patient discharge status (including death) is used to distinguish a limited number of DRGs. For example, burn patients who are transferred to another facility are distinguished from those who are not transferred; patients with alcoholism or drug abuse who left against medical advice are distinguished from otherwise similar patients; and patients with acute myocardial infarction (AMI) who are discharged alive are classified separately from those who die. The CMS-DRGs also have separate DRGs for surgical discharges in which no procedure is related to the principal diagnosis (DRGs 468, 476, and 477), discharges with a principal diagnosis that is invalid as a discharge diagnosis (DRG 469), and ungroupable discharges (DRG 470). The DRGs pertaining to newborns and the pediatric population have never been modified by CMS beyond the splitting of some DRGs by age. In Version 24.0 of the CMS-DRG system, there are 379 base DRGs (i.e., individual and paired DRG groupings that are split based on age, CCs, or discharge status) and 538 total DRGs (CMS, 2006).

Updating process

CMS annually reviews the DRG classification system and proposes refinements for public comment as part of the annual PPS rulemaking process. MedPAC is mandated to recommend modifications to the PPS each year and has recommended that CMS refine the DRGs to more fully capture differences in SOI (e.g., MedPAC, 2005). The updating process is an iterative process of clinical judgment and statistical analyses. For FY07, CMS created 20 new DRGs, deleted 8 DRGs, and modified 32 others. 3M/HIS has a contract with CMS to provide technical support for the annual revisions of CMS-DRG definitions, documentation, and grouper software (Averill, Goldfield, Hughes, Bonazelli, et al., 2003).

Applications

The CMS-DRG system is used by others besides the Medicare program. Some payers use the CMS-DRGs for their own payment systems. In addition, the CMS-DRGs are used by many hospitals for benchmarking and quality-of-care evaluation. The CMS-DRG grouper logic is in the public domain.

2.2.2. CMS-DRGs with All-Patient Severity (CMS+AP-DRG)

Background

In 1987, the state of New York implemented a DRG-based PPS for all non-Medicare patients. The New York State Department of Health determined that the CMS-DRG system was not applicable to that population, especially HIV-infected patients and neonates. New York contracted with 3M/HIS to develop a modified DRG system to apply to all patient populations, which came to be known as the all-patient DRG (AP-DRG) system. Some AP-DRG refinements, including pre-MDCs and MDCs 24 and 25, were subsequently incorporated into the CMS-DRGs. A key distinction between AP-DRGs and CMS-DRGs is that the former distinguishes major CCs (MCCs) from other CCs. On the basis of the work conducted by Yale, the New York Department of Health found that the secondary diagnoses designated as “catastrophic” for surgical cases or “major” for medical cases accounted for most of the improved explanatory power of the Yale-defined R-DRGs.

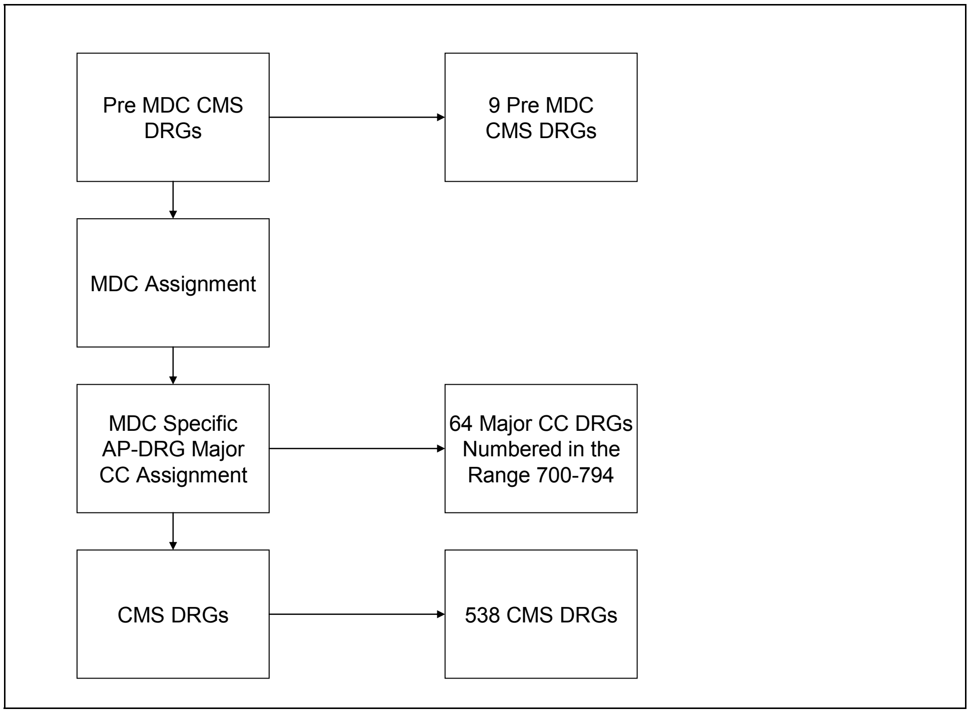
In 2006, 3M/HIS modified its AP-DRG for potential use by the Medicare population. Because AP-DRGs extensively modify DRG assignments to apply to an all-patient population and most of these modifications are not relevant for the Medicare population, 3M/HIS developed a grouper that replicates CMS-DRGs, with one exception: The CMS+DRG-AP logic adds

AP-DRG severity (MCC) subclasses within MDCs (after adaptation for the Medicare population) to the standard CMS-DRG logic (3M/HIS, 2006).

Logic

As with CMS-DRGs, cases are first assigned to one of nine pre-MDC CMS-DRGs, if relevant (Figure 2.2). Then, MDC assignment is made for the remaining cases. Within MDCs, DRG cases with an AP-DRG MCC (determined by MDC) are collapsed into one of the 64 MCC DRGs (numbered from 700 to 794); in other words, the 64 MCC DRGs do not have a one-to-one correspondence with CMS-DRGs. The remaining cases within an MDC are assigned to a DRG according to CMS-DRG logic and with CMS-DRG numbering conventions. All other CMS-DRG logic is retained. There are a total of 602 CMS+AP-DRGs (538 CMS-DRGs plus 64 major CC DRGs).

Figure 2.2
Generic Logic of the CMS+AP-DRGs


Pre MDC CMS DRGs
9 Pre MDC CMS DRGs
MDC Assignment
MDC Specific AP-DRG Major CC Assignment
64 Major CC DRGs Numbered in the Range 700-794
CMS DRGs
538 CMS DRGs

Source: 3M/HIS, 2006.

Updating process

AP-DRGs have been updated every one to two years since 1988 by New York State and 3M/HIS (Averill et al., 2003). CMS+AP-DRGs were developed in 2006 and 3M/HIS has indicated that CMS would be responsible for updating and maintaining the CMS=AP-DRGs if they were adopted by Medicare.

Applications

No entity is currently using CMS+AP-DRG. The AP-DRG system is used by several states for Medicaid hospital payment (e.g., New York, North Carolina, Washington), and some countries use it for hospital reimbursement systems (e.g., Belgium, Czech Republic, Romania, Switzerland). Australia used AP-DRGs until 1992, when it introduced its own system, and France modeled its system on AP-DRGs.

2.2.3. Systems Using Yale’s R-DRG Logic

As previously discussed, Yale researchers developed the first refined DRG (R-DRG) system, which categorized by severity level all secondary diagnoses that were considered CCs in the CMS-DRGs (three for medical cases and four for surgical cases). The R-DRG severity levels more accurately capture variation in resource use.

The classification systems based on the early Yale research use the same general logic. First, they use the CMS-DRGs hierarchical logic for assignment to pre-MDCs and MDCs, surgical DRGs, and the CMS-DRG CC exclusion list. Medical cases involving death within two days of admission are assigned to a unique “early death” DRG.[4] DRG-paired groupings (DRGs with and without CCs or distinguished solely by age or discharge status) are collapsed into a base DRG. The base DRGs are then divided into three (for medical cases) or four (for surgical cases) severity levels. A discharge is assigned to the severity level corresponding to the highest severity level of any secondary diagnosis in the case. Complications of care are not distinguished from comorbidities, and there is no consideration of multiple CCs.

Differences among these systems arise from divergences in the generic approach to grouping and from the way each system collapses the CMS-DRGs into base DRGs and establishes the CC-severity-level assignments. In what follows, we describe these differences and provide information on how each of these systems is updated and used.

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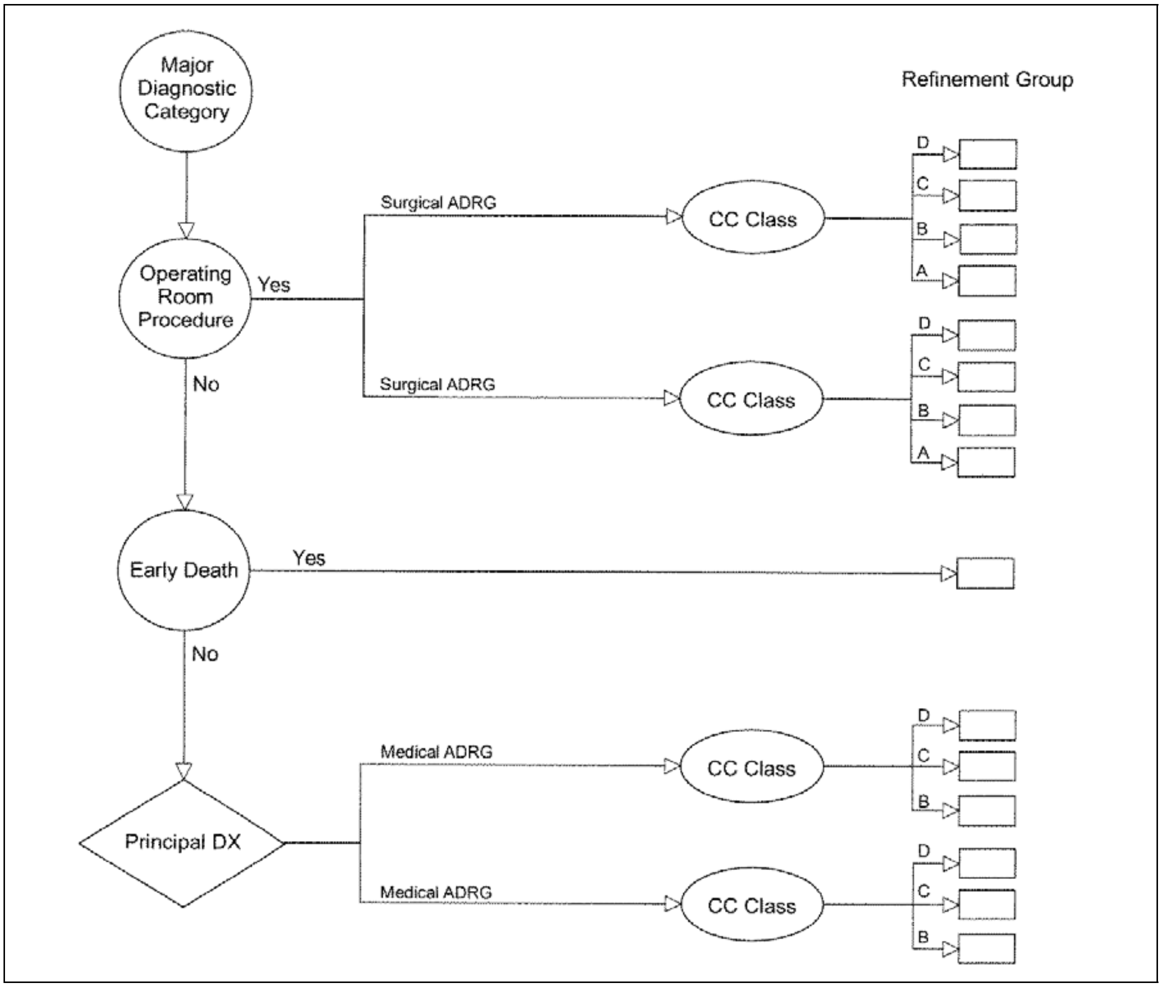
[4] The original Yale R-DRG system also had an MDC-specific DRG for tracheostomies; the current systems eliminated this DRG when the CMS-DRGs adopted pre-MDC DRGs for tracheostomies.

HSC Refined DRGs (HSC-DRGs)

Logic

Health Systems Consultants, Inc., maintains the HSC-DRGs. The grouping logic closely follows that of the original Yale grouper. CMS-DRGs based on age, presence or absence of complications, or death are collapsed into an adjacent DRG (HSC-ADRG) or base DRG. Each HSC-ADRG is assigned a three-digit number that is the same as the lowest number assigned by CMS to any of the DRGs in the paired grouping (Figure 2.3). The severity levels (0-3) are reflected in the fourth digit of the refinement-group number (RGN), with 0 representing the least severe level and 3 representing the most severe. The early death HSC-ADRGs are also assigned a four-digit number, 8xx0. The xx is the two-digit number assigned to the MDC. A severity level is not assigned to early death HSC-ADRGs. Severity levels are also not assigned to the three HSC-ADRGs for discharges involving solely surgical procedures unrelated to the principal diagnosis (HSC-ADRG 468, 476, and 477), a principal diagnosis that is invalid for a discharge diagnosis (HSC-ADRG 469), and ungroupable discharges (HSC-ADRG 470). Pre-HSC-ADRGs 541 and 542 (Extracorporeal Membrane Oxygenation (ECMO) or Tracheostomy with Mechanical Ventilation + 96 Hours or Principal Diagnosis (pdx) Excluding Face, Mouth, and Neck with and without Major O.R. Procedure) are not assigned severity levels; the other pre-HSC-ADRGs, including HSC-ADRG 482 (Tracheostomy with pdx of Face, Mouth, or Neck Diagnosis (dx) or Complete Larynectomy), are assigned severity levels. In contrast to the standard DRG model, HSC-ADRGs for MDC 15 newborns are based on either a diagnosis code or birthweight (if available). There are 391 HSC-ADRGs and 1,293 RGNs in version 19.0/23.0 of the HSC-DRGs.

Figure 2.3 HSC-DRG and Sol-DRG Generic Logic


Major Diagnostic Category
Refinement Group
Surgical ADRG
CC Class
D
C
B
A
Operating Room Procedure
Yes
No
Surgical ADRG
CC Class
D
C
B
A
Early Death
Yes
No
Medical ADRG
CC Class
D
C
B
Principal DX
Medical ADRG
CC Class
D
C
B

Source: HSC, 2005.

CCs are assigned a severity level for medical (0-2) and surgical (0-3) cases. However, each RGN has exclusions and additions to the standard CC list, so there is some variation in CC assignments across the HSC-ADRGs. In those few CMS-DRGs where a secondary diagnosis is used for assignment, the HSC-DRG logic considers that diagnosis as the principal diagnosis and treats the actual principal diagnosis as a CC unless the principal diagnosis is on the exclusions list.

Updating process

Since 1989, HSC has annually updated and validated the HSC-DRG software. A panel of physicians incorporates CMS-DRGs, CCs, and ICD-9-CM changes and validates the assignment of new ICD-9-CM codes to severity levels, using the most current full year of data from the Maryland hospital database. The Maryland hospital database was selected because in the early 1990s, Maryland’s costs and charges were nearly equal (although this may no longer be the case). Although HSC validates prior updates by examining the monotonicity of average length of stay and charges by increasing severity within each HSC-ADRG in subsequent years, it has never reassigned the severity level associated with a given secondary diagnosis.

Applications

HSC licenses its HSC-DRG system software to individual hospitals and hospital systems, consulting companies, academic institutions, insurance companies, health plans, and national healthcare organizations (Schneider, 2006). The HSC-DRG severity-adjustment system is used to evaluate hospital and physician performance and assess the quality of inpatient hospital care, to make severity adjustments for hospital and discharge benchmarking, and to perform validation tests on CMS’s annual recalibration of the CMS-DRG system (Schneider, 2006).

Solucient Refined DRGs (Sol-DRGs)

Another widely used R-DRG derivative is maintained by Solucient Systems (the Solucient refined DRG, Sol-DRG).

Logic

The Sol-DRG grouper methodology also follows logic that is very similar to that of the Yale R-DRG grouper and uses the same numbering system as the HSC-DRGs. However, there are variations in how the paired CMS-DRG groupings are collapsed into Sol-ADRG or base DRGs. For example, within MDC 1, among the paired CMS-DRGs 1 (Craniotomy Age > 17 with CC), 2 (Craniotomy Age >17 with and without CC), and 3 (Craniotomy Age 0-17), the two DRGs for patients age >17 are collapsed into Sol-ADRG 1, and patients age 0-17 are assigned to Sol-ADRG 3. This occurs in other paired CMS groupings within MDC 1 (e.g., CMS-DRGs 24-26 (Seizure, Headache) are collapsed into Sol-ADRG 24 for patients age >17 and Sol-ADRG 26 for patients age 0-17), but it does not occur uniformly. For example, paired CMS-DRGs 31-33 (Concussion) are collapsed into a single Sol-ADRG 31.

There are also differences in the Sol-ADRGs that are assigned severity levels. Within the pre-MDCs, the three Sol-ADRGs for tracheostomies are not assigned severity levels, resulting in 27 pre-MDC RGNs for Sol-DRGs compared with 30 RGNs in the HSC-DRGs (Table 2.2). The Sol-ADRGs in MDC 19 (Mental Diseases and Disorders) and MDC 20 (Alcohol/Drug Use and Alcohol/Drug Induced Organic Disorders) are not assigned severity levels. Sol-ADRGs 426 (Depressive Neuroses), 427 (Neuroses x Depressive) and 430 (Psychoses) are divided on the basis of age (0-17 and >17).

Following MDC assignment, newborns are assigned Sol-ADRGs based on primary procedure and diagnosis codes and, sometimes, discharge status; for many newborn Sol-ADRGs, severity level is based on discharge status, birthweight, and length of stay.

Sol-ADRGs are grouped into 75 classes for purposes of assigning the CC severity class for a given Sol-ADRG. That is, the CC severity class varies across classes of Sol-ADRGs. There are 393 Sol-ADRGs and 1,261 RCNs.

Updating process

Since 1989, Solucient has updated its refined DRG system annually to reflect annual ICD-9-CM code changes, primarily through analysis, with some supplemental clinical input. Like other vendors, Solucient has not revised severity levels assigned to a diagnosis code once the assignment has been made.

Applications

Sol-DRGs are used to produce Solucient’s 100 Top Hospitals annual list and also to help client healthcare facilities and providers assess performance relative to benchmarks. The software for the grouper is not independently marketed from other Solucient products.

2.2.4. Medicare-Modified All-Patient Severity-Adjusted DRGs (MM-APS-DRGs)

Background

In 1995, HSS, Inc. (which was acquired by Ingenix in 2005) developed the all-patient severity-adjusted DRG (APS-DRG) for use for all inpatients (including neonatal cases). Similar to other Yale R-DRG derivatives, the APS-DRG logic begins by collapsing paired CMS-DRG groupings into a base DRG (which Ingenix calls consolidated DRGs, or CDRGs) and then dividing each base DRG into three uniform severity levels. In 2006, Ingenix created the Medicare-modified (MM) APS-DRG classification system we are evaluating in this report, in an effort to reduce the number of APS-DRGs. The changes involved eliminating sparse categories (such as pediatric severity splits) and collapsing the number of neonatal categories in MDC 15, and systematically reviewing CDRGs to identify “opportunities for further aggregation.” The logic of these changes is similar to those that used in the severity-adjusted DRGs that HCFA developed in 1994.

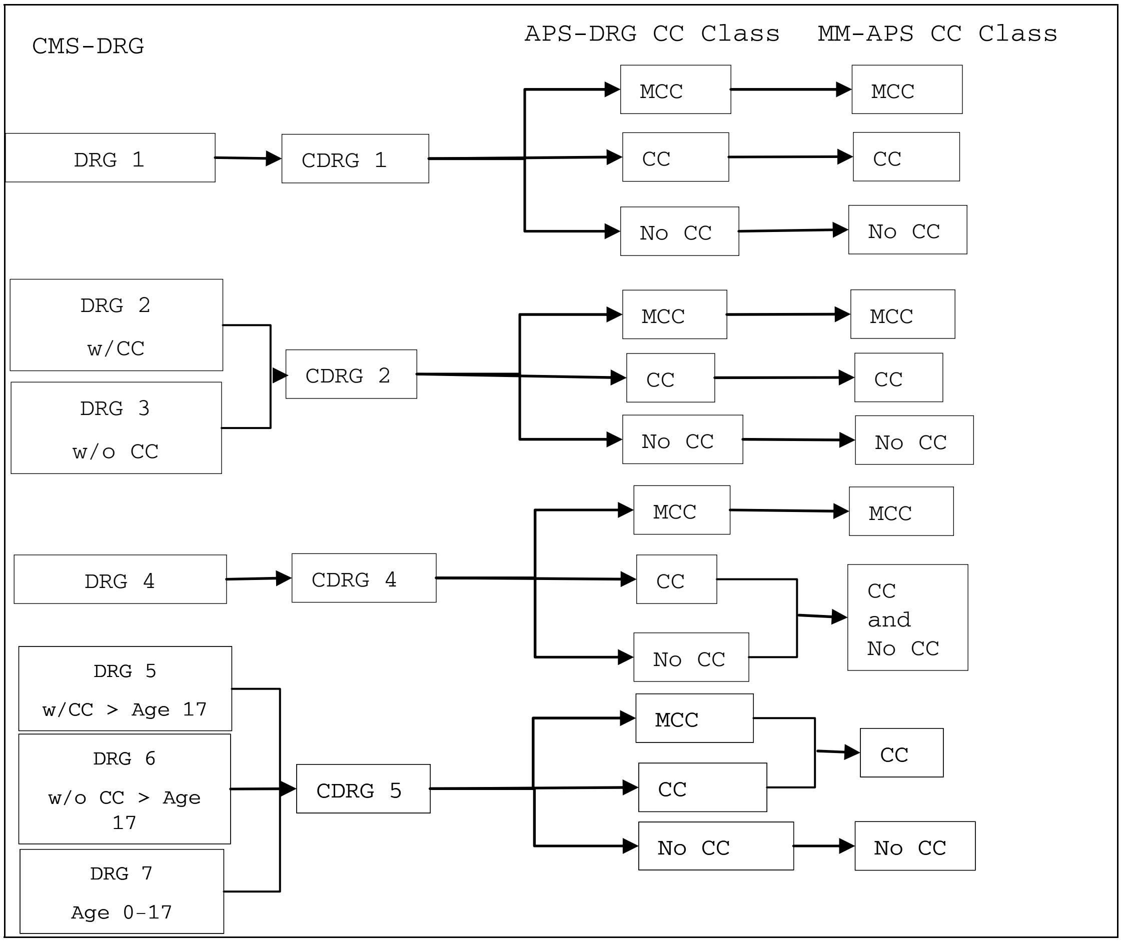
Logic

While it is similar to the Yale R-DRG logic, the grouping logic for MM-APS-DRGs differs in several ways (Figure 2.4):

- The CDRG consolidation includes not only collapsing paired CMS-DRGs (including the age splits), but also combining other low-volume CMS-DRGs that are similar clinically and in resource usage. For example, a single CDRG for major skin disorders is formed by collapsing the paired CMS-DRG groupings DRG 272 and 273 (Major Skin Disorders with and without CCs) with DRG 271 (Skin Ulcers).
- Discharges are assigned to one of three severity levels on the basis of secondary diagnoses: no CCs, with a CC, or with an MCC. The four-level CC classes for surgical patients and the early death medical DRGs in the Yale R-DRGs are not used.
- In MM-APS-DRGs, the CC severity levels are not uniform across CDRGs. Using the approach that CMS considered in refining the CMS-DRGs in 1994, the CC severity levels for a given CDRG may be collapsed if there are only a few cases, the relationship across the severity levels is not monotonic, or the relative weights for the severity levels are not statistically distinguishable.

Figure 2.4

MM-APS-DRG Logic


CMS-DRG
APS-DRG CC Class
MM-APS CC Class
DRG 1
CDRG 1
MCC
CC
No CC
DRG 2 w/CC
DRG 3 w/o CC
CDRG 2
DRG 4
CDRG 4
CC and No CC
DRG 5 w/CC > Age 17
DRG 6 w/o CC > Age 17
DRG 7 Age 0-17
CDRG 5

A CC exclusion list (not identical to the CMS-DRG CC exclusion list) that allows for additional CDRG and MDC exclusions is used, and the severity level assigned to a particular CC is otherwise consistent across all CDRGs. As is the case with the Yale R-DRG logic, the severity subclass is set to the highest severity level of any CC. Complications of care are not distinguished from comorbidities present at admission. Multiple CCs do not affect the classification system. However, Ingenix has developed enhanced relative weights that apply when multiple CCs or MCCs are present for patients with no other coexisting CCs. The case-weighting system consists of a count of coexisting conditions associated with a hospital stay that are independent of one another. Some CCs that may represent poor medical treatment are not counted as CCs, and others are downweighted; the logic for this action is that complications are a part of medical practice, but financial incentives should not be attached to them. This case-weighting system is intended to measure greater SOI and associated increase in resource use.

In the full APS-DRG grouper, MDC 15 cases are assigned to one of 21 APS-DRGs, including severity levels. The MM-APS-DRG assigns all newborn cases to DRG 997 (although Ingenix recommends following the CMS-DRG model, which would increase the number of MDC 15 MM-APS-DRGs to 7).

In total, there are 328 base MM-APS-DRGs (CDRGs) and 915 MM-APS-DRGs. This final number ignores the add-ons for the number of independent secondary diagnoses (Ingenix, 2006). To be consistent with the current three-digit CMS-DRG numbering system, consecutive three-digit numbers have been assigned to the MM-APS-DRGs. While the three-digit numbering system may reduce the changes that would be required to implement MM-APS-DRGs, it increases the difficulty of seeing the relationship between the CMS-DRGs and the severity levels.

Updating process

MM-APS-DRG is owned and maintained by HSS/Ingenix. Each year, Ingenix clinical and statistical staff update the APS-DRG grouper to incorporate new ICD-9-CM codes and CMS-DRG changes, evaluate how changes affect the definition of the CDRGs, and make changes to the MDC and DRG logic for CMS-DRG CC exclusions. The all-payer relative weights are developed using the most recently available data from the Healthcare Cost and Utilization Project (HCUP).

Applications

APS-DRGs are included as a disease-severity measure in the Agency for Healthcare Research and Quality (AHRQ) Nationwide Inpatient Sample (NIS) and Kids' Inpatient Database (KID) (AHRQ, 2005). APS-DRGs are used for quality improvement and benchmarking by providers, payers, and hospital associations (e.g., the Georgia Hospital Association and the state of West Virginia). HSS, which developed and maintains APS-DRGs, includes "over 30 state- and payer-specific systems" for which they manage "grouping, pricing, editing, and mapping for federal prospective payment” (HSS/Ingenix, 2006).[5] The APS-DRG system is not used for payment.

2.2.5. Consolidated Severity-Adjusted DRGs (Con-APR-DRGs)

Background

In response to MedPAC’s recommendation that CMS consider refining the DRG system to better recognize SOI, CMS proposed to adopt consolidated severity-adjusted DRGs (Con-APR-DRG) in FY08.[6] The APR-DRGs were developed for an all-patient population, and while much of the DRG logic for the base DRGs is similar to that used in the CMS-DRGs, there are some differences that reflect applications for non-Medicare populations. 3M/HIS consolidated low-volume base APR-DRGs and severity classes across groups of base APR-DRGs in developing the Con-APR-DRGs for CMS. The logic for the Con-APR-DRGs is fundamentally different from that of CMS-DRGs and the other severity-adjusted-groupers systems that are developed from the CMS-DRGs.

Logic

The APR-DRG logic removes all distinctions of age, CC, and discharge status (including mortality) in establishing base APR-DRGs. A three-phase, 18-step process is used to classify patients according to SOI and risk of mortality. Each classification has four subgroups. Assignment to these subgroups is made separately for each APR-DRG. Severity of illness is defined as the extent of physiologic decompensation or organ system loss of function. The assumption underlying the severity assignments is that the severity and mortality subclass of a patient is dependent on the underlying problem and that patients with high SOI or risk of mortality usually suffer from multiple serious diseases or illnesses (CMS, 2007). We concentrate here on the basic APR-DRG logic and the logic for the SOI subclasses and do not discuss the risk-of-mortality subclasses.

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[5] Accessed October 9, 2006, at http://www.hssweb.com/PDFs_Unsecured/Lit/Collateral/Medicare_Advantage.pdf

[6] In this report, we use the abbreviation Con-APR-DRG to retain the association between the Medicare-modified system and the APR-DRG system. CMS used the acronym CS-DRG to refer to this system in its FY07 rulemaking documents.

The Con-APR-DRG logic begins by assigning cases to one of 25 MDCs on the basis of principal diagnosis. The Con-APR-DRG system’s use of pre-MDCs is not unlike that in the other systems, but the logic collapses the heart and lung DRGs into a single base APR-DRG, and the base APR-DRG analogous to CMS-DRG 482 (Tracheostomy with pdx = Face, Mouth, or Neck dx or Complete Larynectomy) is not a pre-MDC assignment. Within each MDC, the principal diagnosis code (if the case is medical) and the procedure code (if the case is surgical) are used to assign a base APR-DRG. Many base APR-DRGs are consistent with the base CMS-DRGs, but the pattern is not predictable, particularly for conditions that are more common in the non-elderly population. The Con-APR-DRGs are mostly in MDCs that are low-volume conditions for the Medicare population: MDC 14 (Pregnancy, Childbirth and Puerperium), MDC 15 (Newborns), MDC 19 (Mental Diseases and Disorders), and MDC 20 (Alcohol/Drug Use and Alcohol/Drug Induced Organic Mental Disorders).

As with the AP-DRG grouper used in New York, the Con-APR-DRG grouper assigns newborns to MDC 15 based on age and birthweight, but the APR-DRG grouper defines newborns as 0-7 days or 8-14 days (if the patient is low birthweight). All other newborns (at least 15 days to 28 days) are assigned to other MDCs and relevant APR-DRGs. The Con-APR-DRG logics consolidates 28 MDC 15 DRGs into seven base Con-APR-DRGs by collapsing the two highest and two lowest severity classes each into one class. This results in consolidation of 112 APR-DRGs in MDC 15 into 14 Con-APR-DRGs.

In some cases, the principal diagnosis or procedure is too ambiguous to provide a definitive APR-DRG. Unlike other systems, the APR-DRG deals with these instances by applying a rerouting logic that uses information such as age, secondary diagnosis, and, for surgical cases, principal diagnosis to supplement the standard ICD-9-CM codes used to assign a base APR-DRG. In some cases, this involves rerouting across MDCs. The goal of rerouting is to group clinically similar patients together.

Figure 2.5 shows the three-phase, 18-step process used to determine SOI for patients assigned to each base Con-APR-DRG (Averill, Goldfield, Hughes, et al., 2003). Unlike the other classification systems, the Con-APR-DRG system determines the severity level specific to the base APR-

DRG. The first phase (six steps) of SOI determination under Con-APR-DRGs involves determination of a severity level for each secondary diagnosis. There are four SOI levels, ranging from minor to extreme. Each secondary diagnosis is assigned to one SOI level. With some exceptions (complications of organ transplants and limb reattachments), complications of care ICD-9-CM category 996 are assigned to the minor SOI level and therefore do not contribute to the SOI subclass; this eliminates the appearance of providing incentives for less than optimal care (CMS, 2006) but implicitly assumes that complications are avoidable. This is the only grouper under evaluation that does not recognize most complications of care as CCs.

In the second phase (three steps) of SOI determination under Con-APR-DRGs, the base SOI subclass is determined on the basis of the SOI levels of the independent secondary diagnoses and is set at the highest severity level of any of the secondary diagnoses. This phase is comparable to the severity-level determinations made by the other severity-adjusted classification systems.

In the third phase (nine steps) of the SOI determination under Con-APR-DRGs, the final severity of the subclass of the patient is assigned. This final assignment incorporates the interaction among secondary diagnoses, age, principal diagnosis, O.R. surgical procedures, multiple O.R. procedures, and combinations of categories of secondary diagnoses. This phase is unique among the severity-adjusted classification systems.

Each APR-DRG is subdivided into four subclasses. To address concerns over low-volume groupings, the Con-APR-DRG logic consolidates the highest-severity-level cases (Level 4) across APR-DRGs within some MDCs. This action is based on analyses that concluded that the highest severity level was more predictive of resource use than the underlying APR-DRG. Some MDCs do not permit as simple a consolidation. For these MDCs, the groupings of severity levels vary in terms of which levels are consolidated and the groups of ADRGs that are included in the consolidation. There are 314 base Con-APR-DRGs and 859 severity-adjusted Con-APR-DRGs plus two error DRGs. The three-digit DRG numbers are assigned consecutively, making it difficult to identify the DRG severity level. Moreover, because of the different grouping logic for the Con-

APR-DRGs, there is not a simple one-to-one correspondence between the CMS-DRGs and the base Con-APR-DRGs.

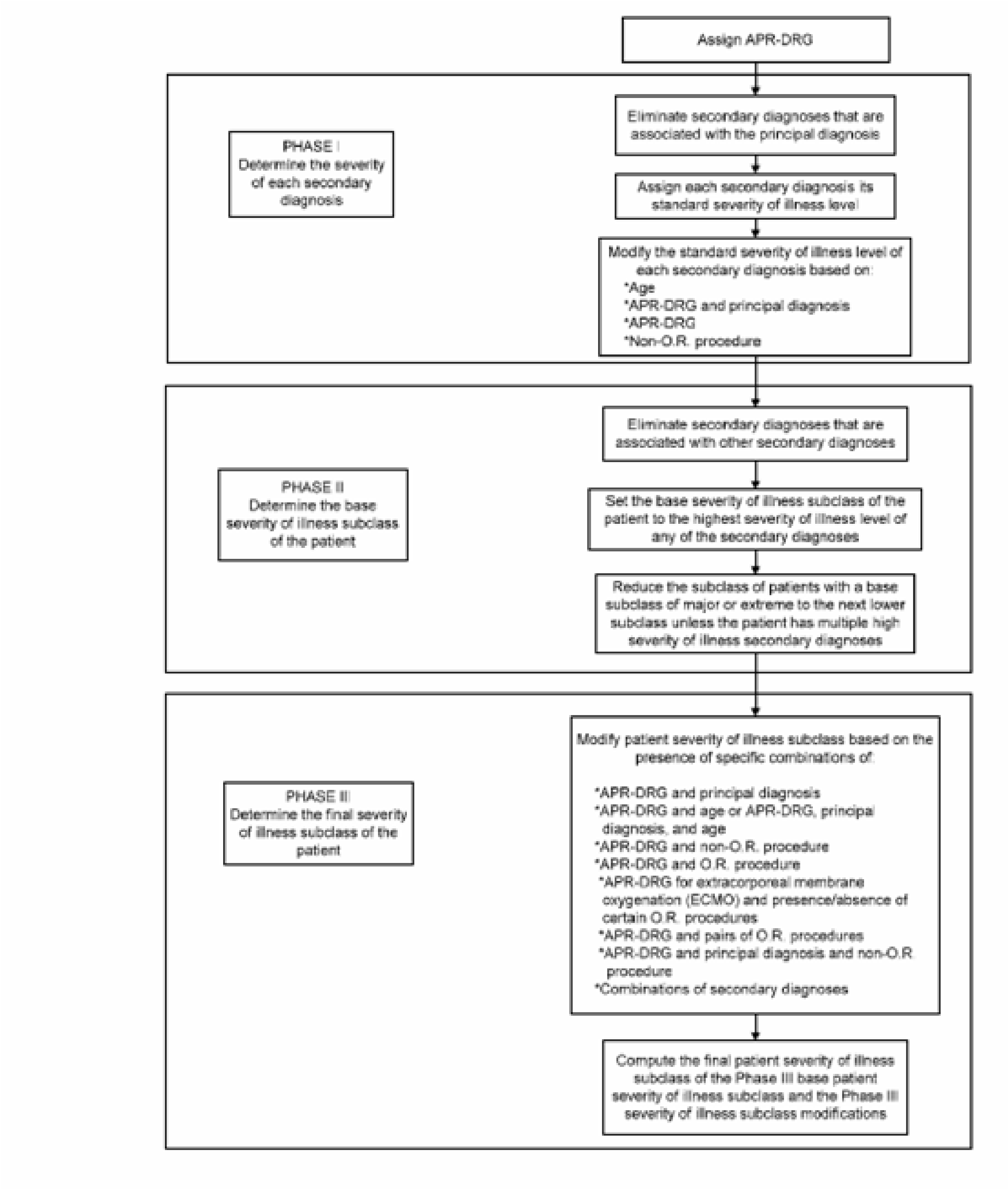
Updating process

3-M/HIS updates APR-DRGs annually to reflect changes to DRG and CC lists and ICD-9-CM codes and to consider refinements in the grouper logic. A complete review is performed every three years. The last complete review of the system occurred in the third quarter of 2003.

Applications

The Con-APR-DRGs are too new to have been used. However, the developers claim that the APR-DRG grouper is the most widely used of all severity-adjustment methodologies (Hornbrook, 2003). Its applications include public provider profiles, prospective payment and pricing, internal quality improvement, and risk adjustment for quality indicators (Averill, Goldfield, Hughes, Muldoon, et al., 2003). It is used for comparing hospital performance by 1,500 hospitals (Hornbrook, 2003) and 33 state agencies and hospital associations representing 25 states (Davies, 2001). MedPAC used the APR-DRG to analyze severity adjustments for the Medicare PPS, AHRQ selected APR-DRGs to adjust their quality indicators (AHRQ, 2005), and Maryland selected the APR-DRG grouper for its Medicaid payment system and hospital rate review system starting in 2005. The APR-DRG has been used by Belgium’s Prospective Payment System since 2002, and it is used in research by the Premier Hospital Quality Incentive Demonstration, as well as in the Joint Commission on Accreditation of Healthcare Organizations hospital accreditation process (Shared Visions-New Pathways).

Figure 2.5
Three Phase Process for Determining Patient Severity of Illness in Con-APR-DRGs


Assign APR-DRG
PHASE I
Determine the severity of each secondary diagnosis
Eliminate secondary diagnoses that are associated with the principal diagnosis
Assign each secondary diagnosis its standard severity of illness level
Modify the standard severity of illness level of each secondary diagnosis based on:
*Age
*APR-DRG and principal diagnosis
*APR-DRG
*Non-O.R. procedure
PHASE II
Determine the base severity of illness subclass of the patient
Eliminate secondary diagnoses that are associated with other secondary diagnoses
Set the base severity of illness subclass of the patient to the highest severity of illness level of any of the secondary diagnoses
Reduce the subclass of patients with a base subclass of major or extreme to the next lower subclass unless the patient has multiple high severity of illness secondary diagnoses
PHASE III
Determine the final severity of illness subclass of the patient
Modify patient severity of illness subclass based on the presence of specific combinations of:
*APR-DRG and principal diagnosis
*APR-DRG and age or APR-DRG, principal diagnosis, and age
*APR-DRG and non-O.R. procedure
*APR-DRG and O.R. procedure
*APR-DRG for extracorporeal membrane oxygenation (ECMO) and presence/absence of certain O.R. procedures
*APR-DRG and pairs of O.R. procedures
*APR-DRG and principal diagnosis and non-O.R procedure
*Combinations of secondary diagnoses
Compute the final patient severity of illness subclass of the Phase III base patient severity of illness subclass and the Phase III severity of illness subclass modifications

Source: CMS, 2007.

2.3. SUMMARY

Our evaluation of the performance of the five severity-adjusted DRG systems uses the current CMS-DRGs as the baseline. Two systems are derived from all-patient severity-adjusted DRG systems that have been modified by their developers for the Medicare population (Con-APR-DRGs and MM-APS-DRGs), and two are all-patient systems (HSC-DRG and Sol-DRG) that introduce severity levels into CMS-DRGs but have not been modified explicitly for the Medicare population. The CMS+AP-DRG system is a hybrid of the CMS-DRG system and a modification of the major CC severity groupings used in the AP-DRG system.

Table 2.4 summarizes key differences in the way the various systems classify patients into base DRGs and severity levels:

- Four systems add severity levels to base CMS-DRGs; the Con-APR-DRG system adds severity levels to base APR-DRGs, which are similar but not identical to the base CMS-DRGs. Both the Con-APR-DRG and the MM-APS-DRG systems collapse some base DRGs with low Medicare volume.
- The HSC-DRG and the Sol-DRG systems use uniform severity levels for each base DRG (three levels for medical and four for surgical). The general structure of the MM-APS-DRG logic establishes three severity levels for each base DRG, but some severity levels for the same base DRG are consolidated to address Medicare low-volume DRGs and monotonicity issues. The general structure of the Con-APR-DRG system establishes four severity levels for each base DRG, but severity-level consolidations occur to address Medicare low-volume DRGs and monotonicity. The Con-APR-DRG system consolidates both adjacent severity levels for the same base DRG and the same severity level across multiple base DRGs (particularly for Level 4).
- Under the CMS+AP-DRG and MM-APS DRG systems, each diagnosis is assigned a uniform CC-severity level across all base DRGs (other than CCs on the exclusion list for specific principal diagnoses). The remaining systems assign diagnoses to CC severity-level classifications by groups of DRGs.

- Under the grouping logic used by all systems other than the Con-APR DRG system, each discharge is assigned to the highest severity level of any secondary diagnosis. The Con-APR-DRG system adjusts the initial SOI-level assignment on the basis of other factors, including the presence of additional CCs. None of the other systems adjust the severity-level classification for additional factors or CCs, but the MM-APS-DRG system handles additional CCs through an enhanced relative weight.
- The HSC-DRGs and the Sol-DRGs have a medical early-death classification within each MDC.
- The Con-APR-DRGs do not use death in the grouping logic. In addition, most complications of care do not affect the DRG assignment.

Our evaluation of the performance of the DRG systems focuses on understanding the implications of these differences on the ability of the systems to explain resource use and the trade-offs they pose on issues such as understandability and administrative costs.

Table 2.4
Logic of CMS and Alternative DRG Systems

	CMS-DRG	**CMS+AP-DRG**	**HSC-DRG**	**Sol-DRG**	**MM-APS-DRG**	**Con-APR-DRG**
Number of MDCs	25	25	25	25	25	25
Number of pre-MDC base DRGs	9	9	9	9	9	7
Number of base DRGs	379	379	215 ADRGs	248 ADRGs	361	379
Total number of pre-MDC DRGs	9	9	30	27	27	9
Total number of DRGs	538	602	1,274	1,261	915*	859
Number of CC (severity) subclasses	2	3	3 (med) or 4(surg)	3 (med) or 4 (surg)	3	4
CC subclasses	With CC, without CC for selected base DRGs	Without CC With CC for selected based DRGs and Major CC across DRGs within MDC	No CC, Class C CC, Class B CC, Class A CC (Surgical only)	Minor/no substantial CCs, Moderate CCs, Major CCs, Catastrophic CCs (Surgical only)	Without CC, With CC, With Major CC with some collapsing at base DRG level	Minor, Moderate, Major, Severe with some collapsing at DRG level
Multiple CCs recognized	No	No	No	No	Yes (in computation of weight)	Yes
CC Assignment specific to base DRG	Mostly no	Mostly no	Mostly no	Mostly no	No	Yes
Logic of CC subdivision	Presence/ absence	Presence/ absence	Presence/ absence	Presence/ absence	Presence/ absence	18-step process
Logic of MDC assignment	Principal diagnosis	Principal diagnosis	Principal diagnosis	Principal diagnosis	Principal diagnosis	Principal diagnosis with rerouting
Death used in DRG assignment?	Yes (in selected DRG definitions)	Yes (in selected DRG definitions)	Yes (includes “early death” DRGs)	Yes (includes “early death” DRGs)	Yes (in selected DRG definitions)	No
Complications of care are CCs ?	Yes	Yes	Yes	Yes	Yes, when is recognized as CC (may be downweighted); no when CC represents “poor medical care”	Few

3. COMPARATIVE PERFORMANCE OF DRG SYSTEMS IN EXPLAINING COST VARIATION

This chapter reports the findings from our analyses of the ability of the DRG systems to explain variation in costs. We begin with a brief explanation of the data and methods we employed to derive the variables used in these analyses. More-detailed information concerning data conditioning and our analysis methods is given in Appendix A.

The issues that we explore and our key findings are as follows:

Within-DRG variation. The goal of the severity-adjusted DRGs is to reduce the amount of cost variation within DRGs. All five severity-adjusted systems reduce the amount of variation, with the MM-APS DRGs, Con-APR-DRGs, and CMS+AP-DRGs having a lower percentage of discharges assigned to DRGs with substantial variation than the HSC-DRGs and Sol-DRGs.

Explanatory power. An important evaluation issue is the ability of DRG systems to explain differences in cost across Medicare discharges. All five severity-adjusted systems have higher explanatory power than the CMS-DRGs. The Con-APR-DRGs explain 45 percent of the cost variation, a 13 percent improvement over the CMS-DRGs. The improvement of other systems is as follows : HSC-DRGs, 11 percent; Sol-DRGs and MM-APS-DRGs, 10 percent; and, CMS+AP DRG, 8 percent. The differences in explanatory power affect how Medicare payments are distributed across discharges and hospitals.

Validity. Another important question is whether SOI is a valid measure for treatment costs. For a given base DRG, the mean cost per discharge should increase as severity level increases and the severity levels should discriminate among discharges with substantially different treatment costs. Across the DRG systems, cost increases as the SOI level increases except in a few DRGs with a very small percentage of discharges. The number of DRGs and severity levels affects the amount of cost discrimination seen between severity levels.

Stability. It is important that the DRG system used in the Medicare PPS result in DRG relative weights that have year-to-year stability. A comparison of relative weights constructed from FY04 data to relative weights constructed from FY05 data found that about five percent of discharges were assigned to DRGs with more than a five percent change in relative weights, with only minor differences in performance across the systems.

3.1. OVERVIEW OF DATA AND METHODS USED TO DERIVE VARIABLES

3.1.1. Data and Derived Variables

For our analyses, we used Medicare Payment and Analysis Review (MedPAR) data for FY04 and FY05 acute-care hospital discharges. We eliminated records for critical-access hospitals, Indian Health Service hospitals, and hospitals 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 determined standardized costs. Our initial analysis file contained 12,190,480 records from FY04 and 12,205,601 records from FY05.

We used the vendor-supplied groupers to assign each record to FY07 CMS-DRGs and their respective severity-adjusted DRGs. Two systems (Sol-DRGs and HSC-DRGs) are based on ICD-9-CM diagnosis and procedure codes version 23 (effective October 1, 2005) and version 23 CMS-DRGs.[7] The Con-APR DRGs also use version 23 IDCD-9-CM codes. The remaining systems use version 24 ICD-9-CM codes and CMS-DRGs.

After grouping the records, we adjusted the discharge count for short-stay transfers to acute-care hospitals. A short-stay transfer counts as a partial discharge based on the ratio of the length of stay for the discharge plus one day to the geometric mean length of stay for the DRG. We did not model the policy for discharges to post-acute-care facilities because the policy is DRG-specific and we were concerned that a discharge might be treated differently across the DRG systems.

We used the national cost-to-charge ratios that CMS published in the FY07 the PPS final rule to estimate the cost for each inpatient stay. We then standardized the costs, using hospital payment factors, and inflated them to a common date for the analyses.[8] Next, we determined the geometric mean standardized cost per discharge for each CMS-DRG. We defined statistical outliers as discharges with a standardized cost per case that is more than three standard deviations from the geometric mean cost per discharge for the relevant CMS-DRG. We uniformly defined statistical outliers based on the CMS-DRGs because we wanted to compare performance on the same discharges across all DRG systems. After removing statistical outliers, we computed relative weights for each DRG system by dividing the mean standardized cost per discharge for each DRG by the mean standardized cost per discharge across all DRGs.

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[7] The HSC-DRG version 24 grouper became available in December 2005 and was not used in this report.

[8] To standardize, we used the geographic adjustment factors derived from the FY07 non-reclassified hospital wage index, the IME and

Most of the analyses in this chapter are reported exclusive of statistical outliers, MDC 15 newborn discharges, and ungroupable discharges (e.g., discharges assigned to CMS-DRGs 469 and 470 and corresponding DRGs in the other systems). Table 3.1 summarizes the numbers of records and DRGs that are affected by the exclusion policies. Small differences in the number of ungroupable discharges across the systems explain the differences in the total number of discharges used in the chapter analyses.

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disproportionate-share hospital (DSH) factors that will be effective under current law in FY08, and the cost-of-living adjustment for Alaska and Hawaii.

Table 3.1
Reconciliation of the Number of Discharges and DRGs used in the Analyses, by DRG System

		CMS		CMSAP		HSC	
	Year	Discharges N	DRGs N	Discharges N	DRGs N	Discharges N	DRGs N
Total Discharges	FY04	12,190,480	538	12,190,480	602	12,190,480	1,274
	FY05	12,205,601	538	12,205,601	602	12,205,601	1,274
Exclusions:							
MDC15	FY04	6	7	6	7	4	17
	FY05	5	7	5	7	5	
Ungroupable	FY04	112	2	113	2	445	2
	FY05	130	2	131	2	130	2
Total after MDC15 and Ungroupable	FY04	12,190,362	529	12,190,361	593	12,190,031	1,255
	FY05	12,205,466	529	12,205,465	593	12,205,466	1,255
Exclusions:							
No Discharges	FY04	-	13	-	14	-	10
	FY05	-	15	-	16	-	10
Statistical Outliers	FY04	72,096	7	72,096	6	72,060	-
	FY05	69,484	3	69,484	2	69,484	-
Total for Chapter 3 Analyses	FY04	12,118,266	509	12,118,265	573	12,117,971	1,245
	FY05	12,135,982	511	12,135,981	575	12,135,982	1,245

		SOL		MMAPS		CONAPR	
	Year	Discharges N	DRGs N	Discharges N	DRGs N	Discharges N	DRGs N
Total Discharges	FY04	12,190,480	1,261	12,190,480	909	12,190,480	861
	FY05	12,205,601	1,261	12,205,601	909	12,205,601	861
Exclusions:							
MDC15	FY04	-	-	2	1	-	14
	FY05	-	-	-	1	-	
Ungroupable	FY04	37	2	116	2	75	2
	FY05	30	2	135	2	67	2
Total after MDC15 and Ungroupable	FY04	12,190,443	1,259	12,190,362	906	12,190,405	845
	FY05	12,205,571	1,259	12,205,466	906	12,205,534	845
Exclusions:							
No Discharges	FY04	-	49	-	3	-	-
	FY05	-	53	-	-	-	-
Statistical Outliers	FY04	72,096	-	72,096	-	72,096	-
	FY05	69,485	-	69,484	-	69,484	-
Total for Chapter 3 Analyses	FY04	12,118,347	1,210	12,118,266	903	12,118,309	845
	FY05	12,136,086	1,206	12,135,982	906	12,136,050	845

Comparison of the performance of the severity-adjusted DRGs across different dimensions is complicated by differences in the way the severity levels are established, the number of severity-adjusted DRGs in each system, whether there are age splits, and the average number of discharges assigned to each DRG. For purposes of this report, we use the following definitions:

- *Base DRG* refers to a grouping of discharges with common classification logic other than severity or age splits. For example, the base DRG is the ADRG in the HSC-DRGs and Sol-DRGs. Base DRG1 in those systems and in the CMS-DRG system is craniotomy.
- *DRG* refers to the grouping of discharges with common classification logic including any severity level or other differentiation. Under the CMS-DRGs, Base DRG 1 splits into three DRGs: DRG 1 (Craniotomy Age >17 with CC), DRG 2 (Craniotomy Age >17 without CC), and DRG 3 (Craniotomy Age 0-17).
- *Severity level* refers to a grouping of discharges with a common severity level (e.g. no or minor CC, moderate CC, major CC).

The number of severity levels and the numbering convention for severity levels differs by classification system. For some analyses in this chapter, we needed to assign severity levels to the DRGs. For consistency, we assigned a 0 to the lowest level (i.e., the DRG with no CC in most systems, but also any base DRG that does not split on CCs). Assigning the remaining levels to the HSC-DRGs and Sol-DRGs was straightforward because these systems have standard severity levels across base DRGs (Levels 0-2 for medical DRGs and Levels 0-3 for surgical DRGs). Assignment was slightly more complex for those systems that collapse severity levels within base DRGs. For these, we assigned to a given DRG the lowest severity level of any discharges assigned to it. For example, if a base MM-APS-DRG divided 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 CC or with CCs and Level 2 to the DRG for discharges with MCCs. For the CMS-DRGs and CMS+AP-DRGs, we did not assign severity levels to the DRGs for age 0-17.

Table 3.2 summarizes the distribution of DRGs and discharges across severity levels by classification system, exclusive of MDC 15, ungroupable discharges, and statistical outliers. Although the basic severity-level logic is the same for the HSC-DRG and Sol-DRG classification systems, more discharges are assigned to higher severity levels in the HSC-DRGs. The CMS+AP-DRGs and Con-APR-DRGs consolidate some of the severity-level assignments across base DRGs. The 64 Level 2 CMS+AP-DRGs include discharges from 288 base CMS+AP-DRGs (i.e., there are 799 base DRG/SOI combinations before consolidation and 575 after consolidation). The 59 Level 3 Con-APR-DRGs include discharges from 258 base Con-APR-DRGs (i.e., there are 1,044 base DRG/SOI combinations before consolidation and 845 after consolidation).

Table 3.2
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		1,245
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		1,204
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
% DRGs	2,475,008	5,588,117	3,308,104	764,821		12,136,050
% Discharges	20%	46%	27%	6%		100%

3.1.2. Differences in Number and Size of DRGs

Figure 3.1 shows the distribution of low-volume DRGs in each system in FY05, exclusive of MDC 15 newborns and ungroupable discharges.

Because the Con-APR-DRG and the MM-APS-DRG systems combine some low-volume severity classes (and a few low-volume base DRGs) and do not have separate DRGs for age 0-17, these systems have considerably fewer low-volume DRGs than the HSC-DRGs and Sol-DRGs, which have standard severity classes across all DRGs regardless of volume.

Figure 3.1
Number of Low-Volume DRGs (500 or Fewer Discharges)

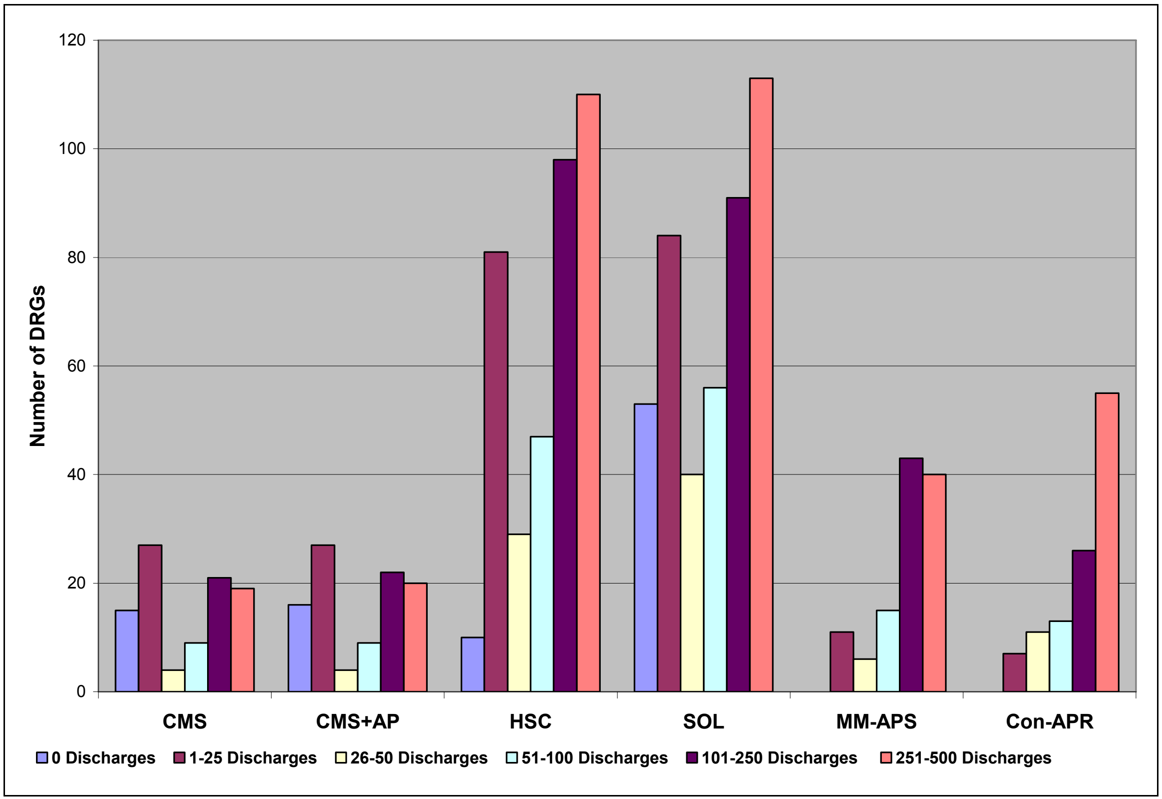


Table 3.3 summarizes the number of low-volume DRGs for each DRG system in the FY04 and FY05 data. The counts exclude MDC 15 newborns and ungroupable discharges. Ninety-five CMS-DRGs had fewer than 500 discharges in FY05; 43 CMS-DRGs with 500 or fewer discharges in FY05 were for age 0-17, 15 of which had no volume. In FY05, the CMS+AP-DRGs had 98 DRGs with fewer than 500 discharges. The MM-APS-DRGs and Con-APR-DRGs had 115 and 112 low-volume DRGs, respectively. The HSC-DRG and Sol-DRG systems had 375 and 437 low-volume DRGs, respectively. The difference between these two systems is largely the result of the Sol-DRG grouping logic, which retains some age splits (0-17, age >17) at the ADRG level, and the fact that DRGs for age 0-17 have little or no

Medicare volume.

Table 3.3
Number of Low-Volume DRGs by Size Categories in FY04 and FY05 and in the Pooled Dataset

No. of Discharges in DRG	Year	CMS DRGs N	CMS+AP DRGs N	HSC DRGs N	SOL DRGs N	MM-APS DRGs N	Con-APR DRGs N
0 Discharges	FY04	13	14	10	49	3	0
	FY05	15	16	10	53	0	0
	Pooled	11	12	5	41	0	0
1-25 Discharges	FY04	29	29	73	89	10	7
	FY05	27	27	81	84	11	7
	Pooled	27	27	57	67	5	2
26-50 Discharges	FY04	4	6	42	43	6	13
	FY05	4	4	29	40	6	11
	Pooled	2	3	21	29	6	4
51-100 Discharges	FY04	12	9	39	42	15	12
	FY05	9	9	47	56	15	13
	Pooled	5	5	36	40	5	14
101-250 Discharges	FY04	18	21	99	101	42	26
	FY05	21	22	98	91	43	26
	Pooled	15	14	61	66	25	16
251-500 Discharges	FY04	17	16	102	114	38	53
	FY05	19	20	110	113	40	55
	Pooled	14	16	84	80	34	0
Total DRGs ≤500 Discharges	FY04	93	95	365	438	114	111
	FY05	95	98	375	437	115	112
	Pooled	74	77	264	323	75	36

The Con-APR-DRGs and the MM-APS DRGs partially address the issue of low-volume DRGs by combining some severity levels and low-volume base DRGs. Another way to reduce the number of low-volume DRGs would be to pool data from multiple years in establishing the relative weights for these DRGs. Because most of the low-volume DRGs are for discharges age 0-17, pooling does not resolve the issue. For example, pooling reduces the number of low-volume CMS+AP severity DRGs only from 98 to 77 in FY05. Pooling eliminates relatively more low-volume DRGS in the MM-APS DRGs and the Con-APR-DRGs, largely because those systems do not have age splits. The low-volume DRGs that remain in these two systems are conditions common to maternity and childhood conditions. Thus, a data source that is representative of all discharges for these DRGs (and is not limited to Medicare discharges) may be more appropriate than pooling.

As discussed below, low-volume severity-adjusted DRGs can affect the relative performance of a classification system. However, the percentage of Medicare discharges assigned to these DRGs is small: about 0.7 percent in the HSC-DRG and Sol-DRG systems and 0.1 percent in the CMS-DRGs. Therefore, in our findings, we generally report both DRG-weighted and discharge-weighted results.

3.2. WITHIN-DRG COST VARIATION IN DRG SYSTEMS

Severity-adjusted DRGs are designed to reduce the amount of cost variation within DRGs. To explore 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. The CV is the standard deviation divided by the mean. It is a normalized measure of variance and thus allows comparison of the variation of populations that have significantly different means and distributions around the mean. We report the CV as a percentage by multiplying the above calculation by 100. A CV equal to 100 thus corresponds to situations in which the standard deviation equals the mean.

Figure 3.2 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. In particular, Medicare patients were assigned to 511 CMS-DRGs in 2005, 17 percent of which had a CV > 100 percent. In contrast, the HSC-DRGs and Sol-DRGs (with 1,245 and 1,206 DRGs, respectively) had a CV > 100 percent in less than 8 percent of their DRGs. In all classification systems, including CMS-DRGs, about two-thirds of discharges are assigned to DRGs with CVs of between 76 and 100 percent (Figure 3.3). The HSC and Sol-DRGs have a slightly higher proportion of discharges assigned to DRGs with a CV < 76 percent but also have a higher proportion of discharges assigned to DRGs with a CV > 100 percent. The Con-APR-DRGs had a slightly lower percentage of discharges assigned to DRGs with a CV < 76 percent than the other severity-adjusted systems. The MM-APS DRGs, Con-APR-DRGs, and CMS+AP-DRGs all have less than 2 percent of discharges assigned to DRGs with a CV > 100 percent.

Figure 3.2 Proportion of DRGs, by Magnitude of CV

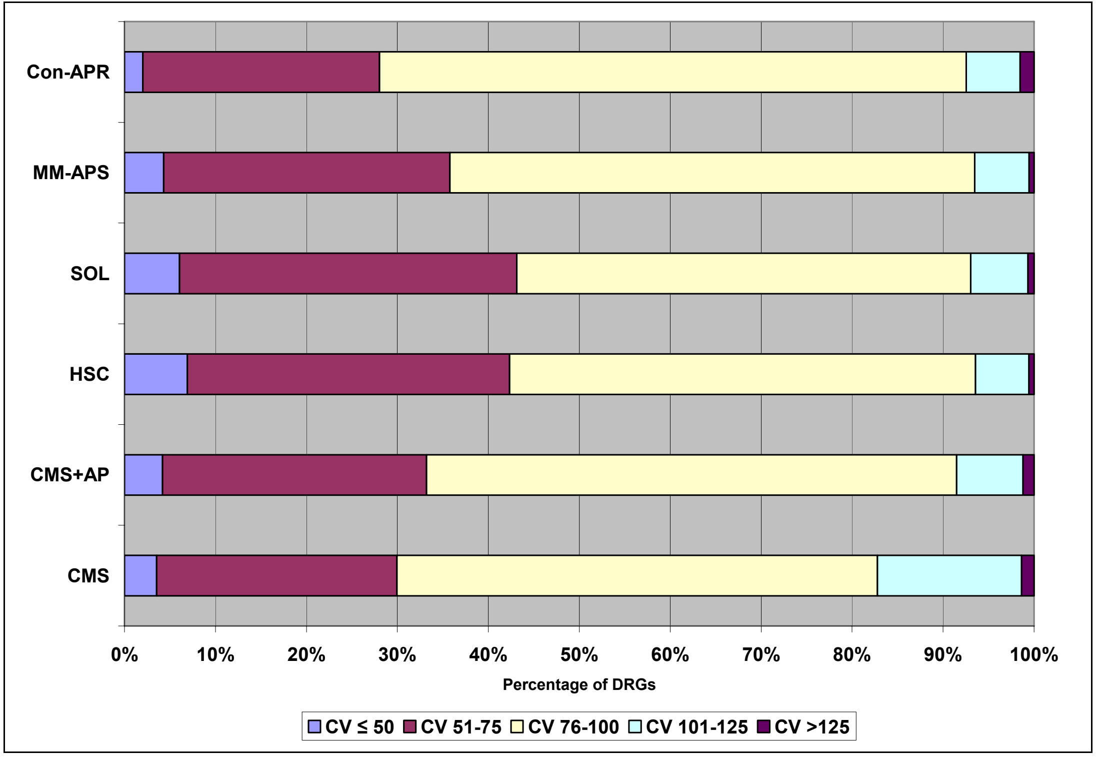
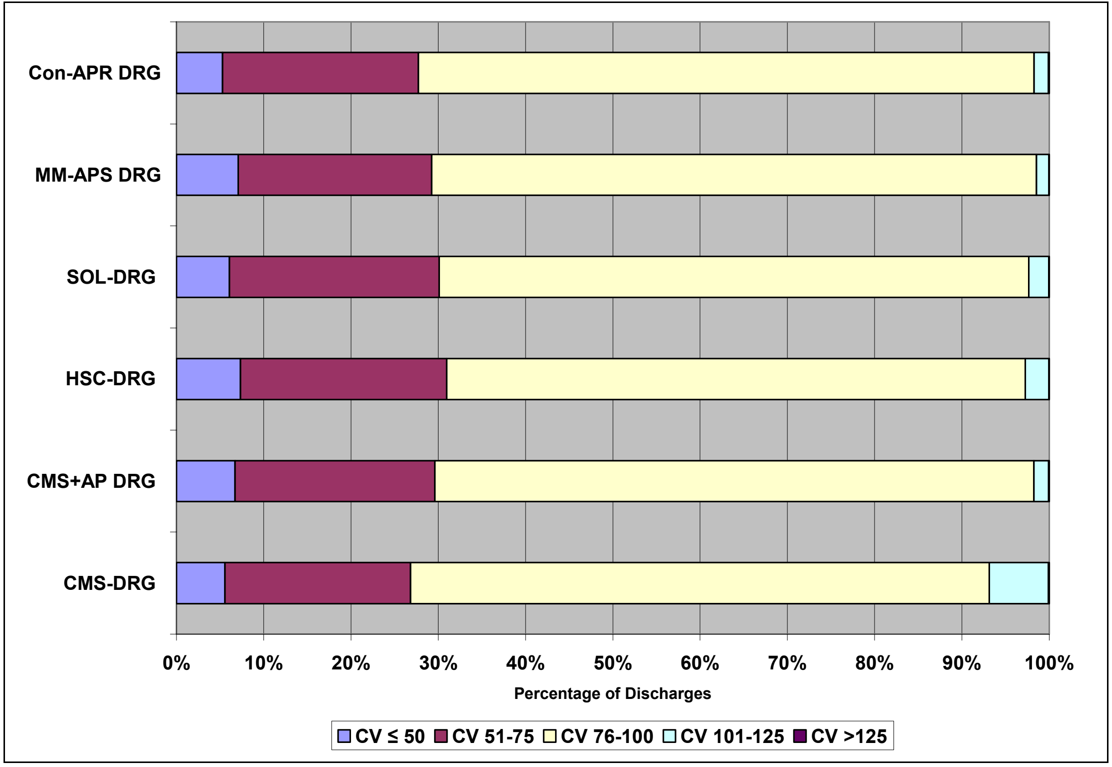


Figure 3.3
Proportion of Discharges Assigned to DRGs, by Magnitude of CV



3.3. ABILITY OF DRG SYSTEMS TO EXPLAIN VARIATION IN COSTS

An important evaluation issue is the ability of DRG systems to explain differences in cost across Medicare discharges. We used a log-linear regression model to explore this issue. 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.

3.3.1. Overview of Analyses

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. About 42 percent of the discharges assigned to MDC 00 in the CMS-DRG-based systems are not assigned by the Con-APR-DRG grouping logic to pre-MDCs. Key differences in the grouping logic include the assignment of heart-assist discharges to MDC 5 and the assignment of discharges with tracheostomies without at least 96 hours of mechanical ventilation or with a principal diagnosis of head, throat, or neck to other MDCs based on their principal diagnosis. 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 3.4. The DRG count is based on the number of severity-adjusted DRGs that had Medicare discharges in FY05.

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.

3.3.2. 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 3.5. and Figure 3.4. The Model 1 regression results show that all five severity-adjusted systems predict cost better than the CMS-DRGs do. The adjusted R-squared value for the Con-APR-DRGs is 0.4458, a 13 percent improvement over the adjusted R-squared value for the CMS-DRGs. The R-squared values for the HSC-DRGs are 11 percent higher, while the adjusted R-squared values for the Sol-DRGs and MM-APS-DRGs are 9.7 percent and 10.0 percent higher, respectively. The CMS+AP-DRGs show the smallest improvement (7.6 percent). Chapter 5 discusses how the differences in explanatory power affect the redistribution of Medicare payments across discharges and hospitals.

To examine the sensitivity of our Model 1 regression results to different specifications of the regression model, we performed regressions using FY04 data only and pooled FY04 and FY05 data. We also performed separate regressions with the FY05 data that used facility-level cost-to-charge ratios instead of national cost-to-charge ratios to determine cost per discharge and that included statistical outliers. The R-squared values are different in these regressions, but the comparative performance of the DRG classification systems is similar in each specification. The results from the alternative specifications are reported in Appendix A.

Generally, the R-squared values are highest in MDCs with substantial numbers of high-cost surgical discharges, e.g., MDC 5 (Diseases and Disorders of the Circulatory System) and MDC 8 (Diseases and Disorders of the Musculoskeletal System). MDCs that primarily have medical discharges or low-cost surgical discharges, e.g., MDC 2 (Diseases and Disorders of the Eye) and MDC 20 (Alcohol/Drug Use and Alcohol/Drug Induced Organic Mental Disorders), tend to have the lowest explanatory power. In nearly every MDC, the Con-APR-DRGs have higher adjusted R-squared values than the other severity-adjusted systems. The HSC-DRGs have the highest explanatory power in four MDCs, while the Sol-DRGs have the highest predictive power in MDC 18.

Table 3.5
Comparative Performance of Severity-Adjusted DRGs in Explaining Cost Variation Overall and by MDC

	CMS-DRG		**CMS+AP DRG**		**HSC-DRG**		**SOL-DRG**		**MM-APS DRG**		**Con-APR DRG***	
MDC**	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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
Discharges	12,135,982		12,135,981		12,135,982		12,136,082		12,135,982		12,136,050	

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.

Table 3.4
FY05 Distribution of Discharges and DRGs, by MDC

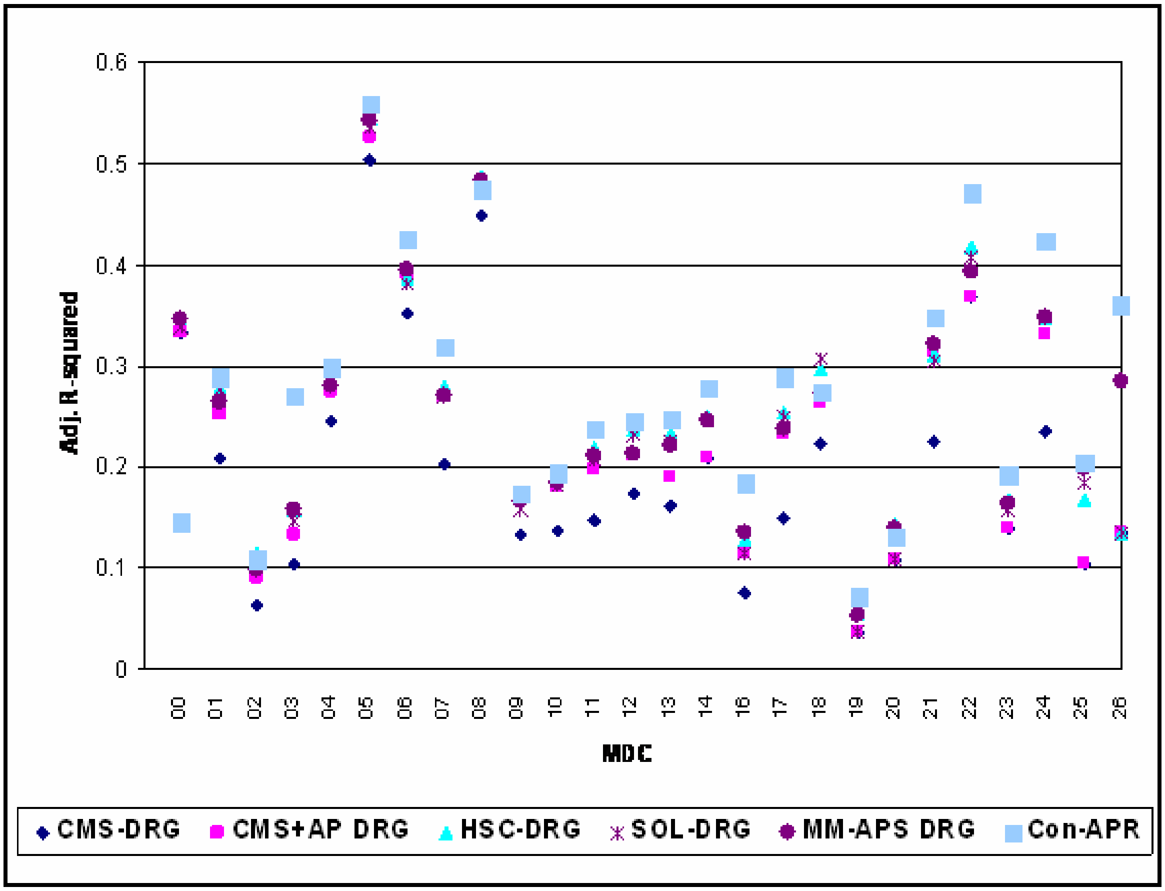
MDC**	CMS-DRG		CMS+AP DRG		HSC-DRG		SOL-DRG		MM-APS DRG		Con-APR DRG*	
	N Discharges	N DRGs	N Discharges	N DRGs	N Discharges	N DRGs	N Discharges	N DRGs	N Discharges	N DRGs	N Discharges	N DRGs
0	54,989	9	54,989	9	54,988	29	54,988	24	54,999	16	31,654	19
1	914,600	44	914,600	48	914,600	90	914,600	92	914,600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

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.

Figure 3.4 Explanatory Power of Alternative DRG Systems by MDC



3.3.3. 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. The CMS+AP DRGs and Con-APR DRGs consolidate severity levels across base DRGs. For example, the CMS+AP DRG 701 (Laparoscopic Cholecystectomy with Major CC) includes discharges from base DRGs that fall into four different cost deciles. Because we assigned cases to deciles by base DRG, the discharges in DRG 702 were assigned across four deciles, and the DRG counts for the CMS-DRGs exceed the actual number of

DRGs. The Con-APR-DRG counts are higher than the actual number of DRGs for the same reason.

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 3.6). The results for the five 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 3.6
Results from Discharge-Level Regressions Using Cost Decile as the Explanatory Variable

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

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 3.7, 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 other DRG systems provide more explanatory power in all deciles than does the CMS-DRGs, but the R-squared values increase as the base DRG cost decile increases, and the most explanatory power occurs in the top deciles. For each cost decile, the Con-APR DRGs have the greatest additional explanatory power.

Table 3.7
Results from Regressions by Base DRG Cost Decile, Using DRG as the Explanatory Variable

Base DRG Cost	CMS-DRG			CMS+AP-DRG*			HSC-DRG		
	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	0.0221	55	625,032	0.0387	75	433,293	0.0398
2	55	1,274,845	0.0290	72	1,274,845	0.0658	112	597,661	0.0607
3	52	1,476,494	0.0270	71	1,476,494	0.0654	115	2,085,490	0.0781
4	55	1,125,647	0.0227	76	1,125,647	0.0679	130	1,362,633	0.0768
5	57	2,125,839	0.0214	78	2,125,839	0.0841	127	2,212,077	0.0899
6	47	1,243,085	0.0182	66	1,243,085	0.0924	126	1,167,796	0.1167
7	55	1,344,747	0.0652	75	1,344,746	0.1072	139	1,343,285	0.1202
8	47	702,821	0.0390	67	702,822	0.1082	143	676,515	0.1353
9	57	1,458,415	0.0603	82	1,458,414	0.1286	140	1,529,064	0.1607
10	43	759,057	0.2968	58	759,057	0.3419	138	728,168	0.3358

Base DRG Cost	SoI-DRG			MM-APS			Con-APR-DRGs *		
	N DRGs	N Discharges	Adj. R-sq	N DRGs	N DRGs	Adj. R-sq	N DRGs	N Discharges	Adj. R-sq
1	69	424,220	0.0350	86	748,140	0.0618	88	1,060,257	0.0850
2	100	577,480	0.0407	93	1,907,587	0.0733	97	1,609,288	0.1105
3	112	1,954,055	0.0638	93	1,603,069	0.0719	96	1,819,102	0.1161
4	124	1,520,423	0.0640	91	2,130,807	0.0861	98	1,950,986	0.1336
5	129	2,210,063	0.0740	93	1,093,131	0.1054	98	891,144	0.1330
6	123	1,112,163	0.1042	88	999,546	0.1019	95	1,188,375	0.1388
7	131	985,748	0.0999	92	890,344	0.1063	98	939,809	0.1651
8	140	1,113,323	0.1456	94	854,166	0.1142	89	856,658	0.1578
9	138	1,492,356	0.1677	98	1,423,088	0.1900	98	1,252,229	0.2343
10	138	746,251	0.3361	78	486,104	0.3358	94	568,202	0.3629

*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 DRG.

3.3.4. 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. For purposes of this and later steps, we treated the 25 DRGs for age 0-17 in the base CMS+AP-DRGs as SOI Level 2.

- 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 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 3.8) show that the base Con-APR DRGs have the lowest explanatory power. The R-squared value is 0.3618, compared with 0.3772 for the base CMS+AP-DRGs (which would also be applicable to the base CMS-DRGs). The other severity-adjusted base DRGs have higher explanatory power than the CMS+AP-DRGs. The added explanatory power for the HSC-DRG and Sol-DRG systems is most likely attributable to the early death medical DRGs. With the creation of two severity levels, the Con-APR-DRGs continue to have the lowest explanatory power. The MM-APS-DRGs create more explanatory power with two and three severity levels than the other systems. The higher explanatory power of the Con-APR-DRG system relative to the other DRG systems comes with the addition of the third and, in particular, the fourth severity level. The latter increases the Con-APR-DRG explanatory power 3.5 percent. By comparison, the addition of the fourth severity level to the HSC-DRGs and Sol-DRGs for surgical discharges increases the explanatory power of those systems by only 1.3 percent.

Table 3.8 Model 4 Regression Results Showing Increase in Explanatory Power Provided by Adding Severity Levels to Base DRGs

	CMS+AP DRGs			HSC-DRGs			SoI-DRGs			MM-APS-DRGs			Con-APR-DRGs		
N SOI Levels	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	0.3772		378	0.3827		377	0.3816		325	0.3803		272	0.3618	
2 Levels	494	0.3942	4.5	722	0.4049	5.8	705	0.4042	5.9	641	0.4081	7.3	531	0.3893	7.6
3 Levels	511	0.3942	0.0	1071	0.4331	7.0	1036	0.4272	5.7	906	0.4348	6.5	791	0.4309	10.7
4 Levels	575	0.4243	7.6	1245	0.4388	1.3	1204	0.4326	1.3				845	0.4458	3.5

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

3.4. 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. For example, in its 1994 DRG refinement activity, CMS established CC splits within base DRGs only if there was at least a 20 percent difference in average charges between the subgroups and at least a $2,000 difference in average charges.

To assess whether the severity levels have validity for resource-cost measurement, we examined both the percentage differences and the absolute differences in cost between the severity levels within base DRGs. For these analyses, we assigned the severity levels for discharges assigned to the CMS+AP DRGs and Con-APR-DRGs that involve multiple base DRGs to the base DRG to which they would have been assigned at a lower severity level. For example, we assigned a discharge that grouped CMS+AP-DRG 734 (Eye Procedures with Major CC) that would otherwise have been assigned to DRG 236 (Retinal Procedures) to DRG 236 and SOI Level 2. Using this approach, we were able to determine how much more costly the discharges assigned to the consolidated severity levels were than the discharges in the base DRG with the next highest severity level (i.e., we could compare the costs of the discharges assigned to DRG 734 from DRG 236 to the costs of discharges in DRG 236). There are 799 CMS+AP DRG base DRG/SOI combinations and 1,044 Con-APR DRG DRG/SOI combinations in these analyses.

Table 3.9 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 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., mean $\text{cost}_{\text{DRG Level 2}}$/mean $\text{cost}_{\text{DRG Level 1}}$) 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.

In the HSC-DRGs, for example, Medicare beneficiaries were assigned to 373 DRGs with SOI Level 0. These DRGs represented 30 percent of the severity-adjusted DRGs and 23 percent of the Medicare discharges. Five base DRGs had no SOI Level 0 discharges but did have discharges assigned to one or more higher severity levels. The remaining Medicare discharges were assigned to 871 DRGs with SOI Levels 1 through 3. The DRGs with a ratio of less than 1.0 are non-monotonic, i.e., the mean cost in the higher severity level is less than the mean cost in the lower severity level. Thirty-three DRGs were non-monotonic, and another 154 DRGs were less than 20 percent more costly (ratio < 1.2) than the adjacent lower-severity DRG; together, these DRGs account for 13 percent of all discharges and 17 percent of discharges assigned to SOI Levels 1 through 3. The HSC-DRGs had the lowest percentage of SOI Level 1 through 3 discharges (84 percent) assigned to DRGs that were at least 20 percent more costly than the adjacent lower severity level.

Table 3.9
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%
% Discharges	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%
% Discharges	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 Discharges	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%
% Discharges	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%
% Discharges	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%
% Discharges	20%	0%	1%	8%	16%	54%	1%	100%
% SOI 1-3 Discharges		0%	2%	10%	20%	69%		

The CMS-DRGs had the lowest proportion of discharges assigned to SOI Levels 1 through 3 (42 percent), but the highest proportion of discharges (98 percent) assigned to DRGs that were at least 20 percent more costly than the adjacent severity level. The CMS+AP DRGs had the next highest proportion of SOI Level 1 through 3 discharges (93 percent) assigned to DRGs that were at least 20 percent more costly, followed by the MM-APS-DRGs (91 percent of SOI Level 1 through 3 discharges). The Sol-DRGs and Con-APR DRG systems both had 89 percent of SOI Level 1 through 3 discharges assigned to DRGs that were at least 20 percent more costly than the adjacent lower severity level.

All systems evaluated exhibited good evidence of DRG monotonicity; across all the systems, only a small percentage of discharges are assigned to DRGs that are non-monotonic. As noted above, the results for the CMS+AP-DRGs and Con-APR-DRGs summarize the differences between each DRG/SOI combination before consolidation of the higher SOI across base DRGs. In four base DRG/SOI combinations in the CMS+AP-DRGs and in three base DRG/SOI combinations in the Con-APR-DRGs, discharges that were assigned to the higher severity level had lower costs than those in the adjacent severity level. In the CMS+AP-DRGs, these represented 3 percent of the discharges assigned to SOI Levels 1 through 3. Less than 0.05 percent of SOI Level 1 through 3 discharges in the Con-APR DRGs were assigned to non-monotonic DRG/SOI combinations.

Table 3.10 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 3.9, the discharge counts are based on the discharges assigned to the DRG with the higher severity level in the comparison. In the MM-APS-DRGs, for example, 68 percent of Medicare discharges were assigned to 581 DRGs with SOI Levels 1 and 2. Of the discharges assigned to these levels, 39 percent were assigned to DRGs that were at least $2,000 more costly than the adjacent lower severity level.

The CMS-DRGs and CMS+AP DRGs assigned a lower percentage of discharges to SOI Levels 1 and 2 (41 and 51 percent, respectively), but a higher percentage of those discharges (58 and 48 percent, respectively) were assigned to DRGs that are at least $2,000 more costly than the adjacent lower severity level. In the other systems, the percentage of SOI Levels 1 through 3 assigned to DRGs at least $2,000 more costly were as follows: Sol-DRG, 36 percent; Con-APR-DRG, 33 percent; and HSC-DRG, 31 percent.

Table 3.10
Difference in Mean Standardized Cost Between Severity Levels 1 Through 3 (as applicable) and an Adjacent Lower Severity Level Within the Same Base DRG

	Base and Other DRGs	DRGs with Severity Levels 1-3 (as applicable)						Total
CMS DRGs								
		Negative	0-$500	$500-999	$1000-1999	$2000-4999	≥ $5000	
N DRGs	385	0	1	8	34	58	25	511
% DRGs	75%	0%	0%	2%	7%	11%	5%	100%
% All Discharges	59%	0%	1%	2%	14%	20%	4%	100%
% SOI 1-3 Discharges		0%	2%	5%	35%	49%	9%	
CMS+AP 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%
% All Discharges	49%	1%	1%	7%	19%	18%	4%	100%
% SOI 1-3 Discharges		3%	2%	14%	39%	37%	9%	
HSC-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%
% All Discharges	23%	1%	3%	16%	33%	18%	6%	100%
% SOI 1-3 Discharges		1%	5%	21%	44%	23%	8%	
Sol-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%
% All Discharges	24%	0%	3%	7%	39%	20%	7%	100%
% SOI 1-3 Discharges		0%	4%	10%	51%	27%	9%	
MM-APS-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%
% All Discharges	32%	0%	0%	11%	30%	21%	5%	100%
% SOI 1-3 Discharges		0%	0%	17%	44%	31%	8%	
Con-APR-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%
% All Discharges	21%	0%	2%	18%	33%	19%	7%	100%
% SOI 1-3 Discharges		0%	2%	23%	41%	24%	9%	

Table 3.11

Differences in Mean Cost, by SOI1 level

CMS DRGs						
	SOI Level 0	SOI Level 1	SOI Level 2	SOI Level 3	Other DRGs	Total
N DRGs	358	128			25	511
N Discharges	6,782,845	5,074,736			278,401	12,135,982
Mean Cost Ratio Between Levels		1.58				1.58
Mean Cost Difference Between Levels		$2,569				$2,569
CMS+AP DRGs						
	SOI Level 0	SOI Level 1	SOI Level 2	SOI Level 3	Other DRGs	Total
N DRGs	358	126	286		29	799
N Discharges	5,842,981	3,895,813	2,262,228		134,959	12,135,981
Mean Cost Ratio Between Levels		1.39	1.53			1.30
Mean Cost Difference Between Levels		$1,616	$2,540			$2,117
HSC-DRGs						
	SOI Level 0	SOI Level 1	SOI Level 2	SOI Level 3	Other DRGs	Total
N DRGs	373	344	348	175	5	1245
N Discharges	2,788,346	5,501,519	3,145,959	700,136	22	12,135,982
Mean Cost Ratio Between Levels		1.32	1.49	1.50		1.39
Mean Cost Difference Between Levels		$1,130	$2,964	$6,510		$2,150
SoI-DRGs						
	SOI Level 0	SOI Level 1	SOI Level 2	SOI Level 3	Other DRGs	Total
N DRGs	368	328	330	169	9	1204
N Discharges	2,923,930	6,608,855	2,113,604	489,520	173	12,136,082
Mean Cost Ratio Between Levels		1.42	1.47	1.52		1.44
Mean Cost Difference Between Levels		$1,533	$3,629	$7,129		$2,311
MM-APS-DRGs						
	SOI Level 0	SOI Level 1	SOI Level 2	SOI Level 3	Other DRGs	Total
N DRGs	325	316	265			906
N Discharges	3,892,398	6,283,024	1,960,560			12,135,982
Mean Cost Ratio Between Levels		1.36	1.59			1.41
Mean Cost Difference Between Levels		$1,694	$4,601			$2,385
Con-APR-DRGs						
	SOI Level 0	SOI Level 1	SOI Level 2	SOI Level 3	Other DRGs	Total
N DRGs	261	258	261	253	11	1044
N Discharges	2,475,008	5,571,882	3,297,862	667,905	123,393	12,136,050
Mean Cost Ratio Between Levels		1.30	1.47	1.76		1.39
Mean Cost Difference Between Levels		$1,252	$2,821	$8,627		$2,311

We also computed by SOI Levels 1 through 3 the discharge-weighted mean cost difference between severity levels and the mean ratio of the cost per discharge for the higher severity level to that for the adjacent lower severity level (Table 3.11). The higher severity levels show greater cost discrimination than the lower levels across all systems. In all severity-adjusted systems, the mean cost difference between SOI Level 1 and SOI Level 0 is less than $2,000. Overall, the CMS+AP-DRG severity levels show less cost discrimination than the levels in the other systems. The mean cost difference across all severity levels in the CMS-DRG system is $2,117, and the average ratio of the higher severity level to the adjacent lower severity level is 1.3. The other systems all have a mean cost ratio around 1.4. The effect of the HSC-DRGs assigning more discharges to the higher severity levels is a reduction in the amount of cost discrimination between levels relative to the Sol-DRGs. The HSC-DRG system has a $2,150 mean cost difference, while the Sol-DRG system has a mean cost difference of $2,311. The Con-APR DRG system also has a $2,311 mean cost difference. The MM-APS-DRG system, with three severity levels, has the highest mean cost difference ($2,385).

3.5. STABILITY OF THE SEVERITY-ADJUSTED DRG RELATIVE WEIGHTS

The DRG system used in the Medicare PPS should result in DRG relative weights that have year-to-year stability. The severity-adjusted DRGs reduce the amount of within-DRG cost variation; however, they also create additional low-volume DRGs that could reduce the stability of the relative weights from one year to the next. To examine this issue, we compared the relative weights constructed from the FY04 data with the relative weights constructed from the FY05 data. Both sets were constructed from costs that were standardized using the same hospital payment factors and were normalized so that the discharge-weighted average relative weight in each year equals 1.0. We would expect some differences in the relative weights assigned to a given DRG due to changes in patient mix and service mix both within and across DRGs.

Figure 3.5 shows the proportion of DRGs in each system by the magnitude of percentage changes in their relative weights. The HSC-DRGs and Sol-DRGs had a higher proportion of DRGs with more than a ten percent change than the other systems. Less than ten percent of the DRGs in the other systems had changes greater than ten percent. No system assigned more than a small percentage of discharges to DRGs with a greater than five percent change in relative weights (Figure 3.6).

Figure 3.5

Proportion of DRGs, by Magnitude of Change in DRG Relative Weights

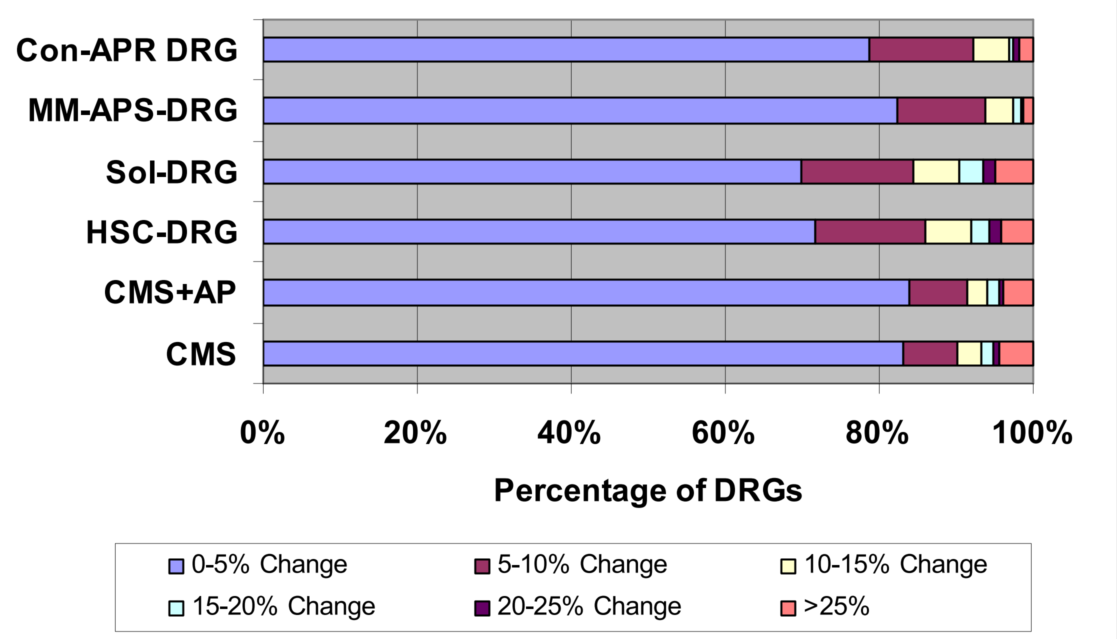
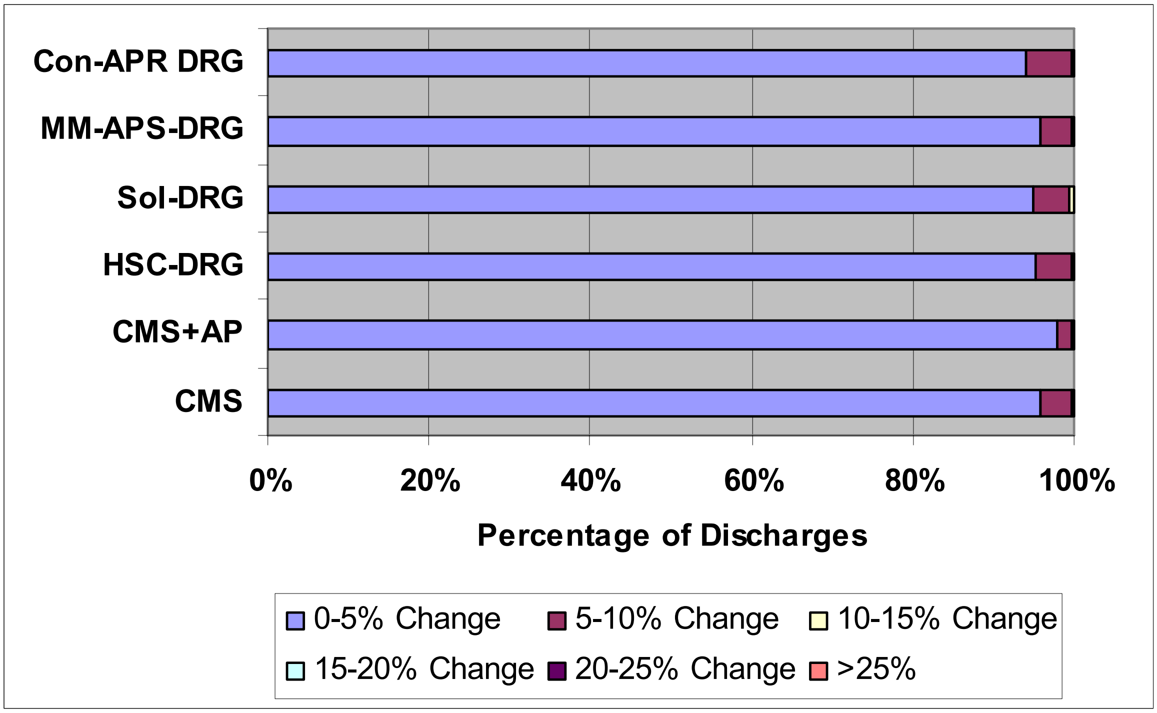


Figure 3.6
Proportion of Discharges Assigned to DRGs, by Magnitude of Change in DRG Relative Weights



3.6. SUMMARY OF FINDINGS AND DISCUSSION

3.6.1. Summary of Findings

Key findings from the evaluation of the performance of the DRG systems included the following:

- Within-DRG variation. All five severity-adjusted systems reduce the amount of variation within DRGs. The HSC and Sol-DRGs have a slightly higher proportion of discharges assigned to DRGs with a CV < 76 percent but also have a higher proportion of discharges assigned to DRGs with a CV > 100 percent. Among severity-adjusted systems, the Con-APR-DRGs had a slightly lower percentage of discharges assigned to DRGs with a CV < 76 percent. The MM-APS DRGs, Con-APR-DRGs, and CMS+AP-DRGs all have fewer than 2 percent of discharges assigned to DRGs with a CV > 100 percent.

- Explanatory power. The regression results show that all five severity-adjusted systems predict cost better than the CMS-DRGs does. Across all discharges, the adjusted R-squared value for the Con-APR-DRGs is 0.4458, a 13 percent improvement over the adjusted R-squared value for the CMS-DRGs. The CMS+AP-DRGs show the smallest improvement (about 8 percent). In nearly every MDC, the Con-APR-DRGs have higher adjusted R-squared values than the other severity-adjusted systems. The highest severity level contributes most of the Con-APR DRG explanatory power relative to the other systems.
- *Validity.* Across the DRG systems, monotonicity is not an issue; the percentage of discharges assigned to non-monotonic DRGs is very small. The CMS+AP-DRGs have the lowest average cost discrimination between severity levels. The other systems have similar percentage cost differences between severity levels, with the MM-APS-DRG system having the highest mean cost difference.
- *Stability*. The HSC-DRGs and Sol-DRGs had a higher proportion of DRGs with a greater than ten percent change in relative weights than did the other systems. Less than ten percent of the DRGs in the other systems had changes greater than ten percent. No system assigned more than a small percentage of discharges to DRGs with a greater than five percent change in relative weights.

3.6.2. Discussion

Assessing the relative performance of the severity-adjusted systems is difficult because of the differences in the number of DRGs and the way in which the severity levels are assigned. The regression results provide an overall measure of the performance of the systems in explaining variation in standardized costs per case. While this is the best comparative summary measure, other considerations that may affect comparative performance should be kept in mind:

The HSC-DRGs and Sol-DRGs are based on version 23 of the CMS-DRGs. We do not know the additional amount of variation these systems might have explained if the groupers had been updated for the additional severity-adjusted DRGs that CMS adopted in version 24. The impact would vary by system because of the different ways the two systems have adapted to the severity-adjusted CMS-DRGs.

The MM-APS-DRG system includes an adjustment to the relative weights for co-existing clinical conditions (CCCs) that are independent of the principal and secondary diagnosis that were used to classifiy the discharge). The CCC adjustment is separately estimated for independent CCs and MCCs based on the marginal percentage impact that each additional CCC has on the cost of surgical and medical discharges. According to Ingenix, the system’s vendor, the adjustment provides an empirically based and transparent method for addressing multiple CCs. Ingenix also provided analyses suggesting that the MM-APS-DRG system represents an 11.5 percent improvement over the CMS-DRGs without the CCC adjustment and a 21 percent improvement with the CCC adjustment. We have not accounted for this adjustment at this stage of the study for two reasons. First, our focus in this interim report is on the issues related to how well the grouper logic per se explains variation in costs. Second, the adjustment is not intrinsic to the MM-APS-DRG system. A similar adjustment using a CC exclusions list could be implemented for the other severity-adjusted systems that determine the severity-level assignment based on the highest level of any CC. We will consider the impact of the adjustment as part of our evaluation of relative weight methdologies.

The Con-APR-DRG system assigns SOI Level 0 to certain complications of care (category 996) and imprecise diagnosis codes. The MM-APS-DRG system also downgrades the severity level for some codes that may indicate substandard care and non-specific NOS codes. We have not investigated the extent to which this reduces the explanatory power of these systems relative to the other systems. In adopting a severity-adjusted DRG system, we assume that CMS would decide whether to apply this policy independent of the selection of a grouper, since any of the systems could be readily modified to reflect such a policy choice.

The Con-APR-DRG system has other precise coding requirements that affect its explanatory power. Because they are so expensive, tracheostomy discharges are of particular interest. Under the Con-APR-DRGs, the code for mechanical ventilation greater than 96 hours is required before a discharge can be assigned to the pre-MDC DRGs for tracheostomies. The CMS-based DRGs do not have this requirement. 3M/HIS provided an analyses suggesting that if complications and tracheostomies were treated in a comparable manner to the CMS-DRGs, the Con-APR-DRGs would represent an 18% improvement over the CMS-DRGs compared to their estimate (using a different regression specification than our analyses) of an 8% improvement under the precise coding requirements.

The HSC-DRGs and Sol-DRGs have a uniform DRG structure that produces the most DRGs. This affects the relative performance of those systems on some validity measures, since the larger number of categories leads to lower cost differences between severity levels. In contrast, the MM-APS DRGs and Con-APR-DRGs have consolidated severity levels and perform better on the validity measures. The HSC-DRG and Sol-DRG uniform severity-level structure also creates more low-volume DRGs, which affects the year-to-year stability of those systems. However, the proportion of Medicare discharges assigned to the low-volume DRGs is quite low (less than 0.7 percent in the case of HSC DRGs).

4. DIFFERENCES IN DRG GROUPING LOGIC

In this chapter, we analyze the impact of differences in the grouping logic used by the DRG classification systems by applying each system's logic to one of the major diagnostic categories, MDC 5 (Diseases and Disorders of the Circulatory System). We selected MDC 5 for several reasons:

- It is the highest-volume MDC, containing over 3.3 million Medicare discharges, or 27 percent of the FY05 Medicare discharges.
- MDC 5 makes the most frequent use of new technology. The major differences in how the classification systems account for new technology are shown by comparing how discharges assigned to particular CMS-DRGs are distributed across the DRGs used by the other systems.
- MDC 5 DRGs range from relatively low resource-intensiveness to high resource-intensiveness.
- Recent changes in CMS-DRG logic introduced severity-level adjustments to MDC 5 that illustrate how CMS has been severity-adjusting certain DRGs and how the CMS-DRG-based systems have adapted to these changes.

We express one caution relating to our selection of MDC 5 for this discussion of comparative clinical logic: The illustrative analyses that follow may not be representative of patterns across other MDCs. In fact, recent significant restructuring of the CMS-DRGs in MDC 5 has implications for the severity-adjusted DRG systems that are based on the CMS-DRGs. Moreover, with this restructuring, the explanatory power of the CMS-DRGs is higher for MDC 5 than for any other MDC (see Table 3.4). As a result, MDC 5 does not demonstrate as well as other MDCs the improvement in explanatory power to be expected with alternative DRG systems.

4.1. OVERVIEW OF MDC 5 DRG GROUPING LOGIC

4.1.1. CMS-DRGs

In CMS-DRGs, discharges that are not assigned to MDC 00 (Pre-MDC), MDC 24 (Multiple Significant Trauma), or MDC 25 (HIV Infections) are assigned to MDC 5 if the principal diagnosis describes a disease or disorder of the circulatory system. There are 29 surgical and 34 medical CMS-DRGs in MDC 5. Of these, 30 are paired DRGs that split based on the presence or absence of complications and comorbidities. One base DRG further splits based on age (0-17 and > 17). (Appendix B summarizes the MDC 5 groupings for the CMS-DRGs). The MDC 5 DRGs have been restructured over the past five years to improve recognition of differences in severity and complexity. For example, a separate DRG was created in FY03 for percutaneous cardiovascular procedures with drug-eluting stents. In FY06, major changes were made that involved the creation of additional severity-adjusted DRGs:

- The DRG for cardiac defibrillator implant with cardiac catheterization was split based on the presence or absence of an acute myocardial infarction (AMI), heart failure, or shock.
- The DRGs for certain procedures (coronary bypass with and without cardiac catheterization, percutaneous cardiovascular procedures, permanent cardiac pacemaker implants, and other vascular procedures) were split based on the presence of a major cardiovascular (MCV) diagnosis (primary or secondary).

The assignment of severity levels to diagnoses beyond the CC designation is a departure from typical CMS-DRG grouping logic and is a model for additional severity-adjusted CMS-DRGs that were adopted in FY07 in other MDCs.

4.1.2. CMS+AP-DRGs

The CMS+AP DRGs add MCC categories for groups of CMS-DRGs, using a consistent severity-level classification for each secondary diagnosis across MDCs. The MDC 5 MCC DRGs are shown in Table 4.1.

Table 4.1
MDC 5 Major CC DRGs in the CMS+AP-DRG System

AP-DRG	Description
700	Cardiac defibrillator procedures with MCC
743	Circulatory disorders except AMI with cardiac cath with MCC
744	Circulatory disorders except AMI without cardiac cath with MCC
745	Cardiac valve procedure with MCC
746	Coronary bypass with MCC
747	Other cardiothoracic procedures with MCC
748	Other cardiac pacemaker implant/revision or AICD procedure with MCC
749	Major cardiovascular procedures with MCC
750	Other vascular procedures with MCC

4.1.3. HSC-DRGs and Sol-DRGs

Most of the HSC-DRGs and Sol-DRGs follow the standard Yale-DRG grouping logic. The systems use the CMS-DRGs to establish base DRGs and create three severity levels for medical DRGs and four severity levels for surgical DRGs. In addition, there is a DRG for medical early deaths (i.e., patients who had no significant O.R. procedure and died within two or fewer days of admission). Because the severity levels that are assigned to secondary diagnoses are not identical, the severity-level of discharges within a base DRG varies between the two systems. Moreover, the two systems have taken different approaches to the severity-adjusted DRGs that CMS adopted in FY06. The HSC-DRG logic creates separate base DRGs for those CMS-DRGs that split based on the presence of a MCV, while the Sol-DRG logic collapses them into a single base DRG (see Table 4.10 for an example). As a result, there are 43 base DRGs and 157 severity-adjusted DRGs in the HSC-DRG system, and 38 base DRGs and 137 severity-adjusted DRGs in the Sol-DRG system.

4.1.4. MM-APS DRGs

The general grouping logic of the MM-APS-DRGs collapses any paired CMS-DRGs into base DRGs and establishes three severity levels (no CC, with CC, and MCC). There is MCC exclusion logic, as well as MDC and DRG-specific logic. In the MM-APS DRGs, low-volume base DRGs are consolidated to form a single base DRG, and low-volume severity levels for a given base DRG are collapsed. Except for three base DRGs where severity levels are not used--305 (Other Heart Assist System Implant), 306 (Cardiac Defibrillator with Catheterization with AMI/Heart

Failure/Shock), and 307 (Cardiac Defibrillator with Catheterization without AMI/Heart Failure/Shock)--there are no consolidated base DRGs or collapsed severity levels in MDC 5. In total, the MM-APS-DRGs have 44 base DRGs and 126 severity-adjusted DRGs.

4.1.5. Con-APR-DRGs

Unlike the other systems, the Con-APR-DRGs are not based on the CMS-DRGs. While the CMS-DRGs and Con-APR-DRGs use the same hierarchy for assigning discharges to MDC 5, more discharges are initially assigned to MDC 5 under Con-APR-DRGs than under the CMS-DRGs (and other systems). This occurs because the grouping logic for the pre-MDC Con-APR-DRGs is more narrowly defined. In FY05, 10,719 patients (0.16 percent of all MDC 5 cases) assigned to one of four pre-MDCs in the systems using CMS-DRG logic were assigned to MDC 5 by the Con-APR DRG grouper:

- DRG 103 (Heart Transplant or Implant of Assist Device), 495 discharges. Patients receiving a heart-assist implant are not assigned to the Con-APR-DRG for heart/lung transplants; those with a heart-assist implant and a circulatory-system principal diagnosis are assigned to MDC 5 DRGs.
- DRGs 541 and 542 (ECMO or Tracheostomy with at Least 96 Hours of Mechanical Ventilation or Non-Face/Mouth/Neck Diagnoses with and without Major Operative Procedure), 10,221 patients. Under the Con-APR DRG grouping logic, the pre-MDCs for tracheostomy require at least 96 hours of mechanical ventilation. Discharges with a circulatory system principal diagnosis that have a tracheostomy but do not report having mechanical ventilation for at least 96 hours are assigned to MDC 5. Almost all of these patients (9,163 patients, or 85.5 percent) fall in the extreme SOI groups: Con-APR DRGs 204 (Cardiothoracic Procedures SOI 4), 205 (Vascular Procedures SOI 4), 206 (Other Circulatory System Procedures SOI 4), or 252 (Circulatory System Diagnoses SOI 4).

The APR-DRG grouping logic for MDC 5 is provided in Appendix B. Each base APR-DRG is divided into four SOI levels. The Con-APR-DRG logic assigns severity levels to secondary diagnoses to make an initial SOI assignment. However, the SOI is adjusted later in the assignment process on the basis of several factors, including the presence of other secondary diagnoses, age, and surgical procedures that might be indicative of a lower level of illness. For example, discharges assigned to Con-APR DRGs 210-215 (Cardiac Valve Procedure with and without Cardiac Catheterization) receiving an open heart valvuloplasty are less complex than discharges receiving cardiac valve replacement. Valvuloplasty discharges that are initially assigned to the moderate SOI level are reassigned to the next lower level.

As is the case with the MM-APS-DRGs, Medicare low-volume base DRGs and/or severity levels are consolidated in the Con-APR-DRGs. The severity-level consolidation may occur within a base DRG or across base DRGs. For example, Con-APR-DRG 204 (Cardiothoracic Procedures SOI 4) represents a consolidation of the APR-DRGs shown in Table 4.2.

Table 4.2
APR-DRGs Consolidated to Create Con-APR-DRG 204 (Cardiothoracic Procedures SOI 4)

APR-DRG	Description
160	Major Cardiothoracic Repair of Heart Anomaly SOI 4
161	Cardiac Defibrillator and Heart Assist Implant SOI 4
162	Cardiac Valve Procedures with Cardiac Catheterization SOI 4
163	Cardiac Valve Procedures without Cardiac Catheterization Soi 4
165	Coronary Bypass with Cardiac Cath or Percutaneous Cardiac Procedure SOI 4
166	Coronary Bypass without Cardiac Cath or Percutaneous Cardiac Procedure SOI 4
167	Other Cardiothoracic Procedures SOI 4

In total, the Con-APR-DRGs have 31 base DRGs and 94 severity-adjusted DRGs for MDC 5. Unique characteristics of the Con-APR-DRG grouping logic are illustrated below.

4.2. REROUTING

4.2.1. Rerouting Across MDCs

Discharges are assigned to MDC 5 DRGs, using a hierarchy for surgical procedures, the principal diagnosis (with respect to the medical DRGs and the new severity-adjusted surgical DRGs), and the highest severity level of any CCs (that are not on the CC exclusion list). Each DRG classification system assigns a surgical discharge to a non-MDC 5-specific DRG when the only surgical procedures performed are unrelated to the principal diagnosis. The systems based on the CMS-DRGs use the CMS grouping logic to determine whether a surgical discharge should be assigned to a DRG for unrelated procedures (see Table 4.3).

Table 4.3
Non-MDC Base CMS-DRGs for Unrelated Procedures

CMS-DRG	Description
468	Extensive O.R. Procedure Unrelated To Principal Diagnosis
476	Prostatic O.R. Procedure Unrelated To Principal Diagnosis
477	Non-Extensive O.R. Procedure Unrelated To Principal Diagnosis

The Con-APR DRG logic uses a narrower definition of whether a procedure is related to the principal diagnosis. This results in more discharges being assigned to the DRGs for surgical discharges with no surgical procedure related to the principal diagnosis. In FY05, an additional 6,239 discharges were assigned to the Con-APR-DRGs for discharges with surgical procedures that are unrelated to principal diagnosis.

The Con-APR DRG system also reroutes patients to DRGs in other MDCs on the basis of supplemental information when an ambiguous principal diagnosis is unclear regarding the appropriate MDC or could lead to similar patients being assigned to DRGs with different relative weights. As Table 4.4 shows, just over 194,000 MDC 5 patients (approximately 3 percent) in the CMS-DRG system are rerouted to other MDCs in the Con-APR-system. More than half of the cases rerouted from MDC 5 are assigned to MDC 11 (Diseases and Disorders of the Kidney and Urinary Tract).

- Diagnosis codes 99662 (Reaction-Other Vascular Device/Graft) and 99674 (Complication of Other Vascular Device) include both peripheral vascular devices and renal dialysis shunts. The grouping logic looks to see whether there is a secondary diagnosis of renal failure (without heart failure) and whether there is a renal shunt procedure to clarify whether the patient should be reassigned to MDC 11.
- Most cases rerouted to MDC 11 (more than 85 percent) are discharges that required dialysis shunt placement or revision. The CMS-DRG logic (which is used by the other severity-adjusted systems) assigns these diagnosis codes to MDC 5; if a dialysis shunt replacement or revision is the only surgical procedure, the

logic assigns the discharge to CMS-DRG 120 (Other Circulatory System O.R. Procedures) or 554 (Other Vascular Procedures with CC without MCV Dx).

- The remaining discharges rerouted from MDC 5 to MDC 11 were medical discharges with a secondary diagnosis of renal failure (and not heart failure), These discharges were assigned to on-APR-DRGs 598-600 (Malfunction, Reaction, Complication of Genitourinary Device or Procedure SOI 1-3). Under the CMS-DRGs, these medical discharges were assigned to DRG 144 (Other Circulatory System Diagnoses with CC).

Table 4.4
Cases Rerouted from MDC 5 in Con-APR DRGs (in FY05)

Con-APR-DRG MDC	Number of Discharges Routed to Another MDC	Percent of CMS-DRG MDC 5 Discharges
1	218	<0.01%
7	2	<0.01%
8	72,989	1.09%
11	120,514	1.79%
24	3	0.00%
25	678	0.01%
Total	194,404	2.97%

Nearly 73,000 discharges were rerouted from MDC 5 to MDC 8 (Diseases and Disorders of the Musculoskeletal System). Virtually all of these cases (99 percent) are amputations assigned under the CMS-DRGs to DRG 113 (Amputation for Circulatory System Disorders Except Upper Limb and Toe) and DRG 114 (Upper Limb and Toe Amputation for Circulatory System Disorders). Here, the APR-DRG grouping logic consolidates patients in different MDCs who received amputations into a single DRG because there is ambiguity about sequencing the principal and secondary diagnoses for these patients that should not affect payment.

4.2.2. Rerouting Within MDCs

The Con-APR DRG system also reroutes some patients to another DRG within the same MDC when a secondary diagnosis provides more clarity for grouping them appropriately. For example, rerouting may occur if the O.R. procedure is unclear, the principal diagnosis is imprecise, or there is ambiguity about the sequencing of the principal and secondary diagnosis codes. One clear example within MDC 5 is the medical patient who presents with chest pain but is found to have angina pectoris. As shown in Table 4.5, 207,051 (42 percent) of patients classified as CMS-DRG 143 (Chest Pain) under the CMS-DRG system are rerouted to an angina pectoris DRG (274, 275, or 276) under the Con-APR DRG system. This occurs when an angina pectoris diagnosis (ICD-9-CM 411.1 to 411.89 or 413.0 to 413.9) is a secondary diagnosis and the principal diagnosis is chest pain (ICD-9-CM 786.50, 786.51, 786.59 or V717). (SOI 4 for chest pain and for angina both group to Con-APR DRG 252 (Circulatory System Diagnoses SOI 4).[9]

Table 4.5
Con-APR DRG Rerouting of Medical Patients Who Presented with Chest Pain but Were Found to Have Angina Pectoris (FY05)

Con-APR DRG		CMS DRG 143 Chest Pain
274	Angina Pectoris and Coronary Atherosclerosis SOI 1	78,256
275	Angina Pectoris and Coronary Atherosclerosis SOI 2	107,557
276	Angina Pectoris and Coronary Atherosclerosis SOI 3	21,238
	Total Cases:	207,051

4.3. USE OF DEATH IN DRG DEFINITIONS

4.3.1. Early Death

Two groupers, Sol-DRG and HSC-DRG, create a DRG 8XX0 (e.g., 8050 for MDC 5) for all medical deaths within two days of admission. The rationale for this approach is that medical cases tend to have their resource use allocated more evenly across each day of the inpatient stay than do surgical cases, where the costs related to the operation are generally front-loaded. Thus, medical discharges that die within two days tend to be more similar to each other than to the other discharges in the DRGs to which they would otherwise be assigned. Creating a separate DRG for early deaths potentially improves payment accuracy by paying less for the early deaths and more for the remaining discharges in the medical DRGs. Table 4.6 confirms that early medical deaths in MDC 5 have an average cost about 40 percent lower ($2,848) than that of the average MDC 5 medical case ($4,897). In other words, not splitting out early medical deaths is equivalent to overpaying for these cases by about 40 percent on average and underpaying other discharges. However, the small number of early medical deaths (1.5 percent of all medical discharges) translates into a small effect on the average cost. If one excludes early medical death discharges from total MDC 5 medical discharges, the average cost is only 1 percent less than it would have been with these discharges included.

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[9] Under the CMS-DRGs, the relative weight for chest pain is higher than for angina so hospitals have incentive to report chest pain code as the principal diagnosis when both diagnoses are present.

Beyond the issue of whether early medical deaths are homogeneous with respect to resource use and severity, there is a reason to be cautious about aggregating early medical deaths into a distinct category. Policymakers want to be careful about implementing any grouping decisions that create an impression that there is an incentive to either hasten or inappropriately postpone patient deaths or to discharge them inappropriately to avoid in-hospital deaths. Further, no good policy rationale exists for treating early-death discharges differently from other very short-stay discharges. Time constraints did not permit us to explore whether the lower average cost associated with early medical deaths is due to the death itself or to the shorter length of stay.

Table 4.6
Total MDC 5 Cases and Different Categories of Deaths Within MDC 5 (in FY05)

	Cases	Weighted average standardized cost per case	Percent of total medical cases
Total medical cases	2,226,373	$4,897	100.0%
Early medical deaths	31,975	$2,848	1.5%
Other medical cases	2,194,398	$4,927	98.5%
Ratio of average cost per case for all medical cases to average cost per case for all medical cases other than early death	0.99		

4.3.2. Any Death

The AMI DRGs are among the few DRGs in which the CMS-DRGs use death in the definition. AMI discharges who have died (both early deaths and others) are classified as belonging in DRG 123 (Table 4.7). Among the severity-adjusted DRG systems, only the CMS+AP DRGs and the MM-APS DRGs use the AMI death category as a base DRG. The CMS+AP DRG system follows the CMS-DRG grouping logic in its entirety for the AMI medical discharges and does not assign any AMI medical patients to the MCC DRGs. The MM-APS-DRG logic creates two base DRGs based on whether the discharge died and establishes t CMS-DRG 122 (Circulatory Disorders with AMI without Major Complications, Discharged Alive).

Table 4.7
Comparison of AMI Medical DRGs (in FY05)

		Discharges	% Transfer	Mean Stdized Cost Per Case	Std. Dev.	Mean LOS
CMS and CMS+AP DRGs						
121	Circulatory Disorders w AMI & Major Comp, Discharged Alive	149,966	13.63%	$8,199	$6,985	6.13
122	Circulatory Disorders w AMI w/o Major Comp, Discharged Alive	54,651	26.01%	$4,874	$3,504	3.28
123	Circulatory Disorders w AMI, Expired	29,554	0.00%	$7,445	$8,746	4.64
HSC DRGs						
1210	Circulatory disorders w AMI, Class 0	26,625	26.57%	$4,237	$3,107	2.63
1211	Circulatory disorders w AMI, Class 1	100,700	16.92%	$5,948	$4,690	4.44
1212	Circulatory disorders w AMI, Class 2	77,292	10.01%	$10,017	$8,057	7.53
Sol-DRGs						
1210	Circulatory disorders w AMI, Class 0	27,390	26.27%	$4,258	$3,112	2.65
1211	Circulatory disorders w AMI, Class 1	154,352	14.86%	$6,945	$5,693	5.26
1212	Circulatory disorders w AMI, Class 2	38,270	7.67%	$12,591	$9,967	8.72
MM-APS-DRGs						
248	Circ Disor w AMI Disch Alive w/o CC	41,245	21.79%	$4,517	$3,360	2.94
249	Circ Disor w AMI Disch Alive w CC	100,674	14.95%	$6,314	$4,991	4.77
250	Circ Disor w AMI Disch Alive w MCC	62,698	9.33%	$10,598	$8,397	7.93
251	Circ Disor w AMI, Expired w/o CC	1,129	0.00%	$3,140	$2,702	2.14
252	Circ Disor w AMI, Expired w CC	9,126	0.00%	$4,674	$5,129	3.15
253	Circ Disor w AMI, Expired w MCC	19,299	0.00%	$9,008	$9,855	5.50
Con-APR-DRGs						
252	Circulatory System Diagnoses Soi 4(AMI only)	45,609	4.54%	$11,717	$10,008	8.07
253	Acute Myocardial Infarction Soi 1	27,254	24.02%	$4,085	$3,163	2.78
254	Acute Myocardial Infarction Soi 2	78,650	16.59%	$5,474	$4,261	3.92
255	Acute Myocardial Infarction Soi 3	68,480	8.42%	$7,738	$6,206	5.96

4.4. COMPLICATIONS OF CARE

An ongoing policy question concerns the extent to which Medicare should pay for avoidable complications of care. Section 5001(c) of the Deficit Reduction Act of 2005 (DRA-Pub. L. 109-171) requires an adjustment in DRG payments for certain hospital-acquired conditions. Specifically, Section 5001(c) requires that CMS select diagnosis codes associated with at least two conditions that result in assignment of a higher-weighted DRG and that reasonably could be prevented through the application of evidence-based guidelines. Effective in FY09, discharges cannot be assigned to higher-weighted DRGs when those preventable conditions were not present upon the patient’s admission to the hospital. Section 5001(c) also mandates that hospitals identify on UB04 claim forms whether secondary diagnoses were or were not present at admission. This new reporting requirement should improve the ability of CMS to distinguish between complications of care and comorbidities present on admission. Any of the DRG systems evaluated in this study should be capable of being modified to reflect CMS policy on these conditions and other complications of care.

One set of codes related to complications of care are IDC-9-CM codes in the 996-999 range. Table 4.8 shows those codes occurring most frequently in MDC 5 discharges and compares the related pattern of severity-level assignment across DRG systems. The CMS-DRG logic considers all but one of these codes a CC, and as a result, the DRG systems that follow the CMS-DRG CC assignment logic also treat the codes as CCs. However, there are differences in the severity levels that the systems assign to them. The CMS+AP-DRGs, which use a standard set of MCC definitions, assign several complications-of-care codes to the MCC category. For example, two pacemaker complication codes are contingent on whether a temporary pacemaker was inserted. The HSC-DRG and Sol-DRG systems establish severity levels by groups of base DRGs. The Sol-DRG system uses 76 categories of ADRGs. For our analysis, we used the categories that most frequently apply to the MDC 5 medical and surgical DRGs. The HSC-DRGs adjust the severity levels for each base DRG. We used high-volume DRGs 110 and 127 for the comparison. The MM-APS DRG system uses a different CC exclusions list than the CMS-DRGs do and treats three complications that reflect poor medical care (9975, 99883, and 99889) as non-CCs. For some complications (e.g., post-operative shock), the MM-APS-DRG severity level assignment is higher if the patient is discharged alive than if the patient dies. The Con-APR-DRG system assigns the codes initially to the lowest severity level and elevates them on the basis of combinations of diagnoses and procedures.

Table 4.8 The Most Common Complications-of-Care Secondary Diagnoses Reported for MDC 5 Discharges (in FY05)

ICD-9-CM Code	Description	Number of Disch	% of Disch	CMS+AP-DRG	Sol-DRG		HSC-DRGs		MM-APS DRG	Con-APR-DRG1
					Med	Sur	Med	Sur		
9961	Malfunc Vasc Device/Graf	4,118	0.123%	CC	1	2	2	2	CC	0
9971	Surg Compl-Heart	34,908	1.047%	CC	1	2	2	2	CC	0
9972	Surg Comp-Peri Vasc Syst	6,623	0.199%	CC	1	2	3	2	CC	0
9973	Surg Complic-Respir Syst	11,355	0.340%	CC	1	2	2	2	CC	0
9974	Surg Comp-Digestv System	4,553	0.137%	CC	1	1	2	2	CC	0
9975	Surg Compl-Urinary Tract	8,567	0.257%	CC	1	1	3	2	Non-CC	0
9980	Postoperative Shock	1,317	0.039%	MCC	1	2	3	2	MCC only if discharged alive	0
9982	Accidental Op Laceration	8,389	0.252%	CC	1	2	3	2	Non-CC	0
9992	Vasc Comp Med Care Nec	2,663	0.080%	MCC only if enteral/parental infusion involved	1	2	2	2	CC	0
9993	Infec Compl Med Care Nec	1,461	0.044%	MCC only if enteral/parental infusion involved	1	3	2	1	CC	0
9998	Transfusion Reaction Nec	1,142	0.034%	MCC only if enteral/parental infusion involved	1	2	3	2	CC	0
99601	Malfunc Cardiac Pacemake	4,996	0.150%	MCC only if Temp pacemaker inserted	1	2	2	2	CC	0
99604	Mch Cmp Autm Mplnt Dfbrl	2,169	0.065%	MCC	1	2	2	2	CC	0
99661	React-Cardiac Dev/Graft	1,160	0.035%	MCC	1 exc MCV1	2 exc MCV1	3	2	MCC	0
99662	React-Oth Vasc Dev/Graft	8,143	0.244%	MCC	1 exc MCV1	2 exc MCV1	3	2	MCC	0
99664	React-Indwell Urin Cath	1,967	0.059%	CC			3		CC	0
99672	Comp-Oth Cardiac Device	21,696	0.651%	MCC if Temp pacemaker inserted	1 exc MCV1	1 exc MCV1	2	2	CC	0
99673	Comp-Ren Dialys Dev/Grft	9,434	0.283%	MCC if Temp pacemaker inserted	1	2	3	2	CC	0
99674	Comp-Oth Vasc Dev/Graft	8,957	0.269%	MCC if Temp pacemaker inserted	1	2	3	2	CC	0
99676	Comp-Genitourin Dev/Grft	2,123	0.064%	MCC if Temp pacemaker inserted	1	2	3	3	CC	0
99702	Iatrogen Cv Infarc/Hmrhg	4,269	0.128%	CC			2	1	CC	0
99769	Amputat Stump Compl Nec	1,443	0.043%	Non-CC			0	0	CC	0
99811	Hemorrhage Complic Proc	18,025	0.540%	MCC	1	2	3	2	CC	0
99812	Hematoma Complic Proc	30,856	0.925%	MCC	1	2	3	2	CC	0
99859	Other Postop Infection	7,925	0.238%	CC	1	3	3	1	CC	0
99883	Non-Healing Surgcl Wound	1,886	0.057%	M1	1	2		2	Non-CC	0
99889	Oth Spcf Cmplc Procd Nec	3,880	0.116%	MCC only if Temp pacemaker inserted	1	2	3	2	Non-CC	0

1To facilitate comparisons across systems, the Con-APR-DRG severity levels 1-4 have been recoded to 0-3.

4.5. PERCUTANEOUS CARDIOVASCULAR PROCEDURES AND OTHER PROCEDURES WITH DEVICES

We use percutaneous cardiovascular DRGs for illustration for several reasons. First, they present an opportunity to compare how the Con-APR-DRGs and the CMS-based DRGs account for an expensive new technology. Second, they were part of the FY06 CMS-DRG MDC 5 restructuring and therefore provide an opportunity to examine how the severity-adjusted systems have adapted to the CMS severity-adjusted DRGs. Finally, these DRGs illustrate again how each classification system assigns severity levels.

For FY03, CMS took the rare step of establishing a separate DRG for a relatively new expensive technology (drug-eluting stents) before the costs of the discharges were accounted for in the MedPAR data used for DRG refinement. At the time, there was virtually no cost information available to assess whether cases using drug-eluting stents were more costly, but there were concerns that a separate DRG was needed to assure that Medicare beneficiaries had access to the promising new technology. By FY05, the predominant stent used was drug-eluting.In the FY06 MDC restructuring, five CMS-DRGs for percutaneous cardiovascular procedures were established that take into consideration whether a stent was used and the type of stent.

Table 4.9 summarizes how the DRGs for percutaneous cardiovascular procedures are defined across the classification systems evaluated here. Under the CMS+AP DRGs, approximately 11.5 percent of discharges are assigned to MCC DRG 750 instead of one of the CMS-DRGs. As noted earlier, the Sol-DRGs and HSC-DRGs differ in the way they have adapted their base DRGs to the severity-adjusted CMS-DRGs. In developing base DRGs, the Sol-DRG system collapses the CMS-DRG splits on the basis of whether a MCV diagnosis is involved but retains the split for drug-eluting stents. The HSC-DRG retains all CMS splits in these DRGs, as does the MM-APS-DRG logic. The Con-APR-DRG system differentiates discharges in SOI Level 1-3 based on the presence or absence of an AMI. No distinction is made for the use of stents. Discharges classified as SOI 4 both with and without an AMI are assigned to Con-APR DRG 206.

Table 4.10 shows how the Con-APR-DRG system groups cases involving drug-eluting and non-drug-eluting stents in relation to CMS-DRGs. Eighty-four percent of these discharges involve drug-eluting stents, which are more costly on average (the mean standardized cost is $9,991) than discharges receiving non drug-eluting stents ($8,340) in the absence of an MCV diagnosis. The discharges in CMS-DRGs 556 and 558 generally map to Con-APR-DRGs 240 and 241 for procedures without AMI (since AMI is an MCV diagnosis, none of the discharges in CMS-DRGs 556 and 558 have an AMI diagnosis). The majority receiving either non-drug-eluting or drug-eluting stents fall into the lower-level SOI. The weighted-average standardized cost of the Con-APR-DRGs to which non-drug-eluting and drug-eluting discharges group is nearly the same ($9,892 and $9,811, respectively). Thus, the two types of technologies would have similar payment rates under a PPS using the Con-APR-DRG system. The average standardized cost of the discharges with non-drug-eluting stents is about 16 percent less than that of the Con-APR-DRGs to which they would be assigned, whereas the average cost of the discharges with drug-eluting stents is about 2 percent higher than that of the Con-APR-DRGs to which they would be assigned. In two of the four Con-APR-DRG, the discharges with drug-eluting stents would be overcompensated, and in the other two, they would be undercompensated.

Table 4.9
Comparison of DRGs for Percutaneous Cardiovascular Procedures

DRG Description	Discharges	Mean Stdized Cost Per Case	Standard Deviation	CV	Mean Length of Stay
CMS-DRGs					
518 Perc Cardio Proc w/o Coronary Artery Stent or AMI	23,637	$ 7,801	$ 4,600	59.0	2.4
555 Percutaneous Cardiovascular Proc w Major Cv Dx	37,020	$ 11,172	$ 7,657	68.5	4.7
556 Percutaneous Cardiovasc Proc w Non-Drug-Eluting Stent w/o Maj Cv Dx	18,905	$ 8,340	$ 4,390	52.6	2.0
557 Percutaneous Cardiovascular Proc w Drug-Eluting Stent w Major Cv Dx	123,281	$ 13,428	$ 7,712	57.4	4.0
558 Percutaneous Cardiovascular Proc w Drug-Eluting Stent w/o Maj Cv Dx	191,822	$ 9,991	$ 5,010	50.1	1.8
CMS+AP DRGs					
518 Perc Cardio Proc w/o Coronary Artery Stent or AMI	22,505	$ 7,620	$ 4,600	59.0	2.3
555 Percutaneous Cardiovascular Proc w Major Cv Dx	28,131	$ 9,818	$ 7,657	68.5	3.8
556 Percutaneous Cardiovasc Proc w Non-Drug-Eluting Stent w/o Maj Cv Dx	17,967	$ 8,192	$ 4,390	52.6	1.9
557 Percutaneous Cardiovascular Proc w Drug-Eluting Stent w Major Cv Dx	96,881	$ 12,327	$ 7,712	57.4	3.3
558 Percutaneous Cardiovascular Proc w Drug-Eluting Stent w/o Maj Cv Dx	183,605	$ 9,872	$ 5,010	50.1	1.7
750 Other Vascular Procedures w Major CC	45,686	$ 15,927	$ 9,653	60.6	6.3
MM-APS-DRGs					
302 Perc Cv Pr w/o Cor Art Stent or AMI w/o CC	16,366	$ 7,337	$ 4,055	55.3	2.0
303 Perc Cv Pr w/o Cor Art Stent or AMI w CC	6,756	$ 8,549	$ 5,178	60.6	3.2
304 Perc Cv Pr w/o Cor Art Stent or AMI w MCC	512	$ 12,742	$ 7,637	59.9	6.5
332 Perc Cv Proc w Major Cv Dx w/o CC	16,493	$ 9,137	$ 5,293	57.9	3.1
333 Perc Cv Proc w Major Cv Dx w CC	15,722	$ 11,211	$ 7,222	64.4	4.9
334 Perc Cv Proc w Major Cv Dx w MCC	4,808	$ 18,007	$ 11,123	61.8	9.4
335 Prc Cv Pr w Ndrg Stent w/o Mj Cv Dx w/o CC	13,264	$ 7,906	$ 3,965	50.2	1.6
336 Prc Cv Pr w Ndrg Stent w/o Mj Cv Dx w CC	5,269	$ 9,086	$ 4,878	53.7	2.6
337 Prc Cv Pr w Ndrg Stent w/o Mj Cv Dx w MCC	370	$ 13,286	$ 6,548	49.3	5.8
338 Prc Cv Pr w Drug Stent w Mj Cv Dx w/o CC	63,801	$ 11,770	$ 6,015	51.1	2.8
339 Prc Cv Pr w Drug Stent w Mj Cv Dx w CC	46,517	$ 13,761	$ 7,622	55.4	4.3
340 Prc Cv Pr w Drug Stent w Mj Cv Dx w MCC	12,957	$ 20,386	$ 10,801	53.0	8.8
341 Prc Cv Pr w Drug Stent w/o Mj Cv Dx w/o CC	142,893	$ 9,660	$ 4,715	48.8	1.5
342 Prc Cv Pr w Drug Stent w/o Mj Cv Dx w CC	46,237	$ 10,736	$ 5,490	51.1	2.3
343 Prc Cv Pr w Drug Stent w/o Mj Cv Dx w MCC	2,680	$ 14,770	$ 7,285	49.3	5.6
Con-APR DRGs					
206 Other Circulatory System Procedures SOI 4	189	$ 20,529	$ 19,304	74.8	11.6
237 Percutaneous Cardiovascular Procedures w AMI SOI 1	23,583	$ 11,358	$ 5,513	48.5	2.8
238 Percutaneous Cardiovascular Procedures w AMI SOI 2	47,301	$ 12,648	$ 6,591	52.1	3.7
239 Percutaneous Cardiovascular Procedures w AMI SOI 3	19,007	$ 16,520	$ 9,281	56.2	6.4
240 Percutaneous Cardiovascular Procedures w/o AMI SOI 1	146,877	$ 9,259	$ 4,639	50.1	1.5
241 Percutaneous Cardiovascular Procedures w/o AMI SOI 2	116,728	$ 10,443	$ 5,663	54.2	2.3
242 Percutaneous Cardiovascular Procedures w/o AMI SOI 3	34,220	$ 14,147	$ 8,865	62.7	5.1
HSC-DRGs					
5180 Percutaneous cardiovascular px w/o stent or AMI,Level 0	10,323	$ 7,436	$ 4,065	54.7	1.9
5181 Percutaneous cardiovascular px w/o stent or AMI, Level 1	8,888	$ 7,369	$ 4,211	57.1	2.3
5182 Percutaneous cardiovascular px w/o stent or AMI, Level 2	3,728	$ 9,019	$ 5,479	60.8	3.6
5183 Percutaneous cardiovascular px w/o stent or AMI, Level 3	692	$ 12,230	$ 7,368	60.2	6.3
5550 Perc Cv Proc w Maj Cv Dx,Level 0	2,871	$ 8,033	$ 5,387	67.1	2.9
5551 Perc Cv Proc w Maj Cv Dx,Level 1	7,802	$ 8,651	$ 5,608	64.8	3.2
5552 Perc Cv Proc w Maj Cv Dx,Level 2	6,287	$ 10,858	$ 7,571	69.7	5.2
5553 Perc Cv Proc w Maj Cv Dx,Level 3	20,053	$ 12,700	$ 8,221	64.7	5.4
5560 Perc Cv Proc w/oMaj Cv Dx,Level 0	4,808	$ 7,569	$ 3,759	49.7	1.4
5561 Perc Cv Proc w/o Maj Cv Dx,Level 1	10,771	$ 8,174	$ 4,082	49.9	1.9
5562 Perc Cv Proc w/o Maj Cv Dx,Level 2	2,765	$ 9,490	$ 5,314	56.0	2.8
5563 Perc Cv Proc w/o Maj Cv Dx,Level 3	559	$ 12,466	$ 6,340	50.9	5.4
5570 Perc Cv Proc w Drug-Eluthing Stent w Maj Cv Dx,Level 0	7,065	$ 10,498	$ 5,646	53.8	2.0
5571 Perc Cv Proc w Drug-Eluthing Stent w Maj Cv Dx,Level 1	22,065	$ 11,146	$ 6,006	53.9	2.6
5572 Perc Cv Proc w Drug-Eluthing Stent w Maj Cv Dx,Level 2	12,892	$ 13,801	$ 7,982	57.8	4.2
5573 Perc Cv Proc w Drug-Eluthing Stent w Maj Cv Dx,Level 3	81,256	$ 14,243	$ 8,044	56.5	4.6
5580 Perc Cv Proc w Drug-Eluthing Stent w/o Maj Cv Dx,Level 0	51,979	$ 9,363	$ 4,618	49.3	1.3
5581 Perc Cv Proc w Drug-Eluthing Stent w/o Maj Cv Dx,Level 1	112,559	$ 9,866	$ 4,787	48.5	1.7
5582 Perc Cv Proc w Drug-Eluthing Stent w/o Maj Cv Dx,Level 2	23,356	$ 11,276	$ 5,841	51.8	2.6
5583 Perc Cv Proc w Drug-Eluthing Stent w/oMaj Cv Dx,Level 3	3,913	$ 14,230	$ 7,115	50.0	5.2
Sol-DRGs					
5180 Percutaneous cardiovascular px w/o stent or AMI, Class 0	10,420	$ 7,437	$ 4,075	54.8	1.9
5181 Percutaneous cardiovascular px w/o stent or AMI, Class 1	9,166	$ 7,438	$ 4,277	57.5	2.3
5182 Percutaneous cardiovascular px w/o stent or AMI, Class 2	3,829	$ 9,349	$ 5,781	61.8	3.9
5183 Percutaneous cardiovascular px w/o stent or AMI, Class 3	217	$ 13,315	$ 7,724	58.0	6.8
5550 Percutaneous cardiovascular px, Class 0	5,104	$ 7,571	$ 3,830	50.6	1.5
5551 Percutaneous cardiovascular px, Class 1	19,058	$ 8,435	$ 4,962	58.8	2.6
5552 Percutaneous cardiovascular px, Class 2	12,247	$ 10,413	$ 7,178	68.9	4.5
5553 Percutaneous cardiovascular px, Class 3	19,513	$ 12,519	$ 8,035	64.2	5.2
5570 PERC cardiovasc px w drug-eluting stent, Class 0	52,594	$ 9,376	$ 4,629	49.4	1.3
5571 PERC cardiovasc px w drug-eluting stent, Class 1	134,895	$ 10,100	$ 5,074	50.2	1.9
5572 PERC cardiovasc px w drug-eluting stent, Class 2	45,703	$ 12,217	$ 6,866	56.2	3.4
5573 PERC cardiovasc px w drug-eluting stent, Class 3	81,904	$ 14,137	$ 7,963	56.3	4.4

Table 4.10
Distribution and Mean Cost of Non-Drug-Eluting and Drug-Eluting Stents, CMS-DRGs and Con-APR DRGs (in FY05)

CMS-DRG	Con-APR DRG		Discharges	Mean Cost of Discharges with PCV procs	Con-APR-DRG mean cost for all discharges assigned to DRG
556 Percutaneous cardiovascular procedure with non-drug eluting stent without major CV DX	206	Other circulatory system procedures SOI 4	26	$18,188	$25,807
	240	Percutaneous CV procs w/o AMI SOI 1	10,342	$7,762	$9,259
	241	Percutaneous CV procs w/o AMI SOI 2	7,873	$8,795	$10,443
	242	Percutaneous CV procs w/o AMI SOI 3	664	$11,566	$14,147
		Total:	18,905		
		Weighted average		$8,340	$9,892
		Average cost ratio		0.84	
558 Percutaneous cardiovascular procedure with drug eluting stent without major CV DX	206	Other circulatory system procedures SOI 4	163	$20,903	$25,807
	240	Percutaneous CV procs w/o AMI SOI 1	116,677	$9,517	$9,259
	241	Percutaneous CV procs w/o AMI SOI 2	70,405	$10,531	$10,443
	242	Percutaneous CV procs w/o AMI SOI 3	4,563	$13,381	$14,147
		Other non-MDC DRGs	14		--
		Total:	191,822		
		Weighted average		$9,991	$9,811
		Average cost ratio		1.02	

4.6 TREATMENT OF OTHER DEVICES

We also compared the way the CMS-DRG system (and the related systems) treated two other high-volume new technologies--defibrillators and heart-assist devices--with the Con-APR-DRG system:

- With the exception of Con-APR-DRG, each system assigns defibrillators (ICD-9-CM procedure codes 37.94, 37.96, and 37.98) to separate DRGs based on CMS-DRG 515 (Cardiac Defibrillator Implant without Cardiac Catheterization) and DRGs 535 and 536 (Cardiac Defibrillator Implant with Cardiac Catheterization with and without pdx AMI, Heart Failure or Shock).
- The CMS-based systems assign implantable heart-assist devices to pre-MDC DRGs, based on CMS-DRG 103 (Heart Transplant or Implant of Heart Assist Systems) and assign replacements and repairs to MDC 5, based on CMS-DRG 525 (Other Heart Assist System Implant).
- The Con-APR DRGs combine defibrillators and heart-assist implants (ICD-9-CM procedure codes 37.62, 37.63, 37.65, and 37.66) into a single DRG in MDC 5.

To compare how well the CMS-DRG system and the alternative DRG systems explain the cost of discharges involving new technology, we regressed relative weights for all discharges involving the three technologies (drug-eluting stents, defibrillators, and heart-assist devices) on log-standardized cost. The adjusted R-squared values for discharges receiving each technology are shown in Table 4.11. It cannot be assumed that having a separate DRG for a specific device increases explanatory power. Con-APR-DRG performs best for drug-eluting stents, a group with large number of discharges with relatively low-cost technology (n = 327,954) and markedly worse for the smallest DRG with a relatively expensive device, heart-assist devices (n = 550). Sol-DRG and MM-APS-DRG perform best for defibrillators, and Sol-DRG does best for heart-assist devices.

Table 4.11
Values of R-Squared from Regressions of Relative Weights for All Cases Involving Technologies on Severity Codes, by DRG System (in FY05)

Technology	**CMS-DRG**	**CMS+AP-DRG**	**Sol-DRG**	**HSC-DRGs**	**MM-APS DRG**	**Con-APR-DRG**
Drug-eluting stents (36.07)	0.1459	0.1690	0.1646	0.1718	0.1891	0.2015
Defibrillators (37.94, 37.96, 37.98)	0.1898	0.2111	0.2201	0.2086	0.2200	0.1782
Heart assist devices (37.62 ,37.63 ,37.65 ,37.66)	0.2680	0.2680	0.3087	0.2813	0.2668	0.1384

5. CHANGES IN RELATIVE WEIGHTS AND CASE MIX

This chapter reports our findings concerning changes in relative weights for severity-adjusted DRGs and the average relative weight or case-mix index (CMI) across hospitals. The first section provides a brief explanation of our data and methods for the analyses, and the remaining sections summarize our findings.

5.1. OVERVIEW OF DATA AND METHODS

The DRG relative weight is a measure of the average costs required to treat a beneficiary assigned to a given DRG relative to those for the average Medicare discharge. We constructed sets of relative weights using the standardized costs determined from the national CCR and MedPAR revenue data. The process by which we determined the relative weights for the CMS-DRGs and the five alternative systems is generally consistent with that used by CMS to determine relative weights in the FY07 final rule. We used the same discharges that were used in the analyses reported in Chapter 3. The average relative weight in each DRG system is 1.0. More detailed information on our methodology is given in Appendix A.

The CMI is a measure of the average relative weight for a group of discharges. We used a slightly different set of hospitals and discharges to analyze the CMI changes in the DRG systems studied. To examine the estimated change in case mix for those hospitals that would be paid under the Medicare PPS, we excluded Maryland hospitals, which have a waiver and are not paid under the Medicare PPS. We added the all-inclusive rate hospitals and other hospitals that do not have departmental charging practices. We excluded these hospitals in the Chapter 3 analyses because we lacked the information to determine the costs for their discharges. With these changes, the records used in this section are representative of the hospitals that will be paid under the Medicare PPS. There are 3,890 hospitals and 12,165,763 discharges in the CMI analysis.

5.2. CHANGES IN RELATIVE WEIGHTS

In Chapter 3, we described differences in the ability of the alternative DRG systems to explain variation in costs per discharge. The improvement in explanatory power over the CMS-DRGs ranged from 13.1 percent in the Con-APR-DRGs to 7.6 percent in the CMS+AP-DRGs. In Table 5.1, we present the results of an analysis of the effect of the different increases in explanatory power on the distribution of Medicare payments. To assess the impact, we first compared the relative weight for each discharge under the alternative severity-adjusted DRG systems to the relative weight under the CMS-DRG system. We then arrayed Medicare discharges into deciles based on standardized cost per discharge and summarized the changes in relative weight by cost decile. 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 discharge[10] 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. A payment simulation would provide a more precise estimate. 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.[11] For example, in the HSC-DRG system, there is an estimated net loss of more than $550 million in Decile 1 and more than a $1.1 billion estimated net increase in payments for discharges in Decile 10.

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[10] 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.

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

The total payment redistribution from the losers to the gainers is $9.7 billion, or 8.4 percent of the total payment.

The total payment redistribution across systems differs and reflects the payment impact of the improvement in explanatory power measured in Chapter 3. The CMS+AP-DRGs showed the least improvement and also would lead to less payment redistribution than the other systems (7.1 percent). The Con-APR-DRGs, with the most improvement (13 percent), would also entail more payment redistribution than the other DRG systems ($13.8 billion, or 11.9 percent of the total payments). The Sol-DRG and MM-APS-DRGs would redistribute about $8.5 and $9.1 billion, respectively. In other words, the difference in overall explanatory power between the Sol-DRGs (0.4326) and the MM-APS-DRGs (0.4348) translates into about a $600 million payment redistribution attributable to improved payment accuracy.

Table 5.1
Changes in Relative Weights, by Cost Deciles of Discharges

		CMS-DRG			CMS+AP-DRG					
Decile	Discharges	CMI	Payment Per Discharge	Total Payments (Millions)	N losers	% Change	$ Impact (Millions)	N Gainers	% Change	$ Impact (Millions)
1	1,190,239	0.59	$ 5,641	$6,714	828,633	-11.21	-$549	362,549	13.68	$249
2	1,200,698	0.63	$ 6,072	$7,290	857,947	-11.51	-$617	343,163	16.81	$325
3	1,204,639	0.67	$ 6,441	$7,759	855,227	-11.77	-$660	349,595	18.30	$394
4	1,206,889	0.72	$ 6,871	$8,292	840,558	-12.04	-$703	366,339	19.24	$472
5	1,208,372	0.78	$ 7,453	$9,006	825,750	-12.21	-$758	382,521	20.17	$565
6	1,209,759	0.87	$ 8,312	$10,056	810,343	-11.93	-$815	399,265	21.07	$679
7	1,210,885	0.99	$ 9,496	$11,499	806,186	-11.03	-$866	404,490	22.18	$810
8	1,211,712	1.13	$ 10,882	$13,186	795,886	-10.41	-$925	415,594	22.86	$983
9	1,212,222	1.35	$ 12,938	$15,684	741,641	-10.72	-$1,048	470,339	22.64	$1,338
10	1,212,452	2.27	$ 21,756	$26,378	550,104	-11.76	-$1,277	662,156	15.55	$2,413
Payment Redistribution							-$8,218			$8,225
% of Payments							-7.1%			7.1%

	HSC-DRG						Sol-DRG					
Decile	N losers	% Change	$ Impact (Millions)	N Gainers	% Change	$ Impact (Millions)	N losers	% Change	$ Impact (Millions)	N Gainers	% Change	$ Impact (Millions)
1	822,329	-16.42	-$803	369,797	13.34	$244	738,767	-13.58	-$623	452,616	8.04	$171
2	817,112	-15.40	-$797	384,412	17.06	$362	757,894	-12.17	-$606	443,205	10.48	$242
3	804,686	-15.13	-$813	400,351	19.31	$462	759,591	-11.93	-$624	445,186	12.31	$311
4	789,729	-14.95	-$837	417,311	21.09	$568	753,690	-11.97	-$655	453,151	14.03	$395
5	775,205	-14.68	-$872	433,131	22.69	$696	745,211	-12.12	-$702	463,017	15.63	$502
6	758,051	-14.10	-$914	451,508	23.87	$853	729,538	-12.26	-$764	479,964	17.08	$652
7	742,954	-13.17	-$957	467,602	24.18	$1,023	713,598	-12.16	-$839	496,928	18.18	$835
8	712,968	-12.66	-$1,005	498,384	23.60	$1,236	688,489	-12.22	-$925	522,830	19.23	$1,079
9	644,836	-13.40	-$1,147	567,091	22.65	$1,613	636,296	-13.37	-$1,112	575,571	20.56	$1,513
10	489,245	-15.56	-$1,550	723,051	16.16	$2,652	519,662	-15.30	-$1,614	692,601	17.51	$2,771
Payment Redistribution			-$9,694			$9,709			-$8,464			$8,474
% of Payments			-8.4%			8.4%			-7.3%			7.3%

	MM-APS-DRG						Con-APR-DRGs					
Decile	N losers	% Change	$ Impact (Millions)	N Gainers	% Change	$ Impact (Millions)	N losers	% Change	$ Impact (Millions)	N Gainers	% Change	$ Impact (Millions)
1	781,620	-13.93	-$662	410,618	13.58	$268	824,179	-18.81	-$907	368,985	20.31	$388
2	801,741	-13.57	-$704	399,957	15.80	$333	801,229	-19.05	-$961	400,927	21.71	$489
3	802,725	-13.45	-$735	402,511	17.30	$397	774,654	-19.41	-$1,005	430,929	22.53	$583
4	795,854	-13.42	-$771	411,378	18.56	$473	746,332	-19.83	-$1,060	461,106	23.47	$693
5	787,309	-13.41	-$824	421,234	19.81	$567	717,822	-20.23	-$1,137	490,818	24.53	$831
6	775,285	-13.23	-$890	434,479	20.75	$690	688,466	-20.15	-$1,227	521,320	25.33	$1,005
7	758,853	-12.77	-$958	451,866	20.86	$834	658,400	-19.39	-$1,307	552,282	25.57	$1,216
8	728,537	-12.58	-$1,032	482,941	20.86	$1,038	626,685	-18.89	-$1,411	584,713	26.48	$1,514
9	673,445	-12.90	-$1,161	538,511	21.94	$1,466	590,010	-18.85	-$1,633	621,802	30.62	$2,149
10	530,441	-12.64	-$1,318	681,756	18.85	$3,006	537,096	-21.66	-$3,174	675,055	42.48	$4,978
Payment Redistribution			-$9,055			$9,073			-$13,821			$13,845
% of Payments			-7.8%			7.8%			-11.9%			11.9%

5.3. CHANGES IN THE CASE-MIX INDEX

Table 5.2 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 other severity-adjusted systems, there is a smaller increase in the average CMI for large urban hospitals, a reduction in the CMI for other urban hospitals, and a smaller reduction for rural hospitals.

The CMI for larger hospitals increases, while that for smaller hospitals decreases across the systems. This is consistent with a severity-adjusted DRG system shifting payment from less-expensive cases to more-expensive cases. Larger hospitals tend to have relatively more complex cases and severely ill patients than smaller hospitals do. Teaching hospitals also tend to treat more complex cases, but the impact on these facilities differs by severity-adjusted DRG system. Across all the severity-adjusted systems, non-teaching hospitals have a lower CMI, ranging from a 0.2 percent reduction under the HSC-DRGs and Sol-DRGs to a 0.5 percent reduction under the Con-APR-DRGs. In three of the systems (CMS+AP-DRG, HSC-DRG, and MM-APS-DRG), hospitals with large teaching programs (100 or more residents) would experience a larger increase than hospitals with smaller teaching programs. Under the Sol-DRG system, hospitals with large teaching programs would have a 0.1 percent increase, compared with a 0.2 percent increase for hospitals with smaller teaching programs. Under the Con-APR-DRG system, 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 5.2
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
ALL	3,890	12,165,763	1.00	0.0%	0.0%	0.0%	0.0%	0.0%
By Geographic Location:								
Large urban areas (pop>1 million)	1,485	5,715,356	1.02	0.5%	0.4%	0.3%	0.6%	0.6%
Other urban areas (pop<1 million)	1,186	4,578,447	1.04	-0.2%	-0.2%	-0.1%	-0.2%	0.1%
Rural hospitals	1,219	1,871,960	0.84	-1.3%	-0.9%	-1.0%	-1.4%	-2.4%
Bed Size (Urban):								
0-99 beds	685	611,139	0.91	-1.0%	-1.1%	-1.1%	-1.3%	-1.6%
100-199 beds	875	2,346,922	0.93	0.0%	0.1%	0.0%	0.1%	0.0%
200-299 beds	511	2,446,737	1.00	0.1%	0.2%	0.3%	0.3%	0.6%
300-499 beds	433	2,965,216	1.08	0.3%	0.3%	0.3%	0.4%	0.8%
500 or more beds	167	1,923,789	1.17	0.6%	0.3%	0.2%	0.4%	0.4%
Bed Size (Rural):								
0-49 beds	543	330,242	0.73	-2.5%	-2.1%	-2.2%	-2.7%	-5.0%
50-99 beds	398	595,599	0.80	-1.4%	-1.0%	-1.1%	-1.6%	-2.7%
100-149 beds	160	415,367	0.85	-1.1%	-0.7%	-0.8%	-1.2%	-2.0%
150-199 beds	69	260,910	0.91	-0.8%	-0.6%	-0.7%	-0.8%	-1.5%
200 or more beds	49	269,842	0.99	-0.6%	-0.1%	-0.1%	-0.6%	-0.5%
Urban by Region:								
New England	129	541,471	0.99	0.1%	-0.2%	-0.5%	-0.5%	-0.6%
Middle Atlantic	370	1,621,488	1.00	0.0%	-0.4%	-0.5%	-0.3%	-1.5%
South Atlantic	432	2,208,336	1.04	0.5%	0.7%	0.7%	0.7%	1.4%
East North Central	410	1,856,164	1.03	0.6%	0.7%	0.6%	0.8%	1.5%
East South Central	168	696,943	1.06	-0.2%	-0.2%	-0.2%	-0.2%	-0.3%
West North Central	164	657,322	1.08	-0.3%	-0.3%	0.0%	-0.3%	0.3%
West South Central	369	1,115,411	1.05	0.1%	0.0%	0.1%	0.3%	0.5%
Mountain	153	465,093	1.08	0.4%	0.2%	0.5%	0.4%	1.0%
Pacific	423	1,016,135	1.03	0.0%	-0.2%	-0.1%	-0.1%	0.2%
Puerto Rico	53	115,440	0.87	-1.1%	-1.4%	-0.1%	-1.2%	-5.1%
Rural by Region:								
New England	34	49,842	0.90	-0.6%	-0.6%	-0.5%	-1.1%	-0.6%
Middle Atlantic	68	139,639	0.85	-1.1%	-0.7%	-0.7%	-1.3%	-1.5%
South Atlantic	191	409,116	0.82	-0.8%	-0.4%	-0.5%	-0.9%	-1.8%
East North Central	163	290,069	0.87	-1.1%	-0.7%	-0.9%	-1.3%	-1.8%
East South Central	201	328,326	0.82	-1.5%	-0.9%	-1.1%	-1.4%	-3.2%
West North Central	184	240,449	0.87	-1.6%	-1.2%	-1.1%	-1.8%	-2.5%
West South Central	227	266,419	0.80	-2.1%	-1.8%	-1.9%	-2.0%	-4.3%
Mountain	91	80,219	0.85	-1.2%	-1.0%	-0.4%	-1.3%	-1.2%
Pacific	60	67,881	0.86	-0.9%	-1.0%	-1.1%	-1.4%	-1.6%

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

The average case-mix change is a measure of the overall impact of the severity-adjusted systems on categories of hospitals, but it does not provide information on the distribution of change experienced by hospitals within a category. Table 5.3 summarizes additional findings for selected hospital groupings. The first set of columns shows the inner-quartile range of hospital CMIs. The CMI values at the twenty-fifth and seventy-fifth percentiles for the hospital groupings are similar across DRG systems. About the same percentage of hospitals would have a reduction in their CMI under each system (61 to 63 percent. The higher percentage of hospitals that would experience a loss relative to the percentage that will experience a gain is consistent with the finding that larger hospitals would, on average, have an increase in their CMI and smaller hospitals would experience a decrease.

Under the CMS+AP-DRG, HSC-DRG, and Sol-DRG systems, fewer than 30 percent of hospitals would experience more than a 2.5 percent change in their CMI. Under the MM-APS-DRG and Con-APR-DRG system, 65 and 45 percent of hospitals, respectively, would experience less than a 2.5 percent change. Across all the CMS-based systems, the percentage of hospitals experiencing less than a five percent change is high, ranging from 92 percent in the MM-APS-DRGs to 95 percent in the CMS+AP-DRGs and Sol-DRGs. In contrast, 73 percent of hospitals would experience a change of less than five percent under the Con-APR-DRG system. Twenty-one percent of hospitals would experience a change of five percent to ten percent, and six percent of hospitals would experience a change of ten percent or more.

Table 5.3
Distribution of Hospitals by Percentage Change in CMI

	N Hospitals	N Discharges	Mean CMI	Innerquartile CMI		Number of Hospitals by % CMI Change									
				25th	75th	-10% or more	-7.5 to -10%	-5 to -7.5%	-2.5 to -5%	0 to -2.5%	0-2.5%	2.5 to 5%	5 to 7.5%	7.5 to 10%	10% or more
			CMS-DRGS												
All	3,824	12,136,115	1.00	0.87	1.11										
By Geographic Location:															
Large urban areas (pop>1 million)	1,441	5,690,094	1.02	0.89	1.12										
Other urban areas (pop<1 million)	1,174	4,574,254	1.04	0.94	1.13										
Rural hospitals	1,209	1,871,767	0.84	0.75	0.89										
Urban teaching and DSH:															
Both teaching and DSH	825	4,679,340	1.08	1.00	1.18										
Teaching and no DSH	203	1,106,543	1.05	0.94	1.15										
No teaching and DSH	1,058	3,012,635	0.95	0.86	1.04										
No teaching and no DSH	570	1,465,830	1.00	0.88	1.08										
			CMS+AP-DRGs												
All	3,824	12,136,115	1.00	0.88	1.11	11	16	124	607	1614	1173	229	21	14	15
By Geographic Location:															
Large urban areas (pop>1 million)	1,441	5,690,094	1.02	0.90	1.13	2	2	16	94	528	618	159	17	1	4
Other urban areas (pop<1 million)	1,174	4,574,254	1.04	0.94	1.13	3	3	18	154	557	376	51	3	4	5
Rural hospitals	1,209	1,871,767	0.83	0.74	0.89	6	11	90	359	529	179	19	1	9	6
Urban teaching and DSH:															
Both teaching and DSH	814	4,679,340	1.09	1.00	1.19	1	1	3	22	300	384	96	7	0	0
Teaching and no DSH	200	1,106,543	1.06	0.94	1.14	1	0	5	5	89	81	17	2	0	0
No teaching and DSH	1,046	3,012,635	0.95	0.86	1.04	1	3	12	135	444	367	70	10	1	3
No teaching and no DSH	555	1,465,830	0.99	0.89	1.08	2	1	14	86	252	162	27	1	4	6
			HSC-DRGs												
All	3,824	12,136,115	1.00	0.88	1.11	28	31	163	615	1481	1241	230	17	4	14
By Geographic Location:															
Large urban areas (pop>1 million)	1,441	5,690,094	1.02	0.90	1.13	13	8	40	129	512	590	135	10	0	4
Other urban areas (pop<1 million)	1,174	4,574,254	1.04	0.94	1.13	9	10	40	163	505	401	40	3	1	2
Rural hospitals	1,209	1,871,767	0.83	0.75	0.90	6	13	83	323	464	250	55	4	3	8
Urban teaching and DSH:															
Both teaching and DSH	825	4,679,340	1.09	1.00	1.18	4	2	8	43	332	363	60	2	0	0
Teaching and no DSH	203	1,106,543	1.05	0.94	1.14	0	1	4	12	83	85	14	1	0	0
No teaching and DSH	1,058	3,012,635	0.95	0.86	1.04	3	7	29	133	406	384	77	6	0	1
No teaching and no DSH	570	1,465,830	1.00	0.89	1.09	15	8	39	104	196	159	24	4	1	5
			Sol- DRGs												
All	3,824	12,136,115	1.00	0.87	1.11	19	29	124	598	1646	1197	177	17	6	11
By Geographic Location:															
Large urban areas (pop>1 million)	1,441	5,690,094	1.02	0.90	1.13	9	12	23	128	562	593	102	8	1	3
Other urban areas (pop<1 million)	1,174	4,574,254	1.04	0.94	1.13	7	10	32	142	538	401	36	5	1	2
Rural hospitals	1,209	1,871,767	0.83	0.74	0.89	3	7	69	328	546	203	39	4	4	6
Urban teaching and DSH:															
Both teaching and DSH	814	4,679,340	1.09	1.00	1.18	3	2	3	30	360	365	49	1	0	1
Teaching and no DSH	200	1,106,543	1.05	0.94	1.15	1	1	2	8	86	93	7	2	0	0
No teaching and DSH	1,046	3,012,635	0.95	0.86	1.04	2	5	23	140	425	387	57	6	1	0
No teaching and no DSH	555	1,465,830	1.00	0.89	1.09	10	14	27	92	229	149	25	4	1	4
			MM-APS DRGs												
All	3,824	12,136,115	1.00	0.88	1.11	31	40	177	715	1391	1098	308	35	8	21
By Geographic Location:															
Large urban areas (pop>1 million)	1,441	5,690,094	1.02	0.90	1.13	13	7	27	140	452	561	207	25	4	5
Other urban areas (pop<1 million)	1,174	4,574,254	1.04	0.94	1.13	10	8	40	190	500	346	66	6	2	6
Rural hospitals	1,209	1,871,767	0.83	0.74	0.89	8	25	110	385	439	191	35	4	2	10
Urban teaching and DSH:															
Both teaching and DSH	814	4,679,340	1.09	1.01	1.18	4	0	6	46	294	338	116	8	2	0
Teaching and no DSH	200	1,106,543	1.05	0.94	1.14	2	2	1	21	82	67	23	2	0	0
No teaching and DSH	1,046	3,012,635	0.95	0.86	1.04	4	6	27	157	359	363	110	16	2	2
No teaching and no DSH	555	1,465,830	0.99	0.89	1.09	13	7	33	106	217	139	24	5	2	9
			Con-APR-DRGs												
All	3,824	12,136,115	1.00	0.87	1.12	202	206	426	673	886	836	413	121	31	30
By Geographic Location:															
Large urban areas (pop>1 million)	1,441	5,690,094	1.02	0.90	1.13	50	42	103	203	324	380	234	81	15	9
Other urban areas (pop<1 million)	1,174	4,574,254	1.04	0.94	1.14	47	44	89	185	313	316	123	32	12	13
Rural hospitals	1,209	1,871,767	0.82	0.72	0.89	105	120	234	285	249	140	56	8	4	8
Urban teaching and DSH:															
Both teaching and DSH	814	4,679,340	1.09	1.00	1.19	11	9	40	115	223	236	129	41	9	1
Teaching and no DSH	200	1,106,543	1.06	0.94	1.14	4	2	8	28	45	61	34	14	4	0
No teaching and DSH	1,046	3,012,635	0.95	0.86	1.05	46	45	103	154	241	263	138	42	9	5
No teaching and no DSH	555	1,465,830	1.00	0.89	1.10	36	30	41	91	128	136	56	16	5	16

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 Section 5.3 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 presented in Section 5.3 is likely to be affected by coding improvement.

The experience of the Maryland hospitals provides some indication of the likely impact on case mix of introducing a severity-adjusted system. The rates that Maryland hospitals may charge are regulated by the Maryland Health Sevices Cost Containment Commission. Rate regulation includes a target overall charge per case that is case-mix adjusted. APR-DRGs were implemented for two major teaching hospitals in state fiscal year (SFY) 2001 (beginning July 2000) and for a third teaching hospital in SFY02. The remaining hospitals began reporting using APR-DRGs in SFY05, and APR-DRGs were implemented for these hospitals in SFY06. For all hospitals, the APR-DRG CMI increased 4.02 percent in SFY05, compared with a 1.3 percent increase in the CMS-DRG CMI. The teaching hospitals showed rates of increase comparable to those of the other hospitals despite having had several years to improve their depth of coding (HSCRC, 2005).

Figure 5.1
Medicare CMI Quarterly Changes, FY04 and FY05

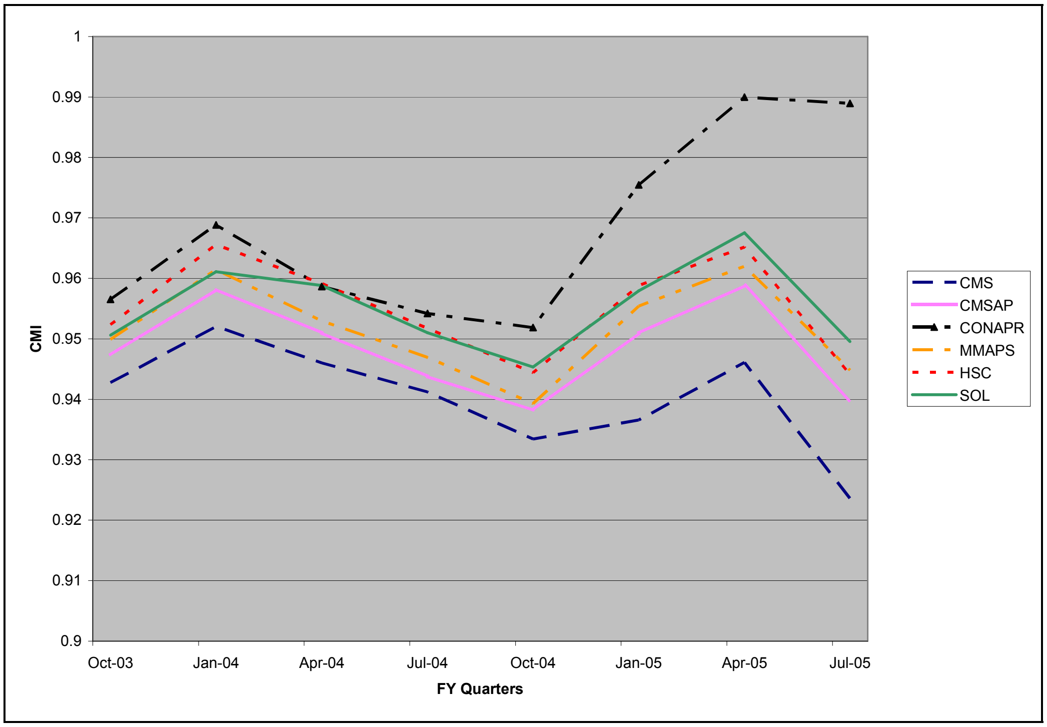

Figure 5.1 compares the CMI under the alternative DRG systems by quarter for the Medicare discharges in Maryland hospitals that began reporting using the APR-DRG system in July 2004 and came under the system in July 2005. The CMI for the Con-APR-DRG system declined less steeply than the other systems in the quarter beginning July 2004. It then began to rise more steeply than the CMI for the other DRG systems in the quarter beginning October 2004 and did not reflect the same pattern of decline as the other systems in the July-October 2005 quarter relative to the preceding quarter.

The CMI for the Maryland hospitals is based on the nine diagnosis codes and six procedure codes available from the MedPAR data and is likely to understate the full amount of CMI change that occurred with additional diagnosis and procedure codes affecting DRG assignment. In particular, there may be under-reporting of the procedure code for mechanical ventilation greater than 96 hours that affects Con-APR-DRG assignment to the higher weighted pre-MDC tracheostomy DRGs. This is a non-O.R. procedure that is likely to be sequenced after O.R. procedures and may not be fully captured in the MedPAR data.

5.5. DISCUSSION

We assume that under any of the systems, aggressive coding will be used to optimize payments. Further, the coding improvement is likely to be in response to specific aspects of the DRG logic used by the selected DRG system, so the pattern of coding improvement that occurred in Maryland under the Con-APR-DRGs is likely to be different under an alternative system. Without having the opportunity to observe actual changes in coding behavior when the DRG system is used for payment, we are not able to assess empirically the relative risk the alternative severity-adjusted systems pose for case mix increases attributable to coding improvement.

Among the severity-adjusted systems, the CMS+AP system may have the lowest potential for coding improvement, for several reasons. First, the system retains the basic logic of the CMS-DRGs and introduces only the MCC level splits. Second, the severity adjustment relies on coding a MCC, which is more likely to be coded under the current system than are less-severe CCs. However, there are other considerations that might lead to coding improvements that affect case mix increases. There are certain non-O.R. procedures that are likely to be under-reported in the CMS-DRGs that affect MCC assignment (e.g., insertion of temporary pacemaker, enteral and parental infusion, mechanical ventilation) and would be reported if the CMS+AP-DRGs were used in the Medicare PPS. Furthermore, there are ambiguous MCC diagnosis codes that may not currently be reported but would be if MCC assignment were dependent on the code. Examples are MCC diagnoses such as pneumonia, septicemia, and acute respiratory failure that have latitude in definition and the evidence required to confirm the diagnosis. The likelihood of liberal coding interpretations for these diagnoses is increased when a single CC can produce substantially higher payments.

The HSC-DRGs and the Sol-DRGs also make severity assignments on the basis of a single CC, but the logic splits all DRGs based on the presence of a CC and takes into account not only the MCCs, but also less-severe CCs that are less likely to have been coded under the current system. Therefore, more-aggressive coding is likely to occur in these two systems than in the CMS+AP DRGs.

As a patient classification system, the MM-APS-DRG system poses a risk of DRG creep similar to that present in the HSC-DRGs and Sol-DRGs. In the short-run, there is also likely to be coding improvement as the vague “not otherwise specified” (NOS) codes that are assigned by the MM-APS-DRGs to low severity levels are replaced by more-precise codes that result in assignment to a higher severity level. In addition, the MM-APS-DRG system incorporates an add-on to the relative weight for independent coexisting conditions (CCCs) that are not used in the DRG assignment and that we have not evaluated in this report but discuss in Chapter 3. If this feature were adopted, particularly without limits on the number of CCCs that would be counted in the calculation of the add-on, the incentives for aggressive coding would be higher than in the other systems.

The Con-APR DRG system has offsetting considerations to weigh in assessing the likelihood of aggressive coding producing increases in the CMI. Because the base Con-APR-DRGs are generally split into four severity levels, and the severity assignment takes into account multiple CCs, hospitals may have a greater incentive for aggressive coding under this system than under the others. However, the fact that multiple major CCs are required for assignment to the highest severity level may reduce the incidence of discharges with ambiguous diagnosis codes being assigned to these DRGs. Also, there are other unique features in the classification logic of Con-APR-DRGs that compensate for the effect of vague or imprecise coding that may eventually control increases in the CMI. Examples from MDC 5 are:

Rerouting of chest pain discharges when angina pectoris is coded as a secondary diagnosis. Under the CMS-DRGs, DRG 140 (Angina Pectoris) has a lower relative weight than DRG 143 (Chest Pain).

Assigning certain diagnosis codes that are likely to be reported as CCs in death cases to the lowest severity level initially and then raising them for particular primary diagnoses. For example, cardiac arrest is raised from minor to severe for principal diagnoses of AMI and heart failure but is otherwise assigned to the lowest severity level in MDC 5.

Other features of the Con-APR-DRG system coding may lead to a higher rate of increase in the CMI in the short run. For example, tracheostomy discharges that do not have at least 96 hours of mechanical ventilation are not assigned to the higher-weighted pre-MDC DRGs for tracheostomies. However, many of these cases probably did have at least 96 hours of mechanical ventilation, and the appropriate codes would be reported if the Con-APR-DRG logic were adopted. Similarly, as is the case for the MM-APS-DRGs, coding specificity is likely to increase for the NOS codes that are assigned by the Con-APR-DRGs to low severity levels.

One might anticipate a transition period during which hospitals respond to the new incentives by fuller coding. This would produce high rates of increase in case mix initially that should diminish as more in-depth coding becomes the norm. However, the Maryland experience with the teaching hospitals suggests that improvement may continue to occur over a longer period than might be expected. Unless specific policies are adopted to address coding improvement, changes in coding behavior will result in unwarranted increases in Medicare program expenditures. In the past, CMS has addressed case-mix increases attributable to coding improvement by making an across-the-board adjustment to PPS payments. This raises an equity issue that CMS will need to consider because the amount of coding improvement is likely to vary across hospitals, depending on how strong their current coding practices are and the resources they are able to devote to improving them.

6. OTHER ISSUES, SUMMARY OF FINDINGS, AND DISCUSSION

The analysis presented thus far in this report has focused on two questions:

- How well does each classification system explain variation in resource usage?
- How would the classification system affect a hospital's patient mix?

In this chapter, we first discuss other questions that are relevant to the choice of a severity-adjusted DRG system, namely:

Are the Severity-Adjusted DRGs Understandable?

Is the Grouper Logic based on Current Patterns of Care?

- How accessible is the system's logic and software?
- What are the operational implications of the implementing the system?
- How relevant is the system for other applications?

We then conclude with an overall summary of our discussion.

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.* Except in the Con-APR DRGs, the logic used by the classification systems relies on uniform hierarchical rules for assigning discharges to their respective MDCs, base DRGs, and severity levels. This uniformity, however, represents a trade-off with better performance. The Con-APR DRG complexities created by the rerouting logic and SOI assignment process result in higher explanatory power and address weaknesses in the coding system. In the end, it may be less important to understand the specifics of the assignment rules than to understand the general approach and whether the result is clinically coherent groups of discharges with comparable costs.

- *Standard DRG severity levels.* The HSC-DRG and Sol-DRG logic is the easiest to understand because each base DRG has an established number of levels; however, this has the disadvantage of creating a large number of low-volume DRGs. The underlying logic for the MM-APS-DRGs and Con-APR-DRGs uses standard DRG severity levels, but the modifications for Medicare have resulted in different schemes for collapsing DRGs. A potential way to preserve the simplicity of the standard DRG severity levels while gaining the advantages of the collapsing of low-volume DRGs would be to retain the underlying DRG structure and collapse DRGs only for purposes of determining the relative weights and other parameters needed for payment purposes.

Standard severity-level assignments for diagnoses. The CMS+AP DRGs and the MM-APS-DRGs assign a standard severity level to each CC (coupled with a CC exclusions list). The HSC, Sol, and Con-APR DRG systems make the severity-level assignments by categories of base DRGs or diagnoses. The DRG-specific severity level assignments make the classification system more complex.

A related question is how easy it is cross walk discharges between the current CMS-DRG system and the severity-adjusted DRG systems. Ability to easily cross-walk between the old and new systems facilitates understanding the new classification logic. However, this is largely a transition issue; e.g., one year after the MDC 5 restructuring, there is limited need to cross-walk discharges from the old MDC 5 DRGs to the new severity-adjusted CMS-DRGs. Moreover, for trending and benchmarking, older claims can be regrouped from earlier DRG assignments to new DRG assignments.

Four of the systems evaluated here (CMS+AP-DRG, HSC-DRG, Sol-DRG, and MM-APS-DRG) use the underlying CMS-DRG grouping logic to establish base DRGs. As a result, the CMS-DRGs can be cross-walked fairly easily to the severity-adjusted DRGs. Cases can easily be reassigned from the CMS-DRGs to the HSC-DRGs and Sol-DRGs because the CMS-DRG numbering system is preserved for the base DRGs. Cross-walking from the CMS-DRGs to the CMS+AP-DRGs is also easy because of the uniform MCC assignments. However, cross-walking in reverse from the CMS+AP DRGs to the CMS-DRGs is difficult because the discharges in the MCCs are from multiple base CMS-DRGs.

Reassignment to the MM-APS-DRGs is more complicated. It requires knowing the APS-DRG assignments and then cross walking them into the MM-APS-DRGs (which reflect across-DRG consolidations and renumbering the DRGs sequentially for Medicare). Retaining the APS-DRG numbering system would simplify the cross-walk considerably but would require accommodating more than 1,000 DRGs (which may raise system implementation issues).

Because the Con-APR-DRGs are based on a unique grouping logic, it is not easy to cross-walk the CMS-DRGs to them. It is feasible to trace how a particular discharge in a CMS-DRG is assigned in the Con-APR-DRGs, using the DRG Definitions Manual, but it is not possible to cross-walk groups of discharges directly between CMS-DRGs and the Con-APR-DRGs.

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. Each of the severity-adjusted systems evaluated in this study is updated annually to take into account ICD-9-CM coding changes. Moreover, the CMS-DRG annual refinement process has affected the structure of the CMS-based severity-adjusted DRGs so that with respect to the base DRGs, these systems reflect recent CMS refinements. However, the major differences between these systems emanate from the CC severity-level assignments, which have not been systematically reviewed and updated on a regular basis. Generally, except for new ICD-9-CM diagnosis codes, severity-level assignments for the HSC-DRG and Sol-DRG systems date from the 1989 Yale study and those for the MM-APS-DRG system date from the 1994 CMS refinement study. The CMs+AP-DRG system MCC assignments reflect periodic review and revision by 3M/HIS and the state of New York, but the system also relies on the CMS-DRG CC exclusions list (which has not been systematically reviewed and updated). The Con-APR-DRG severity-level assignments are periodically reviewed and are more current than the other systems, but the base APR-DRGs have not been reviewed for several years and are not as current as the CMS-based systems.

We did not assess the appropriateness of the severity-level assignments as part of this study. Regardless of the decision that CMS makes regarding the severity-adjusted DRGs, the CC exclusions list and severity-level assignments should be reviewed and revised where appropriate to reflect current patterns of care. Further, if the Con-APR-DRGs are adopted, the base APR-DRGs should be reviewed to determine whether it would be appropriate to incorporate any of the recent changes to the CMS-DRGs.

6.3. DOES THE PUBLIC HAVE ACCESS TO THE SYSTEM LOGIC AND SOFTWARE?

Under the current CMS-DRG system, the classification logic is in the public domain. The source code, logic, and documentation are available for purchase through the National Technical Information Service. As evidenced by four of the five severity-adjusted DRG systems evaluated here, vendors may create their own products, using the CMS-DRGs as the foundation. As a result, hospitals wishing to install the CMS-DRG grouper may either use in-house resources or choose among competing vendors that may offer additional services or create “user friendly” groupers.

Each severity-adjusted system evaluated in this report is maintained as a proprietary system. For informational purposes only, we obtained from each vendor a statement of intentions regarding making the grouper logic and software available to the public should CMS decide to adopt its DRG classification system.

- 3M/HIS indicated that it would place the CMS+AP-DRG system in the public domain. With respect to the Con-APR-DRGs, 3M/HIS agreed during the FY07 rulemaking process to contractual terms that are similar to the agreement between CMS and the American Medical Association with regard to use of the Current Procedural Terminology (CPT), except that CMS would maintain control over all updates, and the price that 3M/HIS could charge would be contractually negotiated. 3M/HIS would license Con-APR-DRGs to all third parties for a fee, third parties could obtain the Con-APR-DRG Definitions Manual without a license, and 3M/HIS would provide third parties with source code if requested.

- HSC indicated a general willingness to place the HSC-DRGs in the public domain under the same terms as those of the current CMS-DRGs but noted that the specifics would need to be negotiated.
- Solucient indicated that in principle the company was willing to discuss putting the classification system into the public domain if CMS decides to adopt the Sol-DRG logic.
- Ingenix, the vendor for the MM-APS-DRGs, stated that the company is prepared to: provide CMS with an open source license to use the system, make the methodology available to hospitals and Medicare Advantage plans in a fully transparent fashion for fees similar to what they now pay for the current CMS-DRGs, and collaborate fully with IT vendors to ensure that they have the opportunity to compete in the open market. Ingenix also indicated that it is prepared to discuss other mutually agreeable arrangements with CMS, up to and including the release of the MM APS-DRG methodology into the public domain.

Accessibility to the DRG classification logic and software was raised as an issue during the FY07 rulemaking process when CMS proposed adopting the Con-APR-DRG system in FY08. Concerns were raised with respect to both sufficient access to evaluate the impact of adopting the system and on-going access by hospital consultants and vendors in order to integrate the grouper software with other hospital systems. If CMS decides to implement one of the severity-adjusted DRG systems evaluated in this study, we assume that negotiations would occur between the vendor and CMS regarding the specifics of arrangements for maintaining the grouper in the future and for public accessibility to the group logic and software. It will be important for CMS to control future revisions in the classification logic for purposes of the Medicare PPS and that the logic and software be readily available to the public at a reasonable cost. While it would be preferable from the public’s perspective for the grouper documentation and software to be placed in the public domain, reasonable access may also be possible through "open licensing" as long as the prices are comparable to what is currently charged for the CMS-DRG grouper through the NTIS and the terms for licensure do not impede the ability of vendors to develop products tailored to meet client needs.

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. A consultant to the Maryland Hospital Association and its member hospitals estimates that, on average, "complete coding" can take up to 20 percent longer than "efficient" coding, and additional retrospective querying of physicians could increase coding time by another 10 percent (HP3, 2006).

In theory, "efficient" coding practices could continue under the systems that assign patients based on the highest severity level of any CCs, but it would still require training to make to make sure coders were sensitive to the severity-level assigned to various CCs. "Efficient" coding would not work under the MM-APS-DRGs if the add-on were implemented for additional CCs. Such coding is also likely to underpay hospitals under the Con-APR-DRGs because the final severity level is determined on the basis of multiple CCs and other considerations. The Con-APR-DRG logic also imposes stricter compliance with coding rules than the other systems do. As a result, the Con-APR DRG system is likely to require more investment in coding staff than the other systems. More-complete coding, however, can have spillover benefits for other uses of the clinical information, such as quality-monitoring activities.

Systems modifications represent the second major category of costs of implementing a severity-adjusted DRG system. In addition to acquiring and installing the grouper software, hospitals would have to integrate that software with other hospital systems, including encoders and financial systems. As discussed in Section 6.3, the ease with which this can be accomplished will depend on the arrangements that CMS and the selected vendor negotiate.

There is also some concern that the systems with four-digit DRG numbers (HSC-DRGs and Sol-DRGs) may have higher system implementation costs. For this reason, the vendors for the MM-APS-DRG and Con-APR-DRG renumbered their DRGs and eliminated the digit that identifies the severity level. This is an issue that warrants further investigation regardless of which system might be adopted, because the separate digit designating severity level has useful applications.

6.5. HOW APPLICABLE IS EACH SYSTEM TO OTHER PAYERS AND PURPOSES?

While the focus of this report has been on the use of the severity-adjusted DRGs in the Medicare PPS, 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 severity-adjusted systems 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. In the Medicare-modified systems, many of the consolidated base DRGs and collapsed severity levels affect how newborns and pediatric cases are classified and diminish the utility of these DRG systems for other payers. Collapsing the severity levels also diminishes the value of a classification system for quality assessment. As discussed earlier, one potential solution might be to retain the original CMS-DRG structure but to group the low-volume DRGs for purposes of assigning relative weights. Further, using a broader all-payer database for the pediatric and newborn cases would most likely improve the reliability of the DRGs for affected Medicare discharges as well as other payers.

6.6. SUMMARY DISCUSSION

Comparisons of the alternative DRG classification systems are difficult because of the differences in the number of DRGs and severity levels that each system recognizes. Each of the severity-adjusted DRG systems improves upon the explanatory power of the CMS-DRGs. Overall and within nearly every MDC, the Con-APR DRGs had higher explanatory power than the other systems. The Con-APR-DRGs explain 45 percent of the cost variation, which is a 13 percent improvement over the CMS-DRGs. The other systems show the following improvement: HSC-DRGs, 11 percent; MM-APS-DRGs and Sol-DRGs, 10 percent; and, CMS+AP DRGs, 8 percent.

The differences in explanatory power affect how Medicare payments are distributed across discharges and hospitals. Assuming no changes in coding practices, we estimate that the Con-APR-DRGs are likely to redistribute at least $14 billion, or 12% of Medicare payments for inpatient hospital services. The CMS+AP-DRGs showed the least improvement and would lead to less payment redistribution than the other systems (about $8.2 billion or 7.1 percent of total payments). The MM-APS-DRGs and Sol-DRGs would redistribute about $8.5 and $9.1 billion, respectively while the HSC-DRGs would redistribute about $9.7 billion.

The CMI for urban hospitals and larger hospitals increases, while that for rural hospitals and smaller hospitals decreases across the systems. This is consistent with a severity-adjusted DRG system shifting payment from less-expensive cases to more-expensive cases. The actual impacts under any of the systems will depend on hospital efforts to improve coding practices in response to the specific incentives of the selected system. One of the challenges facing CMS will be to develop an equitable policy for addressing case mix increases attributable to coding improvement.

Although the Con-APR-DRG system explains the most cost variation, it is also the most complex and is likely to impose the highest implementation and ongoing costs. The CMS-based systems have lower explanatory power but are easier to understand, largely because they build on the existing system. Under any of the systems, reasonable access to the classification logic and grouper software will be critical for facilitating understanding and implementation of the severity-adjusted DRGs.

These systems are not necessarily ready for “off-the-shelf” adoption by CMS. In particular:

- The CC exclusions lists and severity level assignments should be reviewed and updated in all systems using both clinical input and statistical analyses.

- The Con-APR-DRGs (and, to a lesser extent, the MM-APS-DRGs) contain policies to not reward hospitals for complications of substandard care and to encourage precise coding. In principle, these are desirable features that should be reviewed and if found appropriate, could be incorporated into the other systems.
- The CMS-based systems incorporate recent DRG refinements that focus on complexity of care considerations (e.g., the use of new technology) that are not used in the Con-APR-DRG logic. If the Con-APR-DRG system is adopted, these should be reviewed for appropriateness (although modifications to incorporate complexity considerations into the Con-APR-DRGs would represent a departure from the system's traditional classification rules that rely on severity of illness).

Limitations

Our general approach to evaluating the performance of the alternative DRG systems was to use the "off-the-shelf" versions of the groupers that did not control for differences such as the older grouper versions of the HSC-DRG and Sol-DRG systems, the precise coding rules and treatment of complications of care in the Con-APR-DRGs and, to a lesser extent, the MM-APS-DRGs. We also did not evaluate the add-on for independent CCC conditions used by the MM-APS-DRGs as part of this evaluation but will for the final report.

Our focus was on the overall performance of the systems and we did not assess how specific elements of the classification logic, such as the Con-APR-DRG rerouting and consolidation of severity levels across multiple base DRGs affect clinical coherency and cost homogeneity. We also did not decompose the elements accounting for case mix change across the systems but believe a better understanding for the differences in case mix change would be helpful.

The DRG classification system is only one factor that affects payment accuracy and equity. The method used to derive the relative weights, including how case-level costs are estimated, and the method used to estimate case-level costs for purposes of assessing payment accuracy are critical components of the payment system. Other policies, such as those that would be adopted for post-acute care transfers and high cost outlier cases will also need development before the impact of implementing a severity-adjusted DRG system can be determined. It was premature for us to examine hospital-level payment impacts of the severity-adjusted DRG classification systems without considering the relative weight methodologies. For the final report, we will examine different approaches to estimating costs and developing relative weights and the payment impacts of the alternative methodologies.

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APPENDIX A: DATA AND METHODS

1. CREATION OF ANALYTIC FILES

1.1. Administrative (Claims) Data

For beneficiary-level information, we used the Medicare Provider Analysis and Review (MedPAR) FY04 and FY05 files for acute-care hospitals.

- Consistent with the approach CMS uses in setting the PPS rates, we included Maryland hospitals (which have a waiver from the PPS) in the analyses of the explanatory power of the DRGs and in the construction of the relative weights, but we excluded them from facility-level analyses of case mix change.
- We excluded PPS-exempt acute-care hospitals such as cancer hospitals and children's hospitals. We also excluded Indian Health Service facilities and any acute-care hospitals that became critical access hospitals (CAHs) by February 2006.

CMS provided a MedPAR extract file with the data elements needed to assign cases to the other DRG systems, develop costs per case, and simulate payments. Consistent with CMS's current practice, we dropped the following records from the analysis file:

- Records with total charges or total length of stay less than or equal to zero. (Length of stay is day of discharge minus day of admission with a one-day stay assigned to cases for which the admission and discharge date are the same.)
- Records in which the difference between total charges and the sum of the charges for inpatient services (routine and ancillary) is greater than $10.

We excluded records from all-inclusive-rate hospitals and other hospitals whose records do not reflect departmental charging practices from analyses requiring cost information but included them in the analysis of case mix change. Our rule for determining whether a hospital had a departmental charging practice was more lenient than the policy CMS applied in the FY07 rule. In that rule, CMS retained hospitals only if they had charges in at least eight of the 13 revenue centers used to develop national cost-to-charge (CCR) ratios. We retained hospitals with records that show routine charges and charges in at least one ancillary department.

We recoded records with heart, lung, liver, or intestinal transplants that were not performed in an approved transplant center, so only transplants in approved centers are assigned to the transplant DRGs.

1.2. Facility-Level Data

We created a facility-level file, using information taken from the FY07 and FY06 standardization and provider-specific files and from the Healthcare Cost Report Information System (HCRIS) cost report files. The facility-level file contained variables needed to derive cost per case using facility-level cost-to-charge ratios and standardize cost per case using the hospital payment factor method. Generally, we used the most recent available data for a given hospital with respect to resident-to-bed and disproportionate share percentages consistently across all claims years (as opposed to using the actual values for those years) and the non-reclassified wage index. We used the IME adjustment factors that will be effective in FY08.

1.3. Summary of Number of Discharges and Hospitals in Initial Analysis File

We summarize in Table A.1 the number of records and hospitals involved at each step in building our initial analysis file, including the number of records and hospitals that were dropped because we were missing data to determine one or more of the derived variables discussed in the next section. In Chapter 3, we discuss the number of discharges that were used in specific analyses.

APPENDIX A

Table A.1 Summary of Discharge Records and Hospitals in Analysis File

	FY04 MedPAR		FY05 MedPAR	
	Cases	Providers	Cases	Providers
Original Total	12,303,081	4,150	12,295,107	3,980
Duplicates	2		0	
Cost-to-Charge Exclusions				
Cost Center Flag	13,988	63	24,470	59
Charge Flag	13,832		14,401	
New Total	12,275,259	4,087	12,256,236	3,921
Provider Exclusions				
Guam, VI Hospitals	3,532	4	3,657	4
Non-Acute Care	485	7	3,116	16
Cancer Hospitals	24,004	11	24,861	11
Indian Health Services Providers	1,208	2	1,032	2
Critical Access Hospitals	9,146	4	8,388	3
New Total	12,236,884	4,059	12,215,182	3,885
Standardization Process				
No standardization data	702	10	4,622	10
Standardization data but no CBSA	40,278	136	4	4
CBSA but no Large Urban Indicator	4,926	1	4,955	1
No wage index	497	1	0	0
Std Cost denom=0	1		0	
Total in Initial Analysis File	12,190,480	3,911	12,205,601	3,870

2. PATIENT CLASSIFICATION VARIABLES

2.1. DRG Assignments Using Alternative Groupers

Our analyses use the assigned FY07 CMS-DRGs as the baseline for our evaluation of alternative systems. We grouped the FY04 and FY05 data into the FY07 CMS-DRGs (v. 24). We used the 3M/HIS commercial software for this purpose, which has the necessary “mapping” of FY04 and FY05 ICD-9-CM diagnosis and procedure codes into equivalent codes for FY07.

APPENDIX A

We used vendor-supplied software to group the FY04 and FY05 data into the five severity-adjusted systems evaluated in this report:

- CMS- DRGs + All-Patient Severity DRGs (CMS +AP–DRG)
- HSC refined DRGs (HSC-DRG)
- Solucient refined DRGs (Sol-DRG)
- Medicare-modified All-Patient Severity DRGs (MM-APS-DRG)
- Consolidated All-Patient Refined DRGs (Con-APR-DRG)

Our general approach was to utilize the software as given (the off-the-shelf version) and do any mapping necessary to make the ICD-9-CM codes in the MedPAR data consistent with the codes used in the grouper software. All commercial groupers other than the HSC-DRG incorporate an algorithm to map diagnosis and procedure codes into the ICD-9-CM version effective in FY07. Therefore, we did not need to map any ICD-9-CM codes for these groupers. The HSC–DRG software is compatible with ICD-9-CM codes effective for FY06. Therefore, we mapped the FY04 and FY05 ICD-9-CM codes into their FY06 equivalents. We used the standard conversion table published by the National Center for Health Statistics available at http://www.cdc.gov/nchs/datawh/ftpserv/ftpicd9/icdcnv07.pdf for the mapping.

2.2 Severity Level Assignments

We assigned severity levels to the DRGs in each classification system. Assignment is relatively straightforward for the HSC-DRGs and Sol-DRGs because of the standard severity levels across DRGs. It is more complex for those systems (including the current CMS-DRGs) that collapse severity levels within or across DRGs. For the CMS-DRGs, we assigned Level 0 to a base CMS-DRG. If the DRG divides on the presence or absence of CCs, we assigned Level 1 to the DRG with the CCs. We did not assign DRGs for age 0-17 to severity levels. For the CMS+AP-DRGs, the same severity level assignments were used, except that discharges assigned to an MCC DRG were “reassigned” to the base CMS-DRG and assigned Level 2. The MM-APS DRGs and Con-APR-DRGs consolidate the severity levels for some DRGs. We assigned the severity level based on the lowest severity level assigned to the DRG. For example, if Levels 0 and 1 for a particular DRG were combined, discharges assigned to that DRG would be given Level 0; if Levels 1 and 2 were combined, the discharges assigned to that DRG would be assigned Level 1; and so forth.

2.3 MDC Assignments

To examine performance at the MDC-level, we needed to define an MDC for the pre-MDC DRGs and for other DRGs that are not assigned to an MDC. We created MDC 00 for the pre-MDCs and MDC 26 for the latter group. For the CMS-based DRG systems, we created a cross-walk from the severity-adjusted DRGs to the CMS-DRGs (Table A.2). We used the CMS-DRG assignment to determine whether the discharge should be assigned to MDC 00 or MDC 26. Otherwise, the MDC discharge assigned by the severity-adjusted DRG grouper was used. Across these CMS-DRG-based systems, variation in the number of discharges assigned to particular MDCs is largely attributable discharges that were ungroupable and assigned to DRG 470. We were not able to cross-walk the Con-APR-DRGs because some discharges are rerouted across MDCs and some discharges that are assigned to pre-MDCs DRGs in the CMS-based systems are assigned to MDC DRGs in the Con-APR-DRG system. In particular, discharges assigned to CMS-DRG 482 in MDC 00 are scattered across 69 Con-APR-DRGs. Thus, for the Con-APR-DRGs, we have used the MDC assignments from the Con-APR-DRG grouper, with one exception. The CMS-DRGs assign multiple significant trauma to MDC 24 and human immunodeficiency virus (HIV) infections to MDC 25. These assignments are reversed in the Con-APR-DRGs (i.e., multiple significant trauma is MDC 25). For the purpose of reporting results, we have used the CMS-DRG MDC assignments for these two diagnostic categories.

Table A.2
MDC Assignments for Pre-MDC DRGs and Other DRGs without an MDC Assignment

DRGs Assigned to MDC "00"	
103	Heart Transplant or Implant of Heart Assist System
480	Liver Transplant and/or Intestinal Transplant
481	Bone Marrow Transplant
482	Tracheostomy for Face,Mouth & Neck Diagnoses
495	Lung Transplant
512	Simultaneous Pancreas/Kidney Transplant
513	Pancreas Transplant
541	Ecmo or Trach W Mv 96+Hrs or Pdx Exc Face, Mouth & Neck W Maj O.R.
542	Trach W Mv 96+Hrs or Pdx Exc Face, Mouth & Neck W/O Maj O.R.
DRGs Assigned to MDC "26"	
468	Extensive O.R. Procedure Unrelated to Principal Diagnosis
476	Prostatic O.R. Procedure Unrelated to Principal Diagnosis
477	Non-Extensive O.R. Procedure Unrelated to Principal Diagnosis

3. DERIVATION OF COST MEASURES

3.1 Cost per Discharge

We developed an estimate of the cost for each MedPAR record in the analysis file. We used the cost measure to evaluate the how well the alternative DRG systems explain differences in resource use and to construct cost-based relative weights. Our method of estimating cost per discharge follows the methodology CMS adopted (with a transition period) in the FY07 rule as being both an improvement on charge-based weights and administratively feasible.

In the FY07 final rule, CMS computed national CCR for 13 cost center groupings and applied the national cost-to-charge ratio (CCR) to the revenue center charges on each MedPAR record. The national CCR and revenue center groupings that were published in the Federal Register are listed in Table A.2. To estimate cost per case using the national CCR, we took the following steps:

- Using Table A.2, we aggregated MedPAR charges into the 13 revenue center groupings. We multiplied the aggregated charges for the grouping by the applicable national CCR to estimate the costs for each revenue center grouping.

- We summed the estimated costs for each revenue center grouping to determine total costs for each discharge.
- We excluded organ acquisition charges from aggregated charges because these costs are paid for separately. Other pass-through costs such as direct graduate medical education costs and allied health education are excluded in the calculation of the national CCR.

APPENDIX A

Table A.2 Cost Center Groupings and National CCR

Cost Center Group Name	MedPAR Charge Field	Revenue Codes in MedPAR Charge Field	MEDPAR Charge Field Variable Name	CCR
Routine Days	Private Room	011x and 014x	PRIVT_RM_CHG	.56
	Semi-Private Room	010x,012x,013x and 016-019x	SMPRVTRM_CHG	
	Ward	015x	WARD_CHG	
Intensive Care Days	Intensive care	020x	IC_CHG	.50
	Coronary Care	021x	CC_CHG	
Drugs	Pharmacy	025X, 026X and 063X	PHRM_CHG	.21
Supplies and Equipment	Medical/Surgical Supply	027X and 062X	MED_SURG_CHG	.34
	Durable Medical Equipment	0290, 0291, 0292 and 0294-0299	DME_CHG	
	Used Durable Medical	0293	USED_DME_CHG	
Therapy Services	Physical Therapy	042X	PT_CHG	.44
	Occupational Therapy	043X	OT_CHG	
	Speech Pathology	044X and 047X	SPCHPATH_CHG	
Inhalation Therapy	Inhalation Therapy	041X and 046X	INHALTAN_CHG	.20
Operating Room (Other than Labor & Delivery DRGs)	Operating Room	036X, 071X and 072X	OR_CHG	.32
Labor & Delivery DRGs Operating Room Charges	Operating Room	036X, 071X and 072X		.46
	Clinic	051x		
Anesthesia	Anesthesia	037X	ANASTHSA_CHG	.16
Cardiology	Cardiology	048X and 073X	CARDILGY_CHG	.21
Laboratory	Laboratory	030X, 031X, 074X and 075X	LAB_CHG	.19
Radiology	Radiology	028X, 032X, 033X, 034X, 035X, 040X	RADIOLGY_CHG	.19
	MRI Charges	061X	MRI_CHG	
Other Services	Lithotripsy Charges	079X	LITHTPSY_CHG	.38
	Other Service Charges	0002-0099, 022X, 023X, 024X,052X,053X 055X-060X, 064X-070X, 076X-078X, 090X-095X and 099X	OTHER_CHG	
	Blood	038X	BLOOD_CHG	
	Blood Administration	039X	BLD_ADMN_CHG	
	Outpatient Service	049X and 050X	OTPT_CHG	
	Emergency Room	045X	ER_CHG	
	Ambulance	054X	AMBL_CHG	
	ESRD	080X and 082X-088X	ESRD_CHG	
	Clinic Visit (excluding Labor & Delivery DRGs)	051X	CLINIC_CHG	
	Professional Fees	096X, 097X, and 098X	PRO_FEES	

APPENDIX A

Using the national CCR method to derive cost per case does not account for individual hospital differences in charging practices. An alternative way to determine costs would be to use MedPAR revenue center charges and facility-level departmental CCRs derived from Medicare cost report data. Both methods produce an estimate of case-level accounting costs. Arguably, the facility-level CCR method should produce the better estimate, since it accounts for differences in hospital charging practices at the departmental level. It uses the best estimate of the accounting costs of individual cases when the cost report data matches the claims year data, but it requires using updated CCRs or imputed values when the CCRs are missing or invalid. However, it is not clear whether costs using this method will be closer to actual costs (versus accounting costs), because departmental internal pricing rules vary and are unknown.

The national CCR methodology avoids having to update CCRs that are derived from older cost reports and to either drop records with missing or invalid CCRs or impute values for those records. The choice between using the facility-level CCRs and the national CCR approach to estimate costs per case involves choosing between using the more refined methodology and using the more administratively feasible method. Because CMS has concluded that it is not administratively feasible to use this method for annual PPS updates, we have used the national CCR method in this interim report. However, we estimated cost per case using facility-level CCRs and did a sensitivity analysis of the effect on our findings regarding the overall ability of the DRG systems to explain cost variation (see Section 5 below). To develop this cost estimate, we determined the departmental cost-to-charge ratios from the hospital’s cost report that matched the MedPAR record or, if that cost report was not available, we used the most recent available cost report. We used the crosswalk CMS published in the FY07 final rule to match the revenue centers on the MedPAR record to the appropriate cost report line items. For hospitals without 12-month cost reports, we used the national cost-to-charge ratios.

3.2. Standardized Cost per Discharge (STDCOST)

The *hospital payment factor* approach standardizes for hospital differences in resource use by dividing the measure of resource use (cost) by a hospital payment factor. The hospital payment factor is a composite of the payment adjustments that account for differences in both operating and capital costs across hospitals, based on wage index, indirect medical education, disproportionate share of low-income patients, large urban location (for capital-related costs), and cost of living (for Alaska and Hawaii). We used the hospital payment factors to standardize the cost of each discharge for facility characteristics that are accounted for in the payment system. We standardized for both operating and capital payment factors on the basis of the proportion of the hospital’s total costs that are attributable to operating and capital costs, respectively. We used the CCRs on the FY07 PPS impact file to determine the operating and capital shares. The formula that we used is:

```
STDCOST = COST / (OPCCR/TOTCCR*(LSH*WINDEX+ (1-LSH)*COLA)*(1+IME+DSH)
          + CAPCCR/TOTCCR*GAF*CAPCOLA*LU*(1+CAPIME+CAPDSH))
```

Special payment rules apply to hospitals located in Puerto Rico. Namely, the operating and capital geographic adjustment factors for Puerto Rican hospitals are based on 75 percent of the national wage index values and 25 percent of Puerto Rico-specific wage index values (using a Puerto Rico-specific labor-related share in determining the operating cost adjustment).

The variable descriptions used in the standardization formula are given in Table A.3.

Table A.3 Description of Variables Used in Standardization

Variable	Description
Operating Payment Factors	
OPCCR	operating cost-to-charge ratio
LSH	labor-related share for operating costs
WINDEX	non-reclassified hospital wage index
COLA	operating cost of living adjustment for hospitals located in Alaska and Hawaii
IME	indirect medical education adjustment (using FY08 rules) for operating costs
DSH	disproportionate share adjustment for operating costs
Capital Payment Factors	
CAPCCR	capital cost-to-charge ratio
GAF	non-reclassified geographic adjustment factor for capital
CAPCOLA	capital cost of living adjustment for hospitals located in Alaska and Hawaii
LU	add-on rate for hospitals located in large urban areas
CAPIME	indirect medical education adjustment for capital costs
CAPDSH	disproportionate share adjustment for capital costs

To adjust for inflation, we inflated the FY04 estimate of standardized cost per discharge from the date of discharge to the end of the fiscal year using the market basket rates of increase during FY04. We deflated the FY05 estimate of the cost per discharge from the date of discharge to the beginning of the fiscal year using the market basket rates of increase during FY05. By inflating/deflating the estimated cost to a common date, the measured differences between the FY04 and FY05 cost per discharge are not attributable to inflation.

3.3 Adjustment for Short-Stay Transfers

Short-stay transfers to other acute-care hospitals count as a partial discharge. A transfer is considered short-stay if the length of stay (LOS) plus one day is less than the geometric mean LOS for the DRG. We used the LOS variable on the MedPAR record to compute the geometric mean length of stay (GLOS) for the DRGs in each classification system. We used the discharge-destination field on the MedPAR record (DIS_DEST) to identify transfers to acute-care hospitals (discharge status = 02). We compared the LOS for each transfer with the GLOS for all discharges assigned to the same DRG. The transfer-adjusted count for a short-stay transfer to an acute-care hospital equals the lesser of $(\mathrm{LOS}+1)/\mathrm{GLOS}$ or 1.0.

For the analyses in this interim report, we have not modeled the post-acute-care discharge policy in developing the relative weights. We have done this because the policy is DRG-dependent and would require modification if a severity-adjusted DRG system were adopted in the future. While we could devise a rule at the ADRG level that would be consistent for those DRG systems that severity-adjust the CMS-DRGs, we would not be able to easily apply a comparable rule to the Con-APR-DRGs, and we were concerned that this might lead to cases being treated differently across the DRG systems and would bias the results. If CMS decides to implement a severity-adjusted DRG system, an appropriate policy for post-acute care transfers will need to be developed.

3.4 Relative Weights (RELWGT)

The relative weight (RELWGT) measures the average resources required to treat a beneficiary assigned to a given DRG relative to the resources required by the average Medicare patient. For this interim report, we constructed sets of RELWGTs for each DRG classification system, using the standardized costs determined using the national CCR and the FY04 and FY05 MedPAR data. RELWGT is calculated as the transfer-adjusted mean STDCOST for the patients assigned to a DRG relative to the national mean STDCOST for all patients. The general formula for constructing the relative weights is

$$\mathrm{RELWGT} = (\bullet\ \mathrm{STDCOST}_{\mathrm{DRGi}} / \sum \mathrm{DISCH}_{\mathrm{DRGi}}) / (\bullet\ \mathrm{STDCOST}_{\mathrm{All}} / \sum \mathrm{DISCH}_{\mathrm{A;;)}})$$

We determined relative weights for the CMS-DRGs and for the five systems being evaluated, using a process generally consistent with that used by CMS to establish RELWGT in the FY07 final rule. We made one modification: We trimmed for statistical outliers only once, using the CMS-DRGs to identify these records. We did this because we wanted to evaluate the same set of cases across all DRG classification systems. If we trimmed for statistical outliers by DRG classification system, different records would be treated as statistical outliers in each system. This issue is discussed in greater detail in Section 3.2 in the body of this report.

We used the following process to determine RELWGT:

- We computed the geometric mean cost per discharge for each CMS-DRG, using the transfer-adjusted standardized cost for each discharge. We eliminated any record with a standardized cost that was plus or minus three standard deviations from the mean of the log distribution.
- We summed STDCOST for all cases assigned to a given CMS-DRG and divided by the transfer-adjusted discharges assigned to the DRG to determine the (arithmetic) mean STDCOST for each DRG.
- We divided the mean STDCOST for each CMS-DRG by the national mean STDCOST for all discharges in the relative-weight-analysis file to determine the RELWGT for each CMS-DRG. These RELWGTs are not the same as those published in the FY07 rule because of a slightly different set of records and method of standardizing costs.
- Using the same set of records, we repeated the calculation of the mean STDCOST and RELWGT for each DRG in the severity-adjusted DRG systems.

The RELWGT for each DRG classification system equals 1.0. In the annual DRG updating process, CMS normalizes the relative weights so that the average relative weight after DRG classification changes and recalibration equals the average relative weight before updating. For the analyses in this report, we have not normalized the relative weights, because an average relative weight of 1.0 makes it easier to compare relative values across DRGs and CMIs across hospitals. For example, a hospital with a CMI = 1.10 has discharges that, on average, are 10 percent more costly than the average Medicare patient.

The method that we used to compute relative weights in this interim report parallels the method CMS adopted in the FY07 final rule. However, we plan to consider alternative ways to establish relative weights in the final report, including the hospital-relative value or HSRV method. With this method, the total cost (determined using facility-level or national CCR) for each discharge is divided by the average cost per discharge for the hospital in which the case occurred.

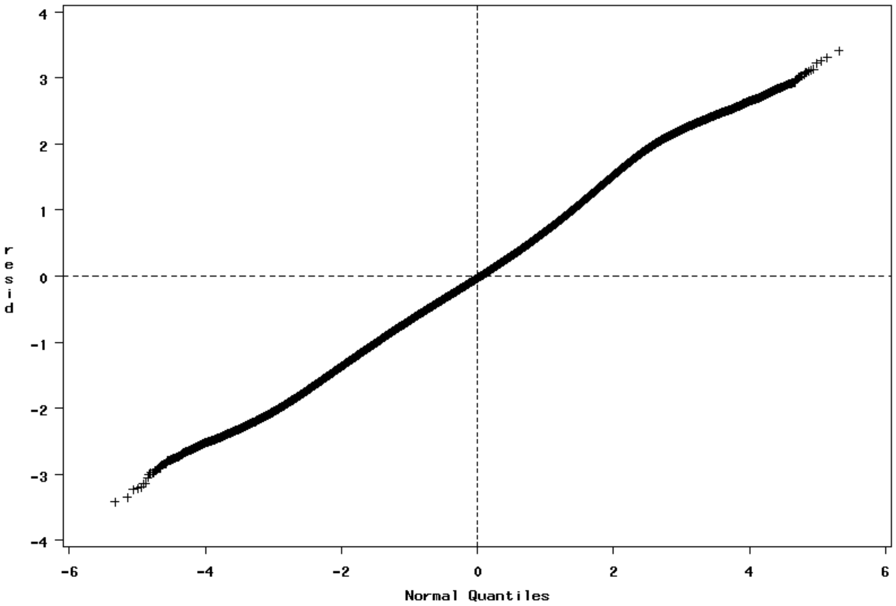
The resulting ratio is then multiplied by the hospital's CMI, or average relative weight, to produce a hospital-specific relative value. This relative value can be viewed as a cost that has been standardized by the hospital's own costliness, in contrast to the standard CMS method, in which the cost estimate is standardized by the hospital payment factor.

4. REGRESSION ANALYSES

One of the most important questions that we examine in Chapter 3 is the comparative ability of the severity-adjusted DRG systems to explain cost variation. Below, we provide the results from additional analyses that were not reported in Chapter 3.

4.1 Distribution of Cost Residuals

Figure A.1 Distribution of Log Cost Residuals Using CMS-DRGs



We relied on log-linear regression models that used log standardized cost as the dependent variable. We used the log transformation of cost to adjust for non-normality in the distribution of the residuals; otherwise our estimates of error (for example, p-values) would be biased. In Figure A.1, we plotted the distribution of the logged residuals for the CMS-DRGs. A normal distribution would look like a centered clean diagonal line starting in the lower left quadrant and ending in the upper right quadrant; our plot approximates a normal distribution and supports the use of logged cost in the regressions. In this regard, we note that this is the approach that has been traditionally used to evaluate DRGs and other payment refinements for the Medicare PPS.

4.2 Statistical Significance of the DRGs

Chapter 3 examined the comparative performance of the DRG systems in explaining cost variations across the Medicare patient population. We also confirmed that the observed differences in the mean costs across the DRGs are statistically significant. This analysis was needed to determine whether the DRGs are reliable predictors of cost differences in the Medicare patient population.

For our measure of statistical significance, we used the probabilities of error (p-values) produced in the Model 1 regression for each DRG. The p-values measured the probability that the observed differences in mean DRG costs reflected actual cost differences between the discharge groupings and a reference grouping and were not the result of error. The lower the p-value, the more statistically significant the results. Results with $p \leq 0.05$ are considered borderline statistically significant. Results with $p \leq 0.01$ are statistically significant, and those with $p \leq 0.001$ are highly significant. We selected as our reference grouping a DRG with no CC in each system with a mean standardized cost per discharge that approximated the mean cost per discharge for the population.

Table A.4 Summary of p-Values from Regression Model 1, Using DRG as the Explanatory Variable for Log Standardized Cost

	CMS DRGs				CMS+AP DRGs			
	p<.001	p<.01	P<.05	p>.05	P<.001	p<.01	P<.05	p>.05
N DRGs	495	498	501	9	552	558	561	13
% DRGs	97%	98%	98%	2%	96%	97%	98%	2%
% Discharges	98%	98%	100%	0%	98%	98%	99%	1%
	HSC-DRGs				**Sol-DRGs**			
	p<.001	p<.01	P<.05	p>.05	P<.001	p<.01	P<.05	p>.05
N DRGs	1048	1083	1122	122	1008	1043	1078	125
% DRGs	84%	87%	90%	10%	84%	87%	90%	10%
% Discharges	90%	91%	92%	8%	90%	90%	92%	8%
	MM-APS-DRGs				**Con-APR-DRGs**			
	p<.001	p<.01	P<.05	p>.05	P<.001	p<.01	P<.05	p>.05
N DRGs	809	832	847	58	819	826	829	15
% DRGs	89%	92%	94%	6%	97%	98%	98%	2%
% Discharges	94%	95%	96%	4%	99%	99%	99%	1%

Note: The reference DRG for the Model 1 regression is omitted from the DRG and discharge count.

Table A.4 summarizes the distribution of the p-values from the Model 1 regressions. The Con-APR-DRGs had the highest percentage of DRGs and discharges that were statistically significant at $p < 0.01$ and the lowest percentage of discharges (1 percent) assigned to DRGs that were not statistically significant. Ninety-eight percent of the discharges in the CMS-DRG and CMS+AP DRG systems were assigned to DRGs that were statistically significant at $p < 0.01$. The MM-APS-DRG system had 95 percent of discharges assigned to DRGs that were significant at $p < 0.01$ and four percent assigned to DRGs that were not statistically significant. Probably because the HSC-DRG and Sol-DRG systems have more low-volume DRGs, they assigned eight percent of discharges to DRGs that were not statistically significant.

4.3 Sensitivity Analysis of Model 1 Regression Specifications

The specifications for the regression results reported in Chapter 3 used FY05 discharges and eliminated statistical outliers, ungroupable records, and MDC 15 discharges. Our dependent variable was log standardized cost determined by applying the national CCRs to the revenue center charges on the MedPAR record. We tested the sensitivity of our Model 1 overall regression results using different specifications shown in Table A.5.

Table A.5 Alternative Specifications of the Regression Evaluating the Overall Ability of DRG Systems to Explain Cost Variation

Model	Year	Includes	Cost Estimation Method

		Outliers ?	
Ch 3	FY05	No	National
A	FY05	Yes	National CCR
B	FY05	No	Hospital-specific CCR
C	FY04	No	National CCR

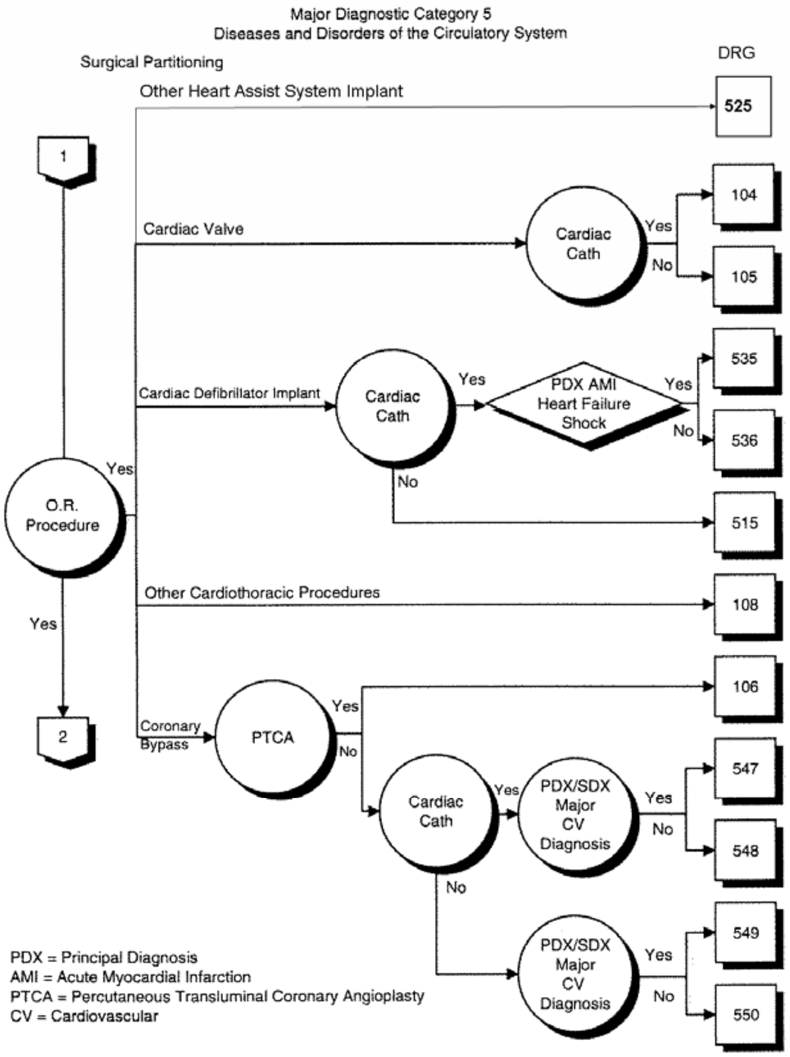
The results from alternative regression specifications are shown in Table A.6. Relative to the overall regression reported in Chapter 3, the R-squared values are lower when statistical outliers are included. The R-squared value is higher when cost is estimated using hospital-specific CCRs instead of national CCRs. There are small differences in the R-squared values for the regression using FY04 data, with the R-squared values slightly higher in FY05 for most systems. For our purposes, however, the important finding is that the relative performance of the DRG systems is consistent across the different specifications.

Table A.6 Regression Results Using Alternative Specifications

Model		CMS-DRG	CMS+AP-DRG	HSC-DRG	Sol-DRG	MM-APS-DRG	Con-APR-DRG
Ch. 3	Adj R-sq	0.394	0.424	0.439	0.433	0.435	0.446
	DepMean	8.49	8.49	8.49	8.49	8.49	8.49
	N Disch	12,135,982	12,135,981	12,135,982	12,136,082	12,135,982	12,136,049
A	Adj R-sq	0.377	0.411	0.426	0.420	0.422	0.437
	DepMean	8.50	8.50	8.50	8.50	8.50	8.50
	N Disch	12,205,466	12,205,465	12,205,466	12,205,566	12,205,466	12,205,534
B	Adj R-sq	0.436	0.470	0.489	0.481	0.483	0.497
	DepMean	8.63	8.63	8.63	8.63	8.63	8.63
	N Disch	12,129,849	12,129,848	12,129,849	12,129,949	12,129,849	12,129,917
C	Adj R-sq	0.392	0.422	0.439	0.432	0.433	0.445
	DepMean	8.45	8.45	8.45	8.45	8.45	8.45
	N Disch	12,118,266	12,118,265	12,117,969	12,118,341	12,118,266	12,118,309

APPENDIX B

CMS+AP-DRG MDC 5 CLASSIFICATION LOGIC

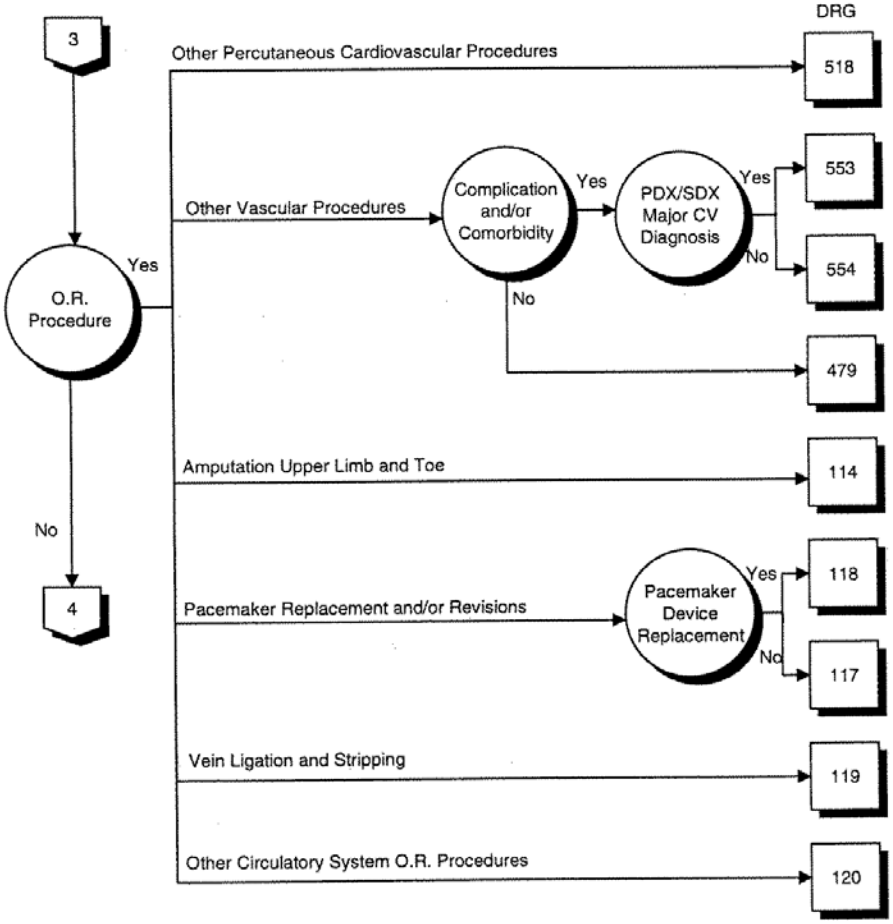

Major Diagnostic Category 5
Diseases and Disorders of the Circulatory System
Surgical Partitioning
DRG
Other Heart Assist System Implant
525
1
Cardiac Valve
Cardiac Cath
Yes
No
104
105
Cardiac Defibrillator Implant
Cardiac Cath
Yes
PDX AMI Heart Failure Shock
Yes
No
535
536
No
515
Yes
O.R. Procedure
Other Cardiothoracic Procedures
108
Yes
2
Coronary Bypass
PTCA
Yes
No
106
Cardiac Cath
Yes
PDX/SDX Major CV Diagnosis
Yes
No
547
548
No
PDX/SDX Major CV Diagnosis
Yes
No
549
550
PDX = Principal Diagnosis
AMI = Acute Myocardial Infarction
PTCA = Percutaneous Transluminal Coronary Angioplasty
CV = Cardiovascular

3.22 CMS DRGs with AP Severity Definitions Manual for AP Severity 09/06

Source 3M/HIS

APPENDIX B

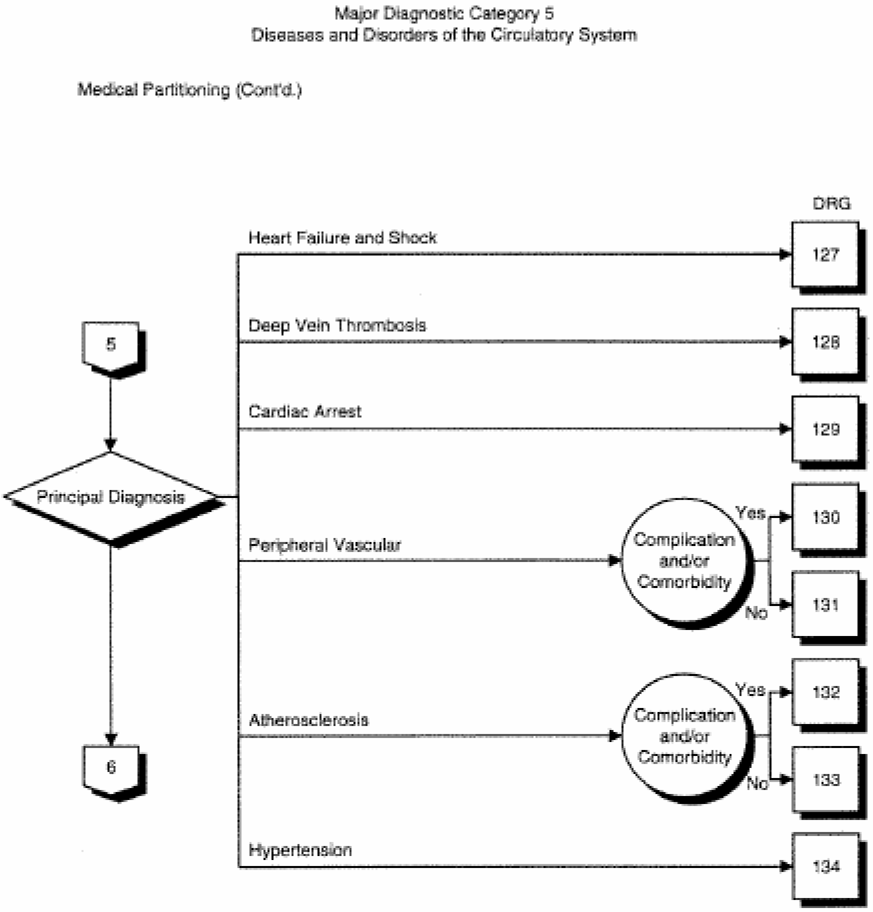
CMS+AP-DRG MDC 5 Classification Logic (con't)


DRG
3
O.R. Procedure
Yes
No
4
Other Percutaneous Cardiovascular Procedures
518
Other Vascular Procedures
Complication and/or Comorbidity
Yes
PDX/SDX Major CV Diagnosis
Yes
553
No
554
No
479
Amputation Upper Limb and Toe
114
Pacemaker Replacement and/or Revisions
Pacemaker Device Replacement
Yes
118
No
117
Vein Ligation and Stripping
119
Other Circulatory System O.R. Procedures
120

Source 3M/HIS

APPENDIX B

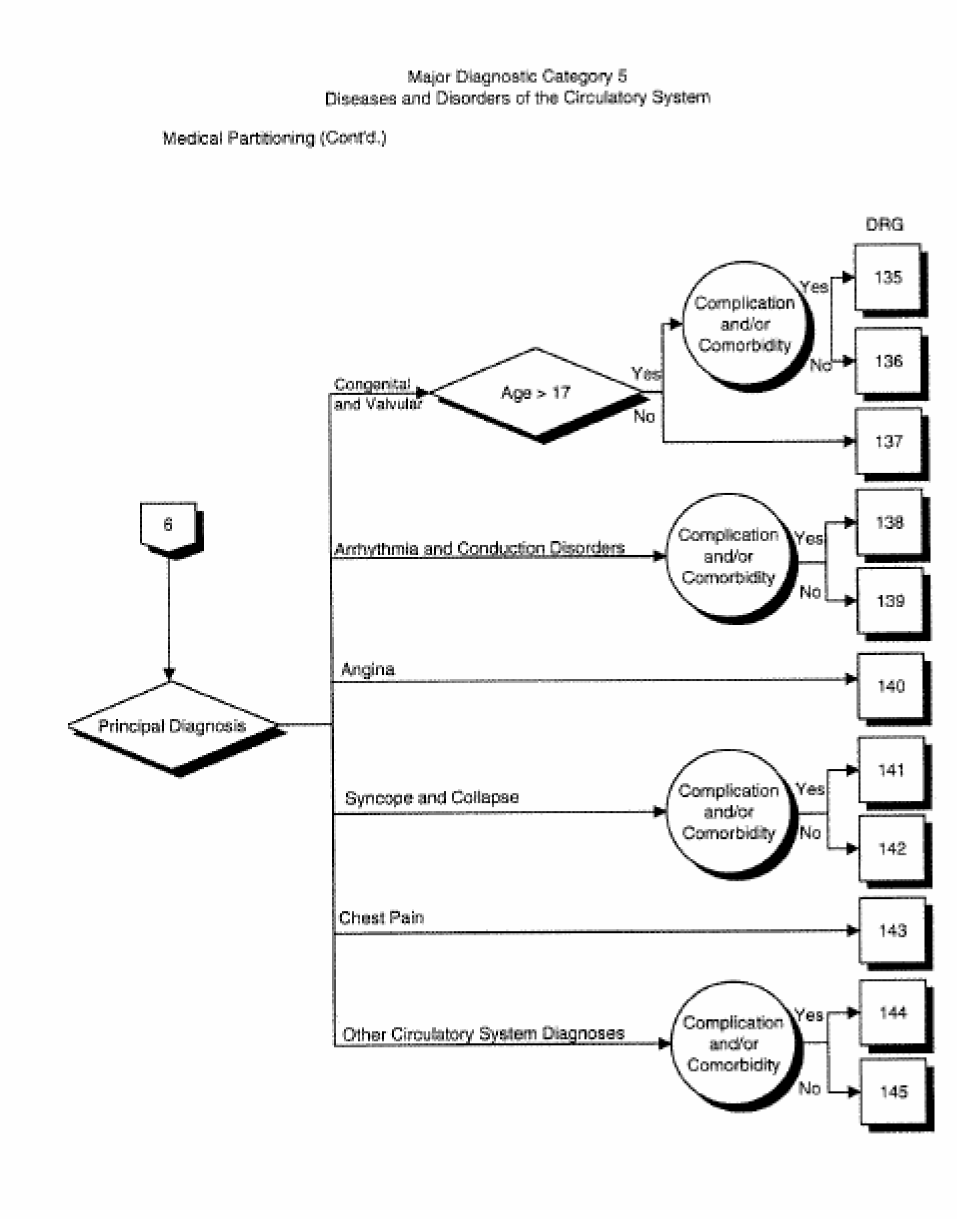
CMS+AP-DRG MDC 5 Classification Logic (con’t)


Major Diagnostic Category 5
Diseases and Disorders of the Circulatory System
Medical Partitioning (Cont'd.)
DRG
5
Principal Diagnosis
6
Heart Failure and Shock
127
Deep Vein Thrombosis
128
Cardiac Arrest
129
Peripheral Vascular
Complication and/or Comorbidity
Yes
No
130
131
Atherosclerosis
Complication and/or Comorbidity
Yes
No
132
133
Hypertension
134

Source 3M/HIS

Appendix B

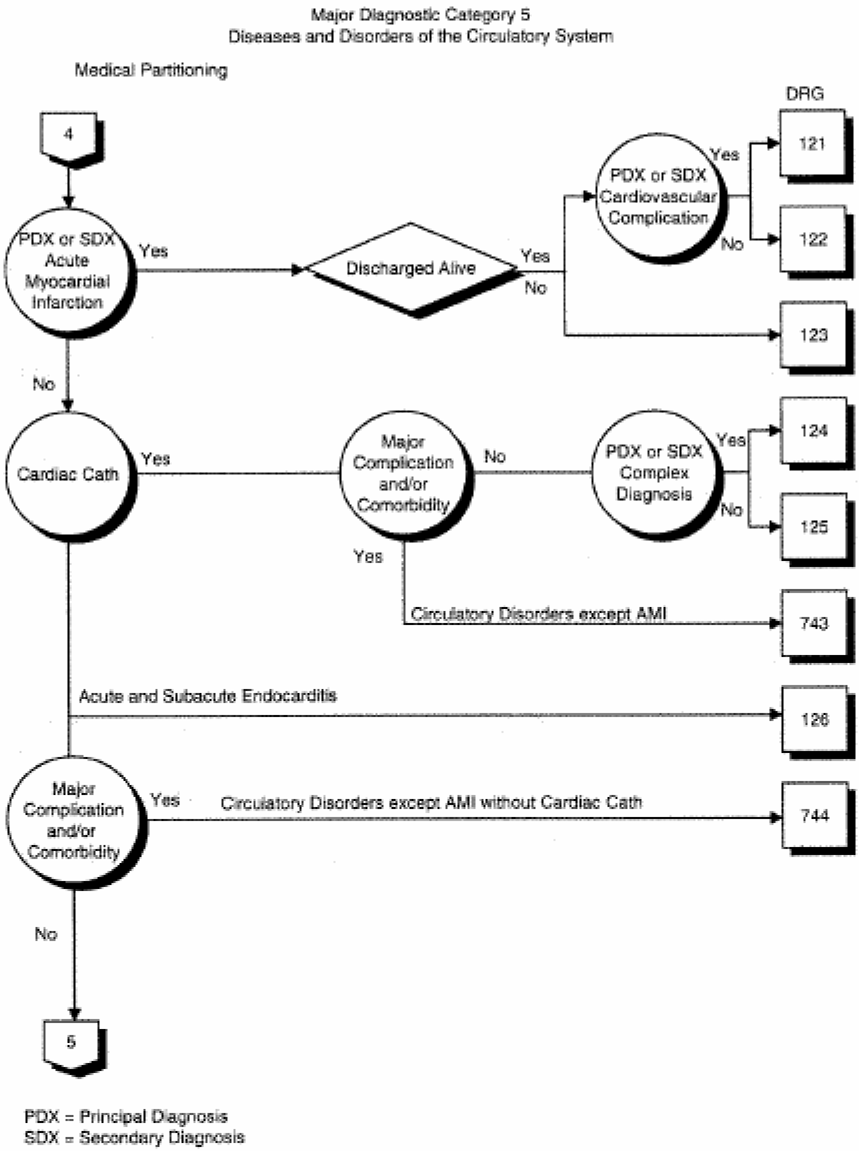
CMS+AP-DRG MDC 5 Classification Logic (con't)


Major Diagnostic Category 5
Diseases and Disorders of the Circulatory System
Medical Partitioning (Cont'd.)
DRG
6
Principal Diagnosis
Congenital and Valvular
Age > 17
Yes
No
Complication and/or Comorbidity
Yes
No
135
136
137
Arrhythmia and Conduction Disorders
Complication and/or Comorbidity
Yes
No
138
139
Angina
140
Syncope and Collapse
Complication and/or Comorbidity
Yes
No
141
142
Chest Pain
143
Other Circulatory System Diagnoses
Complication and/or Comorbidity
Yes
No
144
145

Source 3M/HIS

APPENDIX B

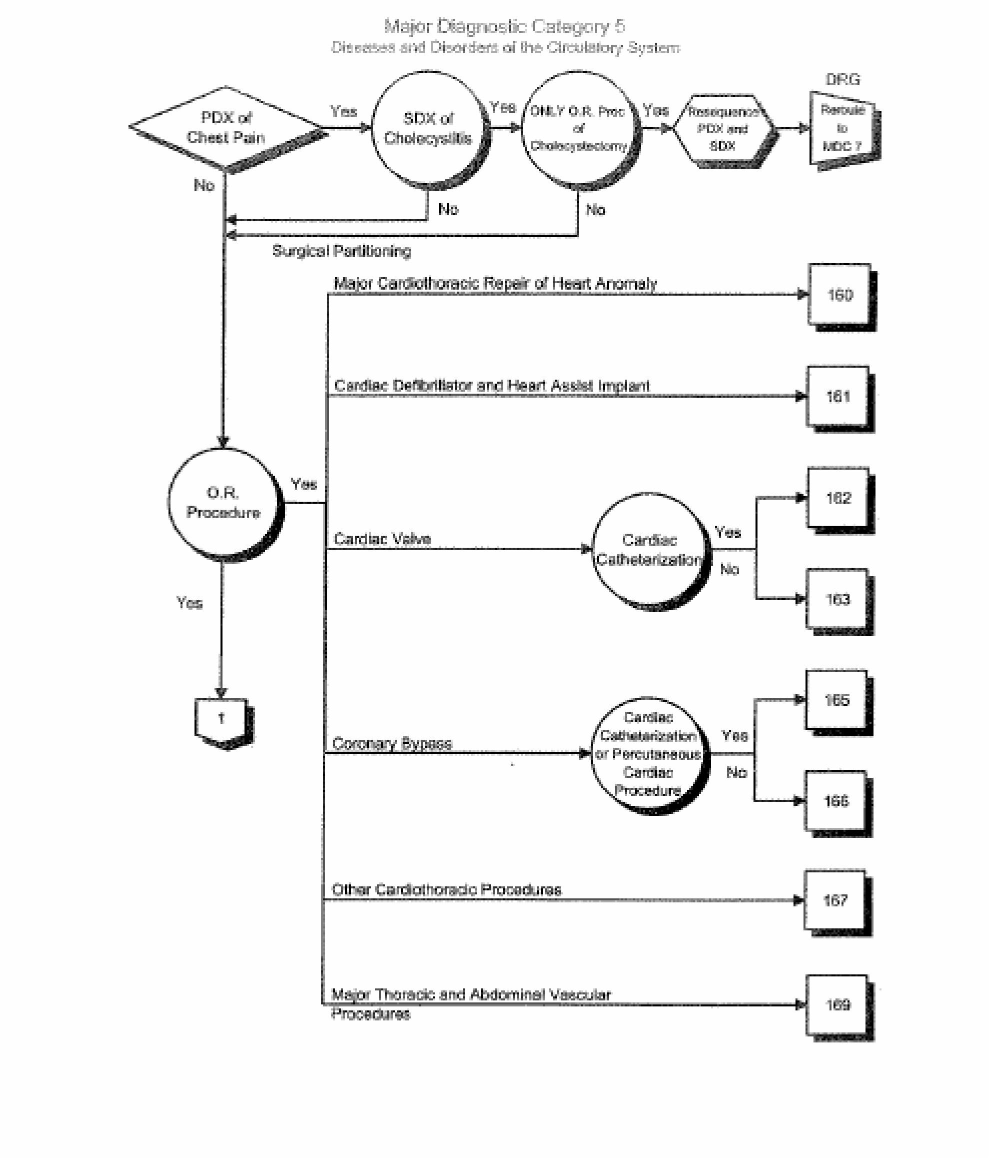
CMS+AP-DRG MDC 5 Classification Logic (con't)


Major Diagnostic Category 5
Diseases and Disorders of the Circulatory System
Medical Partitioning
DRG
4
PDX or SDX Acute Myocardial Infarction
Yes
Discharged Alive
Yes
No
PDX or SDX Cardiovascular Complication
Yes
No
121
122
123
No
Cardiac Cath
Yes
Major Complication and/or Comorbidity
No
PDX or SDX Complex Diagnosis
Yes
No
124
125
Yes
Circulatory Disorders except AMI
743
Acute and Subacute Endocarditis
126
Major Complication and/or Comorbidity
Yes
Circulatory Disorders except AMI without Cardiac Cath
744
No
5
PDX = Principal Diagnosis
SDX = Secondary Diagnosis

Source 3M/HIS

APPENDIX B

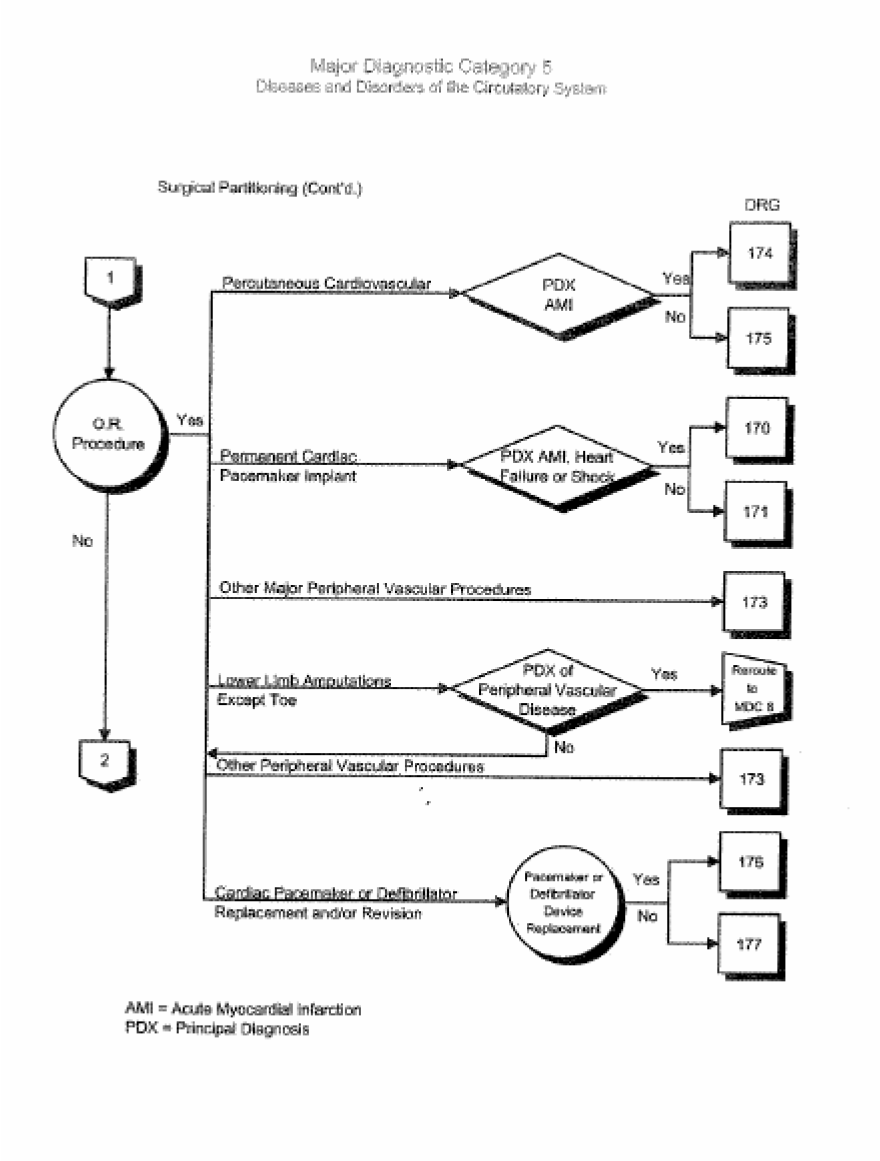
CON-APR DRG MDC 5 CLASSIFICATION LOGIC


Major Diagnostic Category 5
Diseases and Disorders of the Circulatory System
PDX of Chest Pain
Yes
SDX of Cholecystitis
Yes
ONLY O.R. Proc of Cholecystectomy
Yes
Resequence PDX and SDX
DRG
Reroute to MDC 7
No
No
No
Surgical Partitioning
Major Cardiothoracic Repair of Heart Anomaly
160
Cardiac Defibrillator and Heart Assist Implant
161
O.R. Procedure
Yes
Cardiac Valve
Cardiac Catheterization
Yes
162
No
163
Yes
1
Coronary Bypass
Cardiac Catheterization or Percutaneous Cardiac Procedure
Yes
165
No
166
Other Cardiothoracic Procedures
167
Major Thoracic and Abdominal Vascular Procedures
169

Source 3M/HIS

APPENDIX B

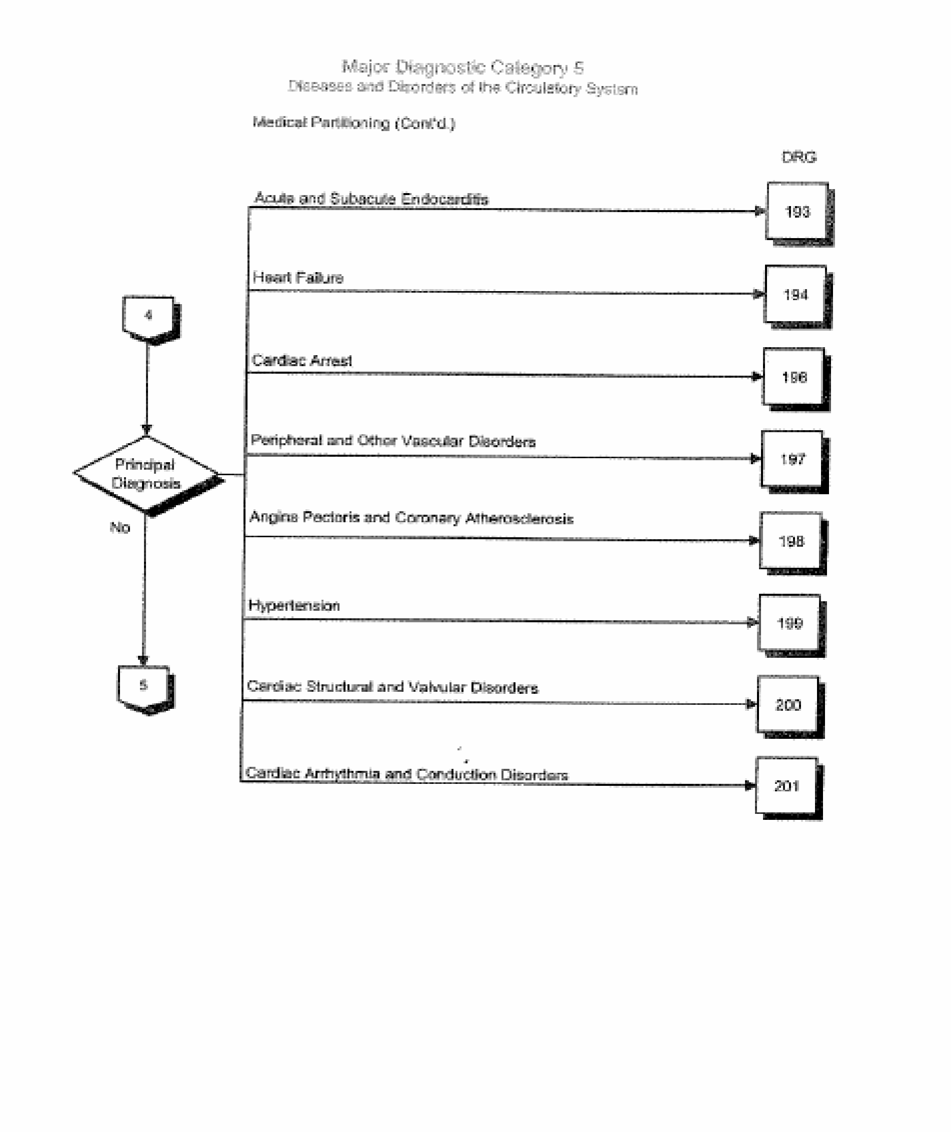
Con-APR DRG MDC 5 Classification Logic (con't)


Major Diagnostic Category 5
Diseases and Disorders of the Circulatory System
Surgical Partitioning (Cont'd.)
DRG
1
O.R. Procedure
Yes
No
2
Percutaneous Cardiovascular
PDX AMI
Yes
No
174
175
Permanent Cardiac Pacemaker Implant
PDX AMI, Heart Failure or Shock
Yes
No
170
171
Other Major Peripheral Vascular Procedures
173
Lower Limb Amputations Except Toe
PDX of Peripheral Vascular Disease
Yes
No
Reroute to MDC 8
Other Peripheral Vascular Procedures
173
Cardiac Pacemaker or Defibrillator Replacement and/or Revision
Pacemaker or Defibrillator Device Replacement
Yes
No
176
177
AMI = Acute Myocardial Infarction
PDX = Principal Diagnosis

Source 3M/HIS

APPENDIX B

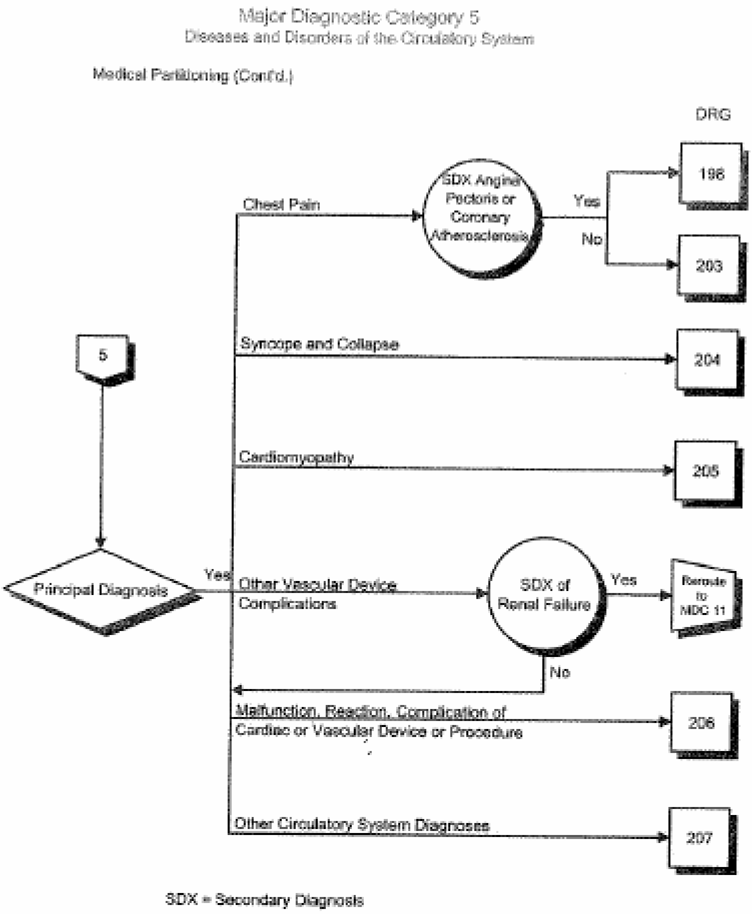
Con-APR DRG MDC 5 Classification Logic (con't)


Major Diagnostic Category 5
Diseases and Disorders of the Circulatory System
Medical Partitioning (Cont'd.)
DRG
4
Principal Diagnosis
No
5
Acute and Subacute Endocarditis
193
Heart Failure
194
Cardiac Arrest
196
Peripheral and Other Vascular Disorders
197
Angina Pectoris and Coronary Atherosclerosis
198
Hypertension
199
Cardiac Structural and Valvular Disorders
200
Cardiac Arrhythmia and Conduction Disorders
201

Source 3M/HIS

APPENDIX B

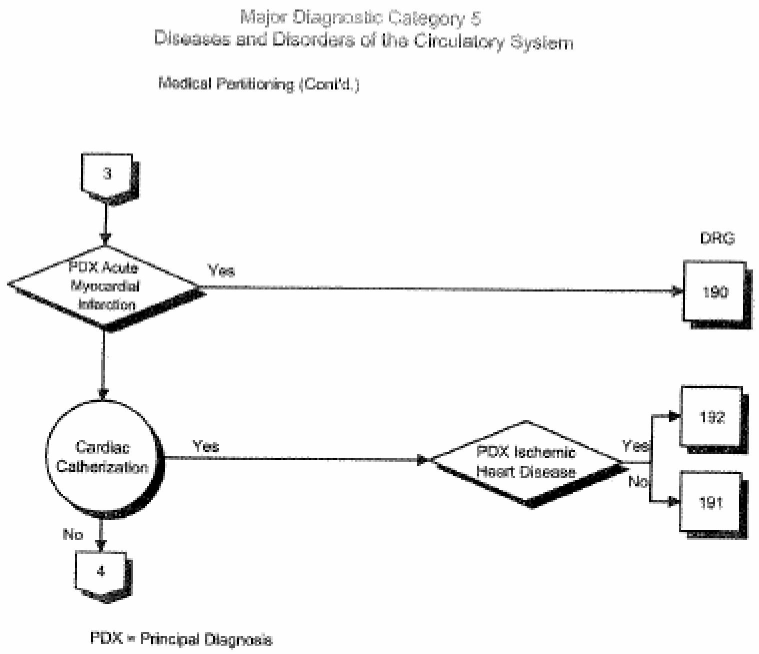
Con-APR DRG MDC 5 Classification Logic (con't)


Major Diagnostic Category 5
Diseases and Disorders of the Circulatory System
Medical Partitioning (Cont'd.)
DRG
5
Principal Diagnosis
Yes
Chest Pain
SDX Angina Pectoris or Coronary Atherosclerosis
Yes
No
198
203
Syncope and Collapse
204
Cardiomyopathy
205
Other Vascular Device Complications
SDX of Renal Failure
Yes
Reroute to MDC 11
No
Malfunction, Reaction, Complication of Cardiac or Vascular Device or Procedure
206
Other Circulatory System Diagnoses
207
SDX = Secondary Diagnosis

Source 3M/HIS

APPENDIX B

Con-APR DRG MDC 5 Classification Logic (con't)


Major Diagnostic Category 5
Diseases and Disorders of the Circulatory System
Medical Partitioning (Cont'd.)
3
PDX Acute Myocardial Infarction
Yes
DRG
190
Cardiac Catherization
Yes
PDX Ischemic Heart Disease
Yes
No
192
191
No
4
PDX = Principal Diagnosis

Source 3M/HIS