

# Pricing Medicare's diagnosis-related groups: Charges versus estimated costs

by Kurt F. Price

*Hospital payments under Medicare's prospective payment system (PPS) are based on prices established for 474 diagnosis-related groups (DRG's). Previous analyses using 1981 data demonstrated that DRG prices based on charges alone were not that different from prices calculated from estimated costs. Data for*

*1986 were used in this study to show that the differences between the two sets of DRG prices are much larger than previously reported. If DRG prices were once again based on estimated costs instead of the current charge-based prices, payments would be significantly redistributed.*

## Introduction

Medicare currently pays for hospital inpatient care based on prospectively set prices for each of 474 diagnosis-related groups (DRG's). The DRG prices represent the relative costliness of inpatient hospital services provided to Medicare beneficiaries. Since the implementation of this prospective payment system (PPS), the DRG prices have been based on both estimated costs and charges. Prices were originally based on estimated costs using cost data from 1981. In the third year of PPS, however, the DRG prices were recalibrated on the basis of charges alone, because sufficiently recent cost data were not yet available.

Timely availability of cost data has greatly improved since the first recalibration in 1986. Now that more recent cost data are available, should DRG prices, once again, be based on estimated costs? Or should they continue to be based on charges alone? These questions raise two very different issues: First, are cost-based prices more accurate than prices based on charges alone? Second, does it really matter? Are the two sets of prices very different? In this article, the arguments related to the first issue are discussed, and empirical evidence regarding the second is presented.

Strong arguments can be made for both the charge-based and the cost-based methodologies. On the one hand, charges may reflect many factors other than hospitals' estimated costs, such as hospitals' revenue maximization strategies. These factors should not be reflected in PPS payments. On the other hand, the current Medicare method of estimating costs may distort estimates of true cost. Unfortunately, there are no data representing true Medicare costs available to test these two methods. Determining which approach more accurately measures relative costliness involves subjective judgment.

There are data, however, to evaluate the differences between the two pricing methods. The study reported here compares DRG prices based on charges alone with prices calculated from estimated costs. The results show that the two approaches produce much larger differences in DRG prices than previously reported (Cotterill, Bobula, and Connerton, 1986; Prospective Payment Assessment Commission, 1985). Further, the results suggest that PPS payments would be significantly redistributed if DRG prices were, once again, based on estimated costs. These findings highlight the need to better understand the effects of hospital charge-setting practices and Medicare cost-finding methods on DRG prices.

## Background

PPS establishes fixed prices for inpatient hospital care in the form of relative weights for each of 474 DRG's. (The actual number of DRG's has varied since the implementation of the prospective payment system. For fiscal year 1989, prices have been established for 474 DRG's.) To calculate payments, the assigned DRG weight is multiplied by a standardized payment amount and adjusted for the hospital's area wages, teaching status, and percent of poor patients. The two alternative methods for calculating DRG weights and the implications of using each approach are discussed in the remainder of this section.

## Medicare methods for calculating weights

There are basically two methods for estimating relative DRG weights. The first approach uses charge information from the hospital bill. The Health Care Financing Administration (HCFA) has implemented these charge-based weights for fiscal years 1986-89. The second method adjusts these charges using cost information obtained from the Medicare Cost Report (MCR).

Under the cost-based approach, routine and special care costs are estimated by multiplying routine and special care lengths of stay (LOS) by the respective per diem costs derived from the MCR. Ancillary costs are estimated by multiplying departmental charges by

The conclusions and opinions presented are solely the author's and do not necessarily reflect those of the Prospective Payment Assessment Commission.

Reprint requests: Kurt F. Price, Deputy Director, Maryland Health Services Cost Review Commission, 4201 Patterson Avenue, Baltimore, Maryland 21215.

the corresponding ratio of cost-to-charge (RCC), which is also derived from the MCR. (A more detailed description of the cost-based methodology is provided in the section of this article on data and methods.)

The DRG weights are recalculated annually by HCFA, using the most recent data available. This process is formally referred to as recalibration. The purpose of recalibration is to create an entirely new set of DRG weights. The establishment of new DRG weights potentially redistributes payments among DRG's as well as among hospitals. The recalibration process is revenue neutral, however, and aggregate PPS payments remain unchanged.

Recalibration is necessary to maintain weights that accurately reflect the relative costliness of inpatient care across DRG's as medical practice patterns and relative use of hospital resources change over time. Practice pattern changes may include adding or dropping services, substituting more or less costly services, and shifting care to other settings (e.g., outpatient).

HCFA computed the original DRG weights using the cost-based methodology with 1981 patient-level data, adjusted using per diem costs and cost-to-charge ratios from the 1981 MCR's. The first recalibration of the weights was completed for fiscal year 1986 using fiscal year 1984 patient billing data. Because up-to-date cost report information was not available at the time, HCFA developed these new weights based on charges alone.

This decision to use charge-based weights for the first recalibration was supported by analyses completed by HCFA and the Prospective Payment Assessment Commission (ProPAC), using 1981 patient discharge data (Cotterill, Bobula, and Connerton, 1986; Prospective Payment Assessment Commission, 1985). In these analyses, DRG weights were computed using the original cost methodology, and 1981 cost data were compared with weights based on charge data alone.

In their analyses, Cotterill et al. and ProPAC reported only small differences between the two sets of weights. Cotterill et al. found that 83 percent of DRG's had weight differences of less than 5 percent and ProPAC reported 92 percent with differences of up to (and including) 5 percent. Further, the two sets of hospital case-mix indexes (CMI's) were similar. Cotterill et al. found that roughly 97 percent of hospitals had CMI's that differed by less than 2 percent, and ProPAC reported that virtually all hospitals had CMI differences that were 2 percent or less.

In the most recent recalibrations for fiscal years 1988 and 1989, HCFA continued to use charges alone to calculate the DRG weights. This is in spite of the fact that MCR data were then available from the second and third years of PPS, respectively. HCFA cited the original analysis using 1981 MCR's to support the charge-based recalibrations (*Federal Register*, 1987; *Federal Register*, 1988). In the study reported here, more recent cost data are

analyzed, and the question of whether a return to cost-based weights is warranted is addressed.

## Hospital charges versus estimated costs

Historically, hospitals have recorded costs at the departmental level. More recently, however, some hospitals have attempted alternative approaches, such as recording costs at the patient or procedural level. Nevertheless, the accuracy and level of detail of cost data collected by hospitals can vary considerably (Eastaugh, 1987; Schimmel, Alley, and Heath, 1987). As a result of this variation and the inherent difficulty in pricing the hospital product, uniform measures of true cost do not generally exist.

Departmental costs, therefore, continue to serve as the basis for estimating the costs of treating Medicare beneficiaries from the MCR. The cost-finding methodology used by the MCR for establishing costs for treating Medicare patients is comprised of a complex series of calculations. These include identifying Medicare allowable costs, stepping down overhead costs to revenue-generating departments, apportioning costs among Medicare and other payers, and assigning costs between PPS and pass-throughs (Berman, Weeks, and Kukla, 1986; Finkler, 1982). This methodology clearly results in some inaccuracies in the Medicare cost data and in analyses that use these data.

For example, consider the process of stepping down overhead costs such as housekeeping, maintenance, and dietary services. The method of allocating costs (e.g., square footage, pounds of laundry) varies and may result in cross-subsidization among departments (Finkler, 1982). As a result, departmental costs may be reflective of hospitals' attempts to maximize reimbursement rather than true estimates of costs of care provided in each department. Apportioning the departmental costs between Medicare and other payers and assigning costs to outpatient, inpatient (PPS), and PPS pass-throughs may exacerbate these inaccuracies.

An alternative measure of resource use is hospital charges. Charges are set by hospitals based on many factors, including estimated costs, market conditions, payer mix, and revenue maximization strategies (Carroll and Gross, 1987; Finkler, 1982; Jacobs and Franz, 1985; Office of Technology Assessment, 1983; Mason, 1987; Scheiderich, 1987; Schimmel, Alley, and Heath, 1987). This process may result in charges that are significantly above or below the costs of resources used to produce the service. The variation in charge-setting practices also results in charges that are generally not comparable across hospitals.

Thus, both alternatives for calculating DRG weights have important inaccuracies and limitations. Determining which approach is more appropriate is beyond the scope of this article. It is clear, however, that such a determination would be subjective at this time. Although the cost-finding methods employed by Medicare and hospitals' charge-setting practices have been documented as previously noted, there is no empirical evidence regarding the implications of each

method's deficiencies. The analyses described in this article focus on whether these deficiencies matter, i.e., whether the DRG weights calculated under these two methodologies are very different.

## Data and methods

The data sources used for this analysis included the MCR file for the second year of PPS, or PPS2, and the fiscal year 1986 Medicare Provider Analysis and Review (MEDPAR) file. The PPS2 file contains hospital cost reports for accounting years beginning in fiscal year 1985. The 1986 MEDPAR file contains billed charge data and clinical characteristics for all Medicare inpatient hospital bills for fiscal year 1986.

The PPS2 file used for this analysis contained a mixture of as-submitted cost reports and cost reports that had been audited, settled, or both. This mix varies from year to year, depending on the timeliness of review and audits as well as the timing of final file creation. For the PPS2 data, roughly 60 percent of the cost reports had been audited. The likely effects of not using fully audited data are discussed in the final section of this article.

The recalibration analysis described here basically followed the same methodology employed by Cotterill et al. and ProPAC in their analyses using 1981 data. The analysis compared charge-based weights, calculated using total charges per case, with cost-based weights, calculated using operating costs per case. The total-charge weights are assumed to reflect variation in capital and direct medical education costs, but the operating-cost weights do not. Because capital and direct medical education costs are currently paid on a pass-through basis under PPS, operating costs are more appropriate for calculating DRG weights. For the charge-based weights, it is not possible to calculate operating charges.

Similar analyses were performed, however, that compared operating-cost weights and total-charge weights with total-cost weights. The total-cost weights include the costs of capital and direct medical education. Although total-cost weights would be inappropriate for PPS (with the current pass-throughs), this comparison was used to decompose the differences found between total-charge weights and operating-cost weights. In their analyses, Cotterill et al. found that inter-DRG differences in pass-through costs were relatively unimportant in explaining differences between total-charge weights and operating-cost weights.

There were two steps for completing the analysis. First, using PPS2 data, operating costs were estimated for all records in the 1986 MEDPAR file, and a patient-level analysis file was created. Second, the specific calculation of weights and tables for analysis were produced. These two steps are described in the following sections.

## Calculating operating and total costs

To estimate costs for the MEDPAR discharges, we used patient variables from the MEDPAR record (LOS and ancillary charges) and hospital-level variables calculated from PPS2 for the corresponding hospital. Thus, each record of the MEDPAR file was linked with the corresponding PPS2 record using the hospital provider number.

The variables that were calculated from the PPS2 data included per diem costs for routine and special care and ratios of costs to charges for 12 ancillary departments. The per diems and RCC's excluded direct medical education costs and capital costs. The variables used from the MEDPAR file include the length of stay for routine and special care and charges in each of the 12 ancillary departments.

The routine and special care per diems (from PPS2) were inflated to make them match the time period for the MEDPAR charge data. The PPS2 cost-report data are based on hospital accounting years that vary and represent hospital cost data for accounting years that begin in fiscal year 1985. However, the MEDPAR includes discharges during Federal fiscal year 1986.

Thus, it was necessary to inflate the per diems to adjust for varying hospital accounting years. The inflators were arrived at by computing the percent change in cost per day from PPS1 (i.e., the MCR for the first year of PPS) and PPS2 (11.6 percent) and the percent change in expenses per day from the American Hospital Association (Oct. 1985-Sept. 1986) panel survey (9.2 percent) for the same period. An annual inflation of 10 percent was determined to be a reasonable estimate for the purposes of the recalibration analysis. Because the variation in accounting year is not very large, applying this inflator increased the per diems by less than 6 percent on average.

To calculate costs for each record in the MEDPAR file that has a corresponding PPS2 hospital record, the routine and special care lengths of stay were multiplied by the routine and special care per diems. Also, the ancillary charges were multiplied by the appropriate cost-to-charge ratio in each of the 12 ancillary departments. Costs for each MEDPAR admission were then estimated by the sum of these 14 components.

Missing or extreme values for the RCC's and per diems were treated in such a way as to limit the loss of observations. Because of the difficulty in determining the appropriate ranges for the departmental RCC's, only crude screens were applied. For each department, if the RCC was below .01 or above 10, the RCC was treated as invalid and set to missing. Similarly, if the routine or special care per diems were less than \$100, or if the routine per diem was greater than \$750, or if the special care per diem was greater than \$1,500, the respective per diem was set to missing.

When costs were calculated for each MEDPAR admission, if any of the respective hospital's per diems or RCC's were missing, and the patient record

showed length of stay or charges greater than zero, costs were estimated as .66 of the charges in that department. Thus, for example, if a patient generated \$1,000 in operating room charges, but the hospital's operating room RCC was missing or extremely high or low, operating room costs were estimated as \$660. The .66 was selected because, at the time of the analysis, HCFA used this factor to estimate costs from charges to determine outlier payments.

The analysis file for recalibration included records from the 1986 MEDPAR with their appended cost variable. The file was created as follows:

- The DRG definitions implemented for fiscal year 1988 were used.
- Costs and charges were standardized for area wages, teaching and disproportionate-share adjustments, and cost-of-living adjustments (COLA's) for Alaska and Hawaii.
- Within each DRG, statistical outlier cases, defined as cases that exceed plus or minus three standard deviations from the mean of the log distribution of costs (for cost weights) or charges (for charge weights) were excluded.<sup>1</sup>
- DRG's with fewer than 10 cases (after removing statistical outliers) were excluded.

## Recalibration analysis methods

This analysis compared DRG weights calculated using two different methods. Under the current method, weights are based on standardized total charges. We compared these with weights based on standardized operating costs. For each DRG  $i$ , the charge-based weight (CHGWT <sub>$i$</sub> ) and the operating-cost-based weight (OCSTWT <sub>$i$</sub> ) were calculated as follows:

CHGWT <sub>$i$</sub>  is the average standardized charges (excluding statistical outliers) in DRG  $i$  divided by the national average standardized charges across all cases.

OCSTWT <sub>$i$</sub>  is the average standardized operating costs (excluding statistical outliers) in DRG  $i$  divided by the national average standardized operating costs across all cases.

By definition, the average case weight (i.e., the case-weighted average DRG weight) for each of these methods was equal to one.<sup>2</sup>

For each hospital  $j$ , the charge-based CMI (CHGCMI <sub>$j$</sub> ) and the operating-cost-based CMI (OCSTCMI <sub>$j$</sub> ) were calculated as follows:

CHGCMI <sub>$j$</sub>  is the sum, across all DRG's, of (the

proportion of hospital  $j$ 's cases in DRG  $i$  multiplied by CHGWT <sub>$i$</sub> ).

OCSTCMI <sub>$j$</sub>  is the sum, across all DRG's, of (the proportion of hospital  $j$ 's cases in DRG  $i$  multiplied by OCSTWT <sub>$i$</sub> ).

Once the two sets of weights were calculated, tables were generated showing the distribution of percent changes in DRG weights and hospital CMI's. The DRG weight comparisons were also made for medical and surgical DRG's separately. In addition, changes in CMI's were computed for various hospital groups. Hospitals with fewer than 50 cases were excluded.

Although the primary goal of this analysis was to compare charge-based weights with weights based on operating costs, total-cost weights were also studied. This allowed us to determine how much of the observed difference between the charge weights and operating-cost weights was the result of the inclusion of capital and indirect medical education costs in the latter.

## Results

A total of 440 DRG's were used for this analysis. Of the 475 DRG's in effect during fiscal year 1986, 32 DRG's were not used because the MEDPAR file contained fewer than 10 cases. Three other DRG's do not have weights and are not used for determining PPS payments. These were also not used for this analysis and include DRG 438 (no longer used), DRG 469 (invalid principal diagnosis), and DRG 470 (ungroupable).

The 440 DRG's accounted for 9.05 million cases for 1986 treated in 5,755 hospitals. Although there are actually more than 5,755 hospitals paid under PPS, the analysis file includes only hospitals with information available for all variables used to calculate weights and used to display the results. Furthermore, because hospitals in Puerto Rico were paid under PPS beginning in fiscal year 1988, they were also included in this analysis. The results for comparing charge- and cost-based DRG weights are presented in the following four sections: comparison of weights for all DRG's, comparison for surgical and medical DRG's separately, effects on hospital CMI's, and comparisons with total-cost weights.

## Comparison of weights

Some descriptive statistics for the two sets of weights, unweighted for the number of cases in each DRG, are shown in Table 1. As indicated, the average charge-based weight is 2 percent higher than the average cost-based weight. (This does not imply that aggregate payments would be different using cost weights rather than charge weights—the case-weighted average was defined to be the same for the two sets of weights.) The cost-based weights are substantially compressed relative to charge-based weights. That is, the range of cost-based weights (i.e., the highest weight minus the lowest weight) is 12 percent lower

<sup>1</sup>The cases determined to be statistical outliers are likely to be different depending on whether a charge or cost criterion is used. Nevertheless, this approach is appropriate because it reflects how a charge- or cost-based policy would be implemented.

<sup>2</sup>The average case weight for the fiscal year 1988 weights published by HCFA is roughly 1.2. For this reason, all charge-based weights (and the average case weight) calculated for this analysis are roughly 20 percent lower than the published weights. This does not, however, affect the comparison made between cost-based and charge-based weights in this analysis—the average case weight is the same for both sets of weights.

**Table 1**

**Comparison of diagnosis-related group (DRG) total-charge-based weights with operating-cost-based weights<sup>1</sup>**

Item	Charge-based weights	Cost-based weights
Mean <sup>2</sup>	1.055	1.038
Standard deviation	1.077	0.971
Minimum	0.110	0.117
Maximum	10.976	9.722

<sup>1</sup>Total-charge-based weights were calculated using 1986 standardized total charges per case. Operating-cost-based weights were calculated using 1986 standardized operating costs per case and do not include capital and direct medical education costs. Weights were computed for only the 440 DRG's with 10 or more cases in the 1986 Medicare Provider Analysis and Review file.

<sup>2</sup>These means are unweighted averages. The average case weight is equal to 1 for both charge-based and cost-based weights.

NOTES: Mean charge per discharge is \$5,184. Mean cost per discharge is \$3,660. Correlation coefficient is 0.9981.

SOURCE: Health Care Financing Administration, Bureau of Data Management and Strategy: Data from the Medicare Statistical System.

than the range of the charge-based weights. Similarly, the cost weights have a lower standard deviation than charge weights.

The correlation coefficient between the two sets of DRG weights is .9981. In spite of the high correlation, the weights for many DRG's are very different under the two methodologies. The differences between the two sets of weights are shown in Table 2: 36 percent of the DRG's have greater than a plus-or-minus-5-percent difference in weights; 10 percent have differences of more than 10 percent. Thus, it appears that, to a large extent, the differences in weights reflect compression where the relative ranking of the DRG weights is preserved.

This compression is explained by the pattern of markups for services in the routine, special care, and ancillary departments. As Cotterill et al. demonstrated, ancillary departments tend to have higher markups (and, therefore, lower RCC's) than the routine service and special care departments. This may be because of (among other factors) the high visibility of nonancillary room-and-board rates. As a result, DRG's with a large portion of costs in ancillary departments will have lower weights under the cost-based methodology. At the same time, DRG's with a high routine and special care component will have higher weights under the cost-based methodology. This relationship is graphically depicted in Figure 1. As the plot shows, the percent difference in DRG weights is highly correlated ( $R^2 = .774$ ) with portion of charges, or share, that is incurred in ancillary departments.

As it turns out, DRG's with a high ancillary component also tend to have higher charge-based weights and vice versa. Thus, moving to cost-based weights would lower the high-weighted DRG's and would raise the low-weighted DRG's. This results in DRG compression. As seen in the next section, this phenomenon leads to very different results for medical and surgical DRG's.

**Table 2**

**Number of diagnosis-related groups (DRG's) and number and percent of cases, by percent difference for cost-based weights compared with charge-based weights<sup>1</sup>**

Percent difference, cost-based weights compared with charge-based weights	Number		Percent of cases
	of DRG's	of cases	
Total	440	9,047,853	100.0
More than 10 percent less	8	7,911	0.1
6-10 percent less	47	944,724	10.4
1-5 percent less	132	2,413,398	26.7
No difference	29	448,004	5.0
1-5 percent more	120	2,758,097	30.5
6-10 percent more	70	1,764,603	19.5
More than 10 percent more	34	711,116	7.9

<sup>1</sup>Cost-based weights are DRG weights calculated using 1986 standardized operating costs per case and do not include capital or direct medical education costs. Charge-based weights were calculated using 1986 standardized charges per case. Weights computed for only the 440 DRG's with 10 or more cases in the 1986 MEDPAR file.

NOTE: Percents may not add to 100.0 because of rounding.

SOURCE: Health Care Financing Administration, Bureau of Data Management and Strategy: Data from the Medicare Statistical System.

**Surgical versus medical weights**

In general, surgical DRG's have higher ancillary shares than do medical DRG's. As a result, cost-based weights are lower for surgical DRG's on average, and cost-based weights for medical DRG's tend to be higher. This is clearly demonstrated in Figures 2 and 3, in which the DRG plot shown in Figure 1 is decomposed into plots for surgical DRG's and medical DRG's, respectively. Surgical DRG's have higher ancillary shares and cost weights that are lower than charge weights. Medical DRG's have lower ancillary shares and cost weights that are higher than charge weights. The distribution of percent differences between charge and cost weights for surgical and medical DRG's is shown in Table 3, indicating that cost-based weights are higher for only 17 percent of the surgical DRG's. By comparison, cost-based weights are higher for 78 percent of the medical DRG's.

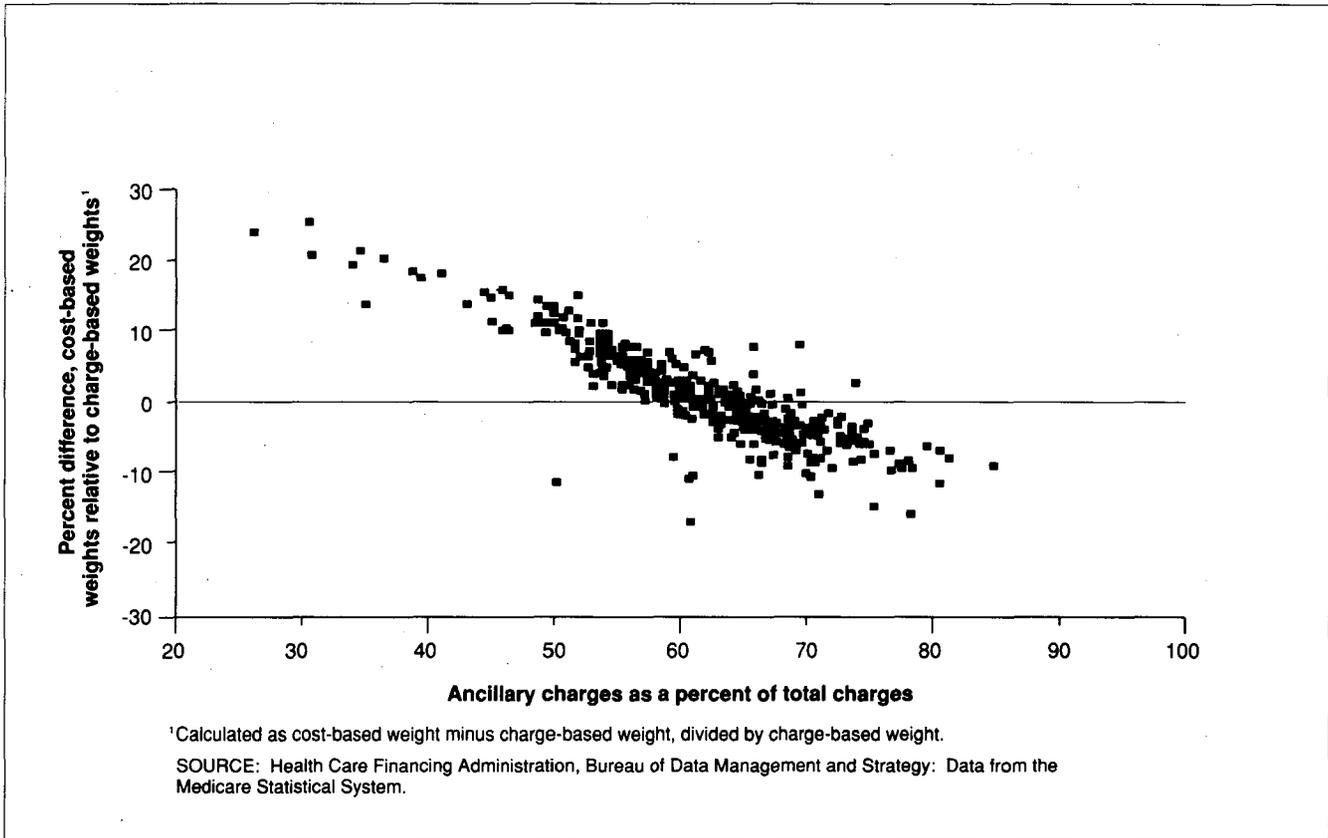
Thus, all other factors being equal, cost-based weights would increase payments for medical DRG's and decrease payments for surgical DRG's. The DRG's that would be most affected by moving from charge-based to cost-based weights are shown in Table 4. Included in this table are the 30 highest-volume DRG's with cost-based weights that are at least 5 percent lower or 5 percent higher than charge-based weights. The predominance of surgical DRG's in the former group and medical DRG's in the latter once again demonstrates the differential effect on surgical and medical DRG's.

**Hospital case-mix indexes**

Like the DRG weights, hospital CMI's computed from cost-based weights are compressed relative to the

**Figure 1**

**The relationship between the percent difference in cost-based and charge-based weights and the ancillary share of charges**



**Table 3**

**Number of diagnosis-related groups (DRG's) and number and percent of cases, by percent difference for cost-based weights compared with charge-based weights<sup>1</sup>**

Percent difference, cost-based weights compared with charge-based weights	Surgical DRG's			Medical DRG's		
	Number of DRG's	Number of cases	Percent of cases	Number of DRG's	Number of cases	Percent of cases
Total	189	2,413,806	100.0	238	6,455,359	100.0
More than 10 percent less	4	301	0.0	2	45	0.0
6-10 percent less	32	527,928	21.9	13	402,476	6.2
1-5 percent less	102	1,113,966	46.1	29	1,184,589	18.4
No difference	19	333,076	13.8	9	114,878	1.8
1-5 percent more	30	434,351	18.0	88	2,323,512	36.0
6-10 percent more	2	4,184	0.2	68	1,760,419	27.3
More than 10 percent more	0	0	0.0	29	669,440	10.4

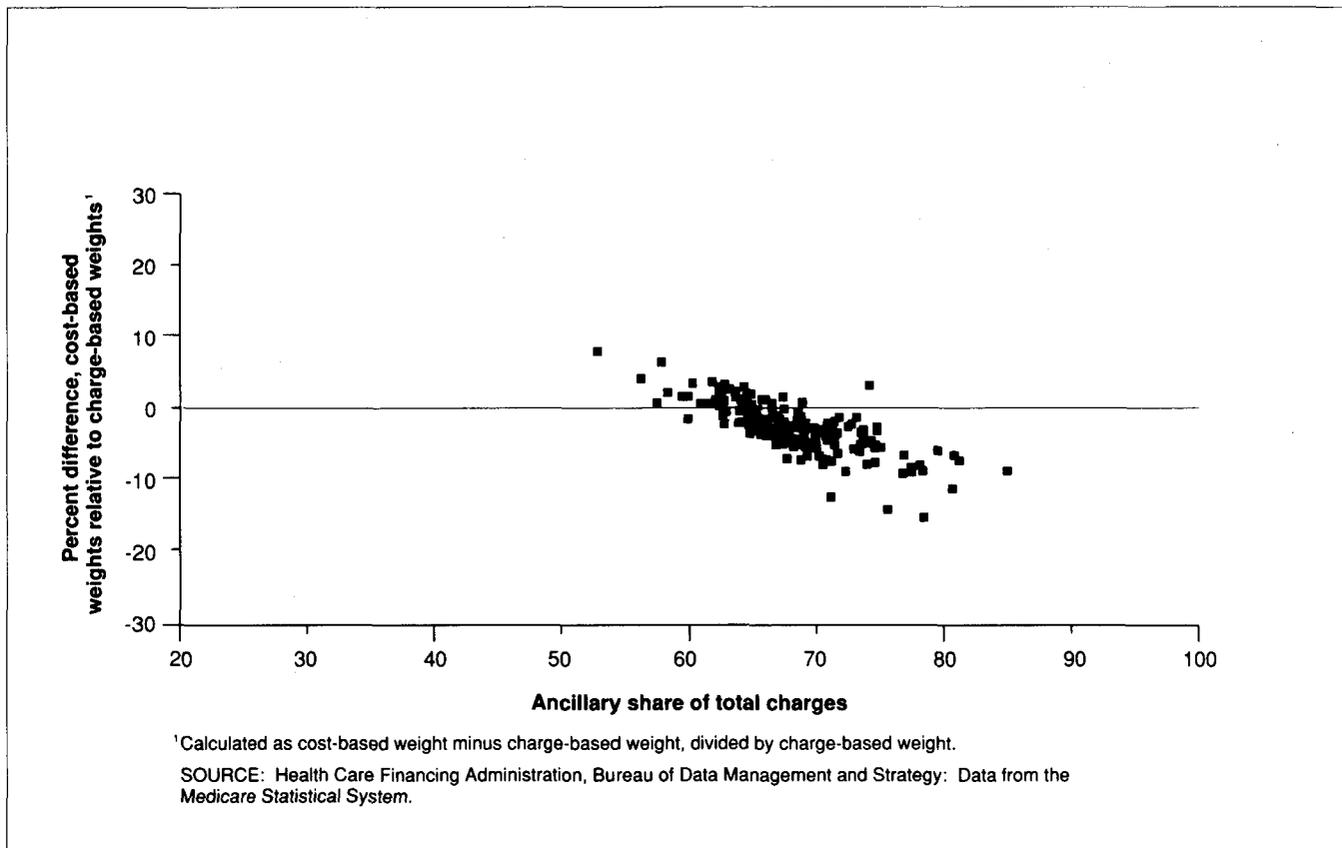
<sup>1</sup>Cost-based weights are DRG weights calculated using 1986 standardized operating costs per case and do not include capital or direct medical education costs. Charge-based weights were calculated using 1986 standardized charges per case. Weights computed for only the 189 surgical and 238 medical DRG's with 10 or more cases in the 1986 Medicare Provider Analysis and Review file.

NOTE: Percents may not add to 100.0 because of rounding.

SOURCE: Health Care Financing Administration, Bureau of Data Management and Strategy: Data from the Medicare Statistical System.

Figure 2

The relationship between the percent difference in cost-based and charge-based weights and the ancillary share of charges for surgical diagnosis-related groups



charge-based CMI's. As seen in Table 5, the range for the cost-based CMI's is 7 percent lower than the range for charge-based CMI's. Similarly, the standard deviation of cost-based CMI's is lower. The CMI's, by averaging across all cases in a given hospital, tend to dampen the compression. As suggested by the next table, however, the CMI compression is still fairly large.

The distribution of percent differences between CMI's calculated using charge weights and CMI's using cost weights is shown in Table 6. In roughly 40 percent of the hospitals, accounting for 25 percent of the cases, CMI's calculated with cost-based weights differed from CMI's calculated with charge-based weights by 2 percent or more.

Although using cost-based weights instead of charge-based weights would have no effect on aggregate payments, the average CMI is 1 percent higher under the cost-based methodology. As seen in Table 6, 67 percent of the hospitals would have a higher CMI under cost-based weights, and 12 percent would have lower CMI's. This uneven effect is related to a larger concentration of high-ancillary (higher markup) DRG's in a small subset of hospitals. As a result, the overall CMI is higher for the vast majority of hospitals under cost-based weights.

The average CMI's calculated using the two methods for various groups of hospitals are compared in Table 7. As groups, large urban and major teaching hospitals have CMI's that are more than 1 percent lower under cost-based weights. Rural hospitals, especially small rural hospitals, and nonteaching hospitals have much higher CMI's under cost-based weights.

### Total-cost weights

As previously discussed, the primary purpose of this analysis was to compare charge-based weights with operating-cost weights. However, because charge-based weights are assumed to reflect variation in capital and direct medical education costs, determining the effect of excluding these costs in the operating-cost weights is also of interest. Thus, total-cost weights that include capital and direct medical education were also analyzed.

The comparison of total-cost weights with the operating-cost weights and the charge weights shows that:

- The total-cost weights are similar to the operating cost weights: the two sets of weights are never more than 5 percent different; and 78 percent of the

Table 4

**Type and weight of diagnosis-related group (DRG), number of cases, and percent difference between charge-based weights and cost-based weights for the 30 highest-volume DRG's with at least a 5-percent difference between such weights, by DRG**

Diagnosis-related group	Type of DRG	DRG weight for fiscal year 1988	Number of cases	Percent difference
DRG's with cost-based weights at least 5 percent lower than charge-based weights (10.5 percent of all cases):				
88 Chronic obstructive pulmonary disease	M	1.1263	150,943	-5
410 Chemotherapy	M	0.4742	104,131	-9
148 Major small and large bowel procedures with complications or comorbidities	S	3.2376	91,391	-6
416 Septicemia, age over 17	M	1.5894	86,895	-6
79 Respiratory infections and inflammations, age over 17 with complications or comorbidities	M	2.0777	68,287	-8
123 Circulatory disorders with acute myocardial infarction, expired	M	1.3979	64,858	-6
87 Pulmonary edema and respiratory failure	M	1.5691	61,331	-6
39 Lens procedures with or without vitrectomy	S	0.5167	54,768	-7
110 Major reconstructive vascular procedure without pump with complications or comorbidities	S	3.6718	51,460	-7
116 Permanent cardiac pacemaker implant without acute myocardial infarction, heart failure, or shock	S	2.7694	49,476	-6
106 Coronary bypass with cardiac catheterization	S	5.5415	40,329	-9
154 Stomach, esophageal and duodenal procedures, age over 17 with complications or comorbidities	S	3.7961	37,740	-8
442 Other operating room procedures for injuries with complications or comorbidities	S	1.9218	32,120	-5
107 Coronary bypass without cardiac catheterization	S	4.2858	31,203	-9
75 Major chest procedures	S	3.0258	27,086	-5
DRG's with cost-based weights at least 5 percent higher than charge-based weights (25.7 percent of all cases):				
127 Heart failure and shock	M	1.0222	465,727	5
140 Angina pectoris	M	0.6689	339,610	9
14 Specific cerebrovascular disorders except transient ischemic attack	M	1.2429	291,273	6
15 Transient ischemic attack and precerebral occlusions	M	0.6293	153,982	5
243 Medical back problems	M	0.6694	145,291	13
138 Cardiac arrhythmia and conduction disorders with complications or comorbidities	M	0.8535	139,164	8
122 Circulatory disorders with acute myocardial infarction without cardiovascular complications, discharged alive	M	1.2002	124,092	13
121 Circulatory disorders with acute myocardial infarction and cardiovascular complications, discharged alive	M	1.7162	114,706	9
183 Esophagitis, gastroenteritis and miscellaneous digestive disorders, age over 17 without complications or comorbidities	M	0.5252	114,447	5
294 Diabetes, age over 35	M	0.7493	98,464	9
139 Cardiac arrhythmia and conduction disorders without complications or comorbidities	M	0.5912	81,289	11
143 Chest pain	M	0.5500	75,719	7
297 Nutritional and miscellaneous metabolic disorders, age over 17 without complications or comorbidities	M	0.5791	65,217	8
430 Psychoses	M	0.9329	58,733	21
141 Syncope and collapse with complications or comorbidities	M	0.6801	56,672	8

NOTES: M is medical. S is surgical.

SOURCE: Health Care Financing Administration, Bureau of Data Management and Strategy: Data from the Medicare Statistical System.

weights are less than 1 percent different.

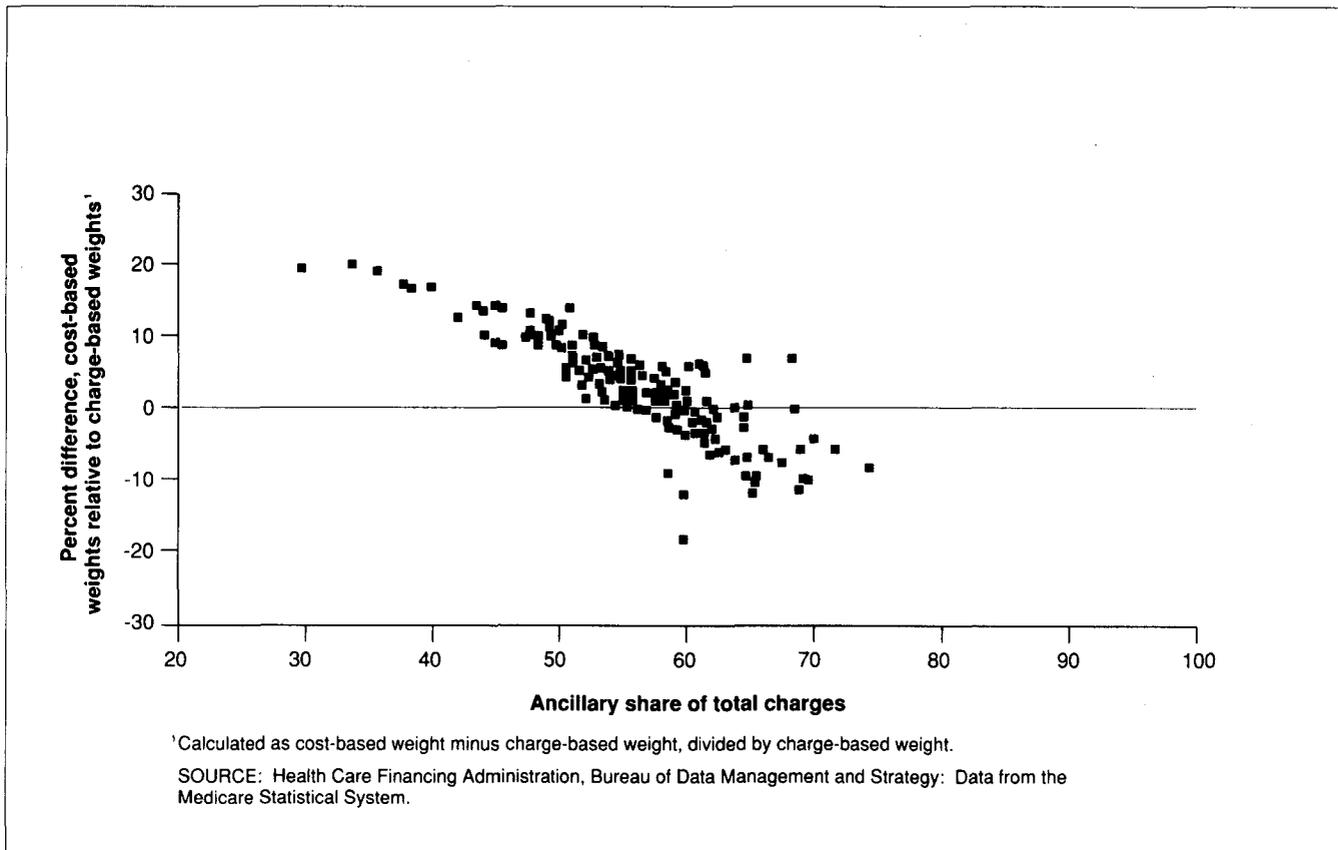
- In contrast, the results comparing total-cost weights and total-charge weights are similar to the comparison of operating-cost weights with total-charge weights: 37 percent of the total-cost weights are more than plus or minus 5-percent different than the charge weights, and 12-percent of the weights are more than 10-percent different.

This suggests that a small portion of the differences between cost-based weights is the result of the

exclusion of capital and direct medical education costs from the cost-based weights. The majority of the differences (and probably all of the compression), however, results from using estimated costs rather than charges in the calculation of the DRG weights. The pattern of differences between total-cost and total-charge weights is the same for medical and surgical DRG's. This finding is consistent with the results reported by Cotterill et al.

**Figure 3**

**The relationship between the percent difference in cost-based and charge-based weights and the ancillary share of charges for medical diagnosis-related groups**



**Table 5**

**Comparison of case-mix indexes calculated using 1986 total-charge weights and 1986 operating-cost weights<sup>1</sup>**

Item	Charge-based case-mix indexes	Cost-based case-mix indexes
Mean <sup>2</sup>	0.920	0.929
Standard deviation	0.125	0.114
Minimum	0.448	0.428
Maximum	1.824	1.706

<sup>1</sup>Operating costs exclude capital and direct medical education costs. Weights were computed for only the 440 diagnosis-related groups with 10 or more cases in the 1986 Medicare Provider Analysis and Review (MEDPAR) file. Comparison includes case-mix indexes for only those hospitals with 50 or more discharges on the MEDPAR file.

<sup>2</sup>These means are unweighted averages. The average case weight is equal to 1 for both charge-based and cost-based weights.

SOURCE: Health Care Financing Administration, Bureau of Data Management and Strategy: Data from the Medicare Statistical System.

**Table 6**

**Distribution of percent differences between hospital case-mix index (CMI) values calculated using diagnosis-related group (DRG) weights based on operating costs and DRG weights based on total charges<sup>1</sup>**

Percent difference, cost-based CMI values compared with charge-based CMI values	Number of hospitals	Percent of hospitals	Percent of cases
Total	5,755	100.0	100.0
More than 4 percent less	6	0.1	0.2
2-4 percent less	269	4.7	11.9
1 percent less	407	7.1	16.1
No difference	1,206	21.0	29.7
1 percent more	1,833	31.9	29.6
2-4 percent more	1,963	34.1	12.3
More than 4 percent more	71	1.2	0.2

<sup>1</sup>Operating costs exclude capital and direct medical education costs. Weights were computed for only the 440 DRG's with 10 or more cases in the 1986 Medicare Provider Analysis and Review (MEDPAR) file. Includes CMI values for only those hospitals with 50 or more discharges on the MEDPAR file.

NOTE: Percents may not add to 100.0 because of rounding.

SOURCE: Health Care Financing Administration, Bureau of Data Management and Strategy: Data from the Medicare Statistical System.

Table 7

Comparison of average case-mix index (CMI) values calculated using diagnosis-related group (DRG) weights based on total charges and DRG weights based on operating costs, by hospital characteristic<sup>1</sup>

Hospital characteristic	Number of hospitals	Charge-based CMI values	Cost-based CMI values	Percent difference
All hospitals	5,670	0.9216	0.9300	0.91
Urban	2,978	0.9797	0.9825	0.29
Rural	2,692	0.8573	0.8720	1.71
Urban, less than 100 beds	698	0.8817	0.8951	1.52
Urban, 100-249 beds	1,156	0.9694	0.9733	0.40
Urban, 250-404 beds	674	1.0241	1.0230	-0.11
Urban, 405-684 beds	371	1.0843	1.0750	-0.86
Urban, more than 684 beds	79	1.1247	1.1088	-1.41
Rural, less than 50 beds	1,224	0.8172	0.8357	2.26
Rural, 50-99 beds	827	0.8639	0.8779	1.62
Rural, 100-169 beds	416	0.9096	0.9194	1.08
Rural, more than 169 beds	225	0.9545	0.9604	0.62
Major teaching	187	1.0973	1.0856	-1.07
Other teaching	886	1.0269	1.0247	-0.21
Nonteaching	4,597	0.8941	0.9055	1.28
Disproportionate share <sup>2</sup>	1,274	0.9587	0.9628	0.43
Nondisproportionate share	4,396	0.9108	0.9205	1.06
New England	245	0.9564	0.9644	0.84
Middle Atlantic	569	0.9569	0.9614	0.47
South Atlantic	819	0.9247	0.9321	0.80
East North Central	879	0.9365	0.9444	0.84
East South Central	492	0.8572	0.8686	1.33
West North Central	773	0.8917	0.9041	1.39
West South Central	822	0.8983	0.9076	1.04
Mountain	362	0.9000	0.9114	1.27
Pacific	667	0.9844	0.9891	0.48
Puerto Rico	42	0.8115	0.8174	0.73

<sup>1</sup>Operating costs exclude capital and direct medical education costs. Weights were computed for only the 440 DRG's with 10 or more cases in the 1986 Medicare Provider Analysis and Review (MEDPAR) file. Includes CMI values for only those hospitals with 50 or more discharges on the MEDPAR file and with known characteristics.

<sup>2</sup>Refers to share of poor patients.

SOURCE: Health Care Financing Administration, Bureau of Data Management and Strategy: Data from the Medicare Statistical System.

## Summary and conclusions

The results of this analysis demonstrate that the differences between cost- and charge-based DRG weights and between cost- and charge-based CMI's are substantially larger than previously reported. The amount of difference between the two weights for a given DRG largely depends on the ancillary share of charges in that DRG. The larger the ancillary share of charges, the higher are charge-based weights relative to cost-based weights. For example, most DRG's with ancillary shares of greater than 60 percent have charge-based weights that are higher than cost-based weights.

This ancillary effect yields different results for medical and surgical DRG's, because the latter tend to have higher ancillary shares. Therefore, weights for medical DRG's would be higher under the cost-based methodology, and surgical DRG weights would be lower. Because medical DRG's, in general, have lower DRG weights, cost-based weights are compressed relative to charge-based weights. This is consistent with the results reported by Cotterill et al., although

the level of compression was much greater in this analysis.

Although aggregate payments would remain unchanged, moving to cost-based weights would redistribute payments from the surgical DRG's to the medical DRG's. In general, this shifting of payments to medical DRG's would result in lower payments to large, urban, teaching hospitals and higher payments to smaller, rural, nonteaching hospitals. This is because the former group of hospitals treats a larger proportion of surgical cases.

Again, the differences between cost-based weights and charge-based weights are much larger in the analysis reported here than was observed in the previous analyses reported by Cotterill et al. and ProPAC. Although the previous analyses were based on 1981 cost-report data, it is uncertain what factors account for the differing results. It is certain, however, that the relationship between costs and charges, as measured by the MCR, changed significantly between 1981 and 1985. A longitudinal analysis of MCR data covering 1981 through 1986 should provide a better understanding of how

the relationship between costs and charges has changed over time.

Several limitations of the methods used in this analysis should be noted. As was previously discussed, the MCR's are based on the hospital accounting year, but the MEDPAR file is based on the Federal fiscal year. The methods used assume that RCC's remain constant over the period between the end of the hospital's accounting year (September 1985 to August 1986) and September 30, 1986. To the extent that RCC's systematically vary over time, the estimates of costs may be inaccurate.

A related problem is the inflation of routine and special care per diems to take into account the mismatched time periods for the MCR data and the MEDPAR data. To the extent that cost increases are erratic over the year, the use of a constant inflation factor may have created some inaccuracies in the estimates of costs. In both of these situations, it is difficult to posit the extent of bias introduced into this analysis by using the mismatched MCR and MEDPAR data.

Nevertheless, for the results of this comparison of weighting methodologies to be affected, there would need to be a strong systematic relationship between a hospital's pattern of changes in costs and RCC's, and the hospital's mix of patients. Because the DRG weights are relative, the results of this analysis would be biased only if selected groups of hospitals with similar biases in per diems and RCC's dominated some DRG's and not others. Thus, although it is possible that the mismatched time frames may bias this analysis, it appears rather unlikely. The only way of testing this is to use multiple years of MEDPAR data to cover the time period of the MCR data.

Another limitation of this analysis is the use of a partially audited MCR file. This is not only an issue for this analysis, but also for the implementation of cost-based weights. At certain points in time, MCR's are in various states of review (e.g., as-submitted, audited). For example, when this analysis was performed, roughly 60 percent of the cost reports in the PPS2 file had been audited. Although it was not possible to measure the audit effect for this analysis, there is some evidence to suggest that it probably is small.

For example, work by Cowles (1988) demonstrates that, for the first year of PPS, auditing of the MCR has relatively little effect on the variables used for estimating operating costs. The capital-cost variables, on the other hand, are much more affected by auditing. This may simply reflect a shift in focus away from operating costs on the part of the fiscal intermediaries once PPS was implemented, rather than accurate reporting by hospitals. In either case, however, it appears that these findings would be unchanged if the data had been fully audited.

The finding that the cost weights are compressed is troubling. Since before the implementation of PPS, there has been continuing concern that the DRG weights are compressed (Lave, 1985; Jencks and Williams, 1988; Pettengill and Vertrees, 1982; Thorpe,

1988). It would seem, therefore, that any pricing method that (further) compresses DRG weights must be inappropriate. This is not necessarily so if one considers the likely sources of compression and how these sources affect the cost and charge weights.

Pettengill and Vertrees (1982) and Lave (1985) originally suggested several possible sources of DRG weight compression. These include diagnostic data errors, the per diem method of estimating nonancillary costs, and charge-setting practices that result in cross-subsidization of services. The first source of compression is likely to affect the charge and cost weights equally, because both methods rely on the diagnostic information contained in the MEDPAR file.

In contrast, the per diem method of allocating routine and special care costs applies only to the cost-based method. Lave (1985) has argued that because the per diem method does not reflect variation in nursing intensity across cases, the cost weights are probably compressed. Cromwell and Price (1988), however, demonstrated that adjusting for nursing intensity does not materially affect the DRG relative weights. Thus, it appears that the per diem method is not a significant source of compression in the cost weights.

The compression effects of hospital charge-setting practices are twofold. First, hospitals tend to subsidize the more expensive ancillary services with the less expensive services. Thus, within the various departments in a hospital, the more costly services are underpriced and the less costly services are overpriced (Lave, 1985; Office of Technology Assessment, 1983). This practice causes the more costly DRG's to have weights that are too low and the less costly DRG's to have weights that are too high. Because the cost-based methodology uses departmental RCC's that preserve these patterns of cross-subsidization, the charge and cost weights are equally affected by this source of compression.

The second pattern of charge setting that may affect compression involves cross-subsidization across departments. As Cotterill et al. demonstrated, the markup for routine and special care services is lower than the ancillary services. As a result, DRG's with relatively large amounts of ancillary services will be overpriced using the charge-based method, and DRG's with lower amounts will be underpriced. As this study shows, high-ancillary DRG's also tend to be higher weighted DRG's and low-ancillary DRG's tend to be low-weighted DRG's. This suggests that using charges alone for calculating weights tends to overprice high-weighted DRG's and underprice low-weighted DRG's, actually causing decompression in the weights. The compression resulting from the cost-based methodology may be appropriate, therefore, as a way of removing the cross-subsidization between the ancillary and nonancillary departments.

But how can the compressing effect of the cost methodology be appropriate if the current weights are already compressed? In fact, the degree and importance of compression in the current weights

continues to be the subject of considerable debate. Thorpe et al. (1988), for example, demonstrate that the amount of compression in hospital CMI's is largely dependent on the methods used to measure the compression. They suggest that the degree of compression in hospital CMI's is largely determined by the variables included in the regression equation used to measure compression. Jencks and Williams (1988) argue that measures of compression may well be influenced by unmeasured severity of illness. Thus, there is no clear consensus on the magnitude, sources, and interpretation of DRG weight compression at this time.

More importantly, judgments as to the most appropriate DRG weighting methodology should be based primarily on the merits of each method, independent of the method's compressing or decompressing effects. The relevant question is which set of weights more accurately reflects the true cost of treating patients. To answer this question, the effect of hospital charge-setting practices and Medicare's cost-finding methodology must be analyzed. Only then can we begin to determine the most appropriate methodology for developing DRG weights.

## Acknowledgments

The author thanks Lisa Potetz and Candace Littell for their useful advice and comments on this analysis and on earlier versions of this article. The author also acknowledges the expert computer programming assistance of Ben Steffen.

## References

- American Hospital Association. *National Hospital Panel Survey Reports*. Chicago. Monthly reports for Oct. 1985-Sept. 1986.
- Berman, H. J., Weeks, L. E., and Kukla, S. F.: *The Financial Management of Hospitals*. Ann Arbor, Mich. Health Administration Press, 1986.
- Carroll, P., and Gross, P.: Optimizing hospital revenues. *Hospital Materials Management* 12(5):6-8, May 1987.
- Cotterill, P., Bobula, J., and Connerton, R.: Comparison of alternative relative weights for diagnosis-related groups. *Health Care Financing Review*. Vol. 7, No. 3. HCFA Pub. No. 03222. Office of Research and Demonstrations, Health Care Financing Administration. Washington. U.S. Government Printing Office, Spring 1986.
- Cowles, C. M.: The Audit Effect on Selected Medicare Cost Report Variables in the First Year of the Prospective Payment System. Unpublished paper. Office of Research and Demonstrations, Health Care Financing Administration. Baltimore, Md., Oct. 1988.
- Cromwell, J., and Price, K. P.: The sensitivity of DRG weights to variation in nursing intensity. *Nursing Economics* 6(1):18-26, Jan./Feb. 1988.
- Eastaugh, S. R.: Has PPS affected the sophistication of cost accounting? *Healthcare Financial Management* 41(11):50-52, Nov. 1987.
- Federal Register*: Changes to the inpatient hospital prospective payment system and fiscal year 1988 rates. Vol. 52, No. 169, 33035-33039. Office of the Federal Register, National Archives and Records Administration. Washington. U.S. Government Printing Office, Sept. 1, 1987.
- Federal Register*: Changes to the inpatient hospital prospective payment system and fiscal year 1989 rates. Vol. 53, No. 190, 38492-38493. Office of the Federal Register, National Archives and Records Administration. Washington, U.S. Government Printing Office, Sept. 30, 1988.
- Finkler, S. A.: The distinction between costs and charges. *Annals of Internal Medicine* 96:102-109, Jan. 1982.
- Jacobs, P., and Franz, C. R.: Developing pricing policies by diagnostic grouping. *Healthcare Financial Management* 15(1):50-52, Jan. 1985.
- Jencks, S. F., and Williams, D. K.: The Effect of "Decompressing" Medicare DRG Payment Weights: A Paradigm for the Effect of Case Mix Refinement on Payment Accuracy. Working Paper. Office of Research and Demonstrations, Health Care Financing Administration. Baltimore, Md., 1988.
- Lave, J. R.: Is compression occurring in DRG prices? *Inquiry* 22(2):142-147, Summer 1985.
- Mason, G. R.: Evaluating existing rate structures. *Topics in Health Care Financing* 14(1):36-49, Fall 1987.
- Office of Technology Assessment, U.S. Congress: *Diagnosis-Related Groups and the Medicare Program: Implications for Medical Technology*. Pub. No. 0TA-TM-H-17. Washington. U.S. Government Printing Office, 1983.
- Pettengill, J., and Vertrees, J.: Reliability and validity in hospital case-mix measurement. *Health Care Financing Review*. Vol. 4, No. 2. HCFA Pub. No. 03149. Office of Research and Demonstrations, Health Care Financing Administration. Washington. U.S. Government Printing Office, Dec. 1982.
- Prospective Payment Assessment Commission: *Technical Appendixes to the Report and Recommendations to the Secretary, U.S. Department of Health and Human Services, April 1, 1985*. Washington. ProPAC, Apr. 1985.
- Scheiderich, W. A.: Pricing constraints. *Topics in Health Care Financing* 14(1):5-15, Fall 1987.
- Schimmel, V. E., Alley, C., and Heath, A. M.: Measuring costs: Product line accounting versus ratio of costs to charges. *Topics in Health Care Financing* 13(4):76-86, Summer 1987.
- Thorpe, K. E., Cretin, S., and Keeler, E. B.: Are the diagnosis-related group case weights compressed? *Health Care Financing Review*. Vol. 10, No. 2. HCFA Pub. No. 03276. Office of Research and Demonstrations, Health Care Financing Administration. Washington. U.S. Government Printing Office, Winter 1988.