Medicare case-mix index increase

by Paul B. Ginsburg and Grace M. Carter

Medicare paid hospitals a higher amount per admission in 1984 than had been planned because the case-mix index (CMI), which reflects the proportion of patients in high-weighted DRG's versus low-weighted ones, increased more than had been projected. This study estimated the degree to which the increase in the CMI from 1981 reflected medical practice changes, the aging of the Medicare inpatient population, changes in coding practices of physicians and hospitals, and changes in the way that the Health Care Financing Administration collects the data on case-mix. All of the above, except for aging, contributed to the increase in the CMI.

Overview

The Medicare case-mix index (CMI) reflects the costliness of a hospital's Medicare patient mix. The costs are based on the diagnosis-related group (DRG) in which each patient is classified and the weight that Medicare has applied to each DRG to reflect patients' relative costs. For Medicare patients for whom payment was made under the prospective payment system (PPS) in States not waived from the Medicare reimbursement system, the CMI for fiscal year 1984 was 9.2 percent higher than that for calendar year 1981. Because the calculations of budget neutrality that underlaid the PPS rates for 1984 assumed that the CMI would increase by only 3.4 percent, Medicare paid 5.6 percent more per PPS admission in that year than had been planned.[1]

To guide the Health Care Financing Administration (HCFA) in how to deal with the unexpectedly large increase in the CMI, we undertook a study of the components of the increase. We sought to assess what part of the increase resulted from changes in coding practices, what part from changes in medical practices, and what part from changes in Medicare patients' resource needs.

We used two extensive data bases on hospital services for Medicare enrollees: Medicare claims files maintained by HCFA and hospital discharge abstract data collected by the Commission on Professional and Hospital Activities (CPHA). CPHA is a private organization that prepares reports for its subscriber hospitals that enable them to compare themselves with their peers on dimensions such as length of stay and certain indicators of quality. We conducted analyses with files at three levels: the hospital system, the individual hospital, and the individual DRG.

In this article, we discuss possible explanations for the increase in the CMI and describe the two data bases. We also examine the CMI change at a system-wide level. Descriptive data that document the increase in the CMI over the 3-year span are presented, and the role of aging of the Medicare population in CMI changes during this period is examined. A series of regression models are described that focus on separating the 1981-84 increase in the CMI into a component that reflects continuation of trends prior to PPS versus shifts coinciding with PPS. One of the models is also used to examine differences in PPS effects by hospital type.

Following the CMI-level analyses, we then focus on changes in the proportion of discharges in individual DRG's and groups of DRG's. This more detailed analysis sheds additional light on the roles played by coding changes versus medical practice changes. Finally, we recapitulate the results of the sorting of the increase in the CMI into components and discuss the implications for policy.

Reasons for case-mix index increase

The increase in the case-mix index (CMI) could have been the result of coding changes, medical practice changes, and changes in patients' medical needs. Two aspects of coding changes could have been at work: inconsistencies between the data base used to measure the 1981 value of the CMI and that used for the 1984 value and changes in the practices of hospitals and physicians in documentation and coding.

The 1981 and 1984 data bases—MEDPAR (Medicare analysis provider and review files) and PATBILL (information available for inpatient hospital care from the patient bill)—were constructed differently. MEDPAR—the 1981 research file that was used to calculate the weights (relative costs) for each diagnosis-related group (DRG)—was constructed from a sample of Medicare bills submitted under the prior cost-based reimbursement system. Most bills did not include ICD-9-CM codes, but a narrative with the names of diagnoses and (if applicable) surgical procedures. From these narratives, the Health Care Financing Administration (HCFA) coded the principal diagnosis, the presence of additional diagnoses, the first surgical procedure listed, and the presence of additional surgical procedures. The DRG was then assigned from these codes and from the beneficiary's age, sex, and where the patient was discharged to.

PATBILL—the 1984 file—was also constructed from a sample of Medicare bills, but because the form

This research was supported by the Health Care Financing Adminstration under Cooperative Research Agreement 18-C-98489/9.

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[1]In addition to data from fiscal year 1984, we have processed data from the first two quarters of fiscal year 1985. Although the CMI from the latter period is reported and used to discuss the extent of continuing PPS effects on the CMI, much of the analysis focuses on the experience through the end of fiscal year 1984.

used to identify inpatient hospital expenses and other data related to diagnosis and discharge was changed, substantially more information was available to classify patients into DRG's. The physician discharging the patient determined the principal diagnosis (as in the 1981 file), but the diagnosis was translated to ICD-9-CM code by the hospital's medical records personnel, rather than by HCFA. Based on a study of the medical record, up to four secondary diagnoses, which specify the principal condition more accurately or indicate substantial complications or comorbidities, could be listed, as could up to three major procedures. Because the amount of payment for hospitals under the prospective payment system (PPS) was based on the information on the bills in 1984, but not in 1981, attention to the accuracy of the former is likely to be much greater.

In addition to the discrepancies between the two Medicare data bases, the CMI is likely to have been affected by changes in coding practices within hospitals. With reimbursement now dependent on classification of patients into DRG's, more attention is likely to be paid to physician documentation on the medical record of diagnoses and procedures and to the coding of this information from the medical record onto the bill that is submitted to the Medicare intermediary. Because the presence of additional diagnoses and procedures tends to change patient classifications toward higher-weighted DRG's, increased thoroughness in documentation and coding is likely to increase the CMI.

Changes in hospital coding practices could go beyond increased thoroughness, however. A wealth of information is being offered to hospitals explaining how to code to maximize reimbursement under the DRG system. Many of these suggestions focus on coding decisions that are subject to considerable judgment, and they point out the reimbursement implications of all of the possible outcomes. Coding practices aimed at maximizing reimbursement would also increase the CMI, but they are difficult to separate from simple thoroughness.

Changes in medical practices can affect the CMI in several ways. The development and diffusion of new procedures affect the number and, thus, the proportion of discharges in specific DRG's. For example, increasing use of coronary artery bypass surgery and angioplasty increases the proportion of discharges classified into DRG's 106, 107, and 108. Some of these additional discharges reflect a shift from medical DRG's, and others reflect a net addition to hospital discharges. Such a trend increases the CMI over time, because these DRG's have weights much higher than the average for both all DRG's and other DRG's that such patients might have been classified into had they been admitted for alternative medical treatments. In contrast, increasing use of lens procedures (DRG 39) lowers the CMI, because the weight for that DRG is relatively low. Although PPS might have affected the CMI through changes in these medical practice trends, most of the changes between 1981 and 1984 in the CMI that are the result of increasing use of major new procedures are likely to have been independent of PPS.

Changes in the location of treatment can affect the CMI. The shift of surgery to outpatient settings tends to increase the CMI, because the majority of those patients no longer hospitalized would have been classified into DRG's with lower-than-average weights. Any PPS impacts on the CMI through this mechanism would depend on whether this trend in medical practice was speeded up or retarded by the incentives of PPS reimbursement and the actions of peer review organizations.

Finally, aging of the population of Medicare inpatients may affect the CMI. It is well known that the Medicare population is aging, and the CMI is likely to vary by age of patients. But the population of Medicare *inpatients* may be aging faster than the population of Medicare *enrollees*. With the implementation of the working aged provisions of the Tax Equity and Fiscal Responsibility Act of 1982, those working Medicare enrollees 65-69 years of age, that elect to have their employment-based health plan as the primary payer and receive no Medicare hospital benefits would not be classified as Medicare inpatients.

Another factor affecting the aging of the Medicare inpatient population is the shift of some cases to outpatient settings. This is likely to have a differential effect across age categories, though the overall direction is not clear. Some have pointed out that technological change is now enabling older Medicare patients to use outpatient settings for certain procedures, whereas younger Medicare patients had already been treated in outpatient settings. The effects of such a phenomenon have already been taken into account in the context of changes in the location of service.

Data sources

Two major data bases on Medicare enrollees' inpatient episodes were used in this study: information from hospital bills that come to the Health Care Financing Administration (HCFA) through its intermediaries and discharge abstract data sent to the Commission on Professional and Hospital Activities (CPHA) from its subscriber hospitals. The latter data base is known as the Professional Activity Study (PAS).

Medicare data

We used two different Medicare files for 1981 and 1984-85: MEDPAR and PATBILL.[2] We do not describe the MEDPAR file here, because it has been used extensively by researchers for some time (Pettengill and Vertrees, 1982.)

[2]The MEDPAR file is also available for calendar year 1982. We did not make use of it because it was of lower quality than the 1981 file. A higher proportion of discharges did not have a diagnosis-related group assigned.

The information on fiscal years (FY's) 1984 and 1985 discharges came from a file constructed by the Rand Corporation; it contained records from a 20-percent sample of bills for that year that HCFA had received through the middle of May 1985.[3] Because this file was incomplete, we had to adjust for the fact that bills taking the longest to reach HCFA differ from the average bill. To deal with this problem, Rand has developed for HCFA a "backcasting" model to adjust for these differences.[4] The adjustment has a smaller effect on the case-mix index than on some other variables such as the percentage of outliers. For the second quarter of FY 1985, the adjustment increased the estimate of the CMI for prospective payment system (PPS) discharges by approximately 1 percent.

Professional Activity Study data

The patient abstract records that comprise the PAS contain demographic and diagnostic data that include such items as the patient's age, sex, race, date of admission, hospital service, admission diagnosis, principal diagnosis, additional diagnoses, and principal and other operative procedures. Since 1979, all diagnoses and procedures have been coded in ICD-9-CM form. Hospitals also submit information on the expected source of payment.

Data in this study are from all PAS hospitals reimbursed under PPS and that sent CPHA complete patient data continuously throughout the January 1981-September 1984 period. Only records listing Medicare as the expected principal source of payment were used. This left a panel of 705 short-term, general care hospitals that supplied records on 5,942,317 Medicare discharges. Later, however, an additional quarter of data became available, reducing the panel slightly. The smaller panel was used only to assess continuing PPS effects.

For this study, the PAS data have two advantages over the Medicare claims files. First, the collection and editing procedures did not change during the period studied. This means that changes in case mix observed over time were not influenced by changes in the collection instrument, as was the case for Medicare data. Second, PAS data are available with no interruption throughout the 1981-84 period. This facilitates separating shifts in case mix coinciding with the beginning of PPS from underlying prior trends.

The disadvantage of PAS is that it comprises a sample of self-selected subscriber hospitals instead of a random sample of hospitals, except in seven States where CPHA obtains data on all hospitals through data exchange processing agreements with statewide associations.

The panel of hospitals used in this study is generally representative of hospitals that participate in the PPS. The most significant discrepancies are an underrepresentation of small hospitals, of hospitals in the South, of Government hospitals, and of investor-owned hospitals. The underrepresentation of investor-owned hospitals is problematic, because the small number represented in the panel precludes drawing inferences concerning differences in the CMI increase for this group compared with other ownership groups.

To examine differences between the panel and the universe that are not explained by hospital type and that might be relevant to this study of the CMI, we regressed each hospital's MEDPAR CMI on a series of hospital type variables and a binary variable for whether the hospital was in the PAS panel. As shown in Table 1, after adjustment for hospital type, PAS hospitals had a CMI in 1981 that averaged 1.0 percent higher than that of otherwise similar hospitals.

Though small, such a difference could affect this analysis. It might reflect PAS hospitals coding more accurately than other hospitals prior to PPS. This could be a combination of hospitals placing more emphasis on careful coding, perhaps associated with their interest in reports from CPHA, and the results of the training that CPHA gives to medical records technicians at participating hospitals.[5] If more accurate coding explains an important part of this difference, this means that the effects of PPS on coding that are measured with data on PAS hospitals only could be understated. That is, if the PAS hospitals already coded more accurately prior to PPS, they might have a smaller increase in their CMI's as a result of PPS-induced attention to accuracy.

To test this hypothesis, we ran the model just described with 1984 PATBILL data, including variables for the quarter in which the hospital began PPS (Table 1). The coefficient for the PAS variable fell from 0.0099 in 1981 to 0.0032 in 1984 and was no longer statistically significant. This substantial narrowing of the difference between PAS hospitals and others is likely to reflect differential changes in coding. Although we cannot rule out other unspecified variables, a diminished difference in coding practices is the most likely explanation for the difference between the 1981 and 1984 coefficients. Translating the CMI difference between PAS and non-PAS hospitals into percentage terms, and taking into account the fact that our PAS panel comprises roughly one-seventh of the PPS universe, we estimate that time-series analysis of PAS data will understate the effect of PPS on the CMI by 0.6 percentage points.

Case-mix index level analysis

The case-mix index has increased substantially during the time the prospective payment system (PPS) has been in effect. As shown in Table 2, the CMI for PPS discharges was initially 7.3 percent above the

[3]We used the same sampling algorithm that HCFA used in drawing the sample of bills for MEDPAR.

[4]Unfortunately, a published description of this model is not yet available.

[5]MEDPAR was built not from hospital coding of diagnoses and procedures, but from a diagnostic narrative included on the bill; therefore, effects of better coding would have to have improved this narrative for this explanation of the regression coefficient to be correct.

Table 1

Regression of case-mix index on hospital characteristics and Professional Activity Study status: 1981 and 1984

Characteristic	1981 Coefficient	1981 Standard error	1981 Significance level	1984 Coefficient	1984 Standard error	1984 Significance level
Professional Activity Study panel	0.010	0.005	0.04	0.003	0.004	n.s.
Teaching status	—	—	0.0001	—	—	0.0001
No teaching	-0.135	0.014	—	-0.068	0.010	—
Minor teaching	-0.124	0.014	—	-0.057	0.010	—
Major teaching	0.000	c.g.	—	—	c.g.	—
Control	—	—	n.s.	—	—	0.0001
Government	0.002	0.006	—	-0.004	0.004	—
Private nonprofit	0.007	0.006	—	0.013	0.004	—
Investor-owned	0.000	c.g.	—	—	c.g.	—
Number of beds	—	—	0.0001	—	—	0.0001
1-99	-0.128	0.010	—	-0.190	0.007	—
100-299	-0.078	0.010	—	-0.135	0.007	—
200-299	-0.055	0.010	—	-0.099	0.007	—
300-499	-0.021	0.010	—	-0.065	0.007	—
500 or more	0.000	c.g.	—	0.000	c.g.	—
Rural location	-0.022	0.004	0.0001	-0.034	0.003	0.0001
Region	—	—	0.0001	—	—	0.0001
Northeast	-0.012	0.005	—	-0.032	0.004	—
North Central	-0.036	0.008	—	-0.042	0.004	—
South	-0.062	0.005	—	-0.052	0.004	—
West	0.000	c.g.	—	0.000	c.g.	—
Prospective payment system start	—	—	—			0.0001
1983: IV	—	—	—	0.024	.003	—
1984: I	—	—	—	0.012	.003	—
1984: II	—	—	—	0.009	.005	—
1984: III	—	—	—	0.000	c.g.	—
Intercept	1.276	0.016	0.0001	1.304	0.011	0.0001

NOTES: Based on 4,877 (1981) and 4,892 (1984) hospitals: R^2 = 0.23 (1981) and 0.44 (1984); c.g. = comparison group; n.s. = not significant.
SOURCE: The Rand Corporation: Analysis of calendar year 1981 MEDPAR and fiscal year 1984 PATBILL files.

Table 2

Case-mix index increase for discharges under the prospective payment system

Quarter	Case-mix index: 1983-85 quarter	Case-mix index: 1981 quarter	Percent change
Oct.-Dec. 1983	1.131	1.054	7.3
Jan.-Mar. 1984	1.132	1.049	7.9
Apr.-Jun. 1984	1.140	1.047	9.0
Jul.-Sept. 1984	1.154	1.035	11.5
Oct.-Dec. 1984	1.177	1.054	11.7
Jan.-Mar. 1985	1.179	1.049	11.4

NOTES: Diagnosis-related group weights for fiscal year 1984 were used for all entries. Excludes waiver States and exempt units, includes backcasting adjustments.
SOURCE: The Rand Corporation: Analysis of calendar year 1981 MEDPAR and fiscal year 1984 PATBILL files.

level in the corresponding quarter of 1981. The percent change from 1981 increased in each of the next three quarters, as additional hospitals came under the PPS and experience was gained with the program. The CMI for the July-September quarter of 1984 was 11.5 percent above that for the comparable 1981 quarter. For all of fiscal year 1984, the increase from calendar year 1981 was 9.2 percent. Since the end of fiscal year 1984, however, the increase in the CMI appears to have slowed substantially. However, preliminary analysis of more recent data that have become available indicates that this slowdown was a transient phenomenon. Substantial increases in the CMI are seen during the second half of fiscal year 1985.

That PPS has something to do with this increase in the CMI is illustrated in Table 3, where the experience of hospitals in the four States with waivers to use an alternative reimbursement system is compared with those under PPS. The Medicare claims data show that the CMI in waiver States increased only 2.2 percent from calendar year 1981 to fiscal year 1984, compared with a 9.2-percent increase for PPS admissions in nonwaiver States. Similar results are obtained with data from the Professional Activity Study (PAS).[6]

In this section we discuss a series of analyses conducted at the CMI (as opposed to the diagnosis-related group) level to break down the calendar year 1981 to fiscal year 1984 increase into components. First, we estimate the role of aging of the Medicare inpatient population. Second, we use a variety of

[6]The PAS comparison is not as reliable, because two of the waiver States are severely underrepresented in the PAS panel. Note that the PAS comparison is for a different time period than the Medicare comparison.

Table 3

Case-mix index increase in waiver versus nonwaiver States

Item	Waiver States	Nonwaiver States
	Percent change	
Medicare data, calendar year 1981—fiscal year 1984	2.2	9.2
Professional Activity Study data, Fourth quarter 1981—fourth quarter 1984	0.3	5.9

NOTE: Waiver States are Maryland, Massachusetts, New Jersey, and New York. Nonwaiver States are those under the prospective payment system.

SOURCE: The Rand Corporation: Analysis of calendar year 1981 MEDPAR and fiscal year 1984 PATBILL files and of data from the Professional Activity Study.

methods to decompose the CMI increase into pre-PPS trends in the CMI and in shifts associated with PPS.

The PAS data are best suited to measuring pre-PPS trends, because of the continuous time series available. Medicare data, however, are particularly useful in investigating differences during 1984 between hospitals on PPS and those not yet under the program and among hospitals with different amounts of PPS experience.

Aging of Medicare inpatient population

To estimate the effect of aging of the inpatient population, we used the Medicare claims data to calculate the CMI by age group and the proportion of Medicare discharges in each age group in 1981 and 1984. As a check, we calculated the CMI by age group with both 1981 data and 1984 data.

As shown in Table 4, aging did not affect the CMI. Using CMI's by age group from 1981 data, the 1984 age distribution would have resulted in a 1981 CMI of 1.0490, close to the actual 1981 CMI of 1.0486.[7] Similarly, the 1981 age distribution would have resulted in a 1984 CMI of 1.1183, close to the actual 1984 CMI of 1.1181.

The fact that the CMI does not increase monotonically with age accounts for this somewhat unexpected result. The CMI rises with age throughout the younger age groups, but peaks at 70-74 years of age and then declines. This pattern is generally consistent with data on charges per admission.[8]

[7]The slight differences between the CMI's in Table 4 and those in Table 3 are the result of cases with missing DRG's. The hospital-level files underlying Table 3 include estimates of the missing values. Adjustments for missing values could not be made for Table 4, which is based on a discharge file instead of a hospital file.

[8]In an earlier article, we noted that 1979 data on reimbursements per admission did not exhibit this pattern (Carter and Ginsburg, 1985). Two factors may explain this difference. First, practice patterns may have changed over the 5-year period, especially during the last year with the introduction of the PPS. If reductions in length of stay were larger for older patients, then costs per admission would decline for these patients relative to those for younger patients. Second, the 1979 data were cost-based and the 1984 data are charges. Hospital types vary in their cost-to-charge ratios, and older patients may be more likely to be admitted to hospitals with lower ratios of costs to charges.

Table 4

Percent distribution of Medicare inpatients and case-mix index (CMI), by age: 1981 and 1984

	1981		1984	
Age	Percent	CMI	Percent	CMI
Total	100.00	1.0486	100.00	1.1181
Under 65 years	11.91	1.0356	11.30	1.1063
65-69 years	22.45	1.0386	21.17	1.1233
70-74 years	21.61	1.0633	21.05	1.1404
75-79 years	18.55	1.0511	19.41	1.1176
80-84 years	13.69	1.0444	14.43	1.0972
85 years or over	11.78	1.0555	12.65	1.1065

SOURCE: The Rand Corporation: Analysis of calendar year 1981 MEDPAR and fiscal year 1984 PATBILL files for the nonwaiver States.

Time pattern of case-mix index increase

In the analyses here, we attempt to separate the increases in the CMI occurring between 1981 and 1984 that are associated with the introduction of PPS from those that reflect pre-PPS trends. Analyses with both data bases indicate that a large proportion of the increase is associated with the PPS. This is shown in Figure 1, in which quarterly estimates of the CMI are plotted from PAS data. The graph shows the steady increase in the CMI through the third quarter of 1983, and the sharp departure from trend that coincided with the implementation of PPS in the fourth quarter of 1983.

Pre-prospective payment system trend

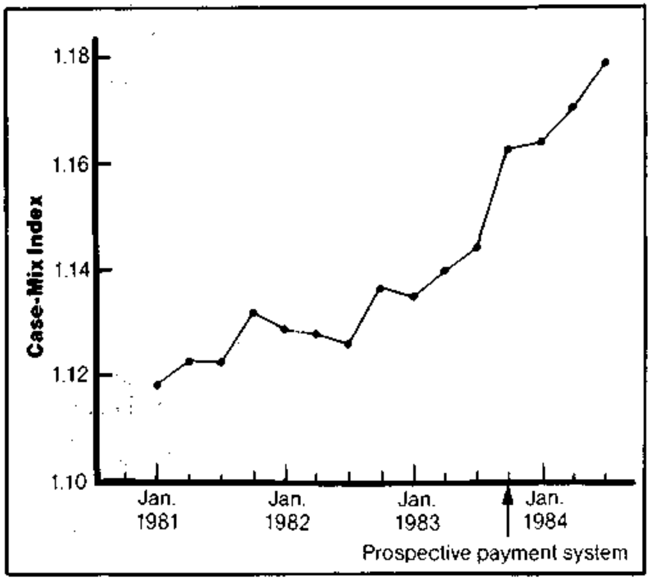
To estimate the magnitude of the pre-PPS trend, we fitted a regression with quarterly data from the PAS panel of 705 community hospitals (Table 5). The dependent variable is based on the ratio of the current CMI to that from the January 1981 quarter. This allows each hospital to be its own control. The model accounts for trends prior to the PPS by including a linear trend that varies by hospital type. Seasonal variation affects the CMI and is captured by four seasonal indicators that vary by census division. The remaining variables in the model are intended to capture the timing of the PPS-induced increase in the CMI and will be discussed later in this article.

The regressions are weighted by the number of Medicare discharges in the hospital.[9] Two factors made weighting desirable. First, weighting reduces the variance of the estimate. Some hospitals had very few Medicare discharges in a quarter, especially in the Medicare file, which sampled 20 percent of

[9]In the regressions with PAS data, the weight of each observation is proportional to the number of Medicare discharges in that hospital quarter. In the regressions on Medicare data, the weight of each observation is proportional to the number of Medicare discharges in that hospital in the calendar year 1981 quarter.

discharges. By giving a lower weight to those hospitals in which sampling error will be more severe, we improve the precision of the estimates. Second, though the observations are CMI's for hospitals, our interest is in the typical Medicare patient discharged. By weighting in this manner, the results on factors associated with the increase in the CMI apply to the average Medicare patient in the data set.

Figure 1
Medicare Case-Mix Index: 1981-84



The trend-variable coefficients give the pre-PPS seasonally adjusted, annual rates of increase in the CMI by type of hospital. Each coefficient is approximately equal to the fraction by which the CMI is changed by a unit increase in the variable.[10] The variable labeled "trend for base case" gives the trend in the type of hospital that is the default for all the other variables—namely, major teaching hospitals in rural locations with fewer than 500 beds in the Pacific census division. The remaining trend interaction coefficients show how the trend changes with differences in each hospital characteristic after controlling for all other hospital characteristics. Thus, hospitals without any teaching and those with only minor teaching responsibilities had smaller pre-PPS trends than major teaching hospitals. This implies that over time teaching hospitals have been specializing in difficult cases to a greater degree. Hospitals with more than 500 beds had larger trends than smaller hospitals. In exploratory analyses, we found no differences among hospitals resulting from type of control. Recalling the small number of investor-owned hospitals in this sample, however, the only implication is that no differences between private nonprofit and public hospitals were discerned.

We estimated the average value of the pre-PPS trend by calculating the weighted average of the trend

[10]The exact formula is that exp(coefficient) = 1 + fraction increase in the CMI. In the range of these coefficients, the given approximation is quite good.

Table 5

Regression of the log case-mix index in a hospital quarter minus the log case-mix index for the same hospital in the first quarter of calendar year 1981

Variable	Coefficient	Standard error	Significance level
April-June 1983 indicator	0.0039	0.0022	0.08
July-September 1983 indicator	0.0084	0.0022	0.0002
Fiscal year 1984 indicator	0.0111	0.0023	0.0001
On prospective payment system during quarter	0.0149	0.0020	0.0001
Number of quarters on prospective payment system	0.0022	0.0018	0.03
Trend for base case	0.0105	0.0010	0.0001
Trend by teaching status	—	—	0.0001
No teaching	-0.0025	0.0011	—
Minor teaching	-0.0042	0.0011	—
Major teaching	0.0000	c.g.	—
Trend by 500 or more beds	0.0053	0.0006	0.0001
Trend by urban location	-0.0001	0.0005	n.s.
Trend by division	—	—	0.0001
New England	-0.0117	0.0019	—
Mid-Atlantic	-0.0047	0.0027	—
South Atlantic	-0.0022	0.0015	—
East North Central	-0.0068	0.0013	—
East South Central	-0.0121	0.0026	—
West North Central	-0.0002	0.0018	—
West South Central	0.0001	0.0025	—
Mountain	0.0036	0.0021	—
Pacific	0.0000	c.g.	—

NOTE: Based on 9,869 hospital quarters, R^2 = 0.152; c.g. = comparison group; n.s. = not significant. The regression also contains 36 coefficients for the four seasons in each of the 9 census divisions. These results are available from the authors.

SOURCE: The Rand Corporation: Analysis of data from the Professional Activity Study.

coefficients for each type of hospital. The weights used were the proportion of Medicare patients discharged from that hospital type in fiscal year 1984, and were taken from our PATBILL file. We estimate that prior to PPS, the CMI was increasing at an annual rate of 0.50 percent. If this trend had continued, the CMI for fiscal year 1984 would have been only 1.38 percent higher than the CMI for calendar year 1981. The remainder of the 9.2-percent CMI increase resulted from the combination of the change in data bases from MEDPAR to PATBILL and from changes that coincided with—and most probably were induced by—PPS implementation.

Prospective payment system effects: Medicare data

A descriptive analysis with the Medicare data shows, dramatically, the effects of hospitals' beginning PPS. The percent increases in the CMI from the corresponding quarter in 1981 are shown in Table 6. The data are organized by the quarter in which the hospital began PPS.

Three important results appear in Table 6. First, substantial increases in the CMI are observed during the quarter in which hospitals first come under PPS. For example, those hospitals beginning PPS during the October quarter (most of them October 1, 1983) had an 8.7-percent increase during the period between that quarter and the corresponding quarter of 1981. In contrast, those hospitals entering PPS during the following quarter had only a 5.3-percent increase in the CMI from the October 1981 quarter to the October 1983 quarter.

Second, hospitals appear to have an increase in their CMI preparatory to their entering PPS. For example, those hospitals entering during the July quarter had a larger increase from 1981 during their April 1984 quarter than during their January 1984 quarter.

Third, increases in the CMI seem to grow with each additional quarter of experience under PPS. Note the pattern for hospitals on PPS during the January 1984 quarter. During each successive quarter, the CMI increase from the corresponding quarter in 1981 was larger. However, this pattern of continued CMI increases appears to have ended abruptly with the October 1984 quarter, and those hospitals entering during the July quarter, which had the greatest preparatory increases, had no increases beyond the July 1984 quarter.

A regression model with the Medicare data confirms the descriptive findings in Table 6. Merging the 1981 and 1984 files and using the hospital quarter as the unit of observation, we regressed the percentage difference in the hospital's CMI between fiscal 1984 and the corresponding quarter in calendar 1981 on a series of variables for hospital type and PPS status (Table 7). The hospital-type variables are teaching status (as defined by interns and residents per bed), ownership, census division, number of beds, and urban or rural location. The PPS-status variables include a binary variable for whether the hospital was under PPS reimbursement during that quarter and one for the number of quarters on PPS. In addition, dummy variables for each quarter are entered to adjust for the October quarter difference spanning only 2 years.

The results show a sharp increase in the CMI associated with being on PPS. After hospital type is held constant, those hospitals on PPS had a 2.8-percent larger increase in their CMI from the corresponding 1981 quarter than hospitals not yet on PPS. The difference grows over time. The coefficient on the number of quarters on PPS indicates that during the period studied, each additional quarter of PPS experience adds 0.51 percentage points to a hospital's CMI.[11] As indicated above, however, this pattern did not continue into fiscal year 1985.

In other regressions, not reported in detail here, we explored the shape of the effect of post-PPS quarters on the CMI increase. In one version of the model, we replaced the variable for the number of quarters with three binary variables indicating whether the hospital had been on PPS for two or more quarters, three or more quarters, or exactly four quarters. The collection of three binary variables was statistically significant ($p < .01$), and the coefficients were 0.47, 0.47, and 0.63, respectively. Consequently, the linear representation in the specification of Table 7 appears to be the correct form of the variable.

We used these regression results to compute PPS's effect on the CMI for the entire fiscal year 1984, taking into account the proportion of Medicare

Table 6
Percent increases in the case-mix index from corresponding quarters in 1981

Discharge quarter	Quarter in which hospital entered prospective payment system: Oct.-Dec.	Jan.-Mar.	Apr.-June	Jul.-Sept.
	Percent change from 1981[1]			
Oct.-Dec. 1983	8.7	5.3	4.9	4.7
Jan.-Mar. 1984	8.5	8.1	5.9	5.0
Apr.-June 1984	9.8	9.3	8.5	6.7
July-Sept. 1984	12.0	11.1	11.7	11.1
Oct.-Dec. 1984	12.1	11.9	12.0	11.3
Jan.-Mar. 1985	11.8	12.6	12.7	12.5

[1] Percent change from corresponding quarter spans a variable number of years. The diagnosis-related group weights for fiscal year 1984 were used for all entries.

SOURCE: The Rand Corporation: Analysis of calendar year 1981 MEDPAR and fiscal year 1984 PATBILL files for the nonwaiver States.

[11] Correlation between a hospital's CMI in successive quarters means that the *t*-statistics are overstated somewhat. However, the *t*-statistics for the PPS variables are so large that we did not bother to make an adjustment.

Table 7

Regression of the percent difference in each hospital's case-mix index between fiscal year 1984 and corresponding quarter in calendar year 1981

Variable	Coefficient	Standard error	Significance level
On prospective payment system during quarter	2.77	0.20	0.0001
Number of quarters on prospective payment system	0.51	0.11	0.0001
Teaching status	—	—	0.0007
No teaching	-1.48	0.41	—
Minor teaching	-1.03	0.40	—
Major teaching	0.00	c.g.	—
Type of control	—	—	0.0001
Government	0.06	0.30	—
Private nonprofit	1.35	0.28	—
Investor-owned	0.00	c.g.	—
Number of beds	—	—	0.0001
1-99	-3.33	0.33	—
100-199	-2.40	0.29	—
200-299	-2.17	0.28	—
300-499	-2.08	0.24	—
500 or more	0.00	c.g.	—
Rural location	-2.14	0.21	0.0001
Census division	—	—	0.0001
New England	-1.23	0.48	—
Mid-Atlantic (Pennsylvania only)	-3.75	0.36	—
South Atlantic	0.79	0.28	—
East North Central	-2.20	0.27	—
East South Central	-0.03	0.33	—
West North Central	4.99	0.32	—
West South Central	4.94	0.30	—
Mountain	1.77	0.40	—
Pacific	0.00	c.g.	—
Quarter	—	—	0.001
Jan.-Mar.	0.19	0.21	—
Apr.-June	1.62	0.23	—
July-Sept.	2.37	0.28	—
Oct.-Dec.	0.00	c.g.	—
Intercept	6.58	0.52	0.0001

NOTE: Based on 19,700 hospital quarters that had cases in both files; R^2 = 0.126; c.g. = comparison group.

SOURCE: The Rand Corporation: Analysis of calendar year 1981 MEDPAR and fiscal year 1984 PATBILL files.

discharges that occurred while hospitals were on PPS and the proportion of those occurring while hospitals were on the program two, three, or four quarters. We concluded that PPS induced a 3.3-percent increase in the CMI for PPS discharges for fiscal year 1984.

Because of the lack of Medicare data for fiscal year 1983, we were not able to estimate increases in the CMI that were associated with the Tax Equity and Fiscal Responsibility Act of 1982 (TEFRA) or were anticipatory to PPS. This analysis depended on comparisons of 1981-84 changes between groups of hospitals entering PPS early and those entering late. Because increases anticipatory to PPS would be reflected in the 1984 CMI of the hospitals entering PPS at the end of the year, the estimate of the PPS effect is likely to be too low. Both the descriptive Medicare data in Table 6 and the analysis of PAS data described later in this article suggest such an anticipatory effect.

Prospective payment system effects: Professional Activity Study data

Through the continuous time series that is available, analysis of the PAS data gives us additional insight into the effect of PPS on the CMI. Besides enabling identification of pre-PPS trends, the PAS data permit estimates of increases anticipatory to PPS. Data analysis cannot distinguish whether this reflects a response to the reimbursement system established by TEFRA or changes in coding procedures made in preparation for PPS, which was enacted in April 1983.

The specification of the model estimated with the PAS data was discussed above (Table 5). The first three variables in Table 5 measure the effect of hospitals preparing for PPS. The first is a binary variable indicating the April 1983 quarter—the first quarter after the enactment of PPS. The coefficient for this variable was very small and not statistically significant. The coefficient for the July 1983 variables shows a substantial increase from the trend, however. Because the coefficient is approximately equal to the fraction by which the CMI is changed by a unit increase in the variable, the July 1983 quarter is estimated to be 0.84 percent higher than it would have been, based on the pre-PPS trend.

The third variable, a dummy for fiscal year 1984, reflects what happened in hospitals during the portion of that year prior to their beginning PPS. The estimates imply that for those quarters, the CMI was 1.11 percent higher than if the pre-PPS trend had continued.

The next two variables measure the post-PPS increase. At entry to PPS, the CMI increased an additional 1.49 percent above the pre-PPS 1984 level (which was itself inflated above the trend). On the average, for the period covered by this regression, it continued to increase an additional 0.22 percent for each additional quarter on PPS.[12]

Assuming that the increase in the CMI during fiscal year 1984 above the pre-existing trend is the result of the PPS, we calculate from these data that the PPS resulted in an increase of 2.9 percent in the CMI for fiscal year 1984 PPS discharges. If we then incorporate our estimate that PAS data are likely to understate the PPS effect by 0.6 percent, our PAS estimate of the total PPS effect is raised to 3.5 percent. This is reasonably consistent with the 3.3-percent PPS effect calculated from the Medicare data, which we considered an underestimate because of the absence of a way to capture the anticipatory effect.

The details of the timing of the PPS effect appear to differ between the two data sources, however. The PAS data, which show a very large preparatory effect (unmeasurable in the Medicare data), show a smaller increase from additional experience with PPS. A possible explanation is that hospitals participating in PAS were quicker than others to implement improvements in their coding practices.

Some analysts have raised the issue of whether the decline in the volume of Medicare admissions coinciding with PPS has been a factor in the increase in the CMI. Their reasoning is that admissions in lower-weighted DRG's may have declined disproportionately, thus increasing the CMI.

To test for this possibility, we added a variable to the model in Table 6 for the change in the number of admissions. Because volume changes may have had a different effect in 1984, when aggregate volume was declining, than in prior years, we added two interactions between volume change and dummy variables for the hospital's being on PPS and the quarter being from fiscal year 1984. The coefficients used to estimate the effect of PPS were essentially unchanged by the addition of these variables. Indeed, the estimates were slightly higher. None of the volume variables had a statistically significant coefficient.

We used an additional specification of the model to test for the effects of volume changes on the CMI. Instead of specifying both the dependent variable and the volume variables as the change from the first quarter of 1981, we used the change from the corresponding quarter in the previous year. Again, the estimates of the effects of PPS were unchanged, but the coefficients for the volume variables were more interesting. The coefficients on both of the interaction variables were significant and indicated that a 4-percent decline in the volume of admissions during 1984 was associated with a 0.2-percent increase in the CMI.[13]

To test whether different hospital types had relatively larger or smaller PPS effects, we added an interaction of each of the hospital-type variables with the fiscal year 1984 variable (Table 5). We used this rather than the "on PPS" variable in order to include anticipatory increases. This specification measures whether some hospital types departed from their specific pre-PPS trends to a greater extent than other hospitals. None of the intereactions were significant except for the teaching status variables. Teaching hospitals had a slightly smaller PPS effect than nonteaching hospitals. This result may be a reflection of better coding prior to PPS on the part of the teaching hospitals.[14] Thus, the increase in the CMI associated with PPS was an across-the-board phenomenon, not restricted to specific types of hospitals.

Diagnosis-related group level analysis

To understand the mechanism of the increasing case-mix index, we examined which diagnosis-related groups (DRG's) were increasing in use relative to others. We looked at which major diagnostic categories (MDC's) were responsible for the largest shares of the CMI increase, whether surgical DRG's increased relative to medical DRG's, whether there was a tendency toward the DRG's with complications and comorbidities, and what role was played by shifts to outpatient settings.

Methodology

Regression analyses related the change in the share of discharges accounted for by each DRG to its trend before going on the prospective payment system and to the introduction of PPS. For each DRG, a simple regression model was estimated with quarterly Professional Activity Study (PAS) data, in which the dependent variable was the change in the percent of Medicare discharges in that DRG compared with the corresponding quarter in the previous year. The independent variables were an intercept term, and a binary variable for whether PPS was in effect during

[12]Like the Medicare data, the PAS data show an end to CMI increases in the first quarter of fiscal year 1985.

[13]Details of these results are available from the authors.

[14]Teaching hospitals had a larger CMI increase between 1981 and 1984, but this was the result of a higher pre-PPS trend instead of a larger PPS effect.

the quarter. Such a model separated pre-PPS trends in the number of discharges from departures from those trends coinciding with PPS.[15]

On the basis of each DRG's two regression coefficients, its relative weight, and its proportion of Medicare discharges, we calculated its contribution to the pre-PPS trend in the CMI and to the shift associated with PPS.

Let

x_k = contribution of DRG_k to CMI trend; and

y_k = contribution of DRG_k to the 1984 shift.

Then

$$x_k = \frac{a_k}{T}(w_k - \bar{w}); \text{ and}$$

$$y_k = \frac{b_k}{S}(w_k - (\bar{w} + 2.75T));$$

where

w_k = weight on the k^{th} DRG;

$\bar{w}$ = 1981 CMI (the average weight);

a_k = intercept in regression equation for k^{th} DRG giving annual trend in the percent of Medicare cases in the DRG;

b_k = coefficient for FYI 1984 (PPS) in the regression equation for the k^{th} DRG (FY 1984 shift);

T = pre-1984 trend in the CMI; and

S = 1984 shift in the CMI.

Thus ($\bar{w}$ + 2.75T) is what the 1984 CMI would have been if only pre-PPS trends had continued.

DRG's with weights larger than average contribute positively to explaining the CMI increase by increasing their share of Medicare discharges. DRG's with weights smaller than average contribute positively to explaining the CMI increase by decreasing their share of Medicare discharges.

The DRG's that had the largest contributions are shown in Table 8. Note that those DRG's contributing most to the pre-PPS trend are different from those contributing most to the shift.

Major diagnostic categories

To obtain a broad perspective on the sources of the trend and shift components of the CMI increase, we aggregated the DRG's into the major diagnostic categories. The proportion of Medicare admissions and the contributions to the shift and trend for each MDC are shown in Table 9.

Contributions by major diagnostic category

Looking at the contributions to the trend, MDC 5 (circulatory system) has the largest contribution, both in absolute terms and relative to its proportion of Medicare discharges. It accounts for 53 percent of the trend in the CMI. Increasing rates of heart surgery play an important role in this. Substantial negative contributions to the trend in CMI increases have been played by MDC 17 (myloproliferative and poorly differentiated neoplasms) and MDC 2 (eye). The latter reflects a trend of increasing admissions for lens procedures.

The explanation for the PPS-shift in the CMI is different. Although MDC 5 has the largest contribution here as well, it is not disproportionate to its share of discharges. Large and disproportionate contributions come from MDC 8 (musculoskeletal and connective tissue) and from MDC 2. In the latter case, the trend towards higher admissions reversed, with a sharp decline beginning about the time of introduction of the PPS. The decline in the proportion of discharges classified into DRG 468 (major operating room procedure unrelated to principal diagnosis) had an important negative contribution to the CMI shift.

Table 8

Diagnosis-related groups with the largest percent contributions to the case-mix index increase

Diagnosis-related group		Percent
Largest contributors to trend		
106	Coronary bypass with cardiac catheter	21
410	Chemotherapy	-10
209	Major joint procedures	9
107	Coronary bypass without cardiac catheter	8
108	Cardiothoracic procedures, except valve and coronary bypass, with pump	8
110	Major reconstructive vascular procedures age >=70 and/or complications or comorbidities	8
Largest contributors to shift		
39	Lens procedures	19
121	Circulatory disorders with acute myocardial infarction and cardiovascular complications discharged alive	8
108	Cardiothoracic procedures, except valve and coronary bypass, with pump	8
209	Major joint procedures	7
148	Major small and large bowel procedures age >=70 and/or complications or comorbidities	7

SOURCE: The Rand Corporation: Analysis of data from a panel of 705 hospitals in the Commission on Professional and Hospital Activities Professional Activity Study.

Surgical versus medical diagnosis-related groups

Most MDC's consist of both medical and surgical DRG's, with the latter tending to have the higher weight. In some cases the surgical procedure responsible for classifying a patient into a surgical DRG is a minor one, so that more complete coding of such procedures can increase the CMI by substituting a surgical DRG for a medical one.

To study the role of such coding, we compared the proportion of medical versus surgical DRG's in 1984 with the proportion that would have been expected if prior trends had continued. For each of the 15 MDC's that have both medical and surgical DRG's, we compared the proportion of discharges in surgical DRG's in 1984 with the proportion projected on the

[15]The results for each DRG are in the appendix of Carter and Ginsburg (1985).

Table 9

Contributions to case-mix index trends and shifts, by major diagnostic category: 1981

Major diagnostic category	Percent of discharges, 1981	Percent contribution to	
		Trend	Shift
1. Nervous system	8.0	8	5
2. Eye	4.7	−9	18
3. Ear, nose, and throat	1.9	4	4
4. Respiratory system	10.9	−1	15
5. Circulatory system	21.5	53	20
6. Digestive system	13.2	16	8
7. Hepatobilia and pancreas	3.2	−1	3
8. Musculoskeletal and connective tissue	9.8	11	19
9. Skin, subcutaneous tissue, and breast	3.3	7	3
10. Endocrine, nutritional, and metabolic	3.4	2	2
11. Kidney and urinary tract	4.9	4	4
12. Male reproductive	3.2	3	1
13. Female reproductive	1.6	4	1
14. Pregnancy, childbirth, and the puerperium	0.1	1	−0
15. Newborns	0.0	1	−0
16. Blood and immunological	1.1	−1	1
17. Myloproliferative and poorly differentiated neoplasms	2.2	−10	−2
18. Infectious and parasitic	0.8	4	7
19. Mental	2.0	1	−0
20. Substance use and induced mental	0.5	2	−1
21. Injuries, poisoning, and toxic effects of drugs	1.1	0	2
22. Burns	0.1	−1	1
23. Other	0.8	2	3

SOURCE: The Rand Corporation: Analysis of a panel of 705 hospitals in the Commission on Professional and Hospital Activities Professional Activity Study.

basis of pre-PPS trends in each of the DRG's.

The proportion of surgical DRG's was higher in 1984 than would have been expected on the basis of prior trends. Although the total increase in the amount of surgery was not very large, the shift occurred in MDC's where there was a substantial difference between the average weight of medical and surgical DRG's.

To estimate the contribution of this shift toward surgical cases within an MDC to the overall increase in the CMI associated with the PPS, we calculated what the CMI for 1984 would have been if the proportion of discharges in each MDC remained the same, but the proportion of surgical discharges within each MDC reflected prior trends. The movement within MDC's from medical to surgical DRG's accounts for 22 percent of the PPS-induced shift in the CMI.

We are unable to infer from the above analysis whether this shift toward surgical cases reflects more complete coding of minor surgical procedures or PPS-induced surgery. Although we suspect that coding is responsible for most, research with claims data from Medicare Part B could answer this question more conclusively. Because Part B payment of physicians depends on coding of surgical procedures, it is likely that pre-PPS and post-PPS data would be comparably complete.

Pairs of diagnosis-related groups

To investigate the role of coding further, we analyzed shifts associated with PPS in pairs of DRG's that differ only by the age of the patient and the presence or absence of complications and comorbidities. We identified 107 pairs of DRG's that are relevant to the Medicare population. Of these 107 pairs, 100 had shifts toward the DRG with the higher weight. This is strong evidence that coding changes have contributed to the increase in the CMI; however, the magnitude of the effect on the CMI of this kind of coding change is actually quite modest. If the relative proportion of each pair had followed their pre-PPS trends, the PPS shift would have been only 12 percent lower than it was.[16]

Inpatient shifts to outpatient services

A substantial shift from inpatient to outpatient services, especially in surgery, has been observed in recent years. Because those patients who would have been admitted to the hospital in the past would typically have been classified into diagnosis-related groups with weights lower than average, the movement to outpatient settings tends to increase the CMI.

To investigate the role of shifts to outpatient settings, we developed a list of 37 DRG's in which outpatient care is a significant alternative (Table 10). We did so by using internal documents of the Health Care Financing Administration; a list given to hospitals by a peer review organization (PRO), specifying procedures that should not warrant hospitalization unless special circumstances apply; and suggestions of a physician-researcher at the Rand Corporation.

[16]The actual contribution of the total set of DRG's to the PPS shift is actually much larger than this 12 percent because of changes in the frequency of cases in each pair. There is much more potential for more complex coding changes.

Table 10

Percent contributions to case-mix index trends and shifts, by diagnosis-related groups with potential for outpatient substitution

Diagnosis-related group	Percent contribution to: Total	Trend	Fiscal year 1984 shift
6 Carpel tunnel release	0.85	0.68	1.07
39 Lens procedures	1.51	-13.98	19.21
40 Extraocular procedures, except orbit age > = 18	1.03	1.83	0.13
53 Sinus and mastoid procedures, age > = 18	-0.10	0.14	-0.38
55 Miscellaneous ear, nose and throat procedures	0.20	0.42	-0.05
61 Myringotomy age > = 18	0.04	0.03	0.06
161 Inguinal and femoral hernia procedures, age > = 70 and/or complications or comorbidities	-0.02	0.93	-1.11
162 Inguinal and femoral hernia procedures, age 18-69 without complications or comorbidities	1.05	2.04	-0.06
187 Dental extractions and restorations	0.33	0.83	-0.22
221 Knee procedures, age > = 70 and/or complications or comorbidities	0.10	0.24	-0.04
222 Knee procedures, age < 70 without complications or comorbidities	-0.01	-0.11	0.12
225 Foot procedures	-0.03	-0.32	0.31
228 Ganglion (hand) procedures	0.18	0.41	-0.07
229 Hand procedures except ganglion	0.40	0.32	0.50
232 Arthroscopy	0.08	-0.00	0.18
261 Breast procedures for nonmalignancy except biopsy and local excision	0.03	0.05	0.00
262 Breast biopsy and local excision for nonmalignancy	0.49	1.17	-0.27
266 Skingrafts except for skin ulcer or cellulitis without complications or comorbidities	0.12	0.15	0.08
267 Perianal and pilonidal procedures	0.00	0.03	-0.03
268 Skin, subcutaneous, tissue and breast plastic procedures	0.14	0.19	0.09
270 Other skin, subcutaneous tissue, and breast operating room procedures age < 70 without complications or comorbidities	0.32	0.55	0.07
310 Transurethral procedure, age > = 70 and/or complications or comorbidities	-0.15	0.46	-0.86
311 Transurethral procedure, age < 70 without complications or comorbidities	0.41	0.65	0.16
320 Kidney and urinary tract infections, age > = 70 and/or complications or comorbidities	-0.81	-2.07	0.61
321 Kidney and urinary tract infections age 18-69 without complications or comorbidities	0.75	1.04	0.44
322 Kidney & urinary tract infections, age 0-17	0.00	0.01	-0.01
328 Urethral stricture, age > 70 and/or complications or comorbidities	0.39	0.67	0.08
329 Urethral stricture, age 18-69 without complications or comorbidities	0.20	0.36	0.02
336 Transurethral prostatectomy, age > = 70 and/or complications or comorbidities	-0.21	-0.17	-0.31
337 Transurethral prostatectomy, age < 70 without complications or comorbidities	0.62	0.91	0.31
342 Circumcision, age > = 18	0.26	0.63	-0.16
359 Tubal interruption for nonmalignancy	0.01	0.02	0.00
361 Laparoscopy and endoscopy (female) except tubal interruption	0.05	0.06	0.06
362 Laparoscopic tubal interruption	0.02	0.05	-0.01
364 Dilation and curettage, conization, except malignancy	1.00	1.47	0.47
410 Chemotherapy	-7.19	-10.41	-3.57
412 History of malignancy, with endoscopy	0.91	1.14	0.64

SOURCE: The Rand Corporation: Analysis of calendar year 1981 MEDPAR and fiscal year 1984 PATBILL files.

In analyzing the contribution that changes in the proportion of discharges in these DRG's made to the overall CMI increase, we found that DRG 39 (lens procedures) had to be analyzed separately. It accounts for such a large proportion of Medicare discharges and has experienced such large changes over time that it tends to dominate the other 36 DRG's on the list. To a lesser extent, DRG 410 (chemotherapy) is also worthy of separate analysis.

Over time, the other 35 DRG's have fallen as a percent of Medicare discharges. Because the resource needs of such patients (as reflected in DRG weights) are much lower than average, this decline has contributed to the increase in the CMI. We estimate that these 35 DRG's account for 15 percent of the trend in the CMI prior to the prospective payment system (PPS). The relative decline in the proportion of discharges in these DRG's accelerated somewhat during PPS, but this accounted for only 1 percent of the shift in the CMI associated with the PPS.

The fact that discharges in these DRG's did not increase during the first year of the PPS must be highly encouraging to HCFA. If the incentives of per case payment were to increase the admission rate, these DRG's would be prime candidates. Either the incentives have turned out not to be as strong as had been commonly predicted or other forces—such as PRO review, technological change, or changes in physician attitudes—have predominated.

The pattern for lens procedures is quite different. During the pre-PPS period, the number of discharges in DRG 39 increased substantially—from 3.62 percent of Medicare discharges in calendar year 1981 to 3.95 percent in fiscal year 1983. This tended to reduce the

CMI, offsetting the increase from other DRG's.

In 1984, however, this was reversed, with discharges declining to 3.52 percent of Medicare discharges. This departure from the previous trend accounted for 19 percent of the increase in the CMI associated with PPS.

Because hospitals regard the reimbursement for DRG 39 under PPS as too low,[17] PPS may have encouraged them to shift the procedures to their outpatient departments, where reimbursement is still on the basis of incurred costs. Discouragement of inpatient lens procedures by PRO's may also have contributed to this shift.

DRG 410 grew more rapidly than other DRG's prior to PPS, slowing the increase in the CMI from what it otherwise had been. During PPS, this rapid growth accelerated, thus keeping the PPS shift smaller than it otherwise would have been.

Confirmation with cross-section data

Because the above DRG-level analysis was based on a time series model, with the observations aggregated over all hospitals in nonwaiver States, there is a risk of confounding the effects of PPS with those of a technological change that happened to coincide with the program. Such a confounding would require a very rapid diffusion of the change, but the possibility cannot be ruled out with time series data.[18]

In order to reduce the chance of incorrectly identifying a technological or other change as a PPS effect, we compared the proportion of discharges in a given DRG in hospitals on PPS with that in hospitals not yet on PPS. We used hospital-level data from PATBILL for discharges in fiscal year 1984.

For each of the 15 DRG's with the largest contributon to the PPS shift, we estimated a regression explaining the proportion of discharges in fiscal year 1984 classified into that DRG.[19] The independent variables were those on hospital characteristics (Table 7), and a variable for the proportion of months in fiscal year 1984 that the hospital was on PPS. The regression was weighted by the number of Medicare discharges, so that large hospitals had a larger influence on the regression.

Where the time series analysis showed that the proportion of discharges in a DRG increased with PPS, we would expect to find that hospitals with more months on PPS would have higher proportions of discharges in that DRG. Table 11 summarizes the results of these regressions. Of the 15 DRG's, all of the coefficients have the predicted sign and all but 1 are statistically significant. This provides strong confirmation that our identification of PPS effects was not confounded by technological change.

The one DRG without a statistically significant coefficient is DRG 39 (lens procedures). The uncertain confirmation of the time series results for DRG 39 may indicate that technological change and/or increased utilization review efforts by the PRO's may have been more of a factor than PPS in shifting cataract surgery to outpatient settings. Because this study treated the shift in DRG 39 as a medical practice change, the doubt that the shift was induced by PPS does not alter our conclusions about the role of coding changes in the CMI increase.

Conclusions

Here we will organize the results presented to answer the question of how much of the 9.2-percent increase in the case-mix index is the result of changes in medical practice, aging of the Medicare population, and documentation and coding practices. We will then discuss the policy implications of these results.

Recapitulation of results

Medical practice changes accounted for a small portion—2.0 percentage points—of the overall increase in the case-mix index (CMI). As shown in Table 12, that figure has two distinct components. The trend in the CMI prior to the prospective payment system (PPS), which we attribute to medical practice changes, accounts for 1.4 percentage points (0.50 percent per year for 2.75 years). The sharp departure from trend in the proportion of admissions for lens procedures accounts for 0.7 percentage points. This was computed by taking 19 percent of the 3.5-percentage point increase in the CMI attributed to PPS by the regression models.

Aging of the population of Medicare inpatients did not contribute to the increase in the CMI over this period, and it is unlikely to in the immediate future.

The remainder of the CMI increase—7.0 percentage points—is attributed to documentation and coding. This consists of 2.8 pcercentage points for the effects of PPS-induced coding changes and 4.0 percentage points for the inconsistencies beteween the 1981 MEDPAR data base and the 1984 PATBILL data base.

The estimate for PPS-induced coding changes comes from the regression models estimated on the Medicare and Professional Activity System (PAS) data bases, respectively. From the Medicare analysis, a 3.3-percent increase in the CMI was associated with PPS. From the PAS analysis, a 3.5-percent increase was calculated. Because the estimates from the regressions on the Medicare data base may be too low because of the inability to measure an anticipatory effect, we have used the slightly higher result from the PAS analysis.

The estimate of PPS-induced coding changes is a 2.8-percentage point impact on the CMI, instead of a

[17]See, for example, the appendix to the report of the Prospective Payment Assessment Commission (1985). In the recalibration of DRG weights for 1986, HCFA increased the weight of DRG 39 from 0.50 to 0.58—a 14-percent increase relative to other DRG's.

[18]In contrast to the hospital-level analysis, the DRG-level file does not include information on the timing of hospitals' entry into PPS. Thus, no control group is available.

[19]The 15 DRG's accounted for 93.5 percent of the PPS shift.

Table 11

Cross-section analysis of the 15 most important diagnosis-related groups, by proportion of Medicare discharges in hospitals on prospective payment system: Fiscal year 1984

Diagnosis-related group	Hypothesis[1]	Proportion of discharges: Coefficient (x100)	Proportion of discharges: Significance level
39 Lens procedures	–	–.22	.3
121 Circulatory disorders with acute myocardial infarction and cardiovascular complications discharged alive	+	.29	.0001
108 Cardiothoracic procedures, except valve and coronary bypass, with pump	+	.03	.03
209 Major joint procedures	+	.20	.0002
148 Major small and large bowel procedures age > = 70 and/or complications or comorbidities	+	.17	.0001
182 Esophagitis, gastroenteritis, and miscellaneous digestive disorders age > = 70 and/or complications or comorbidities	–	–.17	.02
87 Pulmonary edema and respiratory failure	+	.22	.0001
210 Hip and femur procedures except major joint age > = 70 and/or complications or comorbidities	+	.03	.0001
79 Respiratory infections and inflamations age > = 70 and/or complications or comorbidities	+	.16	.0001
124 Circulatory disorders except acute myocardial infarction, with cardiac catheter and complex diagnosis	+	.16	.0001
110 Major reconstructive vascular procedures age > = 70 and/or complications or comorbidities	+	.09	.0001
132 Atherosclerosis age = 70 and/or complications or comorbidities	–	–.55	.0001
134 Hypertension	–	–.17	.0001
416 Septecemia age > = 18	+	.18	.0001
183 Esophagitis, gastroenteritis and miscellaneous digestive disorder age 18-69 without complications or comorbidities	–	–.15	.0001

[1] The hypothesis is the sign of the coefficient expected on the basis of the results of the time series analysis.

NOTES: Other independent variables were teaching status, ownership, bed size, census division, and urban or rural location. See Table 8 for details. DRG's were ranked according to the absolute value of their contribution to the fiscal year 1984 shift.

SOURCE: The Rand Corporation: Analysis of fiscal year 1984 PATBILL file.

Table 12

Decomposition of case-mix index increase, by selected variables: 1981-84

Variable	Percent change
Calendar year 1981—fiscal year 1984	
Case-mix index increase	9.2
Medical practice changes:	
Total	2.0
Trend prior to prospective payment system	1.4
Shifts to outpatient associated with prospective payment system	0.6
Setting for lens procedures	0.7
Setting for chemotherapy	–0.1
Other outpatient substitution	0.1
Older patients	
Coding practice changes:	
Total	7.0
Induced by prospective payment system	2.8
MEDPAR or PATBILL inconsistency	4.0

NOTE: Numbers are multiplicative instead of additive; for example, 1.028 x 1.040 = 1.070.

3.5-percentage point impact, because 0.6 percentage point of the PPS effect reflects shifts in outpatient substitution—medical practice change.

The effect of data base inconsistencies is calculated as a residual. The 4.0-percentage point contribution is that component of the 9.2-percent increase not explained by other factors.[20]

If we look at the change in Medicare/CPHA differences in the CMI over time, the direct method produces an estimate of 2.1 percent. The residual is much closer to the original estimate of 3.4 percent developed by the Medicare Actuary on the basis of a comparison of MEDPAR with data for 1981 collected by the professional standard review organization.

Policy implications

The two critical findings from this study that relate to policy are the following:

- Much of the increase in the CMI between calendar year 1981 and fiscal year 1984 is related to changes in coding practices on the part of hospitals and in data collection procedures on the part of HCFA.
- The increase in the CMI may be a one-time adjustment to the new reimbursement environment.

[20] Originally, we had hoped to estimate this directly by comparing the 1981 MEDPAR CMI with the 1981 PAS CMI for PAS hospitals. We made this comparison, and calculated a 5.2 percent difference. As a check, we made the same comparison for 1984, and instead of finding a negligible difference, we calculated a 3.0 difference. We still do not understand why Medicare's data system and the CPHA data system should indicate such different CMI's for the same hospitals in 1984; for that reason, we prefer calculating the component as a residual.

The first finding supports action by HCFA to offset the component of the increase beyond that projected by the Medicare Actuary. This is not as straightforward as may appear, however, as HCFA may want to treat differently increases resulting from coding and data collection procedures beyond what the Actuary projected versus increases resulting from medical practice changes that exceeded what the Actuary had assumed for that component.

The first finding does not call into question the integrity of the DRG system and those participating in it. An increase in the CMI had been predicted, but with little objective data to estimate the magnitude of the increase. The estimate turned out to be too low. The experience to date is not inconsistent with legitimate improvements in the accuracy of coding practices.

The second finding—that the CMI increase appears to be a one-time adjustment—is a very tentative one, because it is based on only two quarters of experience. If additional experience shows this to be the case, it will give encouragement to those counting on classification on the basis of DRG's to have more than short-term usefulness. If "DRG creep" instead turns out to be more than a one-time adjustment, but a continuing phenomenon, the usefulness of DRG classification is called into question. Although Medicare could protect itself from higher-than-expected payments per case by adjusting the following year's rates, inequities between those hospitals with the largest "creep" and others might become intolerable. As noted above, preliminary analysis of additional data reduces our optimism about this possibility. The second half of fiscal year 1985 showed substantial increases in the CMI, although an important part of the increase represents changes in medical practice, particularly shifts in cataract surgery to outpatient settings.

Acknowledgments

We are grateful to Allen Dobson, Sandra Lichty, and Roland King of the Health Care Financing Administration for suggesting the project, and to James Chesney and Richard Ament of the Commission on Professional and Hospital Activities for preparing the PAS files for analysis. Sally Trude prepared the Medicare claims files for analysis, and George Goldberg advised us on many clinical issues. Joseph Newhouse gave us valuable advice throughout, and Arleen Leibowitz contributed extremely helpful comments on an earlier draft. The authors retain sole responsibility for the views expressed.

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