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TECHNICAL REPORT

Possible Refinements to the Facility-Level Payment Adjustments for the Inpatient Rehabilitation Facility Prospective Payment System

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Prepared for the Centers for Medicare and Medicaid Services

RAND HEALTH

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PREFACE

The Centers for Medicare and Medicaid Services (CMS) implemented the Inpatient Rehabilitation Facility (IRF) Prospective Payment System (PPS) beginning on January 1, 2002. Under this PPS, IRFs are compensated for providing inpatient rehabilitation care based on a pre-determined amount per case according to the patient's impairment, age, level of function and co-morbid conditions. Payments to IRFs are also adjusted to account for additional costs due to certain facility-level characteristics, namely costs due to geographic wage index differences, rural location, and low-income patients. As part of an effort to monitor how well the IRF PPS is functioning, CMS asked RAND to examine potential refinements to the facility-level payment adjustments to improve the alignment between Medicare payments and actual hospital costs.

This work was performed during Phase II of our project to Design, Develop, Implement, Monitor, and Refine the IRF PPS. Phase II began in October 2001. This research has been supported by the Centers for Medicare and Medicaid Services (CMS) through Contract 500-95-0056 and is one part of the final report on that project.

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EXECUTIVE SUMMARY

As part of the Balanced Budget Act of 1997, the U.S. Congress mandated that the Centers for Medicare and Medicaid Services (CMS) implement a prospective payment system (PPS) for care received by Medicare beneficiaries at hospital inpatient rehabilitation facilities (IRFs). This new IRF PPS was implemented beginning on January 1, 2002. Under the new PPS, IRFs are compensated for providing inpatient rehabilitation care based on a pre-determined amount per case according to the patient's impairment, age, level of function and co-morbid conditions. Payments to IRFs are also adjusted to account for additional costs due to certain IRF-level characteristics, namely costs due to geographic wage index differences, rural location, and low-income patients (LIPs).

As part of an effort to monitor how well the IRF PPS is functioning, CMS asked RAND to examine potential refinements to the facility-level payment adjustments to improve the alignment between Medicare payments and actual hospital costs. Several developments make it likely that significant refinements can be made:

- **More recent data.** The data used for these analyses come from calendar year (CY) 2002, while the facility adjustments are based on data from CY 1998-1999. The 2002 data therefore reflect the period during which the IRF PPS was in effect, making it advantageous to use them.
- **Better coding.** Incentives to code comorbidities and severity more thoroughly existed in 2002 that were not present prior to the IRF PPS in 1998-1999, so the potential for different relationships between facility case mix and cost in the 2002 data exists. Similarly, the introduction of payment adjustments for facility

characteristics could have caused IRFs to improve the accuracy of their cost report information on facility characteristics.

- **More complete data.** Our data are more complete for these analyses than before. We now have data on 95 percent of all IRFs, versus the 60 percent we had in when initially developing the facility payment adjustments.
- **New data sources for imputing missing values.** The identification and imputation of missing values for one of the payment variables, the low-income patient measure, has been modified given the availability of different data sources for this variable.
- **More accurate case mix groups.** The case mix groups (CMGs) and tiers used to derive the case mix indices (CMIs) of IRFs are derived using the approach recommended by RAND's Technical Expert Panel (TEP) in June 2004, in contrast to using the CMGs currently used in the IRF PPS.
- **Improved statistical approach.** We have improved our statistical approach to assessing the sensitivity of the facility-level payment adjustments to unduly influential IRFs that could have unusually high (or low) costs.

Our analysis aimed to assess whether the current facility-level payment adjustments are still appropriate and whether changes need to be made.

Our key findings are as follows:

1) Rural and LIP adjustments are still appropriate. Using the standard linear regression approach employed last time would support a rural adjustment of 21.2 percent and a low-income adjustment of $(1+LIP)^{.616}$, as compared to 19.1 percent and $(1+LIP)^{.484}$ currently in use. While these rural and low-income adjustments are larger than those currently being used, they are statistically indistinguishable.

2) There is support in the data for an indirect teaching adjustment. The IRF PPS currently does not include an indirect teaching adjustment, though the acute PPS does include one. In contrast to the Phase I data, the current data show that indirect teaching is positively and significantly related to cost per case. The numeric adjustment would be (1 + interns and residents / average daily census)$^{0.963}$.
3) The CMI is no longer compressed. Compression exists when IRFs with relatively high CMIs have costs that are higher relative to their CMI than hospitals with lower CMIs. The latest measure of CMI more accurately reflects resource use than it did under Phase I.
4) The wage index (WI) is still compressed. IRFs with relatively high wage index values have costs that are higher relative to their wage indices than IRFs with lower wage index values.
5) While we found evidence that an alternative model to the standard linear regression-based approach to derive facility-payment adjustments is an improvement, we did not find that the alternative method resulted in payment adjustments that were statistically significantly different from those obtained using the standard approach.

In CY 2002, provider responses to the IRF PPS were not complete, as many hospitals were not on the PPS throughout the entire calendar year. Under the IRF PPS, IRFs now have incentives to code comorbidities more thoroughly. Other factors could influence the regression results as well, such as reductions in length of stay and other cost containment measures. We will therefore need to repeat the analysis using FY 2003 data before making numerical recommendations. These recommendations will

also depend on the decision CMS will make regarding which definitions of CMGs, tiers and relative weights to use for refinement.

I. INTRODUCTION

As part of the Balanced Budget Act of 1997, the U.S. Congress mandated that the Centers for Medicare and Medicaid Services (CMS) implement a prospective payment system (PPS) for hospital inpatient rehabilitation (IRF) care provided to Medicare beneficiaries. This new IRF PPS was implemented beginning on January 1, 2002. Under the IRF PPS, IRFs are compensated for providing inpatient rehabilitation care based on a pre-determined amount per case according to the patient's impairment, age, level of function and co-morbid conditions.

The payment for an inpatient rehabilitation stay under the IRF PPS is a product of three factors: a national standard payment; the weight assigned to the patient's case mix group (CMG) that adjusts the national standard payment for the relative costliness of patients in the case mix group; and a facility adjustment to compensate IRFs for factors associated with increased costs that are beyond their control. Under the IRF PPS, IRFs are compensated for the geographical wage differences as statutorily required, rural location (rural IRFs receive 19.1 percent additional payment), and for serving low-income patients (LIPs) (the LIP adjustment is $(1 + \text{LIP})^{0.484}$, where LIP is the percentage of Medicare patients who are entitled to supplemental security income (SSI) plus the percentage of all inpatients who are eligible for Medicaid but not Medicare). Payment is further adjusted for outlier cases and short stay transfer cases. The development of the standard payment, case weights and rules for payment of unusual cases are further detailed in our Phase I report (Carter et al., 2002).

The Centers for Medicare and Medicaid Services (CMS) is expected to refine the IRF PPS next year. Potential refinements are driven both by improved methodology and improved data sources. Since the implementation of the IRF PPS, RAND has been

working on improving the methods for deriving case weights and adjusting facility payments. This report describes our work refining the facility payment adjustments under the IRF PPS. The general approach we use here is similar to that used in our Phase I project (Carter et al., 2002, Chapter 7), in that multivariate regression analyses were used to identify and derive facility payment adjustments. The approach used to derive facility payment adjustments differ from previous work in the following ways:

- The data used for these analyses come from CY 2002, while the facility adjustments are based on data from CY 1998-1999. In addition to providing more up-to-date data, the 2002 data were collected after the IRF PPS was implemented, making it advantageous to use them. New incentives to code comorbidities and severity better were introduced in the 2002 payment arrangements that were not present earlier. (Carter and Paddock, 2004), so the potential for different relationships between facility case mix and cost exists. Similarly, the introduction of payment adjustments for low-income patients could have caused IRFs to complete the cost report information on Medicaid patients more accurately.
- Our data source for these analyses is more complete than it was before. We now have data on 95 percent of all IRFs, versus the 60 percent we had in Phase I (Carter et al., 2002, p. 22).
- The identification and imputation of missing values for LIP has been modified given the availability of different data sources for this variable.
- As described in companion reports (Carter, Relles, Ridgeway, and Buntin, 2004; Carter and Totten, 2004), the CMGs and tiers used to derive the case mix indices (CMIs) of IRFs are derived using the approach recommended by RAND's Technical Expert Panel (TEP) in June 2004, in contrast to using the CMGs

currently used in the IRF PPS. We will compare CMIs derived from these "recommended CMGs" with those derived from the "implementation CMGs" that are currently in use under the IRF PPS.

- We assess the sensitivity of the facility-level payment adjustments to the assumptions underlying the standard linear regression model used to derive facility-level payment adjustments. We employ a Bayesian outlier accommodation model (BOAM) that identifies IRFs whose costs are far greater or less than average given their IRF characteristics -- we shall call these IRFs "statistical outliers" in this report – and downweights their contribution to the payment adjustments (Paddock, Wynn, Carter, and Beeuwkes Buntin, 2004).

II. DATA SOURCES

We summarize in Table 1 the data sources used in the analyses for this refinement report compared to those we used in our Phase I report. We describe the derivation of these measures as well as any changes made to the measures since Phase I.

Table 1

Comparison of data used in Phase I and refinement reports

Data element	Phase I report	Refinement report
Claims data	CY1998 and 1999 1998 and 1999: 647 facilities 1998 only: 20 facilities 1999 only: 47 facilities	CY 2002: 1143 facilities
Cost reports	Hospital 2552-96 Cost Report Data files: latest files available as of 4/2000	Hospital 2552-96 Cost Report Data files: latest available as of 3/2004
Average cost per case (derived from cost report)	Average for 1998 and 1999 cases	Average for 2002 cases
Average case mix index	Average for 1998 and 1999 cases	Average for 2002 cases
Wage index	FY 2001 hospital wage index - non-reclassified; no GME wages	FY 2004 SNF wage index - non-reclassified hospital wage data (no GME wages)
SSI percentage	Derived from FY 1999 MedPAR claims for rehabilitation facilities.	Payment SSIs for FYs 2002 and 2001, available at http://www.cms.hhs.gov/providers/irfpps/ssidata_ratios.asp
Medicaid percentage	Latest available cost report; used SSI percentage and state to predict missing values	Latest available cost report; missing values imputed from the PRICER IRF (latest available from FY 2002-2004)
Number of residents	Latest cost report available as of 12/2000	Latest cost report available as of 3/2004
Resident to average daily census ratio	Ratio from latest available cost reports	Ratio from latest available cost reports
Certification date	Date of certification provided on HCRIS-12 cost report; if missing, OSCAR (10/99 version); if missing, first year for which we have MedPAR data (1996 through 1999)	Date of certification provided on HCRIS-12 cost report; if missing, OSCAR (10/99 version); if missing, first year for which we have bills (1996 through 2002)

Cost per Case

Cost per case was derived here as in Phase I. A case is defined consistently with the policies that were implemented in IRF PPS. In particular, short-stay transfers to another hospital, nursing home or skilled nursing facility (SNF) are counted as a fraction of a discharge and interrupted stays are bundled together into a single discharge. A short-stay transfer case's equivalence to a full case is determined by the ratio of the length of stay for the transfer plus one-half day to the average length of stay for all cases paid as typical in the same CMG. Two or more discharges count as a single case when a patient is discharged from the rehabilitation facility and returns to the same facility on the day of discharge or either of the two following days.

The facility's average cost per case is the sum of the costs for all cases divided by the number of equivalent full cases. We use the cost per case calculated from the analysis file rather than the cost per discharge from the cost report. This provides 1) a match between the cases for which we have case mix data and the costs of those cases and 2) accounts for transfer cases and interrupted stays. By treating short-stay transfers as a partial discharge and bundling interrupted stays, the dependent variable is consistent with payment policies under IRF PPS. The cost for each case was estimated as the sum of 1) the estimated costs incurred by the patient in each ancillary department as determined by applying a departmental cost-to-charge ratio from the cost report to the patient's charges in the department as reported in the claims file and 2) the average per diem costs for "room and board" multiplied by the patient's length of stay (Newhouse, Cretin, and Witsberger 1989).

Case Mix Index

Relative case weights were derived by the hospital-specific relative value (HSRV) method and normalized to 1 for the average equivalent full case. The HSRV method reduces the impact of systematic charge among providers on the relative case weights by converting each provider's charge for a case to a relative value based on that facility's average charge and average case mix index (Carter et al., 2002). The case mix index (CMI) is the average of the case weights for all cases at each facility. We give short-stay transfers a partial weight based on the ratio of the length of stay for the transfer plus one-half day to the average length of stay for typical cases. We used the same method to derive CMI as was used in Phase I, with the exception that it is no longer necessary to apply an adjustment to CMI to decompress it, as we will show below.

Wage Index

The wage index adjustment is intended to account for systematic differences in wage levels across labor market areas. The labor market areas are consistent with other Medicare prospective payment systems (i.e., MSAs and non-MSA areas of states) but are determined without regard to hospital geographic reclassification under section 1866(d)(8) or (d)(10) of the Medicare law. For this report, we used the same wage index as used for the SNF PPS as published in the Federal Register (Volume 68, Number 188, September 29, 2003, Tables 7-8). This wage index does not reflect the effects of geographic reclassification as does the acute hospital wage index. The SNF wage index is appropriate to use since geographic reclassification does not affect the IRF PPS. Consistent with the wage index used in Phase I, the wage index excludes wages for services provided by teaching physicians, interns and residents, and non-physician anesthetists under Part B. Since CMS expressed a preference for

using the pre-determined labor-related share in the IRF PPS, we used it to develop the payment adjustments in the Phase I. We use the same specification in this report. We define the wage index variable as (.72359*wage index + .27641). This is consistent with the way the wage index would be applied in an IRF PPS using a 72.359 percent labor-related share. The 72.359 percent is CMS' Office of the Actuary estimate for the labor-related share of hospital costs in FY 2005, where the labor-related share is composed of wages and salaries, employee benefits, professional fees, all other labor-intensive services, and the labor-related share of capital costs (Federal Register, Vol. 69, Number 146, July 30, 2004).

Geographic Location

As in Phase I, we establish variables to identify whether a hospital was located in a large urban area, other urban area, or in a rural area. Large urban IRFs are defined as those in MSAs having more than 1,000,000 population; in addition, a New England County Metropolitan Area with a population of more than 970,000 is classified as a large urban area. Other urban IRFs are those within a Metropolitan Statistical Area (MSA) that are not large urban IRFs. Numerous discrepancies on the urban/rural measure were found on the cost report as compared to the Provider of Service (POS) file and the PRICER program that calculates payment under the IRF PPS. It is possible that an IRF might have had its urban/rural designation changed through geographic reclassification for the acute PPS but that the actual geographic location would continue to apply for IRF PPS. For this reason, we obtained the urban/rural variable from the IRF's county code on the latest available POS file and used the MSABEA crosswalk (version 8/19/2003) to find the MSA code. To further differentiate urban IRFs into large urban and other urban locations, we used the 2002 acute impact file to identify MSAs containing large urban facilities and merged this information to the IRF data.

Indirect Teaching Costs

The indirect teaching measure used here is the same as was used in Phase I, and was computed as the number of residents divided by the average daily census (Carter et al., 2002). The residents included in this count are those who spend time in the rehabilitation unit of the acute care hospital or in the routine areas of freestanding hospitals. The time is aggregated to an FTE-equivalent basis. Evaluation of the impact of teaching on rehabilitation facility costs is complicated by differences in reporting resident counts for freestanding rehabilitation hospitals and units. No FTE resident count specific to inpatient rehabilitation services is reported. For freestanding hospitals, there is a resident count for the hospital that includes resident time spent on outpatient as well as inpatient services. For rehabilitation units, a resident count for the rehabilitation unit is reported. We assume that the FTE resident count reported for rehabilitation units represents the time residents are assigned to the rehabilitation unit and that it does not include time residents spend in ancillary and outpatient departments.[1] A comparable FTE count for freestanding rehabilitation hospitals would be resident time spent in the inpatient routine areas; however, this FTE count is not reported. To develop a consistent count, we estimated the number of residents assigned to the routine areas of freestanding hospitals based on the ratio of resident salaries apportioned to those areas to total resident salaries for the facility.[2]

As discussed in our Phase I report, the TEP panel noted that the ratio of residents-to-average daily census is not consistent with the Residency Review Committee (RRC) accreditation requirements for programs in physical medicine and rehabilitation and suggested

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[1] Worksheet S-3, Part 1, line 14, column 9 (line 14 for subprovider 1, line 14.01 for subprovider 2).

[2] Number of residents for a freestanding facility is the FTE count for the full facility * (Y/X), where the FTE count for full facility comes from Worksheet S-3, Line 25, Col. 9, Y is resident salaries apportioned to routine areas (sum of Worksheet B, Part I, Col. 22 Lines 25-30), and X is total resident salaries for the facility (Worksheet B, Part I, Col. 22, Line 103).

that there may be reporting errors. One RRC requirement is that a minimum of eight inpatients should be available for each resident while assigned full time to an inpatient rehabilitation service. Using this as a guide, we would expect the maximum resident-to-average daily census ratio would be 0.125. In our Phase I analysis file we found 16 facilities (2.2 percent of all facilities, or 15 percent of all teaching facilities) having a resident- to- average daily census ratio of .20 or higher; in the 2002 data, there are 18 such facilities (1.6 percent of all facilities, or 15 percent of teaching facilities). All of these facilities in the 2002 data are units of acute care hospitals where our FTE count was based on the number reported on the cost report for the rehabilitation unit.

Low-Income Patients

We use the same LIP measure used in Phase I. We defined LIP as the percentage of Medicare patients who are entitled to SSI plus the percentage of all inpatients who are eligible for Medicaid (but not Medicare). This measure is consistent with the PPS for acute care hospitals. We used the SSI percentage provided by CMS for payment in FY 2001 and FY 2002, which are provided on the CMS Web site: http://www.cms.hhs.gov/providers/irfpps/ssidata_ratios.asp. We filled in any missing values using the SSI ratios provided to us by CMS for our Phase I work. We estimated the percentage of patients at an IRF who are eligible for Medicaid but not Medicare from the cost report.[3]

As discussed in our Phase I report, Medicaid days are sometimes erroneously reported as zero on the cost report. In Phase I, we had data from UDSmr on the universe of cases (both Medicare and non-Medicare) for many of the IRFs in our sample that allowed us to determine that the cost report zero values were actually missing values. In the absence of this data

[3] Freestandings: F134/F153. Units: F136/F155 or F137/F156 for sub-providers 1 and 2, respectively.

source, we used the following procedure when we encountered zero Medicaid days using the latest available cost report: we examined whether prior cost report years reported zero Medicaid days; if not, we used that value as an imputed value. We then compared the remaining zero Medicaid days to the PRICER values for Medicaid percent, and used the PRICER value for those IRFs. Any IRFs that still had a zero value for Medicaid percent after this point were left as zero.

Other Factors Affecting Cost

In addition to examining factors that may be appropriate to incorporate into IRF PPS, we explore the effect of other factors on rehabilitation facility costs. We use the same variables as we used in the interim report.

Type of facility. There are 212 freestanding hospitals and 931 rehabilitation units of acute care hospitals in our sample. In the Phase I report, the fully specified regressions found that freestanding hospitals were significantly more expensive than units of acute care hospitals.

Size. We use average daily census (ADC) as the size variable and control for type of facility. We show in Table 2 the dummy variables that we use for the size categories.

Table 2

Size categories used in regression analysis

	Freestanding hospitals	**Rehabilitation units**
Size variable	**ADC**	**ADC**
Small	< 25	< 10
Medium	≥25 and <50	≥10 and <25
Large	≥50	≥25

*Time period for certification***.** In previous work, we used the OSCAR certification date to develop three categories for certification: before 1985, 1985-90, and 1991 or later. Certification date is not reported on versions of the cost report after Healthcare Cost Report Information System (HCRIS) 12. We use the certification date as a measure of how long a facility had been operating under TEFRA. We use the earlier of the following as the certification date: the certification date reported on the HCRIS 12 cost report, the certification date reported in OSCAR, or the first year for which we have bills (1996 or later).

*Type of control***.** We use a dummy variable to explore whether type of ownership affects costs. The fully specified regressions in the Phase I report indicated proprietary facilities are more costly than non-profit or governmental institutions.

III. METHODS: MULTIVARIATE REGRESSION ANALYSES

We develop facility payment adjustments using a two-step multivariate regression analysis (Sheingold, 1990; Carter et al., 2002; Paddock et al., 2004). The first step is to fit a fully specified regression model to examine factors that explain variation in costs per case. The second step is to fit a payment regression model in which factors that were significant predictors of cost in the fully specified model and are deemed to be beyond the control of IRFs by CMS are used to predict average cost per case.

Fully Specified Regressions

Our dependent variable for the fully specified regression is the logarithm of the average cost per case. We perform each regression using the logarithm of the CMI (average CMG weight per case) and log(.72359*wage index +.27641) on the right-hand side of the equation.

In this model, we add dummy variables to indicate freestanding units, date of certification category, size category, type of ownership (proprietary versus not) and geographic location (large urban, other urban, or rural). We also include the indirect teaching measure, log(1+number of residents/ADC), and the low-income measure, log(1+LIP). We case-weight the regressions to reflect the case-based payment policy of the IRF PPS.

Payment Regressions

In the payment regression, we drop variables that are not significantly related to cost in the fully specified regression and include only those variables that are found to be significant and that are potential payment variables – that is, variables that are deemed by CMS to be beyond the control of IRFs. The dependent variable in these regressions is the logarithm of cost per case standardized by the wage index and case mix index.

IV. RESULTS

We found that the rural and LIP adjustments are still appropriate. Using the standard linear regression approach employed in the Phase I report would support a rural adjustment of 21.2 percent and a low-income adjustment of $(1+LIP)^{.616}$. These rural and low-income adjustments are larger than those currently being used, but are statistically indistinguishable from those used under the current rule. There is support in the data for an indirect teaching adjustment. In contrast to the Phase I analysis that found teaching intensity does not have a significant effect on costs, the current data show that teaching is positively and significantly related to cost per case. The TEP supports an indirect teaching adjustment, which is also part of the acute care PPS. We also found that the CMI is no longer compressed. Compression exists when IRFs with relatively high CMIs have costs that are higher relative to their CMI than hospitals with

lower CMIs. The CMI more accurately reflects resource use than it did under Phase I. Wage index is still compressed – the wage index adjustment understates the average cost per case of IRFs in higher wage areas and overstates the average cost per case for IRFs in lower wage areas.

Below, we provide a descriptive statistics of the data used to derive facility payment adjustments, followed by the regression models we used to derive facility level payment adjustments and a sensitivity analysis to assess whether there are IRFs with very unusual costs that are unduly influencing the regression results.

Descriptive Statistics

Table 3 shows the breakdown of characteristics of IRFs in our sample. Urban IRFs are slightly more expensive than rural IRFs ($11,143 versus $11,534) but also have a much higher wage index (0.989 versus 0.827). IRFs in the Pacific census region are more expensive than others. Freestanding IRFs are less expensive than units ($10,274 versus $11,702); in contrast, freestanding IRFs were more expensive in Phase I (Carter et al., 2002, Chapter 7). Teaching IRFs are more expensive than non-teaching IRFs, with the cost increasing as the ratio of interns and residents to average daily census increases. As in Phase I and mentioned earlier, there are some IRFs with ratios of interns and residents to average daily census to be much higher than expected – 18 IRFs have ratios greater than 0.2.

Table 3

Characteristics of facilities in the analysis file

			Case weighted					Facility weighted			
	N facilities	Avg. annual cases	Cost per case	LIP	CMI	Resi-dent to ADC	WI	% large urban	% rural	% free-stand-ing	ADC
All facilities	1,143	357	11,181	0.109	1.000	0.010	0.973	45	16	18	22
By geographic area											
Urban	960	383	11,143	0.109	1.001	0.011	0.989	54	0	20	24
Large urban	519	373	11,690	0.115	0.999	0.018	1.050	100	0	17	25
Other urban	441	394	10,534	0.103	1.004	0.004	0.922	0	0	23	23
Rural	183	218	11,534	0.109	0.987	0.0003	0.827	0	100	11	11
By region											
New England	37	499	12,155	0.090	1.040	0.004	1.109	49	11	32	34
Middle Atlantic	158	474	10,808	0.098	0.948	0.025	1.052	60	10	18	31
South Atlantic	66	469	9,874	0.134	1.051	0.005	0.872	26	29	27	29
East North Central	140	491	10,406	0.119	1.009	0.007	0.939	41	16	23	28
East South Central	99	242	11,397	0.101	0.990	0.009	0.913	33	28	8	15
West North Central	213	308	11,630	0.087	0.999	0.010	0.981	43	14	8	17
West South Central	235	335	11,025	0.111	0.997	0.004	0.885	39	20	28	19
Mountain	76	288	10,378	0.092	0.969	0.008	1.002	43	12	24	18
Pacific	118	206	15,314	0.183	1.083	0.010	1.156	69	5	8	15
Puerto Rico	1	382	7,087	0.006	1.442	0	0.491	100	0	100	31
By freestanding / unit											
Freestanding	212	702	10,274	0.105	1.046	0.003	0.964	42	10	100	47
Unit	931	278	11,702	0.112	0.973	0.015	0.979	46	17	0	16
Low-income patient measure											
< 10	620	381	10,441	0.056	0.975	0.006	0.977	42	16	16	21
10-20 (incl.)	344	363	11,608	0.140	1.025	0.013	0.943	42	18	22	24
20-30 (incl.)	106	292	13,009	0.237	1.037	0.020	1.010	55	15	16	22
≥ 30	73	213	15,345	0.421	1.100	0.045	1.086	78	5	25	20

Table 3 (continued)

			Case weighted					Facility weighted			
	N facilities	Avg. annual cases	Cost per case	LIP	CMI	Resi-dent to ADC	WI	% large urban	% rural	% free-stand-ing	ADC
Avg. daily census											
For units:											
< 10	323	133	12,091	0.101	0.944	0.005	0.939	35	33	0	7
10-25 (incl.)	479	288	11,512	0.112	0.973	0.012	0.968	51	11	0	16
≥ 25	129	606	11,824	0.118	0.989	0.025	1.020	57	2	0	39
For freestanding IRFs:											
< 25	51	184	15,400	0.130	1.012	0.000	0.899	29	27	100	12
25-50 (incl.)	78	600	9,674	0.120	1.056	0.002	0.938	42	5	100	38
≥ 50	83	1,116	10,058	0.095	1.045	0.003	0.983	49	4	100	77
Teaching status:											
No teaching	1018	345	10,923	0.105	1.000	0.000	0.956	41	18	19	20
Teaching hospital (by resident to ADC ratio)											
< .1	72	546	12,063	0.117	1.007	0.032	1.057	76	1	22	41
.1-.2 (incl.)	35	400	14,209	0.173	0.975	0.148	1.127	80	3	6	33
≥ .2	18	165	15,743	0.249	1.039	0.300	1.175	83	0	0	19
Type of ownership											
Voluntary	699	333	11,593	0.105	0.976	0.014	0.990	46	14	8	20
Proprietary	333	439	10,218	0.111	1.038	0.002	0.950	45	16	44	27
Government	111	259	12,741	0.139	0.995	0.023	0.957	41	29	7	18
Certification date											
Before 1/1/1985	269	422	11,637	0.115	1.007	0.017	1.018	55	4	17	28
From 1/1/1985-12/31/1990	336	396	10,535	0.104	1.001	0.010	0.964	48	13	16	23
After 1/1/1991	538	299	11,394	0.110	0.994	0.006	0.946	39	23	21	17
Medicare Days as % of inpatient days											
0-49%	161	237	13,816	0.180	1.044	0.056	1.057	70	2	15	26
50-64%	235	386	11,966	0.123	1.000	0.014	1.039	56	4	19	26
65-79%	402	389	10,595	0.096	0.993	0.004	0.961	46	14	15	21
80% and over	345	354	10,527	0.094	0.995	0.001	0.914	27	32	24	17

Table 3 (continued)

			Case weighted					Facility weighted			
	N facilities	**Avg. annual cases**	**Cost per case**	**LIP**	**CMI**	**Resi-dent to ADC**	**WI**	**% large urban**	**% rural**	**% free-stand-ing**	**ADC**
Total costs per case											
< 25th percentile	286	510	7640	0.080	0.958	0.002	0.919	41	12	28	27
26-50th percentile	285	385	9605	0.096	0.988	0.008	0.960	43	20	18	23
51-75th percentile	286	331	11585	0.107	0.999	0.007	0.975	44	19	13	21
> 75th percentile	286	201	15884	0.154	1.055	0.025	1.040	54	13	15	17
Case mix index											
< 25th percentile	286	327	10060	0.085	0.852	0.015	1.003	45	19	5	16
26-50th percentile	286	355	10733	0.096	0.961	0.007	0.955	43	21	14	19
51-75th percentile	286	420	11298	0.107	1.035	0.009	0.967	43	13	26	26
> 75th percentile	285	324	12634	0.154	1.153	0.010	0.967	50	11	29	26
Wage index											
< 25th percentile	283	336	10355	0.085	1.007	0.002	0.825	2	48	23	18
26-50th percentile	288	356	10411	0.096	0.998	0.007	0.911	37	14	20	21
51-75th percentile	286	375	10849	0.114	0.993	0.008	0.987	67	1	16	22
> 75th percentile	286	360	13097	0.142	1.002	0.024	1.166	75	2	14	25

Fully Specified Regression

Table 4 shows the results of the fully specified regression. Almost all characteristics in the regression were significantly related to the logarithm of cost per case. Terms that are positively associated with cost per case are case mix index, wage index, the low-income patient measure and indirect teaching levels. Freestanding IRFs and proprietary IRFs had relatively lower costs on average. Relative to medium-sized IRFs, small IRFs are more expensive ($t = 6.88$, $p<0.0001$) and large IRFs do not have significantly different average costs per case. Relative to IRFs located in other urban areas, rural IRFs are expensive ($t = 5.05$, $p<0.0001$) and large urban IRFs are not significantly different.[4] IRFs with early and newer certification dates were more expensive than those with medium certification dates (Table 4).

Table 4
Fully specified regression model using CMI based on recommended CMGs

Variable	Coefficient	Standard error	t	F	p
Intercept	9.2743	0.0190	488.35		<0.0001
log(case mix index)	1.0693	0.0577	18.54		<0.0001
log(0.27641+0.72359*wage index)	1.1895	0.0796	14.93		<0.0001
log(1 + low-income measure)	0.5930	0.0894	6.64		<0.0001
log(1+ interns & residents/ADC)	0.5658	0.1874	3.02		0.0026
Freestanding IRF (yes/no)	-0.1045	0.0166	-6.30		<0.0001
Size of IRF				28.01	<0.0001
Small	0.1405	0.0204	6.88		<0.0001
Large	-0.0180	0.0145	-1.24		0.2150
Certification date				10.98	<0.0001
Before 1/1/1985	0.0353	0.0167	2.11		0.0348
After 12/13/1990	0.0706	0.0151	4.69		<0.0001
Urban status				15.05	<0.0001
Large urban	-0.0211	0.0150	-1.41		0.1585
Rural	0.1203	0.0238	5.05		<0.0001
Proprietary IRF (yes/no)	-0.0999	0.0160	-6.26		<0.0001
R-squared	0.4689				

[4] Small IRFs are also relatively more expensive than large-sized IRFs ($t = 7.18$, $p < 0.0001$; not shown) and rural IRFs are significantly more expensive than large urban IRFs ($t = -5.38$, $p<0.0001$; not shown).

Unlike our Phase I findings based on the 1998-1999 data at the time of IRF PPS design (Carter et al., 2002), our findings now show that the indirect teaching measure is significantly associated with higher cost per case. Explanations for this new finding include the possibility that changes in coding have altered the relationship between the indirect teaching measure and cost per case, after adjusting for case mix index and improvements in the reporting of teaching data on the cost report. When we compared the indirect teaching measure for 644 IRFs that are in both the data file upon which facility level adjustments were derived during Phase I and in the 2002 data, we found that 36 percent of IRFs that had indirect teaching activity in 1998-1999 no longer had any in 2002 and that 22 percent of those without indirect teaching activity in Phase I had indirect teaching activity in 2002. It is hard to tell whether IRFs are more accurately coding teaching activity on the cost report, but certainly the identification of IRFs with teaching activity has changed, along with the addition of new facilities to the sample, thus affecting the indirect teaching effect.

The case mix index is no longer compressed. Technically, this means that the coefficient on the logarithm of CMI is not statistically distinguishable from one, in particular it is not significantly larger than one. This implies that the CMI (and thus the CMGs upon which the CMI is based) better explains resource use than it did when the IRF PPS was designed. At that time, an adjustment was made to case weights to decompress them; however, such an adjustment is no longer necessary as evidence of CMI compression is lacking. In contrast, the wage index is compressed, as its coefficient is significantly larger than one. This result, which agrees with the finding based on analyses of the 1998-1999 data, implies that the wage index may overpay facilities located in low wage areas and underpay facilities located in high wage areas.

Payment Regression

We used the results of Table 4 to build the payment regression model by first selecting predictor variables for the payment regression model that were significant predictors of high cost per case and then selecting variables that would be appropriate for payment under the IRF PPS. To determine the appropriateness for payment of each of these variables, we considered whether CMS treated it as a potential payment variable during Phase I. The primary criterion used is whether the variable is beyond the control of the IRFs; for example, rural location is considered to be beyond the IRF's control, but IRF size is not. Table 5a shows the payment regression model. The indirect teaching measure is included in the payment regression model. This measure was not a significant predictor of cost per case in Phase I, and so was not then included as a payment variable. Since it is significantly related to cost in the fully specified regression, we include it here. The other two predictors in the model, rural IRF location and LIP, are currently being paid for under the IRF PPS. All three predictors are significantly related to cost in this regression.

Table 5a

Payment regression model using CMI that is based on recommended CMGs

Variable	Coefficient	Standard error	t	p
Intercept	9.2202	0.0119	773.18	<0.0001
log(1 + low-income measure)	0.6164	0.0953	6.47	<0.0001
log(1+ interns & residents/ADC)	0.9632	0.1998	4.82	<0.0001
rural IRF (versus other IRFs)	0.1924	0.0235	8.18	<0.0001
R-Squared	0.1111			

Not only are rural IRFs relatively more expensive that large urban IRFs, but as Table 4 shows, other urban IRFs are more expensive than large urban IRFs in the fully specified regression model. This suggests the possibility that it might be appropriate to provide additional compensation to other urban IRFs. To examine this possibility, we included an indicator variable of being located in an other urban IRF in the payment

model. We did not find other urban IRFs to be significantly different from large urban IRFs in the payment model (Table 5b; t = 0.20, p = 0.8380), and thus would recommend using the payment model of Table 5a.

Table 5b

Payment regression model using CMI that is based on recommended CMGs and including large urban and other urban as predictor variables

Variable	Coefficient	Standard error	t	F	p
Intercept	9.2186	0.0141	651.72		<0.0001
log(1 + low-income measure)	0.6167	0.0953	6.47		<0.0001
log(1+ interns & residents/ADC)	0.9704	0.2030	4.78		<0.0001
Urban / rural location				33.41	<0.0001
rural IRF (versus large urban)	0.1940	0.0247	7.85		<0.0001
other urban IRF (versus large urban)	0.0031	0.0150	0.20		0.8380
R-Squared	0.1111				

Multivariate Regressions Using Implementation CMGs

We repeated the fully specified and payment regression analyses on the same data set, but this time used a CMI variable that was derived using the implementation CMGs, tiers, and relative weights currently being used under the IRF PPS. The goal of this analysis is to assess how much the recommended CMGs, tiers and weights would change the facility level payment adjustments relative to payment under the current system. Table 6 shows the fully specified regression using the CMI based on the implementation CMGs, tiers and case weights. The coefficient for the low-income measure coefficient moves from 0.5930 (Table 4) to 0.6470 (Table 6), though these coefficients are not statistically distinguishable from one another. The coefficient on the logarithm of CMI moves from 1.0693 to 0.8942. We use the standard error of the CMI coefficient in the latter regression (0.0512) to construct a t-statistic to determine whether the CMI is statistically different from 1.0. We find that it is marginally different from 1.0 in this analysis (t = 2.07, p = 0.0385; not shown).

The coefficient on log(CMI) when the CMI is derived from implementation CMGs, tiers, and relative weights suggests that relatively high CMIs are overstating costs, which is in contrast to the CMI compression we found in Phase I. We did a sub-analysis in which we compared the regression error terms resulting from this regression versus those from the model using CMI derived from the recommended CMGs, in hopes of identifying IRFs with relatively high CMIs and low costs under the implementation CMG-based CMI versus using the recommended CMGs to obtain the CMI. There are only one or two IRFs that stood out in this respect, and deleting these IRFs did not affect the regression estimates. Thus, we believe that widespread changes in coding – including expected coding changes due to instrument changes as well as upcoding – could explain this result.

Table 6

Fully specified regression model using CMI based on implementation CMGs

Variable	Coefficient	Standard error	t	F	p
Intercept	9.2833	0.0193	481.27		<0.0001
log(case mix index)	0.8942	0.0512	17.48		<0.0001
log(0.27641+0.72359*wage index)	1.1795	0.0809	14.58		<0.0001
log(1 + low-income measure)	0.6470	0.0905	7.15		<0.0001
log(1+ interns & residents/ADC)	0.5546	0.1908	2.91		0.0037
Freestanding IRF (yes/no)	-0.1105	0.0169	-6.53		<0.0001
Size of IRF				30.19	<0.0001
Small	0.1460	0.0208	7.02		<0.0001
Large	-0.0237	0.0147	-1.61		0.1083
Certification date				10.34	<0.0001
Before 1/1/1985	0.0455	0.0170	2.68		0.0075
After 12/13/1990	0.0686	0.0153	4.49		<0.0001
Urban status				15.68	<0.0001
Large urban	-0.0183	0.0152	-1.20		0.2292
Rural	0.1269	0.0242	5.25		<0.0001
Proprietary IRF (yes/no)	-0.1102	0.0163	-6.76		<0.0001
R-Squared	0.4562				

The payment regression using implementation CMG-based CMI (Table 7) show that the payment parameters change slightly for the LIP and rural variables, with the change for

the teaching variable being greater, with the coefficient for log(1 + interns & residents/ADC) moving from 0.9632 using the recommended CMGs (Table 5a) to 1.0534.

Table 7

Payment regression model using CMI based on implementation CMGs

Variable	Coefficient	Standard error	t	p
Intercept	9.2330	0.0125	739.91	<0.0001
log(1 + low-income measure)	0.5864	0.0998	5.88	<0.0001
log(1+ interns & residents/ADC)	1.0534	0.2094	5.03	<0.0001
Rural IRF (yes/no)	0.2053	0.0246	8.34	<0.0001
R-Squared	0.1085			

Sensitivity of Conclusions to Model Assumptions

The standard linear regression approach used above assumes that the regression residual error terms are normally distributed. This assumption is often violated with cost data, even after taking logarithmic transformations (Paddock et al., 2004; O'Hagan and Stevens 2003). We examine the sensitivity of the fully specified and payment regression results above to the normal errors assumption by using a Bayesian outlier accommodation model (BOAM), in which IRFs that are unduly influential on the regression coefficient estimates will be downweighted in the analysis. Full details are provided in Paddock et al., (2004) but we summarize the approach here.

The BOAM uses a heavier-tailed error distribution than that used in standard linear regression to down-weight the contribution of unduly influential statistical outlier IRFs relative to the standard linear regression model. This approach allows one to use all of the available IRFs for analysis, which has advantages over deleting them from the analysis or including them but not adjusting for their effect (Paddock et al., 2004). The model builds upon the standard linear regression model as follows. The regression errors of the standard linear regression model are assumed to be normally distributed with mean zero and variance σ^2/n_i for IRF i, where n_i is the number of equivalent cases at IRF i. In the BOAM, the error term is normally distributed with mean zero and variance $\sigma^2/(n_i \lambda_i)$,

where λ_i is assumed to follow a Gamma distribution with parameters ($\nu/2$, $\nu/2$) and mean 1. The parameter, ν, is unknown and must be estimated from the data. This framework is equivalent to assuming that the error terms follow a t-distribution with ν degrees of freedom. Large values of ν, say 30 or greater, indicate that the normal error assumption is reasonable. In the standard linear regression model, the λ_i terms are assumed to equal one; with the BOAM, any positive values can be obtained, with most values being close to one. Smaller values of λ_i indicate that IRF *i*'s contribution to the regression will be down-weighed relative to other IRFs in the analysis, while larger values (near 1) indicate otherwise. We will flag statistical outliers as IRFs that have low posterior probabilities of λ being greater than zero.

Table 8 shows the 95 percent posterior probability intervals of the posterior distributions for the regression coefficients for the fully specified BOAM. The results are very similar to those of Table 4 for which the standard linear regression approach was used. The posterior means of the regression coefficients differ slightly from those of Table 4, but the same candidate payment variables would be selected using either Table 8 or Table 4: the indirect teaching measure, low-income measure, and rural status are predictors of higher cost per case in both analyses. Just as in our analysis of the 1998-99 data using the BOAM (Paddock et al., 2004), we found evidence of non-normality of the regression error terms; the posterior mean of the degrees of freedom term, ν, is 8.7 (95 percent posterior probability interval, 5.5—14.9).

Table 8

Fully specified Bayesian outlier accommodation model using CMI based on recommended CMGs

	Posterior mean	Standard deviation	95% Posterior probability interval: 2.5%	97.5%
Intercept	9.2880	0.0189	9.2510	9.3250
log(case mix index)	1.0700	0.0569	0.9580	1.1820
log(0.27641+0.72359*wage index)	1.2490	0.0807	1.0920	1.4060
log(1 + low-income measure)	0.5564	0.0892	0.3822	0.7321
log(1+ interns & residents/ADC)	0.5580	0.1851	0.1966	0.9171
Freestanding IRF (yes/no)	-0.1129	0.0171	-0.1458	-0.0791
Size of IRF				
Small	0.1319	0.0199	0.0928	0.1710
Large	-0.0159	0.0148	-0.0446	0.0138
Certification date				
Before 1/1/1985	0.0296	0.0173	-0.0041	0.0634
After 12/13/1990	0.0675	0.0150	0.0379	0.0965
Urban status				
Large urban	-0.0301	0.0153	-0.0604	-0.0001
Rural	0.1206	0.0232	0.0751	0.1655
Proprietary IRF (yes/no)	-0.0889	0.0163	-0.1212	-0.0568
R-Squared	0.5264	0.0161	0.4962	0.5592

Table 9 shows the payment regression results obtained by using BOAM, using the same candidate payment variables as shows in Table 5a. The posterior mean of the coefficients for the low-income measure and the indirect teaching measure are lower than the coefficient estimates of Table 5a, while the rural estimate is higher. However, the estimates of Table 9 are not statistically distinguishable from those of Table 5a. The difference in the payment adjustments for a case having the average LIP of 0.109 would be 5.4 percent with the standard method versus 4.9 percent using BOAM (Table 9); for the average teaching facility the difference would be 8.5 percent versus 7.9 percent; and for rural IRFs the payment adjustment would be 21.2 percent versus 21.5 percent.

Table 9

Bayesian outlier accommodation payment model using CMI that is based on recommended CMGs

Variable	Posterior mean	Standard deviation	95% Posterior probability interval: 2.5%	97.5%
Intercept	9.2450	0.01286	9.2200	9.2700
log(1 + low-income measure)	0.5552	0.09661	0.3690	0.7463
log(1+ interns & residents/ADC)	0.8645	0.19650	0.4802	1.2510
Rural IRF (versus other IRFs)	0.1944	0.02254	0.1499	0.2386
R-Squared	0.1338	0.01106	0.1134	0.1567

V. CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Our analyses of the 2002 data suggest that the teaching effect appears to be real and large enough that a facility adjustment refinement for FY 2006 is likely needed. Differences between outlier accommodation and standard regression models are not statistically significant, but may be important to some hospitals. Consequently we will evaluate effects of both models in a payment simulation in final report using FY 2003 data. We also found that the CMI using the relative weights associated with the recommended CMGs is more appropriate than that using the implementation CMGs, because the CMI overstates resource use when it is derived from the implementation CMG, tiers and relative weights.

Recommendations

In CY 2002, provider responses to the IRF PPS were not complete as many hospitals were not on the PPS throughout the entire calendar year. Under the IRF PPS, IRFs now have incentives to code comorbidities more thoroughly. For example, there were substantial increases between CY 2002 and FY 2003 in the percentages of patients coded with miscellaneous throat problems, cachexia, malnutrition, and obesity (Carter and

Totten, 2004). Other factors could influence these facility regressions as well, such as reductions in length of stay and other cost containment measures. We will therefore need to repeat the analysis using FY 2003 data before making numerical recommendation. Also, CMS has not made a decision about definition of CMGs, tiers and relative weights; if CMS's decision differs from recommendation in Relles et al., (2004) then the payment adjustments shown here would change.

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