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Impacts Associated with the Inpatient Psychiatric Facility PPS

Final Report

Prepared for

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SECTION 1 INTRODUCTION

1.1 Background

1.1.1 History of Payment for Inpatient Psychiatric Care under Medicare

When the Medicare Acute Inpatient Prospective Payment System (IPPS) was implemented for acute general hospitals in October 1983, providers were permitted to exempt inpatient psychiatric services by instituting Medicare-Certified Distinct Part Psychiatric Units (DPUs). Exempt psychiatric units and freestanding psychiatric hospitals continued to be paid for inpatient services using the cost-based, payment system established under the Tax Equity and Fiscal Responsibility Act (TEFRA; Pub. L. 97-248). A per case payment system using the Diagnostic Related Groups (DRGs) was thought to be too limited for paying for inpatient psychiatric services because of the large variations in cost and the length of stay (Frank and Lave, 1986; Mitchell et al., 1987). As a result, Medicare paid for psychiatric patients in acute hospitals with DPUs through either the cost-based TEFRA system (patients treated in a DPU) or under the DRG-based IPPS (patients treated outside of the DPU in “scatter beds” or non-organized specialty units). Specialty psychiatric hospitals continued to be paid under TEFRA.

The IPPS established a flat, per case rate based on the DRG assignment. In contrast, the TEFRA system established a facility-specific per-case payment “target” based on a provider’s historical costs (per case costs from 1982, or later if the facility opened a DPU after 1982). Providers incurring costs below their target limits were eligible for bonus payments. If the actual cost per case (determined after the fiscal year end) was lower or equal to 90 percent of the target (updated to a performance year), the provider received the maximum “bonus” payment of 5 percent of the target. If the actual cost per case was between 90 and 100 percent of the TEFRA target amount, savings were equally split with the hospital. If actual costs exceeded the target, losses were shared up to 110 percent of the Target, after which the hospital fully absorbed the loss. The TEFRA payment system afforded protections against excessive costs that could result from long lengths of stay and severity levels greater than reflected in DRG payment per case. However, because the target was seldom changed, a hospital could still be at risk for greater severity.

The incentives to control costs under cost based reimbursement were less than under a per case prospective payment system. Hospitals with “rich” targets, established with the longer lengths of stay in the TEFRA year, had little incentive to control costs once the maximum 90 percent threshold was reached. Under the IPPS, hospitals retain the entire difference between their costs and the DRG-adjusted nationally-determined per case amount. However, they receive no additional payments for costs that exceed the per case amount (unless the cost for a case exceeds the “outlier threshold,” triggering payment of 80 percent of the difference between the outlier threshold and the actual cost).

In the Balanced Budget Refinement Act of 1999 (BBRA; Pub. L. 106-113), the Congress mandated a per diem payment system for all TEFRA (IPPS-exempt) inpatient psychiatric facilities (psychiatric DPUs as well and freestanding psychiatric hospitals). In the November 15, 2004 Final Rule as amended by the April 1, 2005 Correction Notice, CMS implemented the Inpatient Psychiatric Facility PPS (IPF-PPS). The system uses a multiplicative per diem payment

formula that adjusts for facility and patient related factors. Facility related payment factors include geographic location, teaching, and the presence of an emergency room. Patient related factors include the DRG assignment, the patient's age, the days of a stay, the use of ECT, and up to 17 co-morbid conditions.¹ Payments were computed for each patient using these factors. The IPF-PPS payment system was phased in beginning in cost reporting year 2005 and was fully phased in by 2008, consistent with the incentives of the payment system.

1.1.2 Behavioral Responses to Changes in Payment Systems

The IPF-PPS has different payment incentives than TEFRA reimbursement primarily due to the use of payment factors. Specifically, a hospital has some control over patient-related factors, but little control over the facility related factors, except over a longer time period. Each patient related factor is discussed below.

- **Length of Stay**—Consistent with the incentives of a per diem system, payments could be increased simply by increasing the length of stay, while still maintaining medical necessity. However, increasing the number of inpatient days also increases costs. If the marginal cost of an additional day, exceeds the marginal payment, a hospital has a financial incentive to discharge at that point. The IPF-PPS used a declining payment per day to promote shorter lengths of stay.
- **Coding Co-morbidities**—Prior to the IPF-PPS, freestanding psychiatric hospitals and DPUs did not receive additional reimbursement for co-morbidities and therefore had little incentive to code them. With the IPF-PPS payment formula, the co-morbid condition multipliers could easily increase the overall payment simply by increasing secondary diagnoses coding.
- **Other**—Modifying the other patient related factors were unlikely candidates for increasing payments. A patient's age is what it is and cannot be changed; and the use of ECT is limited and carried only a small payment differential. Only psychiatric and substance abuse DRGs qualify for a payment differential (extraneous non-psychiatric DRGs would have a payment weight of 1.0). With 70 percent of the psychiatric DRGs clustered in DRG 430 (Psychoses, now MS-DRG 885), little behavioral change in recoding the principal diagnosis was expected.

In addition to behavioral changes associated with the IPF-PPS, acute hospitals with DPUs continued to have the ability to be paid under two payment systems. Because of this dichotomy, another behavioral response could be in the placement of patients in organized psychiatric DRG units, DPUs, or scatter beds. Freestanding psychiatric hospitals had only one choice, the IPF-PPS.

This report explores changes just before, and after the implementation of the IPF-PPS in 2005. Specifically, the analysis explores changes in two payment factors, the length of stay and the coding of co-morbidities, which are expected to influence payments the most. It also explores

¹ The payment increase for a particular category does not depend on the other diagnoses (primary or secondary) or other patient characteristics present on the claims.

the difference in patient characteristics of patients treated in organized DRG psychiatric units and scatter beds and DPUs.

1.2 Organization of This Report

This report is organized as follows. Section 2 presents an analysis of providers' behavioral responses on ALOS and co-morbidity coding due to the implementation of the IPF-PPS. Section 3 presents descriptive and multivariate analyses that attempt to identify case mix and cost differences between scatter bed and hospital psychiatric DPUs and also to identify hospitals that may be operating psychiatric units not certified as DPUs. Section 4 of this report summarizes an analysis of alternative co-morbidity adjustments for the IPF-PPS.

SECTION 2

IMPACTS ON PAYMENTS UNDER THE IPF-PPS DUE TO CHANGES IN CODING OF CO-MORBIDITIES AND LENGTH OF STAY

2.1 Background

In this section, we analyze the impact of the behavioral response of providers to the IPF-PPS. Under the IPF-PPS, the calculation of per diem payments changed. What was effectively payment for the average length of stay (ALOS) moved from hospital specific per diems to standardized per diems. At the same time reimbursement for co-morbidities changed with the IPF-PPS. Under the IPF-PPS, patients can be assigned to up to 17 co-morbidity categories based on the secondary diagnoses reported by the treating hospital on each patient's claims. A separate payment multiplier is determined for each IPF-PPS co-morbidity category, and the overall co-morbidity adjustment is computed as the product of the adjustments for the individual co-morbidity groups.² Prior to the IPF-PPS, freestanding psychiatric hospitals and DPUs did not receive additional reimbursement for these co-morbidities and therefore had little incentive to code them on claims.

The IPF-PPS payment system was phased in beginning in cost reporting year 2005 and was fully phased in by 2008. It is reasonable to assume that the incentive to code co-morbidities would increase. However, the impact on average length of stay may be more ambiguous as facilities move from hospital specific per diems to a standard per diem schedule under the IPF-PPS.

We begin our analysis by looking at changes in the ALOS for psychiatric admissions and frequency of co-morbidity coding. We then perform a simulation of the impact of the IPF-PPS on payments in freestanding psychiatric hospitals and distinct part units (DPUs) within general acute care hospitals.

2.2 Data Sources

The primary data for this analysis are the 2003–2007 (calendar year) 100% National MedPAR files. We only included claims from the 50 states and the District of Columbia. To avoid potential coding changes among scatter bed cases due to the implementation of MS-DRGs in FY 2008, we only used claims through September 2007.³

Each MedPAR record was assigned a setting. Most of our analyses focused on three types of setting: freestanding hospitals (provider numbers *xx4000* through *xx4499*), distinct part units (DPUs; denoted with a special unit code "S" on the MedPAR record), and scatter beds within acute care hospitals (provider numbers *xx0001* through *xx0879*).⁴ Freestanding psychiatric hospitals were then divided into state owned and non-state owned facilities (control type of 6 in the provider of services file) because freestanding state hospitals have much higher LOS and

² The payment increase for a particular category does not depend on the other diagnoses (primary or secondary) or other patient characteristics present on the claims.

³ We scaled 2007 admissions by four-thirds to account for this.

⁴ We also assigned claims to long term care hospitals (provider numbers *xx2000* through *xx2299*), SNFs (provider numbers *xx5000* through *xx6499*) and other (all other provider numbers).

costs than non-state freestanding psychiatric hospitals. We then classified all the claims as either a psychiatric admission or a non-psychiatric admission based on the DRG at admission.⁵

We supplemented the MedPAR data with data from Medicare Cost Report (MCR) Worksheets S-2 and S-3 from CMS HCRIS database. The cost reports were current as of September 2008. On the cost reports, we used hospital-level data, with the exception of DPUs where we used the sub-provider information found on Worksheet S-3, Line 14 where appropriate. The hospital cost report information was merged to the MedPAR data by provider number and date of admission. The date of admission was matched up with the fiscal year begin and end dates in the hospital cost reports.

2.3 Analysis of Length of Stay and Volume

2.3.1 Trends in Length of Stay

Prior to the IPF-PPS, freestanding psychiatric hospitals and DPUs were paid hospital-specific costs. Under the IPF-PPS, per diem rates were standardized with higher per diem rates at the beginning of the stay and then decreasing until the LOS reached 22 days, when the per diem rate then remained constant for the remainder of the covered stay. *Table 2-1* shows the breakdown of per diem adjustments.

Table 2-1
Per Diem Adjustments under the IPF-PPS, Rate Year 2009

Day Range	Per Diem Adjustment Factor
1 (IPFs with an emergency department)	1.31
1 (IPFs without an emergency department)	1.19
2	1.12
3	1.08
4	1.05
5	1.04
6	1.02
7–8	1.01
9–10	1.00
11–14	0.99
15	0.98
16–17	0.97
18	0.96
19–21	0.95
22 or more	0.92

⁵ Psychiatric CMS-DRGs (prior to the implementation of MS-DRGs) are: 012, 023, 424 through 433 and 521 through 523.

Because of declining per diem rates, hospitals should have an incentive to reduce the length of stay under the IPF-PPS. However, if the per diem payment rate and the associated factors exceed the marginal cost for the day, the hospital may not have an incentive to reduce the length of stay. As a result, the net impact on length of stay from the IPF-PPS may be ambiguous. The incentive may also vary depending on the average length of stay in a particular hospital. Those hospitals with shorter lengths of stay will see more of a difference because the per diem adjustment declines 20 percent over the first 10 days. **Table 2-2** shows the average LOS for by setting from 2003 to 2007, while **Table 2-3** shows the percentage change in LOS from 2003 for each setting.

Table 2-2
ALOS for Psychiatric Admissions, by Setting

Year	Freestanding state hospital ALOS (days)	Freestanding non-state hospital ALOS (days)	DPU ALOS (days)	Scatter Bed ALOS (days)
2003	80.5	14.4	11.2	6.1
2004	80.4	14.4	11.1	6.0
2005	74.0	14.6	11.1	6.1
2006	72.2	14.9	11.3	6.1
2007	74.2	14.4	11.3	6.1

SOURCE: RTI International analysis of discharges from IPFs and general acute hospitals using the 2003–2007 100% MedPAR files.

Table 2-3
Percentage Change in ALOS from 2003, by Setting

Year	Freestanding state hospital ALOS change (%)	Freestanding non-state hospital ALOS change (%)	DPU ALOS change (%)	Scatter Bed ALOS change (%)
2004	-0.2%	+0.1%	-1.0%	-0.9%
2005	-8.1%	+1.2%	-1.3%	-0.2%
2006	-10.4%	+3.4%	+0.3%	-0.2%
2007	-7.9%	-0.3%	+0.9%	-0.1%

SOURCE: RTI International analysis of discharges from IPFs and general acute hospitals using the 2003–2007 100% MedPAR files.

The ALOS is shortest for patients in scatter beds within acute care hospitals while the average LOS in DPUs is nearly double at 11.2 days and more than double at freestanding non-state hospitals at 14.6 days. It is freestanding state psychiatric hospitals which stand out with an average LOS of 76.4 days over the 5-year period. This suggests that freestanding state hospitals are treating very different patients than freestanding non-state, DPUs, and scatter beds, or else operating in a completely different manner.

The phase-in of the IPPS does not appear to have had a significant impact on DPUs or scatter beds, which experienced little change in the ALOS. However, the picture is mixed for freestanding psychiatric hospitals. ALOS at freestanding state hospitals fell between 8 and 10 percent in 2005–2007 compared to 2003, while ALOS at freestanding non-state hospitals increased slightly in 2005 and 2006 before falling back to approximately 2003 levels in 2007. The increase in 2005 and 2006 is coincident with the initial phase in of the IPF-PPS, but leaves the sudden decrease in 2007 unexplained.⁶

There are several possible explanations for the different changes in ALOS across settings. One is that there was a shift in admissions for longer stay freestanding hospitals to the shorter stay DPUs and scatter beds and a shift from freestanding state psychiatric hospitals to freestanding non-state psychiatric hospitals. Because admissions at freestanding state hospitals are on average 5 times longer than freestanding non-state psychiatric hospitals, even a small shift could lead to a slight increase in ALOS. In *Table 2-4* we present the percent change in admissions relative to 2003 by setting from 2004 to 2007. Based on the admission data, there was a steady decline in admissions in DPUs beginning in 2005 coincident with the initial phase of the IPF-PPS. At the same time, there was a steady increase in admissions at freestanding non-state owned psychiatric hospitals of 16 percent between 2003 and 2007. Freestanding state psychiatric hospitals however, showed an initial increase in admissions followed by a slight decrease in 2006 and 2007.

Table 2-4
Percentage Change in Psychiatric Admissions from 2003, by Setting

Year	Freestanding state hospital ALOS change (%)	Freestanding non-state hospital ALOS change (%)	DPU ALOS change (%)	Scatter Bed ALOS change (%)
2004	+3.5%	+6.6%	+1.4%	+0.8%
2005	+7.4%	+9.5%	-1.6%	+1.8%
2006	-0.8%	+12.1%	-8.0%	+0.5%
2007	-2.8%	+16.0%	-8.9%	+7.9%

SOURCE: RTI International analysis of discharges from IPFs and general acute hospitals using the 2003–2007 100% MedPAR files.

2.3.2 Survival Analysis of Length of Stay

The earlier descriptive tables show many factors that contribute to changes in ALOS occurring simultaneously; changes in the proportions of psych DRGs at a hospital, changes in ALOS for a particular DRG and setting. However, because the probability of ALOS increasing from 1 to 2 days may differ from 22 to 23 days, a linear regression model was inappropriate. We therefore estimated a proportional hazard model of LOS on patient characteristics, hospital characteristics, co-morbidities, and other control variables. Separate models for each setting were estimated with the following specification:

⁶ One possible explanation may be the switch over to MS-DRGs, but then we would expect to see a similar anomaly in DPU and scatter beds.

$$\log[h([\text{LOS}]_{ift})] = \log[h_B([\text{LOS}]_{ift})] + \beta_R[\text{Rural}]_{ft} + \beta_T \left(1 + \frac{[\text{Residents}]_{ft}}{[\text{ADC}]_{ft}} \right) +$$

(1) $\beta_O[\text{Occupancy Rate}]_{ft} + \beta_{30}[\text{Occupancy Rate} < 30\%]_{ft} + \beta_A[\text{No Ancillaries Charged}]_{ft} +$
 $\gamma_A[\text{Age Group Vector}]_{ift} + \gamma_D[\text{DRG Vector}]_{ift} + \gamma_C[\text{Comorbidity Vector}]_{ift} + \gamma_E[\text{ECT}]_{ift} +$
 $\delta_Y[\text{Year Vector}]_t + \varepsilon_{ift}$

where i indexes the stay for patient i and:

- $\log[\text{LOS}]_{ift}$ is the natural logarithm of the length of stay of patient i .
- The function h is the conditional hazard function for length of stay.
- The function h_B is the baseline hazard function for length of stay.
- $[\text{Rural}]_{ft}$ is an indicator for whether a facility is not in an MSA.
- $[\text{Residents}]_{ft}$ gives the number of residents in the facility (or specifically in the DPU for DPU providers).
- $[\text{ADC}]_{ft}$ gives the ADC of the facility (or specifically of the DPU for DPU providers).
- $[\text{Occupancy Rate}]_{ft}$ gives the occupancy rate, expressed as a number between 0 and 1, of the facility (or specifically of the DPU for DPU providers).
- $[\text{Occupancy Rate} < 30\%]_{ft}$ is an indicator for whether the occupancy rate is less than 30 percent.
- $[\text{No Ancillaries Charged}]_{ft}$ is an indicator for whether the facility charges ancillary services on its Medicare claims.
- $[\text{Age Group Vector}]_{ift}$ is a vector of indicators for patient i 's age: 45–49, 50–54, 55–59, 60–64, 65–69, 70–74, 75–79, and over 80. The omitted age group is less than 45 years old.
- $[\text{DRG Vector}]_{ift}$ is a vector of indicators for patient i 's DRG. The omitted DRG is 430.
- $[\text{Comorbidity Vector}]_{ift}$ is a vector of indicators for the 17 IPF-PPS co-morbidity categories.
- $[\text{ECT}]_{ift}$ is an indicator for whether patient i 's claim includes the ECT procedure code.
- $[\text{Year Vector}]_t$ is a vector of indicators for years 2004–2007. The omitted year is 2004.
- ε_{ift} is the portion of length of stay not explained by the regressors (i.e., the idiosyncratic regression “error” term).

Table 2-5 shows the estimated hazard ratios from the proportional hazard model.

Table 2-5
LOS Proportional Hazard Model: Hazard Ratios for Year Effects

Variable	Freestanding State Hazard Ratio Estimate	Freestanding Non-State Hazard Ratio Estimate	DPU Hazard Ratio Estimate	Scatter Bed Hazard Ratio Estimate
FY 2005	0.97*	1.01	1.01*	1.01*
FY 2006	0.98*	1.04	1.00	1.03*
FY 2007	0.47*	1.15*	1.04*	1.02*

NOTE: One asterisk denotes significance at the 95% confidence level.

SOURCE: RTI International analysis of discharges from IPFs and general acute hospitals using the 2003–2007 100% MedPAR files.

The regression results in Table 2-6 are consistent with the descriptive analyses in Tables 2-2 and 2-3 on LOS, showing little change in LOS in the later years for DPUs and scatter beds, with hazard ratios of 1.04 and less. However, the results differ for non-state freestanding psychiatric hospitals. Table 2-2 shows essentially no change in ALOS between 2004 and 2007 but a large decline between 2006 and 2007, while the model shows a modest increase between 2006 and 2007. However, only the parameter estimate for 2007 is significant. Similarly, Table 2-2 shows a small decline in ALOS at freestanding state psychiatric hospitals between 2004 and 2007, but a much larger decline in the hazard model. This could be related to change in mix of DRGs and ALOS conditional on DRG at freestanding state hospitals during this time. For example, admissions for DRG 430, with an average LOS of 84.5 fell 2.5 percent. Because DRG 430 accounts for approximately 80 percent of admissions at freestanding psychiatric hospitals this could have a pronounced impact in the regressions where we control for DRG.

2.4 Analysis of Co-morbidities

2.4.1 Alternative Co-morbidity Adjustors

In the November 15, 2004 Final Rule implementing the IPF-PPS (as amended by the April 1, 2005 Correction Notice), CMS adopted a “regression-type” approach to determining per diem payments, including payment factors for 17 co-morbidity adjustors.⁷ CMS intended these co-morbidity categories to identify especially high-cost patients, as evidenced in the agency’s response to commenters:

Therefore, the cost for providing patient care (for example, medications, and routine nursing care required for the common conditions seen in the psychiatric population and recommended for co-morbidity adjustment by the commenters (that is, heart conditions or strokes) are included already in the Federal per diem

⁷ A hospital can only receive a single adjustment for each co-morbidity that a patient has—for example, if three secondary diagnoses can trigger a co-morbidity adjustment, the multipliers are applied only once to each day of the entire stay.

base rate and a co-morbidity adjustment for their presence was unnecessary (69FR66939).

These co-morbidity category adjustors were adopted prior to the implementation of MS-DRG and were not intended to measure the severity of the patient's primary (psychiatric) diagnosis. CMS intended that the IPF-PPS DRGs (originally CMS-DRGs 012, 023, 424 through 433, and 521 through 523; currently MS-DRGs 056, 057, 080, 081, and 876 through 897) identify differences in cost due to patients' principal diagnoses and that the co-morbidity categories identify cost differences due to the presence of particular secondary (largely medical) diagnoses. Although degenerative nervous system disorders (MS-DRGs 056 and 057), non-traumatic stupor and coma cases (MS-DRGs 080 and 081), and alcohol or drug abuse or dependence without rehabilitation therapy cases (MS-DRGs 896 and 897) are divided by whether the patient has a major complication or co-morbidity (MCC), the majority of IPF-PPS cases, in the Mental Diseases or Disorders MDC (MDC 19), are not split by whether the patient has an MCC. As a result, the IPF-PPS co-morbidity category adjustors remain relevant for identifying case mix complexity among these patients.

In earlier research on primary cost, resource utilization, and clinical data collected in 40 IPFs, Cromwell, et al. (2005) developed indicators for medical and behavioral diagnosis severity for use in a hierarchical patient case mix classification system. These severity indicators identified significantly more patients as having a higher-severity co-morbid condition than do the IPF-PPS co-morbidity indicators (using data from 2004, before the implementation of the IPF-PPS, roughly 4 times as many patients, 41 percent versus 11 percent). Although upcoding in response to creating new payment adjustors is always a concern, it is also important for a payment system to recognize patients with higher-than-expected costs.

2.4.2 Trends in Coding

Next, we examine the impact of the IPF-PPS on frequency of co-morbidity coding between 2003 and 2007. For psychiatric admissions, we examined freestanding psychiatric hospitals (state and non-state owned), DPUs, and scatter beds in general acute care hospitals. We included scatter beds as a control for any general changes in co-morbidities over the 2003–2007 time frame. As a second control, we also examined the frequency of the psych co-morbidities for non-psychiatric admissions in general acute care hospitals.

Table 2-6 shows the percent of psychiatric cases with one or more of the IPF-PPS co-morbidities within freestanding psychiatric hospitals, DPUs, and scatter beds, as well as for non-psychiatric cases within general acute care hospitals. There is a general increase of between 27 and 34 percent in co-morbidities between 2003 and 2007 based on cases in general acute care hospitals. Over the same period, however, the percent of claims in freestanding psychiatric hospitals increased 182 percent in state owned psychiatric hospitals. The change in non-state owned freestanding psychiatric hospitals was even more dramatic where the percent of claims with at least one co-morbidity increased more than 200 percentage points from less than 5 percent in 2003 to 14.7 percent in 2007, coincident with the phase in of the IPF-PPS. Prior to rate year 2005, there was no financial incentive for freestanding hospitals to code co-morbidities, but as the IPF-PPS was phased in the incentive increased and so did the prevalence of co-morbidity coding.

Table 2-6
Percentage of Cases with at Least One IPF-PPS Co-morbidity, 2003 to 2007, by Setting

Year	Freestanding State	Freestanding Non-State	DPU	Scatter Bed	Non-Psych General Acute Care
2003	3.8%	4.8%	12.7%	15.6%	25.9%
2004	4.4%	5.9%	12.9%	15.7%	26.8%
2005	6.7%	11.2%	14.2%	16.7%	28.6%
2006	9.9%	13.8%	15.7%	18.6%	33.2%
2007	10.7%	14.7%	16.4%	19.8%	34.8%
% Change 2003 to 2007	+182.4%	+205.3%	+28.5%	+27.2%	+34.1%

NOTE: Non-psychiatric DRG general acute care hospital statistics based on a 10 percent sample.

SOURCE: RTI International analysis of discharges from IPFs and general acute hospitals using the 2003–2007 100% MedPAR files.

The dramatic increase in co-morbidity coding by freestanding psychiatric hospitals could be due to the fact that, for payment, the entirety of the facility had no particular incentive to code as completely as possible to maximize payment prior to 2005. While an alternate explanation is that these hospitals began treating patients with more complications, the large increase in coding, from 5.9 percent of cases having at least one IPF-PPS co-morbidity in 2004 to 11.2 percent in 2005 coincides with the start of the IPF-PPS transition. In contrast, acute care hospitals with DPUs have had an incentive to code as completely as appropriate since the IPPS system was introduced in 1982. Since it is unlikely that these facilities maintain separate coders for their psychiatric units, general hospitals (with or without DPUs) were likely coding as completely prior to the IPF-PPS as during the start of the phase-in period in 2005.

Next, in order to determine whether a few or all co-morbidities were driving the increase in number of claims with at least one co-morbidity, we examined the frequency that individual IPF-PPS co-morbidities were being coded. *Table 2-7* shows the annual frequencies of co-morbidities in 2003 and 2007. Some co-morbidities, including coagulation and gangrene, occur so infrequently that their percentage changes are highly variable on an annual basis and show excessively large changes from year to year.

The biggest change in co-morbidity coding appears in chronic renal failure, and is observed for all provider types. For example, free-standing non-state hospitals increased from 0.15 percent of inpatient discharges in 2003 to 1.03 percent in 2007. In absolute terms, the increase was even higher in DPUs, from 1.58 percent in 2003 to 3.96 percent. This increase was likely influenced by the change in definition of the ICD-9 codes that occurred in FY 2006.

Table 2-7
Percent of Claims with each IPF-PPS Co-morbidity, 2003 and 2007, by Setting

IPF-PPS Co-morbidity Category	Free-standing State 2003	Free-standing State 2007	Free-standing Non-State 2003	Free-standing Non-State 2007	DPU 2003	DPU 2007	Scatter Bed 2003	Scatter Bed 2007	Non-Psych General Acute Care 2003	Non-Psych General Acute Care 2007
Artificial openings-digestive and urinary	0.02%	0.03%	0.03%	0.18%	0.41%	0.43%	0.57%	0.49%	1.31%	1.15%
Cardiac conditions	0.00%	0.00%	0.01%	0.04%	0.03%	0.01%	0.05%	0.04%	0.26%	0.16%
Chronic obstructed pulmonary disease	0.00%	0.11%	0.04%	0.86%	0.56%	0.42%	0.81%	0.77%	3.45%	3.68%
Coagulation factor deficits	0.00%	0.06%	0.01%	0.05%	0.04%	0.06%	0.05%	0.07%	0.09%	0.10%
Developmental disabilities	1.70%	3.42%	1.13%	2.44%	3.36%	3.26%	1.64%	1.66%	0.51%	0.51%
Drug and/or alcohol induced mental disorders	0.96%	2.12%	1.66%	3.84%	1.58%	2.08%	3.01%	3.20%	0.21%	0.25%
Eating and conduct disorders	0.20%	0.49%	0.46%	0.96%	0.52%	0.53%	0.20%	0.26%	0.01%	0.01%
Gangrene	0.00%	0.01%	0.01%	0.01%	0.03%	0.03%	0.07%	0.05%	0.64%	0.58%
Infectious diseases	0.86%	4.05%	1.15%	4.60%	3.23%	3.73%	4.30%	5.01%	3.95%	4.11%
Oncology treatment	0.03%	0.06%	0.05%	0.15%	0.01%	0.01%	0.03%	0.03%	6.24%	6.50%
Poisoning	0.03%	0.05%	0.03%	0.18%	0.61%	0.73%	0.55%	0.53%	0.11%	0.14%
Renal failure, acute	0.00%	0.02%	0.01%	0.10%	0.44%	0.89%	0.97%	3.01%	3.69%	6.54%
Renal failure, chronic	0.10%	0.38%	0.15%	1.03%	1.58%	3.96%	3.06%	6.10%	7.96%	16.51%
Severe musculoskeletal and connective tissue diseases	0.03%	0.21%	0.10%	0.35%	0.38%	0.46%	0.43%	0.53%	0.91%	1.04%
Severe protein calorie malnutrition	0.00%	0.01%	0.01%	0.10%	0.11%	0.14%	0.17%	0.17%	0.26%	0.28%
Tracheostomy	0.00%	0.00%	0.00%	0.02%	0.05%	0.05%	0.09%	0.08%	0.21%	0.19%
Uncontrolled diabetes mellitus	0.07%	0.52%	0.19%	1.29%	0.77%	1.29%	1.14%	1.53%	1.90%	2.98%

NOTE: Non-psychiatric DRG general acute care hospital statistics based on a 10 percent sample.

SOURCE: RTI International analysis of discharges from IPFs and general acute hospitals using the 2003–2007 100% MedPAR files.

2.4.3 Multivariate Analysis of the Likelihood of Each Co-morbidity

The descriptive analyses above suggest that the likelihood a claim at a freestanding psychiatric hospital had a co-morbidity virtually tripled between 2003 and 2007, with most of the increase beginning in 2005 with the initial phase-in of the IPF-PPS. The earlier tables also showed that there was a wide variation in the likelihood of a particular co-morbidity as well as the change in likelihood. Further, for some co-morbidities, the change in likelihood also increased at the control scatter beds and non-psychiatric DRG claims, while the likelihood decreased for other co-morbidities. As a result, the change in freestanding psychiatric hospitals attributable to the IPF-PPS may be overestimated for co-morbidities with a general increase but underestimated when there was a general decrease in the control populations. To separate out these factors and to control for other hospital beneficiary characteristics, we estimated the probability a claim would be coded with each of the 17 co-morbidity categories using separate logit models for each category. Each has the following basic specifications:

$$L([\text{Co - Morbidity Indicator } j]_{iftj}) = \alpha_j + \beta_{Rj}[\text{Rural}]_{ft} + \beta_{Tj} \left(1 + \frac{[\text{Residents}]_{ft}}{[\text{ADC}]_{ft}} \right) + \beta_{Oj}[\text{Occupancy Rate}]_{ft} + \beta_{30j}[\text{Occupancy Rate} < 30\%]_{ft} + \beta_{Aj}[\text{No Ancillaries Charged}]_{ft} + (2) \gamma_{Lj}[\text{LOS Vector}]_{ift} + \gamma_{Aj}[\text{Age Group Vector}]_{ift} + \gamma_{Dj}[\text{DRG Vector}]_{ift} + \gamma_{Ej}[\text{ECT}]_{ift} + \delta_{Yj}[\text{Year Vector}]_f + \delta_{Bj}[\text{Setting Vector}]_f + \delta_{ij}[\text{Year Vector}]_f[\text{Setting Vector}]_f + \varepsilon_{iftj}$$

where i indexes the stay for patient i and:

- L is the logit cumulative distribution function.
- $[\text{Rural}]_{ft}$ is an indicator for whether a facility is not in an MSA.
- $[\text{Residents}]_{ft}$ gives the number of residents in the facility (or specifically in the DPU for DPU providers).
- $[\text{ADC}]_{ft}$ gives the ADC of the facility (or specifically of the DPU for DPU providers).
- $[\text{Occupancy Rate}]_{ft}$ gives the occupancy rate, expressed as a number between 0 and 1, of the facility (or specifically of the DPU for DPU providers).
- $[\text{Occupancy Rate} < 30\%]_{ft}$ is an indicator for whether the occupancy rate is less than 30 percent.
- $[\text{No Ancillaries Charged}]_{ft}$ is an indicator for whether the facility charges ancillary services on its Medicare claims.
- $[\text{LOS Vector}]_{ift}$ is a vector of indicators for LOS ranges. The ranges are for: 1 day, 2-3 days, 4-7 days, 15-21 days, 22-28, 29-56, and more than 56 days. The omitted LOS range is 8-14 days.

- [Age Group Vector] $_{ift}$ is a vector of indicators for patient i 's age: 45–49, 50–54, 55–59, 60–64, 65–69, 70–74, 75–79, and over 80. The omitted age group is less than 45 years old.
- [DRG Vector] $_{ift}$ is a vector of indicators for patient i 's DRG. The omitted DRG is 430.
- [ECT] $_{ift}$ is an indicator for whether patient i 's claim includes the ECT procedure code.
- [Year Vector] $_t$ is a vector of indicators for years 2004–2007. The omitted year is 2004.
- [Setting Vector] $_f$ is a vector of indicators for settings. The omitted setting is scatter bed.
- e_{ift} is the portion of the likelihood of co-morbidity j not explained by the regressors (i.e., the idiosyncratic regression “error” term).

Table 2-8 shows the odds ratios for the key variables in the co-morbidity logit models. In interpreting the odds ratios, the comparison is to scatter beds in 2004. First, because of the rarity of some of the co-morbidities—including gangrene, coagulation factor deficits, and cardiac conditions—many of the odds ratios could not be estimated. This is especially true for freestanding state owned psychiatric hospitals.

Therefore, the best information about the impact of the IPF-PPS on the frequency of co-morbidity coding is in the more common co-morbidities: developmental disorders, infectious disease, and drug and alcohol disorders. The interaction terms between setting and year show the impact of the IPF-PPS on that particular setting after controlling for the general time trend in co-morbidity coding (based on scatter beds). Concentrating on these three co-morbidities, there is a general increase in coding at freestanding non-state psychiatric hospitals and DPUs. However, there is a slight decrease in the probability of a co-morbidity in 2007 relative to 2006. At freestanding non-state psychiatric hospitals, the probability of a co-morbidity in 2007, although lower than 2006, is still higher than in 2004. Similarly, at DPUs, the probability was higher for these three co-morbidities in 2007 than 2004 with the exception of developmental disabilities. The results for freestanding state psychiatric hospitals are less reliable and often insignificant due to the small number of admissions in all DRGs and co-morbidities.

Table 2-8
Estimates of Odd Ratios for IPF-PPS Co-morbidities

IPF-PPS Co-morbidity Category	FY2005	FY2006	FY2007	Free-standing State	Free-standing Non-State	DPU	Free-standing State 2005	Free-standing State 2006	Free-standing State 2007	Free-standing Non-State 2005	Free-standing Non-State 2006	Free-standing Non-State 2007	DPU 2005	DPU 2006	DPU 2007
Artificial openings-digestive and urinary	1.019	0.886	0.892	0.096	0.134	0.895	1.022	3.674	0.007	3.144	4.589	2.248	1.094	1.261	1.317
Cardiac conditions	0.782	0.647	0.816	...	0.144	0.394	...	...	0.687	31.900	14.763	...	1.165	0.980	0.596
Chronic obstructed pulmonary disease	1.052	0.907	1.045	0.011	0.080	0.597	15.535	31.478	...	7.385	17.197	1.591	0.969	1.050	0.870
Coagulation factor deficits	0.987	1.358	1.698	...	0.371	1.103	...	...	...	2.690	2.549	2.215	1.24	0.834	0.732
Developmental disabilities	0.994	0.965	0.985	0.400	0.372	1.153	1.382	1.998	1.516	1.548	1.904	1.012	1.022	1.050	0.993
Drug and/or alcohol induced mental disorders	1.037	1.044	1.017	0.693	0.758	0.938	0.970	1.149	0.95	1.461	1.918	2.249	1.040	1.118	1.254
Eating and conduct disorders	1.066	1.114	1.049	0.504	1.429	1.611	1.945	2.398	...	1.260	1.441	1.451	1.044	1.012	1.010
Gangrene	0.894	0.615	0.835	...	0.146	0.690	...	1.125	0.376	2.064	1.762	...	1.082	1.575	1.258
Infectious diseases	1.024	1.043	1.448	0.402	0.367	0.986	1.594	2.746	1.917	2.326	2.632	1.489	1.06	1.022	0.867
Oncology treatment	0.965	0.984	1.226	0.061	0.054	0.449	0.789	1.063	0.002	2.116	2.068	2.959	1.032	0.934	0.801
Poisoning	0.835	0.801	0.851	0.045	0.071	0.862	1.599	1.924	0.005	2.946	4.305	2.544	1.272	1.445	1.490
Renal failure, acute	1.225	1.497	2.190	...	0.069	0.567	...	...	0.215	1.284	1.019	1.591	1.014	0.983	0.807
Renal failure, chronic	1.191	1.906	2.196	0.076	0.114	0.667	1.374	2.333	1.023	1.667	2.290	1.775	1.113	1.197	1.223
Severe musculoskeletal and connective tissue diseases	0.978	1.029	0.976	0.128	0.350	0.918	1.766	4.675	6.605	1.667	1.962	1.022	1.079	1.028	1.369
Severe protein calorie malnutrition	1.172	1.085	1.279	0.178	0.080	0.457	0.334	0.428	...	4.579	7.827	13.883	1.091	1.249	2.193
Tracheostomy	0.960	0.735	1.091	0.092	0.120	0.694	...	6.444	...	1.751	1.947	3.570	1.152	1.448	1.015
Uncontrolled diabetes mellitus	1.128	1.228	1.283	0.153	0.328	0.641	1.427	3.434	...	3.018	2.840	1.068	1.164	1.165	1.28

NOTE: Non-psychiatric DRG general acute care hospital statistics based on a 10 percent sample.

SOURCE: RTI International analysis of discharges from IPFs and general acute hospitals using the 2003–2007 100% MedPAR files.

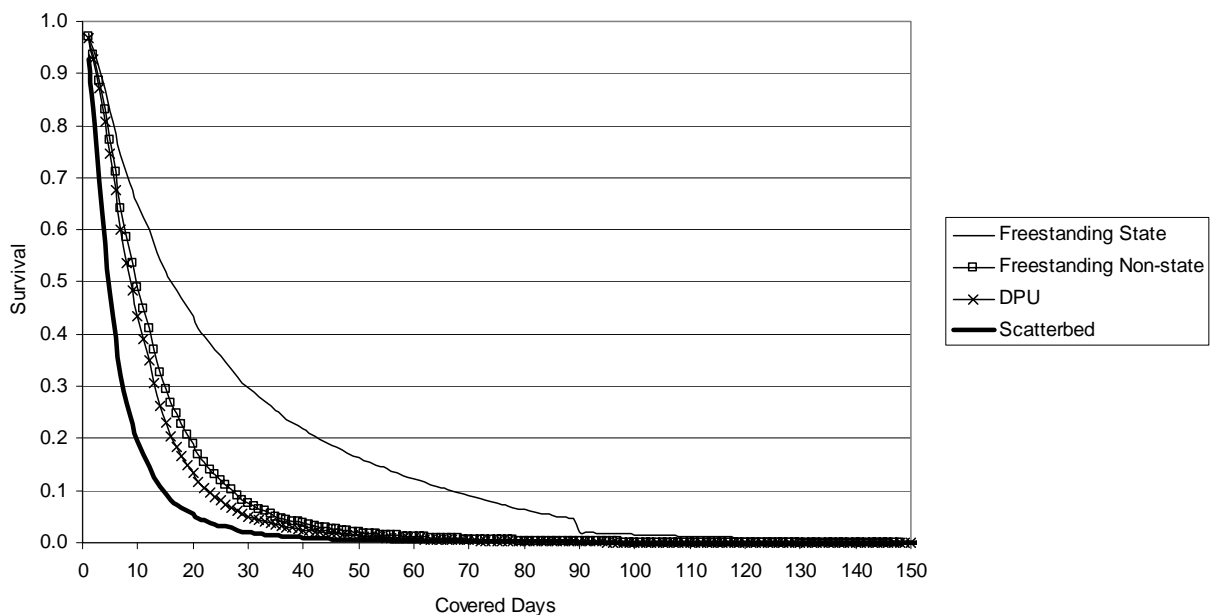
2.5 Simulations of Payment Impacts of Behavioral Change to the IPF-PPS

2.5.1 Change in the Distribution of Medicare-Covered Length of Stay

The first step in the simulation was to estimate the change in covered days as a result of the IPF-PPS.⁸ Because of the declining marginal per diem payment feature of the IPF-PPS, payments under the IPF-PPS are nonlinear functions of each patient's LOS. As a result, we cannot just apply estimates of behavioral changes in ALOS to the payment formula to estimate the change in payments. Instead, it is necessary to simulate the change in the *distribution* of per-case LOS to estimate the change in payments since the marginal impact of a 1-day increase from 2 to 3 days differs from 22-23 days.

To calculate the change in the distribution of LOS, we re-estimated the proportional hazard model presented above using covered days in place of LOS. We then used the results to estimate survival functions for each setting and year. To calculate the survival functions, we assumed a 65 year old beneficiary admitted for DRG 430 with no ECT or co-morbidities to an urban hospital which codes ancillary charges, with mean values for resident ratio and occupancy rate. **Figure 2-1** shows the base survival functions for the 4 settings in 2004. **Table 2-9** shows the change in estimated median length of stay based on the new distribution and the associated change in cost.

Figure 2-1
Covered Day Survival Functions



SOURCE: RTI International analysis of discharges from IPFs and general acute hospitals using the 2003–2007 100% MedPAR files.

⁸ We used covered days rather than LOS because we wanted to simulate the payment change from the IPF-PPS.

Table 2-9
Estimated Percentage Change in Per Diem Cost and Covered Days, by Setting

Change in Per Diem Cost or Days	Freestanding State	Freestanding Non-State	DPU
Change in Per Diem Cost, 2004 to 2005	+2.40%	-0.99%	-0.74%
Change in Per Diem Cost, 2004 to 2006	+3.14%	-1.35%	-0.36%
Change in Per Diem Cost, 2004 to 2007	...	-11.24%	-2.67%
Change in LOS, 2004 to 2005	+2.84%	-1.06%	-0.79%
Change in LOS, 2004 to 2006	+3.72%	-1.44%	-0.38%
Change in LOS, 2004 to 2007	...	-11.98%	-2.87%

NOTE: Estimated percentage change in per diem cost and covered days for freestanding state psychiatric hospitals not displayed due to low statistical precision.

SOURCE: RTI International analysis of discharges from IPFs using the 2003–2007 100% MedPAR files.

2.5.2 Change in the Likelihoods of Each Co-morbidity Category

In the next step of the simulation, we estimated the change in the likelihood a claim would be coded with each of the 17 co-morbidity categories. To obtain these estimates, we began with the 17 logit models, one for each co-morbidity category, estimated earlier. We then used the coefficients in the logit models to compute odds ratios for each setting in each year. To compute the odds ratios, we used the mean occupancy rate, resident ratio, and median⁹ LOS for each bed type and then assumed that each hospital was in an urban area, coded ancillary charges, and had an occupancy rate greater than 30.

We then used the estimated odds ratios to estimate the new probability of each co-morbidity by year and bed type. The probabilities were then used to calculate the expected payment multiplier associated with the new probabilities for each of the co-morbidities. We calculated the expected multiplier as the weighted sum of the probability of each co-morbidity (including no co-morbidity) times its multiplier for each setting and year.

2.5.3 Computing the Total Simulated Change in Payments Due to Changes in LOS and Co-morbidity Coding

To get the initial payment in 2004, we used the payment rates for IPF-PPS Rate Year 2009. We then combined the effect on payment of the change in LOS and co-morbidities. For this calculation, we made three assumptions. First, we assumed that, after controlling for LOS and co-morbidities in the regressions, the changes in LOS and co-morbidity were uncorrelated. Second, we assumed that the change in co-morbidities occurred at admission and then LOS changed for stay. This assumption makes the total change equal to the product of the change in co-morbidities and LOS, rather than additive. Lastly, we assumed that each claim had no more than one co-morbidity. This is a slightly stronger assumption because, depending on the setting, up to 2 percent of psychiatric claims did have more than 2 co-morbidities.

⁹ We used the median rather than mean LOS because LOS was highly skewed in freestanding hospitals. The mean for freestanding state hospitals is 75.3 with a median of 17 while the mean LOS for freestanding non-state hospitals is 14.6 with a median of 10.

Tables 2-10 through 2-12 show the simulated payment effect from the IPF-PPS for DPUs, freestanding state and freestanding non-state psychiatric hospitals. Rows 2 and 3 of each table show the contributions to the payment change separately for co-morbidities and LOS, while rows 5 and 6 show the actual dollar change for co-morbidities and LOS. Tables 2-10 through 2-12 show that, for both DPUs and freestanding psychiatric hospitals, the IPF-PPS had a positive impact on the frequency of co-morbidity coding. The effect on length of stay is more ambiguous.

Table 2-10
Simulated Payment Effects from the IPF-PPS, Freestanding State Psychiatric Hospitals, 2004 to 2006

Payment Component	2004	2005	2006	2007
Percent change in co-morbidity adjustment	...	+0.2%	+0.7%	...
Percent change in per diem payment	...	+2.4%	+3.1%	...
Combined percent change in payments	...	+2.6%	+3.8%	...
Change in co-morbidity adjustment	...	+\$19.22	+\$84.06	...
Change in per diem payment	...	+\$302.28	+\$396.52	...
Combined change in payment	...	+\$321.50	+\$480.58	...
Estimated average payment level	\$12,559.48	\$12,880.97	\$13,040.06	...

NOTE: Estimated percentage change in per diem cost and covered days for freestanding state psychiatric hospitals not displayed due to low statistical precision. The 2004 column is estimated payments prior to the start of the IPF-PPS, and is not the TEFRA cost.

SOURCE: RTI International analysis of discharges from IPFs using the 2003–2007 100% MedPAR files.

Table 2-11
Simulated Payment Effects from the IPF-PPS, Freestanding Non-State Psychiatric Hospitals, 2004 to 2007

Payment Component	2004	2005	2006	2007
Percent change in co-morbidity adjustment	...	+0.6%	+1.1%	+0.7%
Percent change in per diem payment	...	-0.7%	-0.4%	-2.7%
Combined percent change in payments	...	-0.4%	-0.3%	-10.6%
Change in co-morbidity adjustment	...	+\$45.43	+\$82.22	+\$55.48
Change in per diem payment	...	-\$75.26	-\$103.33	-\$858.10
Combined change in payment	...	-\$30.08	-\$21.46	-\$805.54
Estimated average payment level	\$7,602.13	\$7,572.05	\$7,580.67	\$6,796.60

NOTE: The 2004 column is estimated payments prior to the start of the IPF-PPS, and is not the TEFRA cost.

SOURCE: RTI International analysis of discharges from IPFs using the 2003–2007 100% MedPAR files.

Table 2-12
Simulated Payment Effects from the IPF-PPS, DPUs, 2004 to 2007

Payment Component	2004	2005	2006	2007
Percent change in co-morbidity adjustment	...	+0.5%	+1.4%	+2.1%
Percent change in per diem payment	...	-0.7%	-0.4%	-2.7%
Combined percent change in payments	...	-0.3%	+1.0%	-0.7%
Change in co-morbidity adjustment	...	+\$41.05	+\$116.39	+\$173.94
Change in per diem payment	...	-\$62.59	-\$30.59	-\$230.67
Combined change in payment	...	-\$21.54	+\$85.80	-\$56.73
Estimated average payment level	\$8,454.24	\$8,432.70	\$8,540.04	\$8,397.52

NOTE: The 2004 column is estimated payments prior to the start of the IPF-PPS, and is not the TEFRA cost.

SOURCE: RTI International analysis of discharges from IPFs using the 2003–2007 100% MedPAR files.

2.6 Discussion

In this section we examined the impact of the IPF-PPS on LOS, frequency of co-morbidity coding, and payments. We found ambiguous results for LOS. However, there was a clear increase in coding of co-morbidities at both state and non-state freestanding psychiatric hospitals coincident with the phase-in of the IPPS. At the same time, there was little change in co-morbidity coding in acute hospitals and their psychiatric units. One possible explanation for this is that DPUs are located within PPS hospitals and as it is unlikely that these facilities maintain separate coders for their psychiatric units, general hospitals (with or without DPUs) were likely coding as completely prior to the IPF-PPS as during the phase-in period. Freestanding psychiatric hospitals, however, had no incentive prior to IPF-PPS because none of their admissions prior to 2005 were subject to the PPS. Finally, our analysis of the payment impact of the IPF-PPS showed a small increase in payment in all settings due to increased co-morbidity coding, but a slight decrease in total payment at DPUs and freestanding non-state hospitals because of the fall in LOS.

SECTION 3

COST AND CASE-MIX DIFFERENCES BETWEEN IPPS-EXEMPT UNITS AND SCATTER BEDS

3.1 Background

When the Medicare Acute Inpatient Prospective Payment System (IPPS) was implemented for acute general hospitals in 1984, providers with Medicare-Certified Distinct Part Psychiatric Units (DPUs) were permitted to have their DPUs remain on the pre-existing, historical cost-based, payment system established under the Tax Equity and Fiscal Responsibility Act (TEFRA; Pub. L. 97-248) instead of converting their psychiatric units to prospective payment. The Congress believed that prospective payment using DRGs were too limited in categorizing psychiatric patients for explaining cost and length of stay in these facilities (Frank and Lave, 1986; Mitchell et al., 1987). As a result, a dual payment system was established for psychiatric patients treated in acute hospitals: TEFRA payments for patients treated in DPUs versus IPPS payments for patients treated in “scatter beds” elsewhere in the acute portion of the hospital. All psychiatric hospitals continued to be paid under TEFRA.

The key difference in the two payment systems was on the risk borne by providers for the cost of a stay. The TEFRA system establishes a facility-specific per-case payment “target” based on a provider’s historical costs (per case costs from 1982, or later if the facility opened a DPU after 1982). If actual costs (determined after the fiscal year end) fall short of the target, the provider received a “bonus” payment equal to a capped percentage of the difference between actual and target per case costs. Likewise, if actual costs exceeded the target, the hospital received a (smaller) capped percentage of the excess of actual over target costs. In contrast, under the IPPS, hospitals retain the entire difference between their costs and the DRG-adjusted nationally-determined per case amount. However, they receive no additional payments for costs that exceed the per case amount (unless the cost for a case exceeds the “outlier threshold,” triggering payment of 80 percent of the difference between the outlier threshold and the actual cost). Thus TEFRA payment afforded two protections: (1) against costs (and, indirectly, length of stay) being higher than expected based on DRGs; and (2) against case mix being more severe than measured by DRG-adjusted national average costs.

In the Balanced Budget Refinement Act of 1999 (BBRA; Pub. L. 106-113), the Congress mandated that CMS develop a per diem payment system for all TEFRA (IPPS-exempt) inpatient psychiatric facilities (psychiatric DPUs as well and freestanding psychiatric hospitals), replacing the TEFRA system. In the November 15, 2004 Final Rule (CMS, 2004) implementing the Inpatient Psychiatric Facility PPS (IPF-PPS), as amended by the April 1, 2005 Correction Notice (CMS, 2005), CMS created a PPS using DRGs to anchor the patient classification system, as in the IPPS, but shifts from a per discharge to a per day basis of payment. It also uses a multiplicative payment formula that adjusts for patient age, day of stay, facility teaching intensity, and co-morbidities. These adjustments are not made for cases paid under the IPPS. The two systems would also have differing outlier percentages.

Providing two different payment systems for psychiatric inpatients could result in inefficient and inequitable payments. As a general rule of prospective payment, the payments for the same patient treated in the same type of facility in the same market area should be identical. CMS currently makes payment adjustments in the IPPS for teaching status and rural location. It also adjusts payments for local area wage differences. Thus, within a market area, the same

patient treated in two different non-teaching facilities would generate the same payment in each facility. Currently, payments for a psychiatric or substance abuse case would differ depending upon whether a patient is treated in a DPU (paid under the IPF-PPS) or not.¹⁰ Not only would two different standardized amounts be used, but the relative weights would be different, even within the same DRG. More importantly, providers treating patients in scatter beds would be at risk for longer stays while those treating patients in an IPF-PPS unit would not because of per diem payments.

Payment inefficiencies could arise from paying more in one facility type than another for the same patient, particularly for patients a facility believes would have a short length of stay. This could lead to inefficient shifts of patients from lower to higher paying units. In particular, it could encourage providers to shift longer stay patients to IPF-PPS units under per diem payment. This shift could even occur within the same facility from IPPS beds to the IPF-PPS unit.

Different bases of payment also produce different relative weights across types of patients, e.g., psychoses versus organic disturbances. This is caused primarily by differences in lengths of stay within DRG. Thus, patients classified in very short-stay DRGs will have relatively higher per diem payments and relatively lower per case payments in IPF-PPS unit beds. Provider inequities can result both from differing relative weights and bases of payment. Providers without DPUs will be at risk for longer stays while facilities with a DPU will not. Also, because the two systems will have unequal adjustments for teaching status, rural location, and patient age, some providers will be paid less for treating the same patient depending upon the type of unit the patient is treated in.

Whether the dual payment systems for inpatient psychiatric care should be retained, rather than incorporating all inpatient psychiatric care into the IPF-PPS, therefore requires that two criteria be met. First, the patient populations in the two settings (IPF-PPS versus IPPS units) must be distinct; otherwise, inefficiencies resulting from provider gaming may arise. Second, there must be a conceptual foundation for the simultaneous existence of a per case and a per diem system—for example, based on a need to provide length of stay risk protection for certain classes of patients or to reduce the scope of length of stay gaming for others—rather than merely historical accident.

This section addresses the following topics:

- **Organization of Scatter Beds**—What determines whether a hospital will certify its unit as a DPU? How often do hospitals operate both certified and uncertified units? Why are any psychiatric patients treated in true scatter beds outside organized units? What financial incentives exist to affect the decision to operate a unit as a DPU or an uncertified unit?
- **Triaging Patients among DPUs, Uncertified Units, and True Scatter Beds**—What case mix differences exist between DPUs, uncertified units, and true scatter beds? What criteria are used to triage patients between certified and uncertified units when they are present in the same facility? What financial incentives exist that may affect the triage decision?

¹⁰ Of course, since psychiatric hospitals are also paid under the IPF-PPS, payments would differ between these facilities and acute hospitals without a DPU. However, to highlight the dual payment system issue, we are restricting to cases in acute hospitals only to keep as many patient and facility characteristics the same.

- **Cost Differences among DPUs, Uncertified Units, and True Scatter Beds**—How do DPUs, uncertified units, and true scatter beds compare with respect to per diem cost and length of stay? How much do differences in case mix account for any cost differences?

3.2 Data Sources

The data used in the analyses presented in this report are comprised of 625,210 stays in DPUs and scatter beds completed in calendar year 2004. These observations were selected from the 100 Percent National MedPAR file on the basis of the Medicare provider ID (to identify only discharges from general acute hospitals, including DPUs) and DRG. This file contains information on patient demographics, diagnoses, procedures, and charges for each IPF stay. FY2002 and FY2003 Medicare Cost Report (MCR) data from the Healthcare Cost Report Information System (HCRIS) database provided data on the numbers of psychiatric unit beds, numbers of residents, and department-level costs for each hospital. The Provider of Services (POS) File gave information on each facility’s location (urban or rural) and whether it has an emergency department. Data from the latter two datasets were merged on to each MedPAR record by the Medicare provider ID. Scatter bed cases were further subset by whether the provider had a psychiatric DPU.

In this study, the dependent variable (the natural log of measured per diem cost) was measured using the 2004 MedPAR and MCR datasets. This measure replicates (except for using more recent claims data) the per diem cost calculation used by CMS in developing the IPF-PPS payment weights. To construct this measure, discharge-level ancillary department charges reported on the MedPAR record were converted to estimated costs using facility-specific department-level CCRs reported on the facility’s most recent (generally fiscal year 2003) Medicare Cost Report. CCRs outside three standard deviations of the facility type¹¹ mean (psychiatric hospital versus DPU) were reset to the facility-type median department-specific CCR. To this estimated ancillary cost was added the facility-level per diem routine cost (again applying facility type-specific ceilings and floors). Constructed this way, patients’ “daily costs” do not vary by day of stay but are a single average for the stay. The resulting per diem cost was adjusted for differences in area wages according to:

$$(3) \quad [\text{Adjusted Per Diem Cost}]_i = [\text{Per Diem Cost}]_i \left(\frac{0.72828}{[\text{Facility Area Wage Index}]_i} + 0.27172 \right),$$

where $[\text{Facility Area Wage Index}]_i$ is the FY2005 area wage index for the Metropolitan Statistical Area¹² in which the facility treating patient i is situated and 0.72828 is the labor-related share of cost determined by CMS for the IPF-PPS.

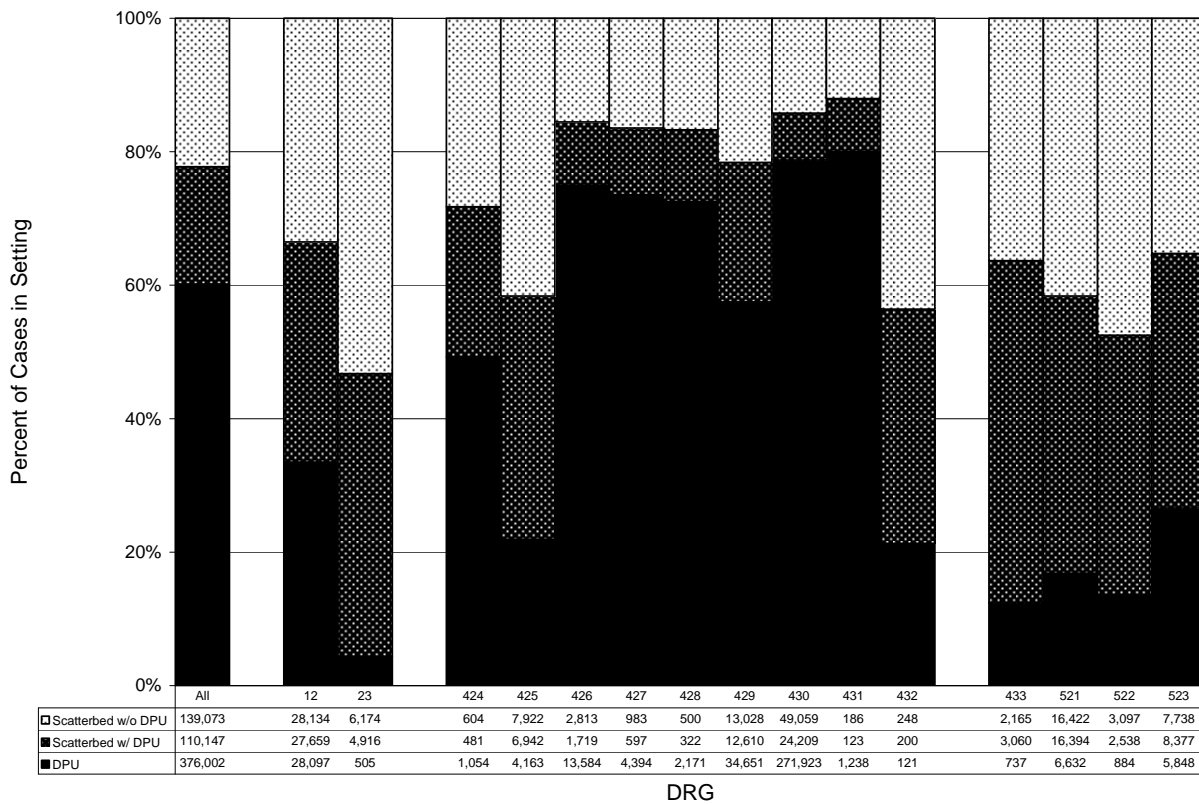
¹¹ Separate means for psychiatric hospitals and DPUs were computed to control for differences in cost allocation among departments between these facilities.

¹² The IPF-PPS Final Rule for FY2005 used the Metropolitan Statistical Areas defined by the OMB in 1993 without any reclassifications of rural areas as urban. The FY2006 Proposed Rule (71FR3616) used the more recent Core Based Statistical Areas (CBSAs) for determining wage index values.

3.3 Descriptive Analysis of Case Mix and Length of Stay

The first step in our analysis of differences between DPUs and scatter bed cases is identifying diagnosis and patient age differences between these settings. *Figure 3-1* displays the distribution of cases overall and by DRG for DPUs, scatter beds in hospitals with a DPU, and scatter beds in hospitals without a DPU. Each vertical bar in Figure 3-1 represents the population of patients in DPUs and scatter beds with a particular DRG. Counts of cases are shown in the table below the graph. DPUs treat significantly fewer DRG 012 and 023 (Degenerative Nervous System Disorders, and Non-traumatic Stupor and Coma, respectively) and substance abuse (DRGs 433 and 521–523) patients. The relative sizes of the two scatter bed bars indicate that there are few principal diagnosis differences between scatter beds with and without DPUs, which suggests that few scatter bed cases are in organized units that resemble DPUs.

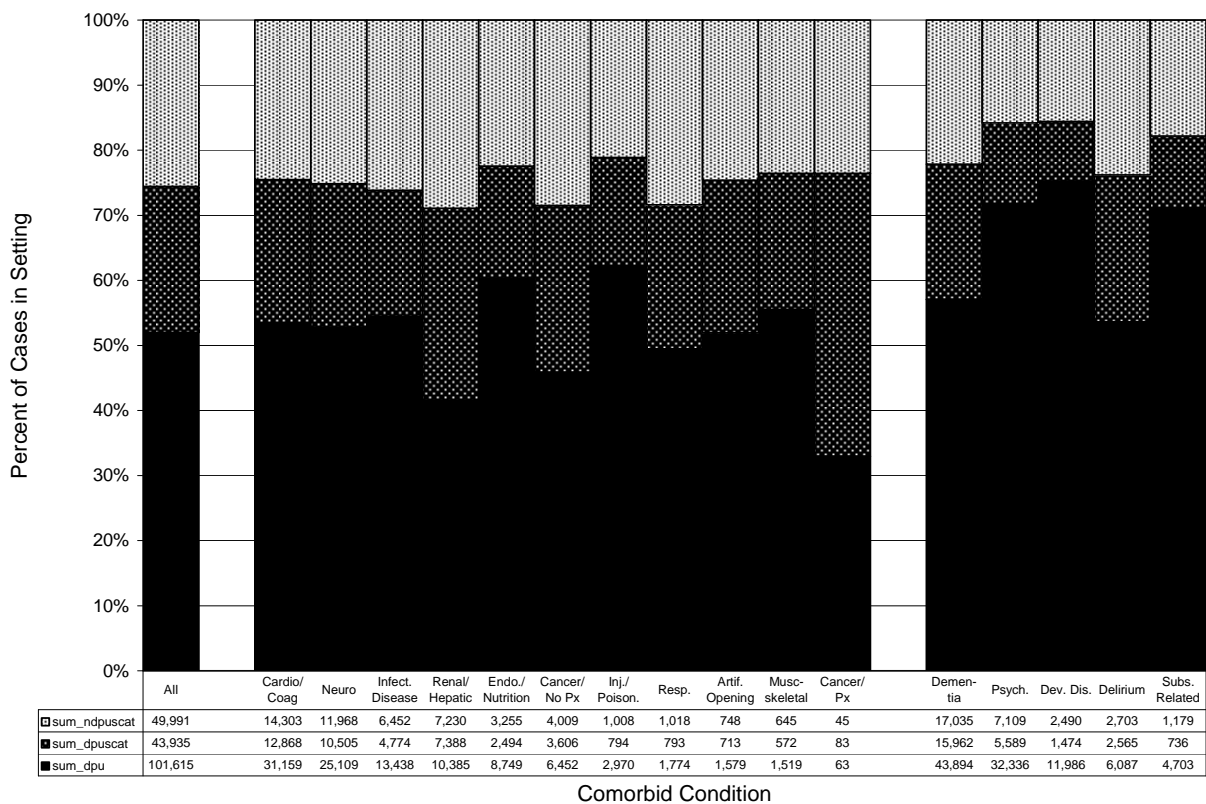
Figure 3-1
DRG Distribution of DRGs in General Acute Hospitals, by Setting



SOURCE: RTI International analysis of discharges from inpatient psychiatric units and hospitals using the 2004 100% MedPAR file.

Figure 3-2 displays the distribution of cases overall and by RTI co-morbid condition (see Section 4 for details on these co-morbid condition groups) for DPUs, scatter beds in hospitals with a DPU, and scatter beds in hospitals without a DPU. Co-morbidity differences across settings for psychiatric inpatients are less pronounced than for DRG. Among medical co-morbidities, only renal and cancer conditions are markedly less prevalent among patients in DPUs than scatter beds, and the largest difference from the overall distribution is for patients receiving radiation or chemotherapy for cancer—and such patients are exceedingly rare. Behavioral co-morbidities are relatively more prevalent among patients treated in DPUs. The similarity in the relative sizes of the vertical bars for the two types of scatter bed cases (those scatter bed cases in general acute hospitals with, and without, DPUs) indicates that, similarly for DRG, there are few co-morbidity differences between scatter beds with and without DPUs, which suggests that few scatter bed cases are in organized units that resemble DPUs.

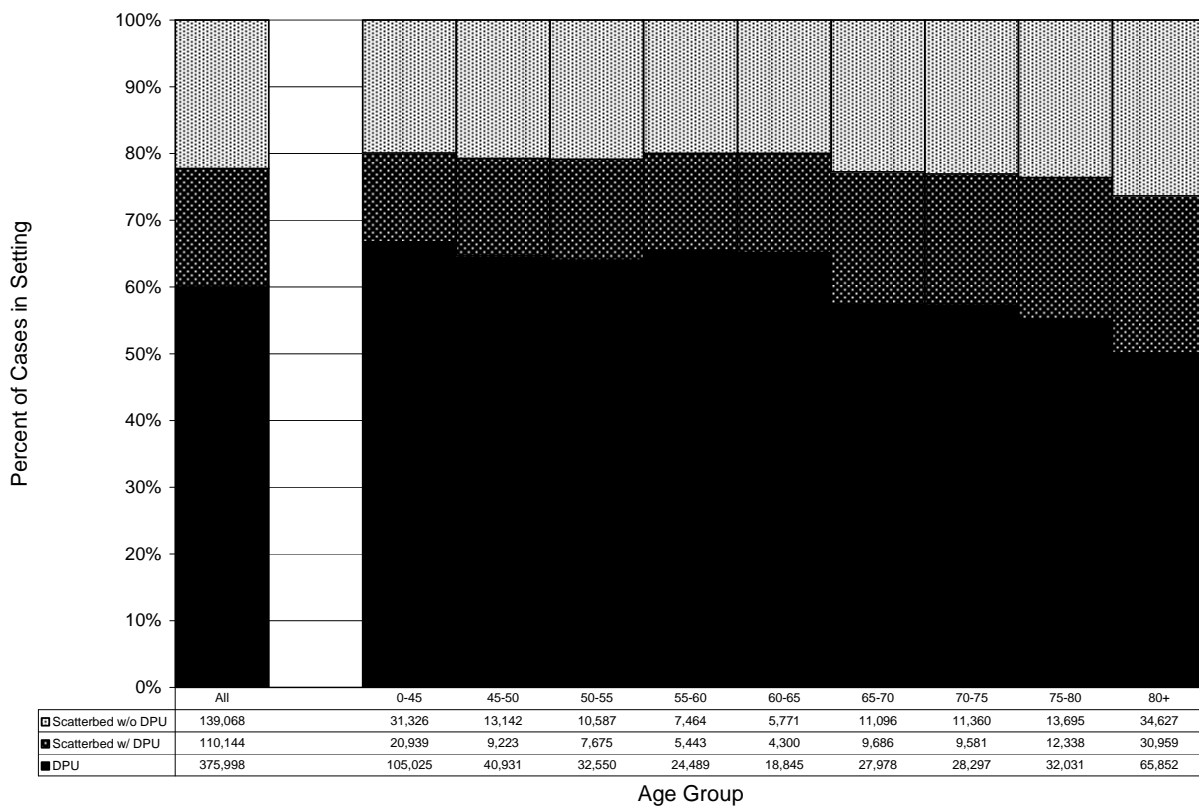
Figure 3-2
DRG Distribution of Co-morbid Conditions in General Acute Hospitals, by Setting



SOURCE: RTI International analysis of discharges from inpatient psychiatric units and hospitals using the 2004 100% MedPAR file.

Figure 3-3 displays the distribution of cases overall and by age group for DPUs, scatter beds in hospitals with a DPU, and scatter beds in hospitals without a DPU. Although patient age differences across settings for psychiatric inpatients are less pronounced than for DRG, there is a pattern. Younger patients tend to be more likely, not controlling for other factors, to be treated in DPUs and in scatter beds where no DPU is present. As age increases, the patient is both more likely to be treated in a scatter bed than a DPU and also in scatter beds in hospitals that also have a DPU. Combined with the finding in Figure 3-1 that neurologic DRGs are more likely to be treated in scatter beds than DPUs, that older patients are particularly more likely to be treated in scatter beds where a DPU is present suggests that hospitals with DPUs may triage older, neurologic or dementia patients into scatter beds and others into DPUs. Alternatively, these patients may first be treated in a general medical bed until medically clear to be in a psychiatric unit.

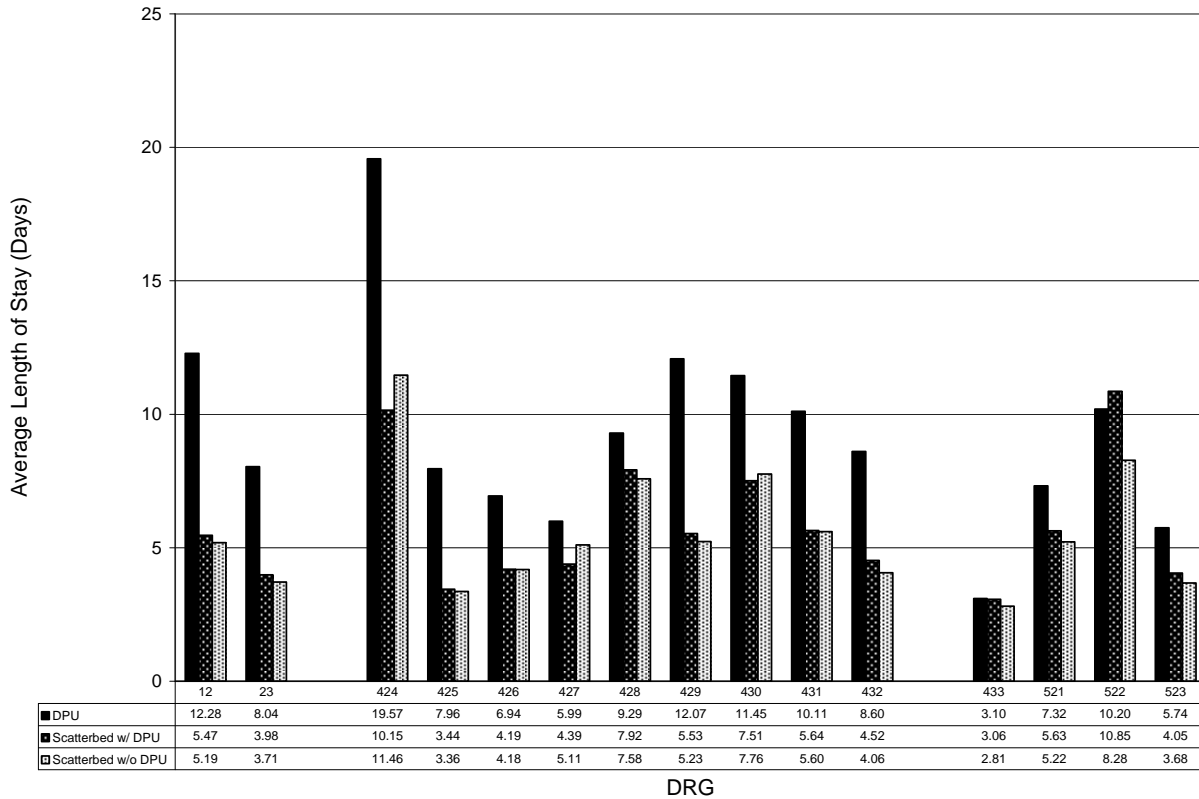
Figure 3-3
DRG Distribution of Patient Age in General Acute Hospitals, by Setting



SOURCE: RTI International analysis of discharges from inpatient psychiatric units and hospitals using the 2004 100% MedPAR file.

Figure 3-4 displays the average lengths of stay (ALOSs) for psychiatric patients by DRG in each hospital setting. Patients in DPUs have significantly greater average lengths of stay ALOS than do patients in scatter beds (about double the ALOS), regardless of whether the hospital operates a DPU. Scatter bed discharges tend to be shorter than DPU discharges even when restricting to patients within the same DRG and having co-morbid condition group. However, this ALOS difference is much less pronounced for substance abuse-related cases, suggesting less difference between DPU patients and scatter bed patients with these conditions, and possibly less difference in the care provided.

Figure 3-4
DRG Distribution of Patient Age in General Acute Hospitals, by Setting



SOURCE: RTI International analysis of discharges from inpatient psychiatric units and hospitals using the 2004 100% MedPAR file.

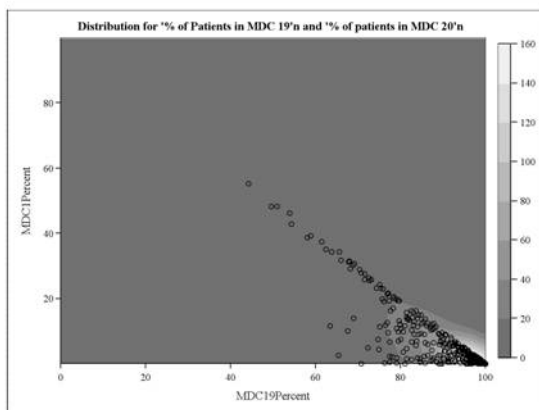
Figure 3-4 displays the average lengths of stay (ALOSs) for psychiatric patients by DRG in each hospital setting. Patients in DPUs have significantly greater average lengths of stay ALOS than do patients in scatter beds (about double the ALOS), regardless of whether the hospital operates a DPU. Scatter bed discharges tend to be shorter than DPU discharges even when restricting to patients within the same DRG and having co-morbid condition group. However, this ALOS difference is much less pronounced for substance abuse-related cases, suggesting less difference between DPU patients and scatter bed patients with these conditions, and possibly less difference in the care provided.

To understand the degree to which some scatter beds may be arranged in true units not certified as DPUs rather than “scattered” throughout the hospital, we estimated 2-dimensional

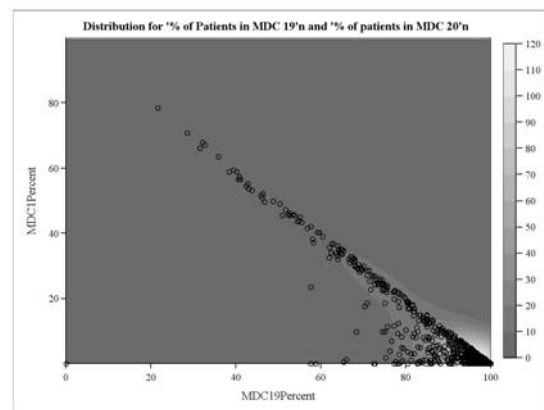
kernel densities of hospitals' proportions of MDC 1 (neurological disorders) psychiatric DRG discharges versus both proportions of MDC 19 (mental health disorders) and age greater than or equal to 65. The 2-dimensional kernel density gives a smoothed estimate of the joint distributions of the characteristics. These kernel densities are purely descriptive, used here to suggest whether scatter bed hospitals tend to "cluster" into a small number of archetypal groups that would be difficult to detect using traditional linear methods (e.g., correlation coefficients). *Figures 3-5 through 3-8* present the kernel density estimates, stratified by number of Medicare discharges (with breakpoints at the 10th, 25th, and 75th percentiles of DPU discharges).

Figure 3-5
Kernel Density Estimate of DPU MDC 1 and MDC 19 Percentages, by DPU Volume Groups

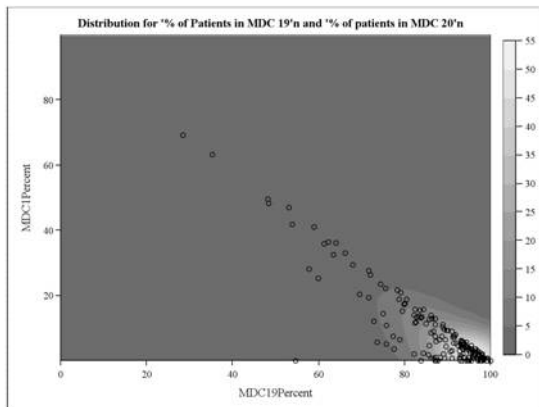
351 or More Discharges
(75th to 100th Percentile of DPU Discharges)



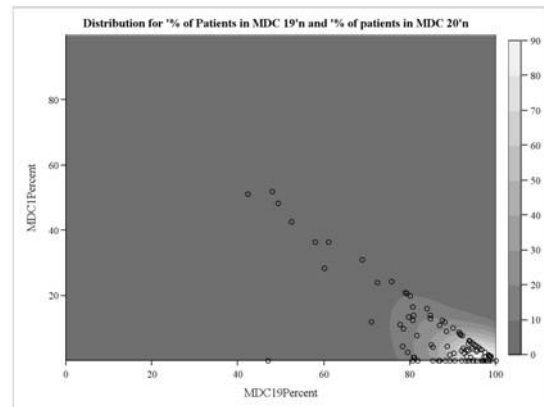
Between 144 and 350 Discharges
(25th to 75th Percentile of DPU Discharges)



Between 91 and 143 Discharges
(10th to 25th Percentile of DPU Discharges)



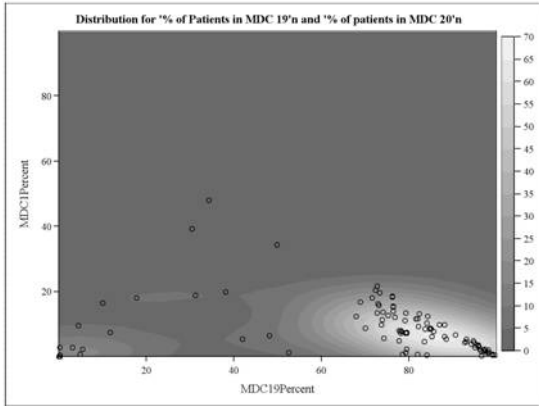
91 and Fewer Discharges
(Up to 10th Percentile of DPU Discharges)



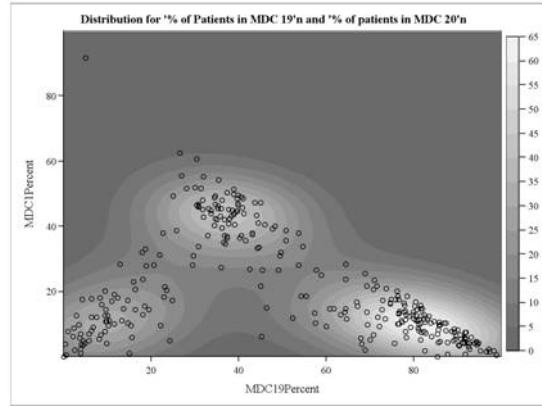
SOURCE: RTI International analysis of discharges from inpatient psychiatric units and hospitals using the 2004 100% MedPAR file.

Figure 3-6
Kernel Density Estimate of Scatter Bed MDC 1 and MDC 19 Percentages, by DPU Volume Groups

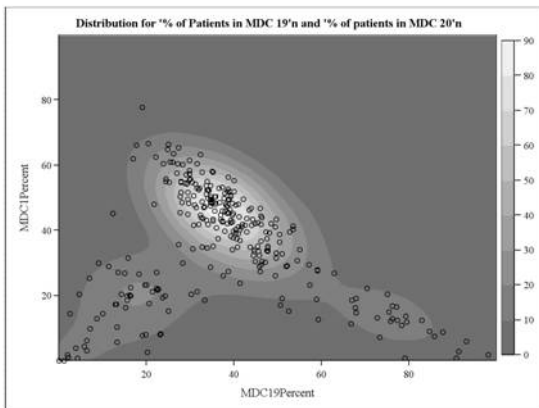
351 or More Discharges
(75th to 100th Percentile of DPU Discharges)



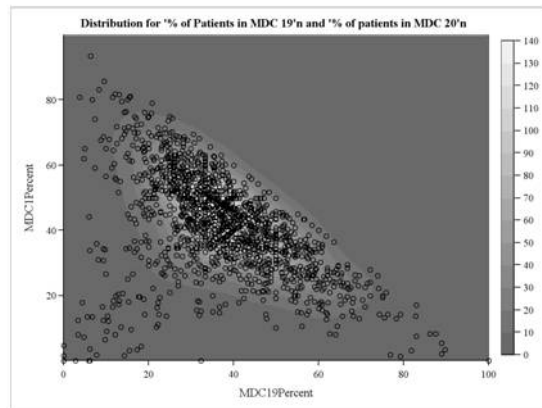
Between 144 and 350 Discharges
(25th to 75th Percentile of DPU Discharges)



Between 91 and 143 Discharges
(10th to 25th Percentile of DPU Discharges)



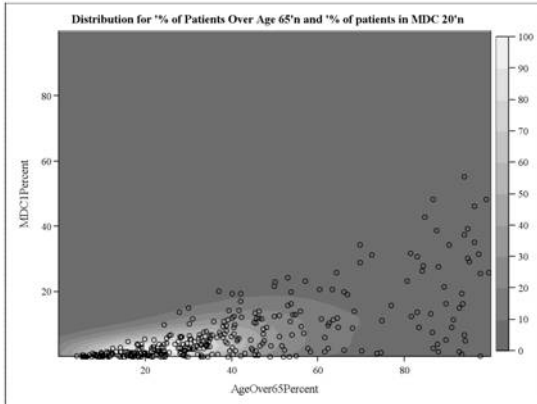
91 and Fewer Discharges
(Up to 10th Percentile of DPU Discharges)



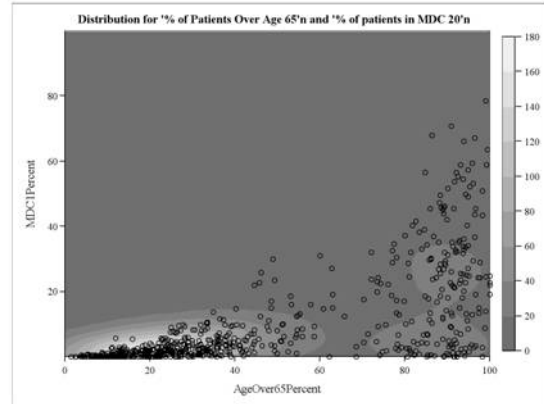
SOURCE: RTI International analysis of discharges from inpatient psychiatric units and hospitals using the 2004 100% MedPAR file.

Figure 3-7
Kernel Density Estimate of DPU MDC 1 and Age 65+ Percentages, by DPU Volume Groups

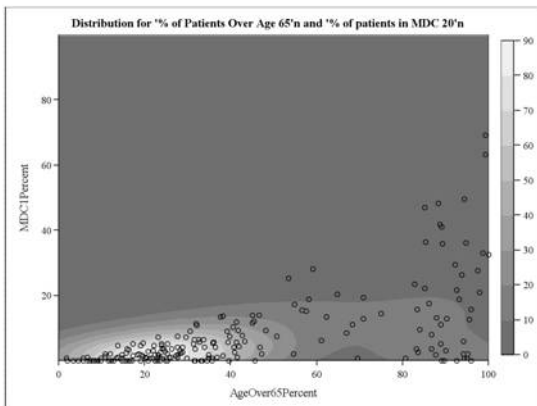
351 or More Discharges
(75th to 100th Percentile of DPU Discharges)



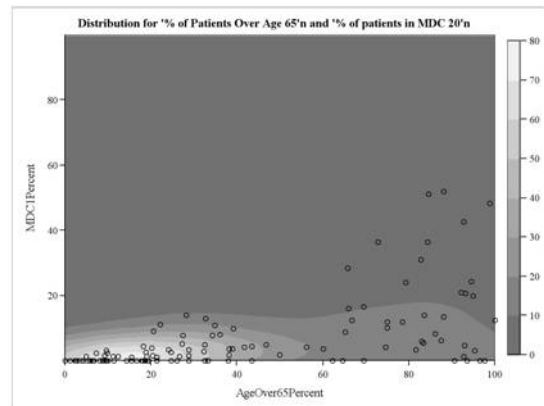
Between 144 and 350 Discharges
(25th to 75th Percentile of DPU Discharges)



Between 91 and 143 Discharges
(10th to 25th Percentile of DPU Discharges)



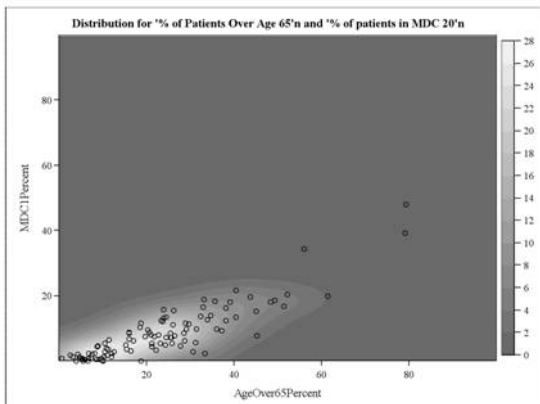
91 and Fewer Discharges
(Up to 10th Percentile of DPU Discharges)



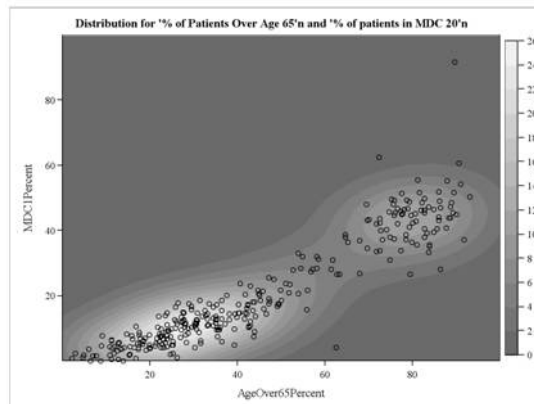
SOURCE: RTI International analysis of discharges from inpatient psychiatric units and hospitals using the 2004 100% MedPAR file.

Figure 3-8
Kernel Density Estimate of Scatter Bed MDC 1 and Age 65+ Percentages, by DPU Volume Groups

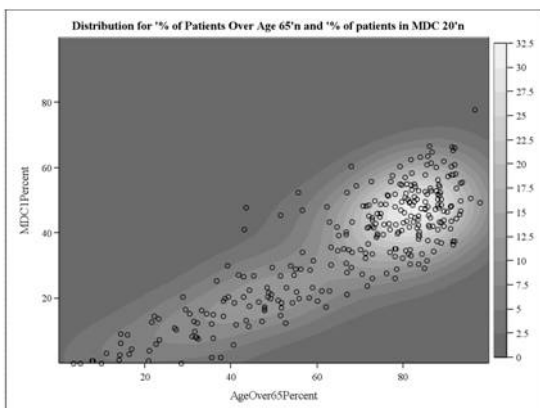
351 or More Discharges
(75th to 100th Percentile of DPU Discharges)



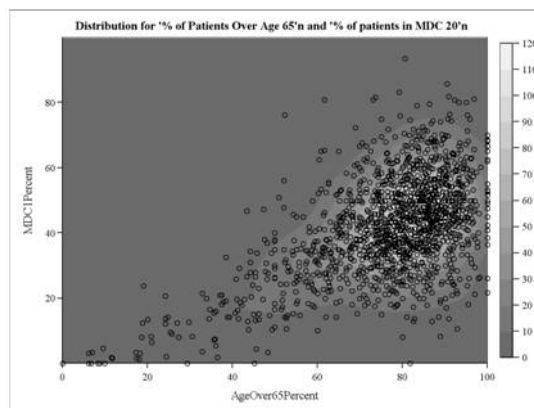
Between 144 and 350 Discharges
(25th to 75th Percentile of DPU Discharges)



Between 91 and 143 Discharges
(10th to 25th Percentile of DPU Discharges)



91 and Fewer Discharges
(Up to 10th Percentile of DPU Discharges)



SOURCE: RTI International analysis of discharges from inpatient psychiatric units and hospitals using the 2004 100% MedPAR file.

Inspection of Figures 3-5 through 3-8 suggests that the largest scatter bed hospitals, those with a number of Medicare psychiatric DRG discharges greater than the 75th percentile of DPUs' Medicare discharges, strongly resemble DPUs. As illustrated in Figure 3-5, DPUs, regardless of size, are strongly clustered in the bottom-right corner of each of the 4 graphs, indicating very small proportions of neurological (MDC 1) and substance abuse (MDC 20) cases (because the sum of proportions of MDCs 1, 19, and 20 must equal 1, points toward the bottom-left corner of the graphs indicate positive MDC 20 proportions). However, as shown in Figure 3-6, only the largest scatter bed hospitals exhibit this clustering. In addition, there is positive density in the bottom-left corner of the graph for the largest scatter bed hospitals, unlike for DPUs, suggesting that some large scatter bed hospitals (that may or may not operate DPUs as well) are operating substance abuse units. Furthermore, as the number of scatter bed cases falls, density shifts away from the bottom-left and bottom-right corners of the graphs and into a large interior area. Such a cluster represents a varied mix of MDC 1, 19, and 20 discharges and likely represents "true" scatter bed cases, with a small number of psychiatric patients "scattered" around the hospital.

Figures 3-7 and 3-8 also indicate that there is differential clustering of psychiatric DRG patients in DPUs versus scatter beds based on proportions of neurological patients and elderly that is also size-dependent. The density estimates in Figure 3-7 indicate 2 distinct clusters of DPU patients. One cluster has a very low neurological DRG proportion and a roughly 30 percent proportion of elderly patients. The second cluster, most apparent for DPUs between the 25th and 75th percentiles of Medicare volume, has a neurological case proportion spread over 0 to 50 percent and an elderly patient proportion of about 80 percent. This may represent hospitals operating a gero-psych unit. As shown in Figure 3-8, however, the largest scatter beds do appear to have mostly a "general" psychiatric case mix that is slightly skewed toward a higher neurological case mix. However, as the number of scatter bed cases from a hospital falls, the density shifts to a population that is mostly elderly and concentrated in having a relatively high neurological condition case mix. These results suggest that DPUs and scatter beds do specialize in a few archetypal clusters. The largest scatter bed hospitals do tend to resemble DPUs, though with an additional specialization in substance abuse cases, possibly in an organized unit. However, as the scatter bed volume falls, scatter bed hospitals' case mix tends toward an older population with a more varied psychiatric DRG case mix than DPUs, particularly with higher neurological volume.

3.4 Multivariate Analysis of Case Mix

The descriptive analyses of case mix presented above suggest that DPUs and scatter beds differ markedly on several case mix characteristics. In this section we estimate logit models of whether a patient would be treated in a DPU versus a scatter bed; using a model-based approach will help determine the relative importance of each characteristic. We will estimate two models. The first is linear in the characteristics of interest:

$$\begin{aligned}
L([DPU]_f) = & \alpha + \beta_1 [MDC 1 Proportion]_f + \beta_{19} [MDC 19 Proportion]_f + \\
& \beta_{119} [MDC 1 Proportion]_f [MDC 19 Proportion]_f + \beta_{65} [Patient Age \geq 65 Proportion]_f + \\
& \beta_{165} [MDC 1 Proportion]_f [Patient Age \geq 65 Proportion]_f + \\
(4) \quad & \beta_V \log([Medicare Psych DRG Discharges]_f) + \\
& \beta_M [Medical Comorbid Condition Proportion]_f + \\
& \beta_M [Behavioral Comorbid Condition Proportion]_f + \varepsilon_f
\end{aligned}$$

where i indexes the stay for patient i and:

- L is the logit cumulative distribution function.
- $[MDC 1 Proportion]_f$ is the proportion of the facility's psychiatric cases in MDC 1.
- $[MDC 19 Proportion]_f$ is the proportion of the facility's psychiatric cases in MDC 19.
- $[Patient Age \geq 65 Proportion]_f$ is the proportion of the facility's psychiatric cases associated with patients aged 65 years or older.
- $[Medicare Psych DRG Discharges]_f$ gives the facility's number of psychiatric cases.
- $[Medical Comorbid Condition Proportion]_f$ is the proportion of the facility's psychiatric cases with an RTI medical co-morbid condition.
- $[Behavioral Comorbid Condition Proportion]_f$ is the proportion of the facility's psychiatric cases with an RTI behavioral co-morbid condition.
- e_{if} is the portion of the likelihood the patient is in a DPU not explained by the regressors (i.e., the idiosyncratic regression "error" term).

The parameter estimates from estimating the linear logit model in equation (4) are shown in **Table 3-1**. With the exception of the interaction between the provider's MDC 1 proportion and its MDC 19 proportion, all estimated coefficients are highly statistically significant. However, it is important to note that many of the estimated coefficients are quite extreme, with absolute values greater than 10. This is likely due to the high correlation coefficients among the characteristics listed. To gauge the impact of each characteristic on the model's predictive power, we re-estimated the model, each time omitting one characteristic. The misclassification rate for the restricted model was compared to that of the full model, and standard errors of the difference were bootstrapped with 100 replications. The result of these tests are shown in the third column of Table 3-1. In this, more rigorous test, only the MDC 19 and the behavioral co-morbid condition proportions significantly affected the model predictive power. A second model that included three area-level characteristics (occupancy rate of other IPFs in the hospital referral region, the number of IPF beds per 1,000 Medicare beneficiaries in the hospital referral region, and an indicator for rural location) was estimated. However, all coefficients of the area-level coefficients, plus a test that all coefficients equal zero, were highly insignificant.

Table 3-1
Parameter Estimates of Linear Logit Model of Characteristics Associated with a Provider
Being a DPU versus a Scatter Bed Provider

Variable	Coefficient Estimate	Coefficient Standard Error	Coefficient <i>p</i> -value
MDC 19 proportion	10.664	1.242	0.000
MDC 1 proportion	-56.563	6.615	0.000
MDC 19 proportion × MDC 1 proportion	3.862	5.483	0.481
Age 65+ proportion	3.675	0.809	0.000
MDC 1 proportion × age 65+ proportion	45.291	4.845	0.000
log (Medicare psych DRG discharges)	0.794	0.110	0.000
Medical Co-morbid Condition Proportion	-4.130	1.168	0.000
Behavioral Co-morbid Condition Proportion	18.619	1.275	0.000
Area IPF beds/beneficiary (thousands)	40.192	35.034	0.251
Occupancy rate of other area IPFs	1.343	0.466	0.004
Whether facility in a rural area	0.374	0.384	0.330
Constant	-14.849	1.343	0.000

NOTE: Facilities with fewer than 20 psychiatric DRG discharges in 2004 were excluded.

SOURCE: RTI International analysis of discharges from inpatient psychiatric units and hospitals using the 2004 100% MedPAR file.

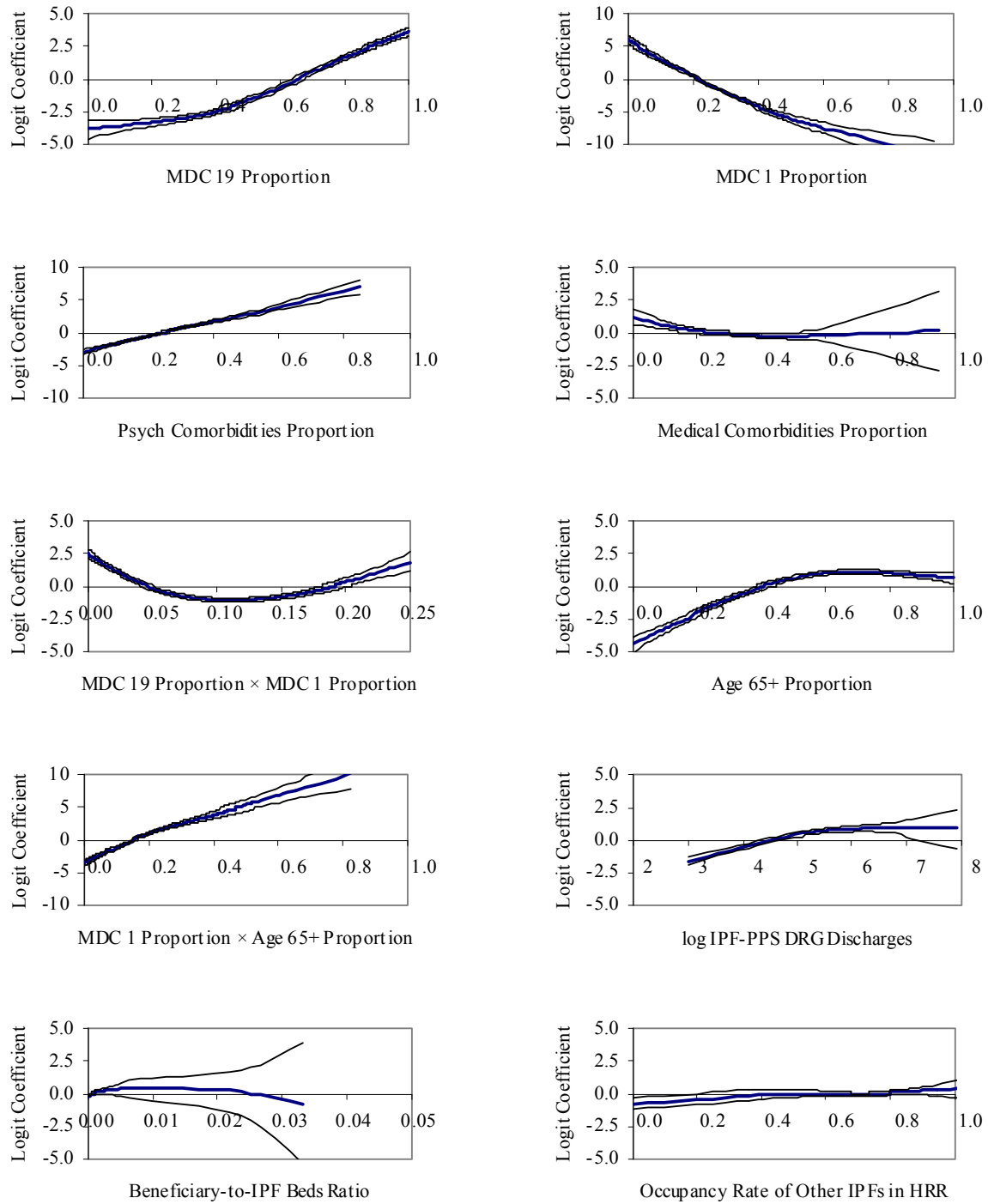
The extreme coefficient estimates in the linear logit model suggest that the linear logit model may poorly identify the clustering of facilities shown in Figures 3-5 through 3-8 despite the inclusion of the products of the MDC 1 proportion with both the MDC 19 and the age 65 or older proportions. To allow for more nonlinearity in the response of the probability of being a DPU with each facility characteristic, we estimated a version of equation (4) in which the linear terms are replaced with cubic spline functions:

$$\begin{aligned}
 L([DPU]_f) = & \alpha + g_1([MDC\ 1\ Proportion]_f) + g_{19}([MDC\ 19\ Proportion]_f) + \\
 & g_{119}([MDC\ 1\ Proportion]_f [MDC\ 19\ Proportion]_f) + g_{65}([Patient\ Age \geq 65\ Proportion]_f) + \\
 & g_{165}([MDC\ 1\ Proportion]_f [Patient\ Age \geq 65\ Proportion]_f) + \\
 (5) \quad & g_V(\log([Medicare\ Psych\ DRG\ Discharges]_f)) + \\
 & g_M([Medical\ Comorbid\ Condition\ Proportion]_f) + \\
 & g_M([Behavioral\ Comorbid\ Condition\ Proportion]_f) + \varepsilon_f
 \end{aligned}$$

Figure 3-9 presents the estimated cubic splines estimated for equation (5), and **Table 3-2** presents the linear portions¹³ of the estimated splines and tests of significance against a null hypothesis of zero. A test of the estimated nonlinearity of the *g* functions in equation (5) against a null that the *g* functions are linear was significant at the 1.4 percent level.

¹³ The linear portion of each spline is a line with a slope equal to the average first derivative of the spline and an intercept set so that the average difference between the spline and the line equals zero.

Figure 3-9
Estimated Spline Functions of Additive Logit Model of Characteristics Associated with a Provider Being a DPU versus a Scatter Bed Provider



Source: RTI International analysis of 2004 MedPAR file.

Table 3-2
Linear Components of Estimated Spline Functions of Additive Logit Model of
Characteristics Associated with a Provider Being a DPU versus a Scatter Bed Provider

Variable	Linear Component Parameter Estimate	Linear Component Standard Error	Linear Component <i>p</i> -value	Nonlinear Component <i>p</i> -value
MDC 19 proportion	9.134	0.390	0.000	0.000
MDC 1 proportion	-22.692	1.229	0.000	0.000
MDC 19 proportion × MDC 1 proportion	-10.100	1.285	0.000	0.000
Age 65+ proportion	4.798	0.358	0.000	0.000
MDC 1 proportion × age 65+ proportion	17.709	1.334	0.000	0.001
log (Medicare psych DRG discharges)	0.732	0.072	0.000	0.000
Medical co-morbid condition proportion	-1.580	0.531	0.006	0.179
Behavioral co-morbid condition proportion	11.709	0.459	0.000	0.561
Area IPF beds/beneficiary (thousands)	36.386	27.286	0.091	0.213
Occupancy rate of other area IPFs	0.754	0.275	0.003	0.539
Whether facility in a rural area	0.318	0.216	0.071	...
Constant	-2.101	0.057	0.000	...

NOTES: Facilities with fewer than 20 psychiatric DRG discharges in 2004 were excluded. The linear component of each spline is the slope of a least squares regression of the fitted spline on the predicted values. The nonlinear component is the residual after subtracting the linear component from the spline, and the *p*-value is from a LR test of the restriction of the spline to be a straight line.

SOURCE: RTI International analysis of discharges from inpatient psychiatric units and hospitals using the 2004 100% MedPAR file.

As Figure 3-9 illustrates, the effects of several of the characteristics (the MDC 19, MDC 1, the behavioral co-morbidities, and the product of the age 65+ and MDC 1 proportions) have largely linear effects. The greater are the MDC 19, behavioral co-morbidities, and product of the age 65+ and MDC 1 proportions, all else equal, the greater is the likelihood of the facility being a DPU. However, not all characteristics have linear effects on the likelihood of being a DPU. The age 65+ proportion and natural log of the number of Medicare psychiatric DRG discharges (“size”) increases approximately linearly for about two-thirds of their ranges, but after a threshold, increases in these have little if any effect on the likelihood of being a DPU. The age 65+ coefficient may be driven by the twin forces of DPUs having geriatric specialty units versus the correlation between age and neurological disorders, the effect of which is identified by the effect of the product of the age 65+ and MDC 1 proportions. The attenuation of the effect of size on the likelihood of being a DPU may identify the effect of the existence of scatter bed units. In addition, the effect of the product of the MDC 1 and MDC 19 proportions is U-shaped. When this product is near 0, the case mix is concentrated in a single MDC; this tends to be the hallmark of a unit versus true scatter beds. As this product falls, the case mix becomes less concentrated, as true scatter beds tend to be. However, as this product tends to 0.25, the case mix is equally divided between MDCs 1 and 19, and the likelihood of being a DPU increases somewhat.

We next used the estimated equation (5) to identify those scatter bed providers that most resemble DPUs and may represent psychiatric units not certified as DPUs. We compared the predicted odds from the additive logit model against the “naïve” predictor equal to the average

odds to predict whether a provider is a DPU or scatter bed facility. **Table 3-3** presents the misclassification counts and percentages, and **Table 3-4** presents summary statistics.

Table 3-3
Misclassification Rates from the Additive Logit DPU Predictor Model

Provider Type	Classified as DPUs Count	Classified as DPUs Percent	Classified as Scatter Beds Count	Classified as Scatter Beds Percent
DPUs	1,299	93.9%	42	1.8%
Scatter beds	84	6.1%	2,312	98.2%

NOTES: Facilities with fewer than 20 psychiatric DRG discharges in 2004 were excluded.

SOURCE: RTI International analysis of discharges from inpatient psychiatric units and hospitals using the 2004 100% MedPAR file.

Table 3-4
Summary Statistics for Correctly & Misclassified Facilities from Additive Logit DPU Predictor Model

Classified as from Model	Variable	Correctly Classified Mean	Correctly Classified Std. Dev.	Mis-classified Mean	Mis-classified Std. Dev.	Diff.	Std. Err.	p-value
DPU	MDC 19 proportion	0.887	0.128	0.884	0.089	-0.003	0.010	0.739
DPU	MDC 1 proportion	0.079	0.125	0.057	0.064	-0.022	0.008	0.004
DPU	MDC 19 proportion × MDC 1 proportion	0.056	0.070	0.046	0.041	-0.009	0.005	0.056
DPU	Age 65+ proportion	0.429	0.299	0.267	0.206	-0.162	0.024	0.000
DPU	MDC 1 proportion × Age 65+ proportion	0.059	0.115	0.025	0.056	-0.034	0.007	0.000
DPU	log (Medicare psych DRG discharges)	5.422	0.697	5.521	0.900	0.099	0.099	0.318
DPU	Medical co-morbid condition proportion	0.232	0.094	0.200	0.075	-0.032	0.008	0.000
DPU	Behavioral co-morbid condition proportion	0.257	0.147	0.204	0.125	-0.053	0.014	0.000
DPU	Area IPF beds/beneficiary (thousands)	0.701	0.174	0.655	0.194	-0.046	0.021	0.033
DPU	Occupancy rate of other area IPFs	0.949	1.854	1.010	2.458	0.061	0.271	0.822
DPU	Whether facility in a rural area	0.082	0.274	0.048	0.214	-0.034	0.024	0.159
Scatter bed	MDC 19 proportion	0.389	0.177	0.735	0.175	0.346	0.027	0.000
Scatter bed	MDC 1 proportion	0.382	0.167	0.124	0.107	-0.259	0.017	0.000
Scatter bed	MDC 19 proportion × MDC 1 proportion	0.137	0.055	0.087	0.060	-0.050	0.009	0.000
Scatter bed	Age 65+ proportion	0.713	0.216	0.332	0.211	-0.382	0.033	0.000
Scatter bed	MDC 1 proportion × Age 65+ proportion	0.300	0.162	0.061	0.088	-0.239	0.014	0.000
Scatter bed	log (Medicare psych DRG discharges)	4.096	0.793	5.002	1.081	0.906	0.165	0.000
Scatter bed	Medical co-morbid condition proportion	0.363	0.107	0.221	0.077	-0.142	0.012	0.000
Scatter bed	Behavioral co-morbid condition proportion	0.246	0.100	0.239	0.118	-0.007	0.018	0.710
Scatter bed	Area IPF beds/beneficiary (thousands)	0.703	0.169	0.682	0.147	-0.021	0.022	0.348
Scatter bed	Occupancy rate of other area IPFs	0.769	1.787	0.767	1.050	-0.003	0.162	0.987
Scatter bed	Whether facility in a rural area	0.055	0.228	0.048	0.216	-0.007	0.033	0.824

NOTES: Facilities with fewer than 20 psychiatric DRG discharges in 2004 were excluded. Column percentages sum to 100 percent. Classification based on predicted probability of being a DPU from the estimated additive logit model from equation (5). Standard errors were adjusted for clustering of scatter bed and DPU providers in the same facility.

SOURCE: RTI International analysis of discharges from inpatient psychiatric units and hospitals using the 2004 100% MedPAR file.

As shown in Table 3-3, only a small handful of facilities were misclassified (6.1 percent of facilities classified as DPUs and 1.8 percent of facilities classified as scatter beds). The scatter bed facilities misclassified as DPUs by the additive logit model (upper panel of Table 3-4) tend to have similar MDC 19 proportions as DPUs and tend to be similarly-sized, suggesting that these scatter bed providers may be operating units not certified as DPUs. The MDC 1 and comorbid condition proportion is lower than for DPUs; combined with the similar MDC 19 proportion indicates that at least some of these units may be substance abuse units. The comorbid condition and elderly patient proportions for these scatter bed facilities resembling DPUs are in fact lower than for DPUs, also consistent with at least some of them operating substance abuse units. These “uncertified” units tend to be located in areas with fewer IPF (DPU or freestanding) beds relative to the Medicare population, suggesting that these facilities are substituting for IPFs in those areas.

The misclassified DPUs (lower panel of Table 3-4) are quite different from both scatter bed providers and other DPUs. They have significantly higher MDC 19 proportion than scatter beds, but lower than compared to other DPUs. The situation is reversed for the MDC 1 proportion. The proportion of patients aged 65 years or older is also quite high. It may be possible that these DPUs are operating geriatric psychiatric units as the only specialty in their DPU. The lack of certification of all psychiatric units, and of specialization of units, precludes verifying the hypotheses suggested by these findings.

3.5 Multivariate Analysis of Length of Stay Differences Between IPFs and Scatter Beds

The descriptive analyses in Section 3.3 indicated that there are significant differences in length of stay between DPUs and scatter beds. In this section we estimate loglinear models of length of stay, using a specification similar to that used for the LOS impact analysis in Section 2:

$$(6) \quad \log([\text{LOS}]_{if}) = \alpha + \beta_S [\text{Scatterbed}]_f + \beta_R [\text{Rural}]_f + \beta_T \left(1 + \frac{[\text{Residents}]_f}{[\text{ADC}]_f} \right) + \beta_O [\text{Occupancy Rate}]_f + \beta_{30} [\text{Occupancy Rate} < 30\%]_f + \beta_A [\text{No Ancillaries Charged}]_f + \gamma_A [\text{Age Group Vector}]_{if} + \gamma_D [\text{DRG Vector}]_{if} + \gamma_C [\text{Comorbidity Vector}]_{if} + \gamma_E [\text{ECT}]_{if} + \varepsilon_{if}$$

where i indexes the stay for patient i and:

- $\log[\text{LOS}]_{if}$ is the natural logarithm of the per diem cost of patient i .
- $[\text{Scatterbed}]_f$ is an indicator for whether a facility is a scatter bed provider.
- $[\text{Rural}]_f$ is an indicator for whether a facility is not in an MSA.
- $[\text{Residents}]_f$ gives the number of residents in the facility (or specifically in the DPU for DPU providers).
- $[\text{ADC}]_f$ gives the ADC of the facility (or specifically of the DPU for DPU providers).

- [Occupancy Rate]_f gives the occupancy rate, expressed as a number between 0 and 1, of the facility (or specifically of the DPU for DPU providers).
- [Occupancy Rate < 30%]_f is an indicator for whether the occupancy rate is less than 30 percent.
- [No Ancillaries Charged]_f is an indicator for whether the facility charges ancillary services on its Medicare claims.
- [Age Group Vector]_{if} is a vector of indicators for patient *i*'s age: 45–49, 50–54, 55–59, 60–64, 65–69, 70–74, 75–79, and over 80. The omitted age group is less than 45 years old.
- [DRG Vector]_{if} is a vector of indicators for patient *i*'s DRG. The omitted DRG is 430.
- [Comorbidity Vector]_{if} is a vector of indicators for the 17 IPF-PPS co-morbidity categories.
- [ECT]_{if} is an indicator for whether patient *i*'s claim includes the ECT procedure code.
- e_{if} is the portion of patient per diem cost not explained by the regressors (i.e., the idiosyncratic regression “error” term).

The LOS regression results of estimating equation (6) are summarized in **Table 3-5**. This table gives the estimated regression coefficient, standard error of the coefficient estimate, *p*-value, resulting percentage difference in LOS in scatter beds after controlling for case mix, and regression adjusted R-squared. The first column of Table 3-5 includes only a single indicator for scatter bed cases, and the second column is from a model that interacts the scatter bed indicator with the age and DRG indicators. Restricting the model with the age and DRG interactions to the scatter bed indicator-only model was highly statistically significant. Restricting models with additional interactions with the scatter bed indicator to the model with the age and DRG interactions was not statistically significant.

As Table 3-5 indicates, assuming that age and diagnosis have the same effects on scatter bed cases as in DPUs, scatter bed cases have nearly half the LOS as do DPU cases, controlling for case mix. This mirrors results presented in the descriptive analyses earlier in this section. However, the multivariate case mix analyses between DPUs and scatter bed facilities indicate that, with some exceptions among the largest scatter bed providers, DPUs and scatter beds serve different niches. Expecting case mix to similarly influence LOS in both types of settings is likely an erroneous assumption. When the impact of case mix on LOS is allowed to differ between IPFs and scatter beds, the impact of being a scatter bed provider on LOS, controlling for case mix, falls by more than half. Thus scatter bed providers, based on LOS differences, appear to provide different models of care.

Table 3-5
Summary of Log Length of Stay Regression Models

Regression Model Statistic	Scatter Bed Indicator Only	Scatter Bed Indicator with Age and DRG Interactions
Scatter bed indicator coefficient estimate	-0.467	-0.178
Scatter bed indicator coefficient standard error	0.015	0.020
Scatter bed indicator coefficient <i>p</i> -value	0.000	0.000
Estimated scatter bed LOS difference (%)	-37.3%	-16.3%
Regression adjusted R-squared	0.209	0.228
Number of observations used	627,584	627,584

NOTES: LOS model includes all DPU and scatter bed cases in 2004 regardless of facility size. Standard errors were adjusted for clustering of cases within facility.

SOURCE: RTI International analysis of discharges from inpatient psychiatric units and hospitals using the 2004 100% MedPAR file.

3.6 Multivariate Analysis of Per Diem Cost Differences between IPFs and Scatter Beds

The previous section has shown that patients in scatter beds have shorter LOS than do patients in DPUs, controlling for case mix differences. In this section we turn to per diem cost differences between DPUs and scatter beds. To do so we estimate a similar model of per diem cost as described in Section 4 of this report, but instead include an indicator for scatter bed cases as well as interactions of this indicator with the case mix characteristics.

The per diem cost regression results of estimating this model are summarized in **Table 3-6**. This table gives the estimated regression coefficient, standard error of the coefficient estimate, *p*-value, resulting percentage difference in per diem cost in scatter beds after controlling for case mix, and regression adjusted R-squared. The first column of Table 3-6 includes only a single indicator for scatter bed cases, and the second column is from a model that interacts the scatter bed indicator with the age, DRG, and LOS group indicators. Restricting the model with the age, DRG, and LOS group interactions to the scatter bed indicator-only model was highly statistically significant. Restricting models with additional interactions with the scatter bed indicator to the model with the age, DRG, and LOS group interactions was not statistically significant.

As Table 3-6 indicates, assuming that age and diagnosis have the same effects on scatter bed cases as in DPUs, scatter bed cases have only a slightly lower per diem cost than do DPU cases, controlling for case mix. However, the multivariate case mix and LOS analyses between DPUs and scatter bed facilities indicate that, with some exceptions among the largest scatter bed providers, DPUs and scatter beds serve different niches and may provide a different model of care. When the impact of case mix on LOS is allowed to differ between IPFs and scatter beds, the impact of being a scatter bed provider on per diem cost, controlling for case mix, rises in absolute magnitude to 16.5 percent. Thus, not only are cases in scatter beds shorter, they are also less resource-intensive, as measured by cost. These results suggest that scatter bed providers and their patients are, on the whole, fundamentally different—patients who are treated in scatter beds may be treated there because they are sufficiently less costly that providers are will to provide care for them under a per case payment system with nationally-set prices.

Table 3-6
Summary of Log Per Diem Cost Regression Models

Regression Model Statistic	Scatter Bed Indicator Only	Scatter Bed Indicator with Age and DRG Interactions
Scatter bed indicator coefficient estimate	-0.009	-0.180
Scatter bed indicator coefficient standard error	0.014	0.026
indicator coefficient <i>p</i> -value	0.528	0.000
Estimated scatter bed per diem cost difference (%)	-0.9%	-16.5%
Regression adjusted R-squared	0.179	0.191
Number of observations used	627,584	627,584

NOTES: LOS model includes all DPU and scatter bed cases in 2004 regardless of facility size. Standard errors were adjusted for clustering of cases within facility.

SOURCE: RTI International analysis of discharges from inpatient psychiatric units and hospitals using the 2004 100% MedPAR file.

3.7 Triaging of Patients into Scatter Beds versus DPUs

The previous sections indicated that there are significant case mix, LOS, and cost differences between scatter bed and DPU patients. However, these results combine units of scatter bed patients and other scatter beds in hospitals without DPUs, where no decision must be made on which service a patient will be admitted. To better identify case mix and other characteristics that influence whether a patient is admitted to a DPU or a scatter bed, in this section we estimate a logit model of patient admission into a DPU versus a scatter bed, but only for facilities with DPUs.

The model we estimate is a so-called conditional logit model, where only differences in patients' admission location *within* a facility are used; facility-level variation in patients being admitted to a scatter bed versus a DPU is ignored. The model we estimate is:

$$(7) \quad L([\text{Admit to DPU}]_{if}) = \beta_L [\text{LOS Vector}]_{if} + \beta_A [\text{Age Group Vector}]_{if} + \beta_D [\text{DRG Vector}]_{if} + \beta_E [\text{ECT}]_{if} + \beta_C [\text{RTI Comorbid Condition Vector}]_i + \gamma_F [\text{Female}]_{if} + \gamma_S [\text{Admission Source Vector}]_{if} + h_f + \varepsilon_{if}$$

where *i* indexes the stay for patient *i* and:

- *L* is the logit cumulative distribution function.
- $[\text{LOS Vector}]_{if}$ is a vector of indicators for LOS ranges. The ranges are for: 1 day, 2-3 days, 4-7 days, 15-21 days, 22-28, 29-56, and more than 56 days. The omitted LOS range is 8-14 days.
- $[\text{Age Group Vector}]_{if}$ is a vector of indicators for patient *i*'s age: 45-49, 50-54, 55-59, 60-64, 65-69, 70-74, 75-79, and over 80. The omitted age group is less than 45 years old.

- $[\text{DRG Vector}]_{if}$ is a vector of indicators for patient i 's DRG. The omitted DRG is 430.
- $[\text{ECT}]_{if}$ is an indicator for whether patient i 's claim includes the ECT procedure code.
- $[\text{RTI Comorbid Condition Vector}]_{if}$ is a vector of RTI Co-morbid Condition indicators and selected interactions.
- $[\text{Female}]_{if}$ is an indicator for whether patient i is female.
- $[\text{Admission Source Vector}]_{if}$ is a vector of admission sources indicated on the patient's claim: clinic referral; transfer from a hospital; transfer from a SNF; transfer from another healthcare facility; admission through the emergency department; legal-related admission; or direct admission. The omitted category is direct admission.
- h_f is the portion of the likelihood that the patient will be admitted to the DPU that is facility-specific. All observed and unobserved facility-level differences are absorbed into this factor.
- e_{if} is the portion of the likelihood that the patient will be admitted to the DPU not explained by the regressors (i.e., the idiosyncratic regression "error" term).

Table 3-7 presents the results of estimating the linear conditional logit model in equation (7). Conditional on other case mix characteristics, elderly patients (aged 65 years or older) with a psychiatric principal diagnosis are more likely to be admitted to a scatter bed than a DPU. Although this effect is conditional on other case mix characteristics, it may be possible that age is identifying clinical case mix not identified by DRG or other co-morbid conditions.

Patients in DRGs other than 430 are less likely to be admitted to the DPU than a scatter bed. This is especially true for neurological and substance abuse DRGs, with odds ratios below 0.1, consistent with the scatter bed case mix specialization findings shown earlier. Patients with medical co-morbid conditions are generally less likely to be admitted to the DPU, and patients with behavioral co-morbid conditions are generally more likely to be admitted to the DPU. The exceptions to this general pattern are infectious diseases and injuries and poisoning, which are more likely to be observed among patients admitted to the DPU, and delirium, patients with which are more likely to be admitted to a scatter bed. The injuries and poisoning may be related to a co-morbid substance abuse issue. The patients with a co-morbid delirium condition may be admitted to a scatter bed because of medical conditions that may be causing their delirium (e.g., urinary tract infections).

Patients transferred in from another healthcare facility (hospital, SNF, or other) or through the legal system are more likely to be admitted to the DPU. These patients are likely referred to the hospital specifically for a behavioral health issue.

Patients admitted for longer stays (2 or more weeks) are more likely to be admitted to the DPU, and short stays are more likely to be admitted to a scatter bed, consistent with findings presented earlier. Patients with at least a portion of their stay not covered by Medicare are significantly less likely to be admitted to the DPU.

Table 3-7
Estimated Conditional Logit Model for Triaging of Patients into DPUs versus Scatter Beds

Variable	Coefficient		p-Value	Odds Ratio
	Coefficient Estimate	Estimate Std. Err.		
Age <45	...	...	...	1.000
Age 45–50	–0.039	0.022	0.073	0.962
Age 50–55	–0.066	0.024	0.005	0.936
Age 55–60	0.011	0.027	0.674	1.011
Age 60–65	0.028	0.031	0.364	1.028
Age 65–70	–0.141	0.025	0.000	0.869
Age 70–75	–0.186	0.025	0.000	0.830
Age 75–80	–0.331	0.025	0.000	0.718
Age 80–85	–0.454	0.025	0.000	0.635
Age 85–99	–0.541	0.025	0.000	0.582
Female	–0.031	0.012	0.010	0.970
DRG 012 Degenerative nervous system disorders	–4.320	0.030	0.000	0.013
DRG 023 Nontraumatic Stupor and Coma	–5.242	0.065	0.000	0.005
DRG 424 OR procedure with principal diagnosis of mental illness	–2.130	0.078	0.000	0.119
DRG 425 Acute adjustment reactions and psychosocial dysfunction	–2.996	0.030	0.000	0.050
DRG 426 Depressive neuroses	–0.104	0.035	0.003	0.901
DRG 427 Neuroses except depressive	–0.098	0.057	0.084	0.906
DRG 428 Disorders of personality and impulse control	–0.640	0.077	0.000	0.527
DRG 429 Organic disturbances and mental retardation	–1.682	0.022	0.000	0.186
DRG 430 Psychoses	...	...	...	1.000
DRG 431 Childhood mental disorders	–0.321	0.123	0.009	0.726
DRG 432 Other mental disorder diagnoses	–3.148	0.155	0.000	0.043
DRG 433 Alcohol/drug abuse or dependence, left against medical advice	–3.301	0.053	0.000	0.037
DRG 521 Alcohol/drug abuse or dependence with CC	–3.448	0.023	0.000	0.032
DRG 532 Alcohol/drug abuse or dependence with rehab therapy w/o CC	–4.241	0.060	0.000	0.014
DRG 533 Alcohol/drug abuse or dependence w/o rehab therapy w/o CC	–2.634	0.026	0.000	0.072
Neurological conditions	–0.228	0.023	0.000	0.796
Cardiovascular and coagulation factor deficit disorders	–0.110	0.020	0.000	0.896
Artificial openings	–0.087	0.082	0.290	0.917
Renal and hepatic disorders	–0.592	0.028	0.000	0.553
Neoplasms, with radiation or chemotherapy	–2.006	0.267	0.000	0.135
Neoplasms, w/o radiation or chemotherapy	–0.500	0.037	0.000	0.606
Endocrine and nutritional disorders	–0.084	0.038	0.029	0.920
Infectious diseases	0.105	0.030	0.001	1.110
Respiratory conditions	–0.199	0.087	0.021	0.819
Severe musculoskeletal and connective tissue diseases	–0.201	0.082	0.014	0.818
Injury and poisoning	0.146	0.063	0.021	1.157
Psychiatric disorders	0.331	0.025	0.000	1.392
Dementia	2.131	0.030	0.000	8.425
Delirium	–0.529	0.048	0.000	0.589
Childhood onset disorders	0.360	0.485	0.458	1.434
Substance-related disorders	0.021	0.057	0.717	1.021
Psychiatric disorders with cardiovascular and coagulation factor deficits	0.464	0.097	0.000	1.591
Psychiatric disorders with respiratory conditions	–0.149	0.359	0.679	0.862
Psychiatric disorders with neurological conditions	0.198	0.079	0.013	1.219

(continued)

Table 3-7 (Continued)
Estimated Conditional Logit Model for Triaging of Patients into DPUs versus Scatter Beds

Variable	Coefficient		p-Value	Odds Ratio
	Coefficient Estimate	Estimate Std. Err.		
Psychiatric disorders with dementia	0.599	0.080	0.000	1.820
Psychiatric disorders with delirium	0.111	0.077	0.150	1.117
Childhood onset disorders with neurological conditions	0.080	0.090	0.374	1.084
Cardiovascular and coagulation factor deficits with respiratory conditions	-0.151	0.183	0.412	0.860
ECT use	0.036	0.063	0.573	1.036
Admission source: physician referral	...	...	...	1.000
Admission source: facility's clinic referral	-0.792	0.055	0.000	0.453
Admission source: transfer from hospital	0.563	0.033	0.000	1.756
Admission source: transfer from SNF	0.151	0.055	0.006	1.163
Admission source: transfer from other healthcare facility	0.370	0.045	0.000	1.448
Admission source: facility's emergency department	-0.994	0.015	0.000	0.370
Admission source: legal system	0.072	0.069	0.297	1.075
Length of stay: 1 day	-1.704	0.024	0.000	0.182
Length of stay: 2-3 days	-1.721	0.018	0.000	0.179
Length of stay: 4-7 days	-0.989	0.016	0.000	0.372
Length of stay: 8-14 days	...	...	...	1.000
Length of stay: 15-21 days	0.524	0.024	0.000	1.688
Length of stay: 22-28 days	0.450	0.037	0.000	1.568
Length of stay: 29-56 days	0.495	0.045	0.000	1.640
Length of stay: 57+ days	1.087	0.132	0.000	2.967
One or more days not covered by Medicare	-0.503	0.029	0.000	0.604

NOTES: DPU and scatter bed cases of only hospitals operating DPUs included. An ellipsis in the coefficient estimate column indicates the level of the categorical variable is the omitted category.

SOURCE: RTI International analysis of discharges from inpatient psychiatric units and hospitals using the 2004 100% MedPAR file.

3.8 Summary

In summary, the analyses presented in this section indicate that patients in scatter beds have several case mix and utilization differences from those in DPUs. Scatter bed patients tend to have a much wider range of case mix and demographic characteristics than do DPU patients. They also tend to have not only shorter LOS but also smaller costs per day than do DPUs. As a result, by and large, it seems that the care provided to patients in scatter beds is different from that provided in DPUs, and so including them in the same payment system would require a case mix adjustment scheme that included the majority of scatter bed patients. However, even prior to the implementation of the IPF-PPS, some scatter bed providers appear to be providing care in units not certified as Medicare DPUs. Although many of these units seem to provide care to patients with behavioral conditions, many also seem to provide substance abuse care. However, all seem to have LOS shorter than for DPUs. As a result, since the Medicare program provides an option to receive payment under two different payment systems, the option gives providers an opportunity to specialize care not only for clinical reasons, but also for payment reasons.

SECTION 4 ALTERNATIVE CO-MORBIDITY OPTIONS FOR THE IPF-PPS

4.1 Background

In the November 15, 2004 Final Rule implementing the IPF-PPS (as amended by the April 1, 2005 Correction Notice), CMS included a set of 17 payment adjustors for patients with (generally medical) co-morbidities that tend to increase per diem costliness (measured using claims data) in the new payment system. Patients can be assigned to multiple co-morbidity categories based on the secondary diagnoses¹⁴ reported by the treating hospital on each patient's claim. A separate payment multiplier is determined for each IPF-PPS co-morbidity category, and the overall co-morbidity adjustment is computed as the product of the adjustments for the individual co-morbidity groups.¹⁵ The payment increase for a particular category does not depend on the other diagnoses (primary or secondary) or other patient characteristics (e.g., age or ECT use) present on the claim.

CMS intended these co-morbidity categories to identify especially high-cost patients, as evidenced in the agency's response to commenters:

Therefore, the cost for providing patient care (for example, medications, and routine nursing care required for the common conditions seen in the psychiatric population and recommended for co-morbidity adjustment by the commenters (that is, heart conditions or strokes) are included already in the Federal per diem base rate and a co-morbidity adjustment for their presence was unnecessary (69FR66939).

These co-morbidity category adjustors were adopted prior to the implementation of MS-DRG and were not intended to measure the severity of the patient's primary (psychiatric) diagnosis. CMS intended that the IPF-PPS DRGs (originally CMS-DRGs 012, 023, 424 through 433, and 521 through 523; currently MS-DRGs 056, 057, 080, 081, and 876 through 897) identify differences in cost due to patients' principal diagnoses and that the co-morbidity categories identify cost differences due to the presence of particular secondary (largely medical) diagnoses. Although degenerative nervous system disorders (MS-DRGs 056 and 057), nontraumatic stupor and coma cases (MS-DRGs 080 and 081), and alcohol or drug abuse or dependence without rehabilitation therapy cases (MS-DRGs 896 and 897) are divided by whether the patient has a major complication or co-morbidity (MCC), the majority of IPF-PPS cases, in the Mental Diseases or Disorders MDC (MDC 19), are not split by whether the patient has an MCC. As a result, the IPF-PPS co-morbidity category adjustors remain relevant for identifying case mix complexity among these patients.

Using 2004 MedPAR data (from prior to the implementation of the IPF-PPS), we found that only about 10 percent of patients discharged from a psychiatric hospital or a Medicare-certified distinct part psychiatric unit in an acute hospital (DPU) had at least one of the IPF-PPS

¹⁴ One category, Oncology, also requires the presence of certain procedure codes.

¹⁵ A hospital can only receive a single adjustment for each co-morbidity that a patient has—for example, if three of a patient's secondary diagnoses can trigger a single co-morbidity adjustment, the multiplier for that co-morbidity is applied only once.

co-morbidities, and many of the conditions are in fact quite rare (e.g., the cardiac conditions co-morbidity category accounted for only 0.015 percent, or less than two-in-10,000, of cases). A set of adjustors specific to only a small set of patients may fail to identify other patients. In other words, the adjustors may be insufficiently sensitive in identifying higher-cost patients, and CMS may systematically underpay providers for such patients. In contrast, previous research by Cromwell, *et al.* (2005) on 696 Medicare beneficiaries discharged from 40 inpatient psychiatric facilities between 2001 and 2003 developed a set of medical and psychiatric conditions that clinicians considered severe and highly resource-intensive. Nearly 40 percent of patients had at least one of our severe medical or psychiatric conditions. It is important to determine whether a broader list of co-morbidities warrants increased payment.

4.2 Methods

4.2.1 Developing Alternative Co-morbid Condition and Severity Groups

In developing groupings of secondary diagnoses for alternative co-morbidity adjustors, the goal was not to only regroup the constituent diagnoses in the IPF-PPS co-morbidity adjustors but also to consider additional conditions that may increase per diem cost. Our approach was to first identify a set of composite set of conditions that are likely costly and then to recombine these likely high-cost conditions into groups. Some of the resulting groups were identical to IPF-PPS co-morbidity categories, but others were very different. The process of selecting diagnoses to group proceeded in two stages. In the first stage we assembled a set of diagnoses to review for appropriateness for inclusion in co-morbidity adjustors. These were drawn from the existing IPF-PPS co-morbidity adjustor conditions, co-morbidities identified by Cromwell, *et al.* (2005) as increasing nursing and ancillary costs, and a select set of other conditions identified by the RTI clinical team. These conditions were then subject to more intensive review and rating of expected nursing and ancillary intensity to determine a final set of conditions for the alternative co-morbid groups.

The candidate set of diagnoses to rate on expected nursing and ancillary costs was drawn from three sources. First, all 772 diagnoses included in a IPF-PPS co-morbidity category were included to maintain maximum comparability with the current IPF-PPS. These diagnoses were selected by a team of CMS clinical experts as particularly severe and producing high per diem costs. Second, 92 diagnoses identified by Cromwell, *et al.* (2005) as increasing resource intensity, but not included in any IPF-PPS co-morbidity category, were also added. Although these diagnoses included both psychiatric and medical conditions, most of the additional codes (beyond those used in the IPF-PPS) reflected greater psychiatric severity.

After including these diagnoses in the set to be rated for nursing and ancillary cost, there remained 5,938 ICD-9-CM codes that appeared as a secondary diagnosis on one or more Medicare inpatient claim in 2004. However, most of these secondary conditions were very rare—4,352 appeared on fewer than 100 claims. Using their clinical judgment, RTI's clinical team inspected the remaining 1,586 diagnoses and identified 47 that, when reported as secondary diagnoses, would likely increase per diem cost and should be candidates for further review. Examples of added codes include V-codes for drug-resistant infections, chronic airway obstruction not elsewhere classified, cranial trauma and other severe injuries, grand mal status, and various types of delirium. In total, 911 diagnoses were identified for nursing and ancillary intensity rating.

Prior to rating these 911 codes on nursing and ancillary intensity, the RTI clinical team developed a scale to rate codes for nursing intensity and ancillary use. Nursing intensity refers to the amount of time needed on average for nursing care for behavioral and medical needs of patients with a specific diagnosis. RTI's clinical experts developed a Likert scale to stratify diagnoses by nursing intensity. Co-morbid conditions that involve, for example, frequent dressing changes, ostomy care, frequent medication administration (including IVs), monitoring for response to medications, infection precautions, and increased frequency and complexity of assessments, were considered candidates for inclusion in an adjustor.

A few of the IPF-PPS co-morbidity category diagnoses were rated as not requiring this level of care on both nursing and ancillary dimensions (such as pyromania and poisoning by latex), implying little if any expected increase in routine or ancillary cost, were retained for co-morbidity grouping. Most of the IPF-PPS co-morbidity adjustor conditions were rated at least at an elevated of care.

Once the additional candidate co-morbid diagnoses were identified, they were assigned to groups. The 17 IPF-PPS co-morbidity categories were deemed to be insufficient to encompass the additional diagnoses. Many of the additional conditions did not fit logically into the IPF-PPS groups. For example, dementia and delirium cannot logically be called a developmental disability, eating or conduct disorder, or (with a few exceptions) a drug or alcohol-induced mental disorder. Also, some categories correspond to a highly specific disease state (uncontrolled Type I diabetes), but others range over broad classes of conditions (e.g., infectious diseases). Kidney disease was divided into acute and chronic, while hepatic disease was not included.

Several approaches to create alternative co-morbid groups were employed. One strategy combined IPF-PPS categories. This approach was taken when very small categories could be combined into a single group exhibiting clinical similarity. In another approach, existing categories were split and recombined with others. A third approach was expanding categories by adding conditions identified by the RTI clinical team. The names of these groups required modification to reflect the broader range of conditions. Finally, some conditions are not logically related to those in existing groups, and new groups were formed. In these circumstances, ICD-9-CM chapter headings were used when possible for clinical consistency.

4.2.2 Per Diem Cost Regression Model Structure

To maintain comparability with the IPF-PPS, the models of per diem cost that we estimated followed as closely as possible the regressions estimated by CMS for developing payment weights for the IPF-PPS. The general structure of these models was:

$$\log([\text{Per Diem Cost}]_{if}) = \alpha + \beta_R[\text{Rural}]_f + \beta_T \left(1 + \frac{[\text{Residents}]_{if}}{[\text{ADC}]_{if}} \right) + \beta_{Oj}[\text{Occupancy Rate}]_f +$$

$$(8) \quad \beta_{30}[\text{Occupancy Rate} < 30\%]_j + \beta_A[\text{No Ancillaries Charged}]_f + \gamma_L[\text{LOS Vector}]_{if} +$$

$$\gamma_A[\text{Age Group Vector}]_{if} + \gamma_D[\text{DRG Vector}]_{if} + \gamma_E[\text{ECT}]_{if} + \gamma_C[\text{Comorbidity Vector}]_{if} + \varepsilon_{if}$$

where i indexes the stay for patient i and:

- $[\text{Per Diem Cost}]_{if}$ is the average per diem cost for patient i .

- $[\text{Rural}]_f$ is an indicator for whether a facility is not in an MSA.
- $[\text{Residents}]_f$ gives the number of residents in the facility (or specifically in the DPU for DPU providers).
- $[\text{ADC}]_f$ gives the ADC of the facility (or specifically of the DPU for DPU providers).
- $[\text{Occupancy Rate}]_f$ gives the occupancy rate, expressed as a number between 0 and 1, of the facility (or specifically of the DPU for DPU providers).
- $[\text{Occupancy Rate} < 30\%]_f$ is an indicator for whether the occupancy rate is less than 30 percent.
- $[\text{No Ancillaries Charged}]_f$ is an indicator for whether the facility charges ancillary services on its Medicare claims.
- $[\text{LOS Vector}]_{if}$ is a vector of indicators for LOS ranges. The ranges are for: 1 day, 2-3 days, 4-7 days, 15-21 days, 22-28, 29-56, and more than 56 days. The omitted LOS range is 8-14 days.
- $[\text{Age Group Vector}]_{if}$ is a vector of indicators for patient i 's age: 45–49, 50–54, 55–59, 60–64, 65–69, 70–74, 75–79, and over 80. The omitted age group is less than 45 years old.
- $[\text{DRG Vector}]_{if}$ is a vector of indicators for patient i 's DRG. The omitted DRG is 430.
- $[\text{ECT}]_{if}$ is an indicator for whether patient i 's claim includes the ECT procedure code.
- $[\text{Comorbidity Vector}]_{if}$ is a vector of indicators for co-morbid conditions, whether the IPF-PPS co-morbidities or the RTI co-morbid conditions.
- e_{if} is the portion of per diem cost not explained by the regressors (i.e., the idiosyncratic regression “error” term).

The dependent variable in these models is the natural logarithm of measured per diem cost. We, and CMS, decided to model per diem cost using a semi-log model for several reasons. First, per diem costs, like most cost measures, are bounded below by zero (no negative costs) and have a very right-skewed distribution, with a small number of observations with very high per diem costs. Estimating a purely linear model—in which the dependent variable would be per diem cost, not its natural logarithm—might result in predicting *negative* costs for patients with no indicators of higher acuity. This could occur because of the undue influence of the small set of observations with very high per diem cost. In addition, the semi-log model assumes that case mix adjusters (e.g., age, co-morbidities, ECT use) raise or lower per diem cost in a multiplicative fashion (exponentiating both sides of Equation (2) yields an equation with per diem cost on the left-hand side and the product of exponentiated adjustment factors on the right-hand side). A

payment model with multiplicative payment adjustors applied to a base rate is consistent with other CMS payment systems.

4.3 Data Sources

The per diem cost regression model in Equation (1) was estimated using 501,770 stays in IPFs completed in calendar year 2004. These observations were selected from the 100% National MedPAR file on the basis of the Medicare provider ID. This file contains information on patient demographics, diagnoses, procedures, and charges for each IPF stay. FY2002 and FY2003 Medicare Cost Report (MCR) data from the Healthcare Cost Report Information System (HCRIS) database provided data on the numbers of psychiatric unit beds, numbers of residents, and department-level costs for each hospital. The Provider of Services (POS) File gave information on each facility’s location (urban or rural) and whether it has an emergency department. Data from the latter two datasets were merged on to each MedPAR record by the Medicare provider ID.

In this study, the dependent variable (the natural log of measured per diem cost) was measured using the 2004 MedPAR and MCR datasets. This measure replicates (except for using more recent claims data) the per diem cost calculation used by CMS in developing the IPF-PPS payment weights. To construct this measure, discharge-level ancillary department charges reported on the MedPAR record were converted to estimated costs using facility-specific department-level CCRs reported on the facility’s most recent (generally fiscal year 2003) Medicare Cost Report. CCRs outside three standard deviations of the facility type¹⁶ mean (psychiatric hospital versus DPU) were reset to the facility-type median department-specific CCR. To this estimated ancillary cost was added the facility-level per diem routine cost (again applying facility type-specific ceilings and floors). Constructed this way, patients’ “daily costs” do not vary by day of stay but are a single average for the stay. The resulting per diem cost was adjusted for differences in area wages according to:

$$(9) \quad [\text{Adjusted Per Diem Cost}]_i = [\text{Per Diem Cost}]_i \left(\frac{0.72828}{[\text{Facility Area Wage Index}]_i} + 0.27172 \right),$$

where $[\text{Facility Area Wage Index}]_i$ is the FY2005 area wage index for the Metropolitan Statistical Area¹⁷ in which the facility treating patient i is situated and 0.72828 is the labor-related share of cost determined by CMS for the IPF-PPS. To adjust for the possibility that the idiosyncratic components of per diem cost e_i may not be independent within facility, we adjusted coefficient standard errors for “clustering” at the facility level.¹⁸

¹⁶ Separate means for psychiatric hospitals and DPUs were computed to control for differences in cost allocation among departments between these facilities.

¹⁷ The IPF-PPS Final Rule for FY2005 used the Metropolitan Statistical Areas defined by the OMB in 1993 without any reclassifications of rural areas as urban. The FY2006 Proposed Rule (71FR3616) used the more recent Core Based Statistical Areas (CBSAs) for determining wage index values.

¹⁸ Standard errors of regression coefficients were computed using the Taylor linearization method assuming a clustered, unstratified sample design (see Research Triangle Institute, 2002). Because of the very large number of provider “clusters,” this method is equivalent to constructing robust estimates of standard errors of estimated coefficients using clustered Huber-White (Huber, 1967; White, 1980) “robust” standard errors (Froot, 1989).

4.4 Alternative Co-morbid Groups

The RTI co-morbid groups were designed to be as comparable as possible with the existing IPF-PPS co-morbidity categories while making changes deemed to be clinically important. The IPF-PPS co-morbidity categories, definitions (ICD-9-CM diagnosis and procedure codes), and frequencies among IPPS-exempt providers in 2004 are shown in **Table 4-1**. Many of the IPF-PPS co-morbidity categories are for fairly rare conditions. Only four categories (Renal Failure–Chronic, Infectious Disease, Developmental Disabilities, and Drug and/or Alcohol Induced Mental Disorders) account for more than one percent of cases (about 5,000 patients). Fewer than 500 (one-in-1,000) patients are assigned to the five least common of the 17 categories. Only 11 percent of patients had any co-morbidity category assigned, with 6.5 percent assigned only for a medical condition.

In developing these groups, CMS used regression analysis of the increase in per diem costs attributable to these conditions to identify especially high-cost conditions. However, there may be a larger set of moderately high-cost patients who are not included in these categories but whose high costs might warrant additional payment. **Table 4-2** presents the reorganization of the IPF-PPS co-morbidity categories into a new set of co-morbid groups based on the goal of maintaining a reasonable number of groups (fewer than 20) that are clinically relevant and neither too specific nor too broad. The clinical team retained the IPF-PPS co-morbidity categories where feasible and collapsed a few small related IPF-PPS categories into new groups. In most cases, however, either IPF-PPS co-morbidity categories were expanded to incorporate additional diagnoses or entirely new groups were developed. No IPF-PPS co-morbidity groups were eliminated, but the few individual codes rated as zero for nursing intensity from the IPF-PPS diagnoses were excluded from the new groups. Group titles were taken from ICD-9-CM chapter headings when there was a clear overlap with chapter codes. In other cases, group titles were simplified or made more specific.

All the diagnosis codes within two of the IPF-PPS co-morbidity categories remained unchanged, and a few other small but related categories were collapsed into a new group. The IPF-PPS category Musculoskeletal and Connective Tissue Disorders was retained without modification. Likewise, the Drug and/or Alcohol Induced Mental Disorders category remained largely intact (the diagnosis delirium tremens was combined with a new Deliriums group), but the name was shortened to Substance-Related Disorders. The IPF-PPS groups Artificial Openings–Digestive and Urinary; and Tracheostomy were combined into a single group: Artificial Openings.

Several entirely new groups were created, all relating to mental and behavioral disorders: Delirium, Neurological Disorders, Dementia, and Psychiatric Disorders. The new Delirium group includes all patients with this condition regardless of etiology because their similar behavioral presentation and high expected ancillary intensity. The Neurological Disorders group was created to include patients with general convulsive epilepsy, convulsions, gangrene, grand mal status, neuroleptic malignant syndrome, and blindness. These patients require intensive monitoring and care. Most patients with dementia require very intensive behavioral monitoring and are likely to need more ADL assistance, but they may have very low ancillary costs.

Psychiatric Disorders was created as a new group to encompass several types of high nursing intensity psychiatric patients, inclusive of the IPF-PPS Eating and Conduct Disorders co-morbidity category. Bulimia was added to the eating and conduct disorders list, and this set of conditions was split into two subgroups. Mood disorders, psychoses, and post-traumatic stress

disorder (PTSD)/borderline personality disorder are the other three subgroups. These three sets of conditions were identified as the most severe psychiatric diagnoses by Cromwell, *et al.* (2005). Although some of these diagnoses are more likely to be primary rather than co-morbid (secondary) diagnoses, the clinical team believes their nursing severity justifies their consideration if they are indeed reported as secondary diagnoses. The psychoses subgroup is unique in that it only has one diagnosis, psychosis NOS, as no schizophrenic disorders were rated as severe by Cromwell, *et al.* (2005). Together, these five subgroups comprise the Psychiatric Disorders co-morbid group.

The first column of **Table 4-3** gives the frequencies of the RTI co-morbid groups and subgroups. The frequencies of many of the RTI co-morbid groups, and even the subgroups, are greater than related IPF-PPS categories. In particular, the frequency of identified co-morbidities for cardiovascular/circulatory disorders rose from less than 0.1 percent to 6.7 percent; cancer-related co-morbidities rose from 0.01 percent to 1.58 percent; respiratory conditions rose from 0.36 percent to 7.67 percent; and psychiatric disorders rose from 0.51 percent to 9.42 percent. Using the RTI co-morbid groups, nearly one-quarter (rather than one-sixteenth) of patients are identified as having a medical co-morbidity, and over 40 percent (rather than 11 percent) are identified as having any co-morbidity. The second column of Table 4-3 gives the proportion of patients in each RTI co-morbid group who would also be assigned to an IPF-PPS co-morbidity category. RTI groups composed entirely of one or more IPF-PPS categories (Artificial Openings; the Neoplasm groups with radiation or chemotherapy; Severe Musculoskeletal Disorders; the Conduct Disorders Subgroup of Psychiatric Conditions; Childhood Onset; and Substance-Related Disorders) have 100 percent noted in this column. The largest RTI co-morbid groups, however, are composed largely of patients who are not assigned to an IPF-PPS co-morbidity category.

For per diem cost analyses, we created a 16-group set of adjusters using only the higher-level co-morbid groups (preliminary analyses indicated there was minimal improvement in model performance when using the RTI subgroups). However, to maintain comparability with the IPF-PPS co-morbidity categories, two neoplasm groups were retained by combining the two subgroups of diagnoses with radiation and chemotherapy and combining the two subgroups without radiation or chemotherapy.

Table 4-1
Percentage of Inpatients in Psychiatric Units or Hospitals with Each IPF-PPS
Co-morbidity Category, 2004

IPF-PPS Co-morbidity Category and Constituent ICD-9-CM codes	Percent of Patients with Co-morbidity
Artificial Openings—Digestive and Urinary 56960 through 56969, 9975, and V441 through V446	0.29%
Tracheostomy 51900 through 51909 and V440	0.04%
Cardiac Conditions 3910, 3911, 3912, 40201, 40403, 4160, 4210, 4211, and 4219	0.02%
Coagulation Factor Deficits 2860 through 2864	0.04%
Gangrene 44024 and 7854	0.03%
Renal Failure—Acute 5845 through 5849, 63630, 63631, 63632, 63730, 63731, 63732, 6383, 6393, 66932, 66934, and 9585	0.37%
Renal Failure—Chronic 40301, 40311, 40391, 40402, 40403, 40412, 40413, 40492, 40493, 585, 586, V451, V560, V561, and V562	1.24%
Oncology Treatment 1400 through 2399; with procedure codes 9221 through 92.29 or 9925	0.01%
Uncontrolled Diabetes-Mellitus 25002, 25003, 25012, 25013, 25022, 25023, 25032, 25033, 25042, 25043, 25052, 25053, 25062, 25063, 25072, 25073, 25082, 25083, 25092, and 25093	0.66%
Severe Protein Calorie Malnutrition 260 through 262	0.07%
Severe Musculoskeletal and Connective Tissue Diseases 6960, 7100, 73000 through 73009, 73010 through 73019, and 73020 through 73029	0.33%
Infectious Disease 01000 through 04110, 042, 04500 through 05319, 05440 through 05449, 0550 through 0770, 0782 through 07889, and 07950 through 07959	2.90%
Chronic Obstructive Pulmonary Disease 49121, 4941, 5100, 51883, 51884, V4611, and V4612	0.36%
Poisoning 96500 through 96509, 9654, 9670 through 9699, 9770, 9800 through 9809, 9830 through 9839, 986, 9890 through 9897	0.48%
Developmental Disabilities 317, 3180, 3181, 3182, and 319	2.79%
Drug and/or Alcohol Induced Mental Disorders 2910, 2920, 29212, 2922, 30300, and 30400	1.73%
Eating and Conduct Disorders 3071, 30750, 31203, 31233, and 31234	0.51%
Any Co-morbidity	11.04%

SOURCE: RTI International analysis of discharges from inpatient psychiatric units and hospitals using the 2004 100% MedPAR file.

Table 4-2
Crosswalk from IPF-PPS Co-morbidity Categories to RTI Alternative Co-morbid Groups

IPF-PPS Co-morbidity Category	Revisions	RTI Co-morbid Group
<ul style="list-style-type: none"> • <i>Conditions not in an IPF-PPS co-morbidity category: selected neurological disorders</i> 	Added group for severe neurological disorders such as blindness, general convulsive epilepsy, gangrene, grand mal status, and convulsions.	<ul style="list-style-type: none"> • Neurological Disorders
<ul style="list-style-type: none"> • Cardiac Conditions • Coagulation Factor Deficits • Gangrene • <i>Conditions not in an IPF-PPS co-morbidity category: selected heart failures and strokes</i> 	Combined into a single group and added heart failure and stroke diagnoses to the combined group.	<ul style="list-style-type: none"> • Cardiovascular & Coagulation Factor Deficit Disorders
<ul style="list-style-type: none"> • Artificial Openings–Digestive & Urinary • Tracheostomy 	Combined into a single group.	<ul style="list-style-type: none"> • Artificial Openings
<ul style="list-style-type: none"> • Renal Failure–Acute • Renal Failure–Chronic • <i>Condition not in an IPF-PPS co-morbidity category: severe hepatic impairment</i> 	Combined both renal failure categories. Added severe hepatic impairment codes.	<ul style="list-style-type: none"> • Renal & Hepatic Disorders
<ul style="list-style-type: none"> • Oncology Treatment • <i>Conditions not in an IPF-PPS co-morbidity category: oncology treatment diagnoses without radiation or chemotherapy</i> 	Created two basic neoplasm groups by diagnosis only: <ul style="list-style-type: none"> • High includes: all malignancies not in remission; benign neoplasms in the nervous system or vital organs; and patients undergoing diagnostic evaluation. Hemangiomas and lipomas were excluded. • General includes: other neoplasms; malignancies in remission; Hodgkins disease; and patients undergoing testing for these conditions. General was further divided by whether receiving radiation or chemotherapy.	<ul style="list-style-type: none"> • Neoplasms: General with Radiation or Chemotherapy subgroup • Neoplasms: General without Radiation or Chemotherapy subgroup

(continued)

Table 4-2 (Continued)
Crosswalk from IPF-PPS Co-morbidity Categories to RTI Alternative Co-morbid Groups

IPF-PPS Co-morbidity Category	Revisions	RTI Co-morbid Group
<ul style="list-style-type: none"> • Uncontrolled Diabetes Mellitus • Severe Protein Calorie Malnutrition • <i>Condition not in an IPF-PPS co-morbidity category: Type II diabetes</i> 	<p>Malnutrition was combined with diabetes conditions to accord with ICD-9 hierarchy. Type II diabetes was added.</p>	<ul style="list-style-type: none"> • Endocrine/Nutritional Disorders
<ul style="list-style-type: none"> • Infectious Diseases • <i>Conditions not in an IPF-PPS co-morbidity category: drug-resistant infections</i> 	<p>Added V-codes for drug-resistant infections.</p>	<ul style="list-style-type: none"> • Infectious Diseases
<ul style="list-style-type: none"> • Chronic Obstructive Pulmonary Disease • <i>Condition not in an IPF-PPS co-morbidity category: chronic airway obstruction</i> 	<p>Added chronic airway obstruction, not elsewhere classified and renamed to Respiratory Diseases.</p>	<ul style="list-style-type: none"> • Respiratory Diseases
<ul style="list-style-type: none"> • Severe Musculoskeletal & Connective Tissue Disorders 	<p>Retained without modification.</p>	<ul style="list-style-type: none"> • Severe Musculoskeletal & Connective Tissue Disorders
<ul style="list-style-type: none"> • Poisoning • <i>Conditions not in an IPF-PPS co-morbidity category: selected injuries</i> 	<p>Added injuries:</p> <ul style="list-style-type: none"> • Self-inflicted injuries and poisonings. • Cranial trauma. • Blindness due to injury. • Closed skull fractures. • Chronic non-healing wounds. <p>Subdivided group by expected nursing intensity. All self-inflicted injuries and poisonings considered high-intensity.</p>	<ul style="list-style-type: none"> • Injury and Poisoning

(continued)

Table 4-2 (Continued)
Crosswalk from IPF-PPS Co-morbidity Categories to RTI Alternative Co-morbid Groups

IPF-PPS Co-morbidity Category	Revisions	RTI Co-morbid Group
<ul style="list-style-type: none"> • Eating and Conduct Disorders • <i>Conditions not in an IPF-PPS co-morbidity category: bulimia; severe mood disorders; psychosis NOS; PTSD</i> 	<p>Separated eating and conduct disorders as subgroups under psychiatric disorders.</p> <p>Added bulimia to eating disorders.</p> <p>Created a group of high-severity mood disorders.</p> <p>Created a group from patients with psychosis, not otherwise specified.</p> <p>Created a group of PTSD patients.</p>	<ul style="list-style-type: none"> • Psychiatric
<ul style="list-style-type: none"> • <i>Conditions not in any IPF-PPS co-morbidity category: dementias</i> 	<p>Created a group for dementias</p>	<ul style="list-style-type: none"> • Dementia
<ul style="list-style-type: none"> • Developmental Disabilities • <i>Additional condition not in an IPF-PPS co-morbidity category: pervasive developmental delay</i> 	<p>Renamed Developmental Disabilities and made a subgroup of Childhood Onset.</p> <p>Added pervasive developmental delay as a subgroup of Childhood Onset.</p>	<ul style="list-style-type: none"> • Childhood Onset
<ul style="list-style-type: none"> • Drug and Alcohol Induced Mental Disorders • <i>Additional conditions not in an IPF-PPS co-morbidity category: delirium conditions</i> 	<p>Renamed to Substance-Related Disorders group.</p> <p>Moved delirium tremens from drug and alcohol disorders to a new group for deliriums of any etiology.</p>	<ul style="list-style-type: none"> • Substance-Related Disorders • Delirium

NOTE: ICD-9-CM diagnosis and procedure code definitions for the IPF-PPS co-morbidity categories are given in Table 4-1, and definitions for the RTI alternative co-morbid group and subgroups are given in Table 4-3.

SOURCE: FY2006 IPF-PPS Co-morbidity Category definitions and RTI International alternative co-morbid groups developed with analysis of individual ICD-9-CM diagnosis code frequencies in the 2004 100% MedPAR file and RTI clinicians' expectations of routine and ancillary care needs.

Table 4-3
Percentage of Inpatients in Psychiatric Units or Hospitals with Each
RTI Co-morbid Group and Subgroup, 2004

RTI Co-morbid Group or Subgroup	Percent of Patients in Co-morbid Group	Percent of Patients also in a IPF-PPS Co-morbidity Category
Neurological Disorders 33392, 34510, 34511, 3453, 36901, 78003, and 78039	5.41%	0.00%
Circulatory Disorders 2860 through 2864, 3910, 3911, 3912, 40201, 40403, 4160, 4210, 4211, 4219, 4280 through 4289, 436, 44024, 7854, and V1259	6.67%	5.89%
Artificial Openings 51900 through 51909, 56960 through 56969, 9975, and V440 through V446	0.32%	100.00%
Renal and Hepatic Disorders 40301, 40311, 40391, 40402, 40403, 40412, 40413, 40492, 40493, 5710 through 5728, 5845 through 586, 63630, 63631, 63632, 63730, 63731, 63732, 6383, 6393, 66932, 66934, 9585, V451, V560, V561, and V562	2.27%	66.72%
Neoplasms: All	1.58%	3.37%
Neoplasms: General–With Radiation or Chemotherapy subgroup 20120 through 20198, 20411, 20481, 20491, 20511, 20521, 20531, 20581, 20591, 20801, 20811, 20821, 20881, 20891, 2100 through 2249, 22800, 22801, 22803 through 2299, 2350 through 23690, 23699, 2380 through 2395; with procedure codes 9221 through 9229 or 9925	0.04%	100.00%
Neoplasms: General–Without Radiation or Chemotherapy subgroup Same diagnoses as General–With Radiation or Chemotherapy subgroup; without procedure codes 9221 through 9229 or 9925	0.36%	0.00%
Neoplasms: High–With Radiation or Chemotherapy subgroup 1400 through 20118, 20200 through 20381, 20400 through 20410, 20420 through 20480, 20490, 20500, 20501, 20510, 20520, 20530, 20580, 20590, 20600 through 20800, 20810, 20820, 20880, 20890, 2250 through 2279, 22802, 2300 through 2349, 23691, 2370 through 2379; with procedure codes 9221 through 9229 or 9925	0.01%	100.00%
Neoplasms: High–Without Radiation or Chemotherapy subgroup Same diagnoses as High–With Radiation or Chemotherapy subgroup; without procedure codes 9221 through 9229 or 9925	1.16%	0.00%
Endocrine and Nutritional Disorders 25001 through 25003, 25011 through 25013, 25021 through 25023, 25031 through 25033, 25041 through 25043, 25051 through 25053, 25061 through 25063, 25071 through 25073, 25081 through 25083, and 25091 through 25093	2.01%	36.24%
Infectious Diseases 01000 through 04110, 042, 04500 through 05319, 05440 through 05449, 0550 through 0770, 0782 through 07889, 07950 through 07959, and V090 through V0991	3.04%	95.63%
Respiratory Diseases 49121, 4941, 496, 5100, 51883, 51884, V4611, and V4612	7.67%	4.69%
Severe Musculoskeletal & Connective Tissue Disorders 6960, 7100, 73000 through 73009, 73010 through 73019, and 73020 through 73029	0.33%	100.00%
Injury & Poisoning: All	0.69%	69.77%

(continued)

Table 4-3 (Continued)
Percentage of Inpatients in Psychiatric Units or Hospitals with
Each RTI Co-morbid Group and Subgroup, 2004

RTI Co-morbid Group or Subgroup	Percent of Patients in Co-morbid Group	Percent of Patients in this RTI Co-morbid also in a IPF-PPS Co-morbidity Category
Injury & Poisoning: General subgroup 80300 through 80399, 8911, 8912, 9896 through 9899, and 99883	0.03%	38.93%
Injury & Poisoning: High subgroup 85400 through 85409, 9500 through 9509, 96500 through 96509, 9654, 9670 through 9699, 9770, 9800 through 9809, 9830 through 9839, 986, 9890 through 9895, and E9500 through E9589	0.67%	71.05%
Psychiatric Disorders: All	9.42%	5.41%
Psychiatric Disorders: Mood Disorders subgroup 29623, 29624, 29633, 29634, 29643, 29644, 29653, 29654, 29663, and 29664	1.62%	0.00%
Psychiatric Disorders: Psychoses subgroup 2989	1.88%	0.00%
Psychiatric Disorders: PTSD subgroup 30183 and 30981	5.79%	0.00%
Psychiatric Disorders: Eating Disorders subgroup 3071, 30750, and 30751	0.35%	77.99%
Psychiatric Disorders: Conduct Disorders subgroup 31203, 31233, and 31234	0.23%	100.00%
Dementia 2900 through 29043, 2912, 29282, 29410, 29411, 33119, and 33182	10.54%	0.00%
Delirium 29011, 2903, 29041, 29081, 2910, 2930, 2931, and 78009	1.59%	6.69%
Childhood Onset 2998, 317, 3180, 3181, 3182, and 319	2.79%	100.00%
Substance-Related Disorders 2920, 29212, 2922, 30300, and 30400	1.64%	100.00%
Any RTI Medical Co-morbidity	24.41%	26.51%
Any RTI Co-morbidity	41.09%	26.87%

SOURCE: RTI International analysis of discharges from inpatient psychiatric units and hospitals using the 2004 100% MedPAR file.

4.5 Estimating Alternative Models of Per Diem Cost

Estimating models of per diem cost proceeded in five basic steps. In the first step, three “comparison” models were estimated: one baseline model that included the CMS facility, length-of-stay, age, DRG, and ECT use indicators, but no co-morbidities; and two medical-only models, one using IPF-PPS co-morbidity categories and one using the RTI co-morbid groups, that include only medical conditions, not mental disorders.

The second step added the psychiatric co-morbidity indicators (the IPF-PPS and RTI psychiatric co-morbidities as appropriate) to the cost model. The IPF-PPS conditions were expanded by only three groups that, from Table 4-1, added only an additional 4.5 percent of the psychiatric inpatient population. In contrast, the RTI co-morbid groups were expanded by eight additional groups, covering an extra 16.5 percent (from Table 4-3) of patients.

In the third step, interactions of co-morbidities, identifying patients with specific multiple combinations of conditions, were included in the model. The relative weights for the co-morbidity interaction terms identify whether a purely one-way additive model would over- or underestimate the cost of treating patients with these combinations. Because of the very small number of patients with any combination of multiple IPF-PPS co-morbidities (less than 0.2 percent, or 1,000 cases, in 2004), we did not estimate cost regressions using combinations of IPF-PPS co-morbidity categories.

In the fourth step, we created indicators of the severity of the principal diagnosis using the IPF-PPS co-morbidity categories and the RTI alternative co-morbid groups and included these as additional regressors.

In the fifth and final step, we constructed two “benchmark” models by including indicators for either the CMS Hierarchical Condition Categories (CMS-HCCs) or their constituent DxGroups, plus the IPF-PPS and RTI co-morbidity adjustors. These models, with 210 and 825 adjustors, respectively, provide an upper bound on the explanatory power feasible with a DRG-plus-co-morbidity-adjustor model.

4.5.1 Comparison Models—No Co-morbidities and Only Medical Co-morbidities

Table 4-4 gives relative payment weights for the 15 IPF-PPS DRGs computed from the baseline model that excludes all co-morbidities but includes DRGs as well as facility characteristics (the logarithm of the occupancy rate, an indicator for occupancy rate less than 30 percent, an indicator for whether the facility charges for ancillaries, a rural area indicator and one plus the ratio of residents to ADC), age groups, length of stay, and ECT use. The regression R-squared of 0.313 sets a floor on the overall explanatory power that should be expected from the cost regressions that include co-morbidities. The DRG relative weights are generally within two percent of the FY2006 IPF-PPS weights (which were calibrated using 2002 MedPAR data).

Table 4-5 gives relative weights for DRGs and IPF-PPS medical co-morbidity categories. The three psychiatry-related co-morbidity categories—developmental disabilities, drug and alcohol-induced mental disorders, and eating and conduct disorders—were omitted from the regression model. The regression R-squared for this model was 0.317, an increase of 0.004 above the no-co-morbidities cost model. As the medical co-morbidity and severity groups are stepped into the model (starting with no co-morbidity adjustments), the estimated DRG weights remain

remarkably unchanged. This is a result of two phenomena. First, as shown in Section 3, the IPF-PPS co-morbid conditions are relatively rare. Second, there is relatively little association between a patient's DRG and the incidence of the IPF-PPS co-morbidities. However, the relative weights for two DRGs—424 (operating room procedures with a psychiatric principal diagnosis) and 521 (alcohol and drug abuse or dependence with complications or co-morbidities), DRGs that are defined implicitly or explicitly in part on the basis of medical conditions reported on the claim did change by more than 0.01 units.

Most of the co-morbidity category weights are similar to the weights used in the FY2006 IPF-PPS, with the exception of oncology treatment. The estimated weight based on this regression is 1.257, significantly different from the IPF-PPS weight of 1.07. This anomaly may be due to the very low frequency (0.01 percent) of this co-morbidity category, which may result in instability of this relative weight as different years' data are used to calibrate it. Also noteworthy is the fact that, with the exception of Gangrene, the relative weights of the IPF-PPS co-morbidity categories are statistically significantly greater than 1.0, while the increase in the model R-squared is quite minor. This is due to the very low frequencies of the IPF-PPS co-morbidity categories. These adjustors may explain a significant portion of the difference in average costs between these patients and the average. However, since less than seven percent of patients have these particular medical conditions, the model's ability to explain costs for *all* patients.

Table 4-6, in contrast, gives the relative weights for the medical co-morbidities-only model that uses the RTI alternative co-morbid groups. The regression R-squared for this model was 0.325, an increase of 0.008 over the IPF-PPS medical co-morbidities-only model and 0.012 over the no-co-morbidities model. The increase in explanatory power between RTI's medical co-morbidity model and the medical-only IPF-PPS co-morbidity categories is in fact greater than the increase in explanatory power from no co-morbidities to the IPF-PPS medical co-morbidities, despite there being fewer co-morbidity adjustor groups (11 versus 14).

The majority of the increase in explanatory power is not likely due to the magnitude of the higher cost of the additional conditions. For example, the added oncology cases are less costly than those actively receiving oncology treatment, and the renal/hepatic RTI group is less costly than the acute and chronic renal IPF-PPS categories. The improvement in R-squared is more likely due to the greater number of patients whose costs are more accurately measured.

Table 4-4
Estimated DRG Relative Weights, No Co-morbidity Adjustors

DRG	Relative Weight
DRG 012 Degenerative nervous system disorders	1.057***
DRG 023 Nontraumatic stupor and coma	1.092***
DRG 424 OR procedure with principal diagnosis of mental illness	1.320***
DRG 425 Acute adjustment reactions and psychosocial dysfunction	1.053***
DRG 426 Depressive neuroses	0.988
DRG 427 Neuroses except depressive	1.004
DRG 428 Disorders of personality and impulse control	1.051**
DRG 429 Organic disturbances and mental retardation	1.040***
DRG 430 Psychoses	1.000
DRG 431 Childhood mental disorders	1.017
DRG 432 Other mental disorder diagnoses	0.775*
DRG 433 Alcohol/drug abuse or dependence, left against medical advice	0.942
DRG 521 Alcohol/drug abuse or dependence with CC	1.037**
DRG 532 Alcohol/drug abuse or dependence with rehab therapy w/o CC	0.978
DRG 532 Alcohol/drug abuse or dependence w/o rehab therapy w/o CC	0.848***
Adjusted R-squared	0.313
Number of observations	501,770

NOTE: Relative weights computed by exponentiating estimated coefficients from a regression of the natural logarithm of per diem cost. Discharge-level per diem costs were calculated using facility-specific routine per diem costs and facility- and department-level cost-to-charge ratios and department-level charges for each stay, adjusted for area wage levels and updated for the Medicare Cost Report fiscal year. Relative weights for facility characteristics, length-of-stay, age group, and the ECT indicator (included in the regression) are not shown. One asterisk indicates significance at the 95% confidence level, two asterisks indicate significance at the 99% level, and three asterisks indicate significance at the 99.9% level.

SOURCE: RTI International analysis of discharges from inpatient psychiatric units and hospitals using the 2004 100% MedPAR file.

Table 4-5
Estimated DRG and Co-morbidity Adjustor Relative Weights,
IPF-PPS Medical Co-morbidity Categories Only

DRG/IPF-PPS Co-morbidity Category	Relative Weight
DRG 012 Degenerative nervous system disorders	1.057***
DRG 023 Nontraumatic stupor and coma	1.088***
DRG 424 OR procedure with principal diagnosis of mental illness	1.300***
DRG 425 Acute adjustment reactions and psychosocial dysfunction	1.051***
DRG 426 Depressive neuroses	0.986
DRG 427 Neuroses except depressive	1.004
DRG 428 Disorders of personality and impulse control	1.053***
DRG 429 Organic disturbances and mental retardation	1.039***
DRG 430 Psychoses	1.000
DRG 431 Childhood mental disorders	1.019
DRG 432 Other mental disorder diagnoses	0.777*
DRG 433 Alcohol/drug abuse or dependence, left against medical advice	0.940
DRG 521 Alcohol/drug abuse or dependence with CC	1.022
DRG 532 Alcohol/drug abuse or dependence with rehab therapy w/o CC	0.983
DRG 532 Alcohol/drug abuse or dependence w/o rehab therapy w/o CC	0.853***
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IPF-PPS Co-morbidity: Artificial openings-digestive and urinary	1.086***
IPF-PPS Co-morbidity: Tracheostomy	1.076***
IPF-PPS Co-morbidity: Cardiac conditions	1.135**
IPF-PPS Co-morbidity: Coagulation factor deficits	1.089**
IPF-PPS Co-morbidity: Gangrene	1.047
IPF-PPS Co-morbidity: Renal failure, acute	1.090***
IPF-PPS Co-morbidity: Renal failure, chronic	1.108***
IPF-PPS Co-morbidity: Oncology treatment	1.245***
IPF-PPS Co-morbidity: Uncontrolled diabetes-mellitus	1.068***
IPF-PPS Co-morbidity: Severe protein calorie malnutrition	1.120***
IPF-PPS Co-morbidity: Severe musculoskeletal and connective tissue diseases	1.097***
IPF-PPS Co-morbidity: Infectious disease	1.084***
IPF-PPS Co-morbidity: Chronic obstructive pulmonary disease	1.096***
IPF-PPS Co-morbidity: Poisoning	1.155***
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Adjusted R-squared	0.317
Number of observations	501,770

NOTE: Relative weights computed by exponentiating estimated coefficients from a regression of the natural logarithm of per diem cost. Discharge-level per diem costs were calculated using facility-specific routine per diem costs and facility- and department-level cost-to-charge ratios and department-level charges for each stay, adjusted for area wage levels and updated for the Medicare Cost Report fiscal year. Relative weights for facility characteristics, length-of-stay, age group, and the ECT indicator (included in the regression) are not shown. One asterisk indicates significance at the 95% confidence level, two asterisks indicate significance at the 99% level, and three asterisks indicate significance at the 99.9% level.

SOURCE: RTI International analysis of discharges from inpatient psychiatric units and hospitals using the 2004 100% MedPAR file.

Table 4-6
Estimated DRG and Co-morbidity Adjustor Relative Weights, RTI Alternative
Medical Co-morbid Groups Only

DRG/RTI Co-morbid Group	Relative Weight
DRG 012 Degenerative nervous system disorders	1.056***
DRG 023 Nontraumatic stupor and coma	1.079***
DRG 424 OR procedure with principal diagnosis of mental illness	1.276***
DRG 425 Acute adjustment reactions and psychosocial dysfunction	1.047***
DRG 426 Depressive neuroses	0.985
DRG 427 Neuroses except depressive	1.005
DRG 428 Disorders of personality and impulse control	1.049**
DRG 429 Organic disturbances and mental retardation	1.031***
DRG 430 Psychoses	1.000
DRG 431 Childhood mental disorders	1.012
DRG 432 Other mental disorder diagnoses	0.783*
DRG 433 Alcohol/drug abuse or dependence, left against medical advice	0.941
DRG 521 Alcohol/drug abuse or dependence with CC	1.001
DRG 532 Alcohol/drug abuse or dependence with rehab therapy w/o CC	0.993
DRG 532 Alcohol/drug abuse or dependence w/o rehab therapy w/o CC	0.862***
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RTI Co-morbid: Neurological	1.073***
RTI Co-morbid: Cardiovascular and coagulation factor deficit disorders	1.067***
RTI Co-morbid: Artificial openings	1.077***
RTI Co-morbid: Renal and hepatic disorders	1.087***
RTI Co-morbid: Neoplasms, with radiation or chemotherapy	1.246***
RTI Co-morbid: Neoplasms, without radiation or chemotherapy	1.082***
RTI Co-morbid: Endocrine and nutritional disorders	1.062***
RTI Co-morbid: Infectious diseases	1.080***
RTI Co-morbid: Respiratory	1.067***
RTI Co-morbid: Severe musculoskeletal and connective tissue diseases	1.088***
RTI Co-morbid: Injury & poisoning	1.143***
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Adjusted R-squared	0.325
Number of observations	501,770

NOTE: Relative weights computed by exponentiating estimated coefficients from a regression of the natural logarithm of per diem cost. Discharge-level per diem costs were calculated using facility-specific routine per diem costs and facility- and department-level cost-to-charge ratios and department-level charges for each stay, adjusted for area wage levels and updated for the Medicare Cost Report fiscal year. Relative weights for the facility characteristics, length-of-stay, age group, and the ECT indicator (included in the regression) are not shown. One asterisk indicates significance at the 95% confidence level, two asterisks indicate significance at the 99% confidence level, and three asterisks indicate significance at the 99.9% confidence level.

SOURCE: RTI International analysis of discharges from inpatient psychiatric units and hospitals using the 2004 100% MedPAR file.

The relative weights in this model are generally consistent with those computed using the IPF-PPS medical co-morbidities. The relative weight for DRG 424, OR procedures with a primary psychiatric diagnosis, did fall from 1.32 to 1.29 likely due to the additional medical co-morbid conditions that might be associated with OR use. Also, the range of relative weights (1.07 to 1.26) is approximately the same as the range of weights in the IPF-PPS co-morbidities model (1.08 to 1.26). The Artificial Openings RTI co-morbid group, composed of the Digestive and Urinary Artificial Openings and Tracheostomy IPF-PPS co-morbidity categories, has a relative weight of 1.077, closer to that of the latter category (1.076) than the former (1.086). The Cardiac Conditions IPF-PPS category (relative weight of 1.135) was combined with Coagulation Factor Deficits (1.089), Gangrene (1.047), and additional conditions to produce the Cardiovascular and Coagulation Factors Deficits RTI group. Its relative weight of 1.067 is likely due to adding a substantial number of additional cases (not assigned to an IPF-PPS category) with above average, but not extremely high costs (combining with Gangrene likely did not produce the lower weight because of the very low frequency of that category). The renal failure categories (acute and chronic) were combined with relatively lower-cost liver failure patients, producing a lower weight for Renal/Hepatic than each of the two Renal Failure groups. The weight for oncology patients actively receiving radiation or chemotherapy is virtually identical across models, but the RTI model includes cancer patients not actively receiving oncology treatment, whose relative weight of 1.082 is relatively high compared to patients with other co-morbidities.

4.5.2 Additive Co-morbidity Models (Medical and Behavioral Conditions)

Table 4-7 presents the relative weights derived from estimating the log per diem cost model that includes all IPF-PPS co-morbidity categories, including the three behavioral categories. This is the model used by CMS to develop weights for the FY2006 IPF-PPS. The adjusted R-squared for this model is 0.318, just 0.001 greater than that for the medical-only IPF-PPS co-morbidities. With the exception of the weight for Gangrene, a very uncommon condition in IPFs, the relative weights for the other 16 co-morbidity categories are all significantly greater than 1.0 at the 99 percent significance level (presumably since these co-morbidities were selected by CMS in part through evaluation of statistical significance). The relative weights of the co-morbidity category indicators also are relatively invariant to adding the indicators for the psychiatric co-morbidities. The relative weights for two DRGs—428, Disorders of Personality and Impulse Control; and 431, Childhood Mental Disorders—fell somewhat with the introduction of the psychiatric co-morbidity categories. This is most likely due to the addition of the Developmental Disabilities category. By including this co-morbidity, the model can distinguish between the typical DRG 428 patient and those with particularly profound disabilities. These are the DRGs in which a large proportion (more than 25 percent) has a psychiatric co-morbidity, and no medical co-morbidity, and where the patients with a psychiatric co-morbidity are significantly more costly on a per day basis.

Table 4-7
Estimated DRG and Co-morbidity Adjustor Relative Weights,
All IPF-PPS Co-morbidity Categories

DRG/IPF-PPS Co-morbidity Category	Relative Weight
DRG 012 Degenerative nervous system disorders	1.057***
DRG 023 Nontraumatic stupor and coma	1.087***
DRG 424 OR procedure with principal diagnosis of mental illness	1.300***
DRG 425 Acute adjustment reactions and psychosocial dysfunction	1.050***
DRG 426 Depressive neuroses	0.985
DRG 427 Neuroses except depressive	1.002
DRG 428 Disorders of personality and impulse control	1.042**
DRG 429 Organic disturbances and mental retardation	1.039***
DRG 430 Psychoses	1.000
DRG 431 Childhood mental disorders	1.000
DRG 432 Other mental disorder diagnoses	0.777*
DRG 433 Alcohol/drug abuse or dependence, left against medical advice	0.939
DRG 521 Alcohol/drug abuse or dependence with CC	1.021
DRG 532 Alcohol/drug abuse or dependence with rehab therapy w/o CC	0.981
DRG 532 Alcohol/drug abuse or dependence w/o rehab therapy w/o CC	0.853***
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IPF-PPS Co-morbidity: Artificial openings-digestive and urinary	1.085***
IPF-PPS Co-morbidity: Tracheostomy	1.076***
IPF-PPS Co-morbidity: Cardiac conditions	1.136**
IPF-PPS Co-morbidity: Coagulation factor deficits	1.089***
IPF-PPS Co-morbidity: Gangrene	1.047
IPF-PPS Co-morbidity: Renal failure, acute	1.090***
IPF-PPS Co-morbidity: Renal failure, chronic	1.108***
IPF-PPS Co-morbidity: Oncology treatment	1.246***
IPF-PPS Co-morbidity: Uncontrolled diabetes-mellitus	1.068***
IPF-PPS Co-morbidity: Severe protein calorie malnutrition	1.119***
IPF-PPS Co-morbidity: Severe musculoskeletal and connective tissue diseases	1.097***
IPF-PPS Co-morbidity: Infectious disease	1.084***
IPF-PPS Co-morbidity: Chronic obstructive pulmonary disease	1.097***
IPF-PPS Co-morbidity: Poisoning	1.156***
IPF-PPS Co-morbidity: Developmental disabilities	1.062***
IPF-PPS Co-morbidity: Drug and/or alcohol induced mental disorders	1.041***
IPF-PPS Co-morbidity: Eating and conduct disorders	1.057***
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Adjusted R-squared	0.318
Number of observations	501,770

NOTE: Relative weights computed by exponentiating estimated coefficients from a regression of the natural logarithm of per diem cost. Discharge-level per diem costs were calculated using facility-specific routine per diem costs and facility- and department-level cost-to-charge ratios and department-level charges for each stay, adjusted for area wage levels and updated for the Medicare Cost Report fiscal year. One asterisk indicates significance at the 95% confidence level, two asterisks indicate significance at the 99% level, and three asterisks indicate significance at the 99.9% level. Relative weights for facility characteristics, length-of-stay, age group, and the ECT indicator (included in the regression) are not shown.

SOURCE: RTI International analysis of discharges from inpatient psychiatric units and hospitals using the 2004 100% MedPAR file.

Table 4-8 shows the impact on the regression R-squared from dropping, individually, each co-morbidity category indicator (second column) as well as the FY2006 IPF-PPS relative weights for that indicator. Eliminating a co-morbidity indicator from the cost regression will reduce the R-squared (though not the adjusted R-squared unless the absolute value of the *t* statistic is greater than 1.0). But the amount of the reduction depends on the size of the coefficient, the number of cases with that co-morbid condition, and the degree to which that co-morbidity affects cost. The reduction in R-squared is therefore a reasonable statistic to measure the “importance” of that co-morbid condition indicator for the model. Only two IPF-PPS co-morbidities, Chronic Renal Failure and Infectious Disease, were they dropped from the model, would produce R-squared reductions greater than 0.001 from the baseline of 0.318. The estimated relative weights for these co-morbidities are not the highest of the 17—in fact, four of the categories have higher estimated relative weights. However, the increase in per diem cost caused by these conditions is less variable than for the others, resulting in stronger explanatory power for per diem cost. The Poisoning (0.0007 reduction) and Developmental Disabilities (0.0005 reduction) categories are two other IPF-PPS co-morbidities having some effect on explanatory power.

The third column of Table 4-8 gives the relative weights computed by CMS when estimating the per diem cost regression used to calibrate the payment system. CMS used MedPAR files and MCRs for 2002, so it is not surprising that relative weights might differ. For the most part, however, our relative weights are within one or two percentage points of the FY2006 IPF-PPS weights. The exceptions, such as gangrene and oncology treatment, tend to be co-morbidities with very low (less than 0.1 percent, or fewer than 500 cases annually) frequencies, estimates of which might tend to be unstable from one year to the next. It is unclear why there is a six percentage point difference in relative weights for eating and conduct disorders (0.5 percent of cases in 2004), but it is possible that there have been changes in the composition of hospitals providing care to these patients, which would have affected estimated per diem cost.

Table 4-9 gives the relative weights for the analogous model using the RTI co-morbid groups. Relative to the model using only the medical RTI co-morbid groups, a few DRGs now have significantly different relative weights. In particular, the weight for DRG 012, Degenerative Nervous System Disorders, falls from 1.059 to 0.993. Over 95 percent of DRG 012 cases also have the dementia co-morbid group assigned, so much of the cost impact of DRG 012 is identified by the dementia co-morbid group. The DRG with the next highest proportion of dementia cases is DRG 023, Non-traumatic Stupor and Coma, with 25 percent of such cases with dementia assigned. The relative weight for DRG 428, Disorders of Personality and Impulse Control, fell 0.020, the weight for DRG 431, Childhood Mental Disorders, fell 0.024 due to the association with the Childhood Onset co-morbid group. Twenty-four percent of DRG 428 cases and 40 percent of DRG 431 cases have the Childhood Onset co-morbid group assigned, with DRG 427, Neuroses Except Depressive, having the next-highest proportion of Childhood Onset assigned (6.6 percent). Thus, the indicator for a Childhood Onset co-morbid condition identifies a significant proportion of the effects of DRGs 428 and 431. The increase in the adjusted R-squared from 0.325 (from Table 4-6) to 0.329 indicates that the behavioral condition co-morbid groups also contribute additional explanatory power to the model ($p = 0.047$). Also, the difference in R-squared between this model and the IPF-PPS model in Table 4-7 (0.329 versus 0.318, or difference of 0.011), exceeds the difference between the IPF-PPS model and one that includes no co-morbidity adjusters at all, presented in Table 4-4 (0.318 versus 0.313, a difference of only 0.005). Thus, the RTI co-morbid groups appear to offer a substantial improvement in the explanatory power of the co-morbidity adjusters.

Table 4-8
Reduction in R-squared from Dropping Individual Co-morbid Categories and Comparison to IPF-PPS FY2006 Relative Weights, All IPF-PPS Co-morbidity Categories

IPF-PPS Co-morbidity Category	RTI Estimated Relative Weight	R-Squared Reduction from Dropping Category	FY2006 IPF-PPS Relative Weight
Artificial openings-digestive and urinary	1.085***	0.0002	1.08
Tracheostomy	1.076***	<0.0001	1.06
Cardiac conditions	1.136**	<0.0001	1.11
Coagulation factor deficits	1.089***	<0.0001	1.13
Gangrene	1.047	<0.0001	1.10
Renal failure, acute	1.090***	0.0004	1.11
Renal failure, chronic	1.108***	0.0010	1.11
Oncology treatment	1.246***	<0.0001	1.07
Uncontrolled diabetes-mellitus	1.068***	0.0002	1.05
Severe protein calorie malnutrition	1.119***	0.0001	1.13
Severe musculoskeletal and connective tissue diseases	1.097***	0.0002	1.09
Infectious disease	1.084***	0.0013	1.07
Chronic obstructive pulmonary disease	1.097***	0.0002	1.12
Poisoning	1.156***	0.0007	1.11
Developmental disabilities	1.062***	0.0005	1.04
Drug and/or alcohol induced mental disorders	1.041***	0.0001	1.03
Eating and conduct disorders	1.057***	0.0001	1.12
Adjusted R-squared	0.318		
Number of observations	501,770		

NOTE: Relative weights computed by exponentiating estimated coefficients from a regression of the natural logarithm of per diem cost. Discharge-level per diem costs were calculated using facility-specific routine per diem costs and facility- and department-level cost-to-charge ratios and department-level charges for each stay, adjusted for area wage levels and updated for the Medicare Cost Report fiscal year. One asterisk indicates significance (difference from 1.0) at the 95% confidence level, two asterisks indicate significance at the 99% level, and three asterisks indicate significance at the 99.9% level. Relative weights for facility characteristics, length-of-stay, age group, and the ECT indicator (included in the regression) are not shown. R-squared reduction computed as $F(1 - R^2) / (N - k)$, where F is the F -statistic for the adjustor's regression coefficient and $N - k$ is equal to the number of observations minus the number of regressors in the model (Greene, 2002).

SOURCE: RTI International analysis of discharges from inpatient psychiatric units and hospitals using the 2004 100% MedPAR file.

Table 4-9
Estimated DRG and Co-morbidity Adjustor Relative Weights,
All RTI Alternative Co-morbid Groups

DRG/RTI Co-morbid Group	Relative Weight
DRG 012 Degenerative nervous system disorders	0.993
DRG 023 Nontraumatic stupor and coma	1.064**
DRG 424 OR procedure with principal diagnosis of mental illness	1.273***
DRG 425 Acute adjustment reactions and psychosocial dysfunction	1.036***
DRG 426 Depressive neuroses	0.981*
DRG 427 Neuroses except depressive	0.996
DRG 428 Disorders of personality and impulse control	1.032
DRG 429 Organic disturbances and mental retardation	1.026**
DRG 430 Psychoses	1.000
DRG 431 Childhood mental disorders	0.990
DRG 432 Other mental disorder diagnoses	0.782*
DRG 433 Alcohol/drug abuse or dependence, left against medical advice	0.940
DRG 521 Alcohol/drug abuse or dependence with CC	0.996
DRG 532 Alcohol/drug abuse or dependence with rehab therapy w/o CC	0.988
DRG 532 Alcohol/drug abuse or dependence w/o rehab therapy w/o CC	0.861***
<hr/>	
RTI Co-morbid: Neurological	1.067***
RTI Co-morbid: Cardiovascular and coagulation factor deficit disorders	1.065***
RTI Co-morbid: Artificial openings	1.077***
RTI Co-morbid: Renal and hepatic disorders	1.087***
RTI Co-morbid: Neoplasms, with radiation or chemotherapy	1.256***
RTI Co-morbid: Neoplasms, without radiation or chemotherapy	1.082***
RTI Co-morbid: Endocrine and nutritional disorders	1.062***
RTI Co-morbid: Infectious diseases	1.079***
RTI Co-morbid: Respiratory	1.067***
RTI Co-morbid: Severe musculoskeletal and connective tissue diseases	1.087***
RTI Co-morbid: Injury and poisoning	1.138***
RTI Co-morbid: Psychiatric	1.059***
RTI Co-morbid: Dementia	1.075***
RTI Co-morbid: Delirium	1.057***
RTI Co-morbid: Childhood onset	1.045***
RTI Co-morbid: Substance related	1.026***
<hr/>	
Adjusted R-squared	0.329
Number of observations	501,770

NOTE: Relative weights computed by exponentiating estimated coefficients from a regression of the natural logarithm of per diem cost. Discharge-level per diem costs were calculated using facility-specific routine per diem costs and facility- and department-level cost-to-charge ratios and department-level charges for each stay, adjusted for area wage levels and updated for the Medicare Cost Report fiscal year. Relative weights for facility characteristics, length-of-stay, age group, and the ECT indicator (included in the regression) are not shown. One asterisk indicates significance at the 95% confidence level, two asterisks indicate significance at the 99% level, and three asterisks indicate significance at the 99.9% level.

SOURCE: RTI International analysis of discharges from inpatient psychiatric units and hospitals using the 2004 100% MedPAR file.

The impacts (reductions) in R-squared from dropping individual RTI co-morbid groups (based on the regression model in Table 4-9) are shown in **Table 4-10**. Dropping individual co-morbid group indicators from the RTI group-based model generally has a greater impact on the model's explanatory power than dropping co-morbidity group indicators from the IPF-PPS-based model. In particular, dropping the Neurological, Cardiovascular & Coagulation Factor Deficits, and Respiratory co-morbid groups would, individually, reduce the model R-squared by more than 0.0002. In addition, the Renal/Hepatic, Infectious Diseases, Psychiatric, and Dementia groups have R-squared impacts greater than 0.0001.

4.5.3 Co-morbidity Interactions

The models estimated up to this point have assumed that the impact on cost of multiple co-morbidities is purely additive, so that the cost increase of a particular condition does not depend on the patient's other co-morbidities. **Table 4-11** presents a model that tests that assumption by adding seven interactions of RTI co-morbid groups:

- Psychiatric disorder and a cardiovascular condition.
- Psychiatric disorder and a respiratory condition.
- Psychiatric disorder and neurological disorder.
- Psychiatric disorder and a dementia.
- Dementia and delirium.
- Childhood onset disorder and a neurological disorder.
- A cardiovascular conditions and a respiratory condition.

These interactions were tested because more than 0.5 percent of cases exhibited these combinations—we set a threshold to avoid identifying groups that may have statistically unstable cost weights. No CMS co-morbidity category interactions met this threshold.

The bottom panel of Table 4-11 gives the relative weights for the co-morbid group interactions. All weights are less than 1.0 and statistically significant, indicating that the per diem cost impact of multiple co-morbid groups is less than the product of the weights for the individual groups considered separately. Not controlling for the attenuating effect of these interactions would bias upward the estimate of per diem cost. For example, from Table 4-9, the estimated combined effect on per diem cost of a psychiatric and a dementia co-morbidity is a 1.138 percent increase in per diem cost. However, based on the interaction-effect model in Table 4-11, the estimated combined effect of these conditions is a 9.4 percent increase in per diem cost. Ignoring this interaction effect would, therefore, result in a 4.4 percentage point overpayment for patients with both a psychiatric and a dementia co-morbidity. Thus the effect of omitting the co-morbid group interaction terms is to slightly underpay for patients with a single co-morbid condition and significantly overpay for the quite small number of patients with multiple co-morbidities. However, because of the very small number of patients with multiple co-morbidities, the impact on model explanatory power from omitting co-morbid group interactions is insignificant (R-squared values of 0.330 versus 0.329).

Table 4-10
Reduction in R-squared from Dropping Individual Co-morbid Categories and Comparison to IPF-PPS FY2006 Relative Weights, All RTI Alternative Co-morbid Groups

RTI Co-morbid Group	Estimated Relative Weight	R-squared Reduction from Dropping Category
Neurological	1.067***	0.0022
Cardiovascular and coagulation factor deficit disorders	1.065***	0.0024
Artificial openings	1.077***	0.0001
Renal and hepatic disorders	1.087***	0.0014
Neoplasms, with radiation or chemotherapy	1.256***	0.0001
Neoplasms, without radiation or chemotherapy	1.082***	0.0007
Endocrine and nutritional disorders	1.062***	0.0005
Infectious diseases	1.079***	0.0013
Respiratory	1.067***	0.0021
Severe musculoskeletal and connective tissue diseases	1.087***	0.0002
Injury & poisoning	1.138***	0.0009
Psychiatric	1.084***	0.0019
Dementia	1.097***	0.0016
Delirium	1.156***	0.0003
Childhood Onset	1.062***	0.0004
Substance Related	1.041***	0.0001
Adjusted R-squared	0.329	
Number of observations	501,770	

NOTE: Relative weights computed by exponentiating estimated coefficients from a regression of the natural logarithm of per diem cost. Discharge-level per diem costs were calculated using facility-specific routine per diem costs and facility- and department-level cost-to-charge ratios and department-level charges for each stay, adjusted for area wage levels and updated for the Medicare Cost Report fiscal year. One asterisk indicates significance at the 95% confidence level, two asterisk indicates significance at the 99% level, and three asterisks indicate significance at the 99.9% level. Relative weights for facility characteristics, length-of-stay, age group, and the ECT indicator (included in the regression) are not shown. R-squared reduction computed as $F(1 - R^2) / (N - k)$, where F is the F -statistic for the adjustor's regression coefficient and $N - k$ is equal to the number of observations minus the number of regressors in the model (Greene, 2002).

SOURCE: RTI International analysis of discharges from inpatient psychiatric units and hospitals using the 2004 100% MedPAR file.

Table 4-11
Estimated DRG and Co-morbidity Adjustor Relative Weights, All RTI
Alternative Co-morbid Groups and Group Interactions

DRG/RTI Co-morbid Group	Relative Weight
DRG 012 Degenerative nervous system disorders	0.995
DRG 023 Nontraumatic stupor and coma	1.065***
DRG 424 OR procedure with principal diagnosis of mental illness	1.272**
DRG 425 Acute adjustment reactions and psychosocial dysfunction	1.036***
DRG 426 Depressive neuroses	0.981*
DRG 427 Neuroses except depressive	0.995
DRG 428 Disorders of personality and impulse control	1.031*
DRG 429 Organic disturbances and mental retardation	1.026**
DRG 430 Psychoses	1.000
DRG 431 Childhood mental disorders	0.990
DRG 432 Other mental disorder diagnoses	0.781*
DRG 433 Alcohol/drug abuse or dependence, left against medical advice	0.940
DRG 521 Alcohol/drug abuse or dependence with CC	0.995
DRG 532 Alcohol/drug abuse or dependence with rehab therapy w/o CC	0.988
DRG 532 Alcohol/drug abuse or dependence w/o rehab therapy w/o CC	0.861***
RTI Co-morbid: Neurological	1.073***
RTI Co-morbid: Cardiovascular and coagulation factor deficit disorders	1.075***
RTI Co-morbid: Artificial openings	1.077***
RTI Co-morbid: Renal and hepatic disorders	1.087***
RTI Co-morbid: Neoplasms, with radiation or chemotherapy	1.257***
RTI Co-morbid: Neoplasms, without radiation or chemotherapy	1.082***
RTI Co-morbid: Endocrine and nutritional disorders	1.062***
RTI Co-morbid: Infectious diseases	1.082***
RTI Co-morbid: Respiratory	1.075***
RTI Co-morbid: Severe musculoskeletal and connective tissue diseases	1.087***
RTI Co-morbid: Injury and poisoning	1.137***
RTI Co-morbid: Psychiatric	1.069***
RTI Co-morbid: Dementia	1.079***
RTI Co-morbid: Delirium	1.070***
RTI Co-morbid: Childhood onset	1.051***
RTI Co-morbid: Substance related	1.026*
RTI Co-morbid: Psychiatric & Cardiovascular	0.959***
RTI Co-morbid: Psychiatric & Respiratory	0.964***
RTI Co-morbid: Psychiatric & Neurological	0.976***
RTI Co-morbid: Psychiatric & Dementia	0.963***
RTI Co-morbid: Dementia & Delirium	0.963**
RTI Co-morbid: Childhood Onset & Neurological	0.967***
RTI Co-morbid: Cardiovascular & Respiratory	0.969***
Adjusted R-squared	0.330
Number of Observations	501,770

NOTE: Relative weights computed by exponentiating estimated coefficients from a regression of the natural logarithm of per diem cost. Discharge-level per diem costs were calculated using facility-specific routine per diem costs and facility- and department-level cost-to-charge ratios and department-level charges for each stay, adjusted for area wage levels and updated for the Medicare Cost Report fiscal year. Relative weights for facility characteristics, length-of-stay, age group, and the ECT indicator (included in the regression) are not shown. One asterisk indicates significance at the 95% confidence level, two asterisks indicate significance at the 99% level, and three asterisks indicate significance at the 99.9% level.

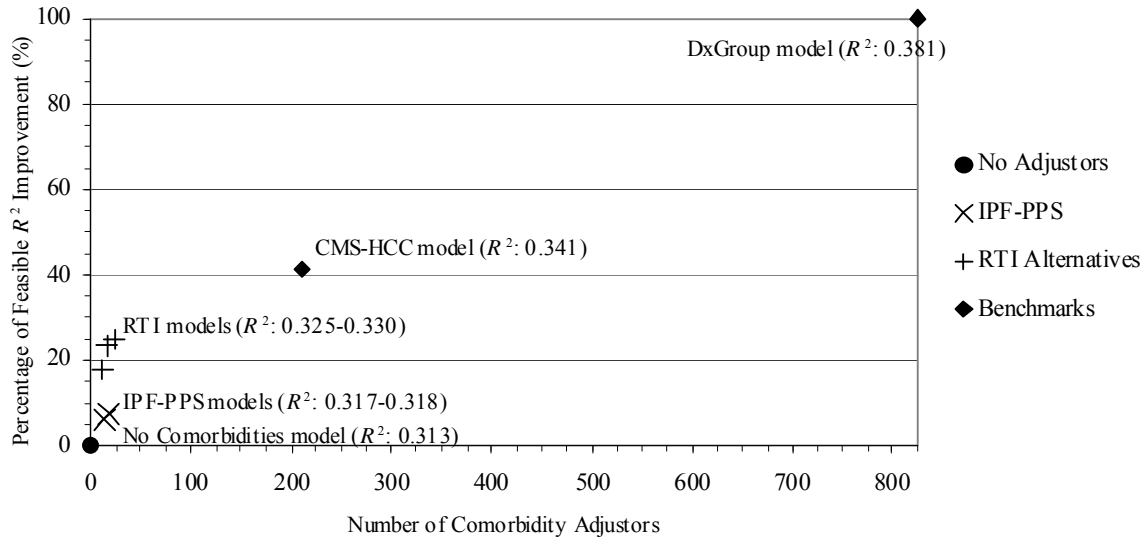
SOURCE: RTI International analysis of discharges from inpatient psychiatric units and hospitals using the 2004 100% MedPAR file.

4.6 Comparing Overall Explanatory Power of Per Diem Cost Regression Models

The difference in R-squared of 1.1 percentage points between the RTI co-morbid groups (without interactions or severity indicators) shown in Table 4-9 and the IPF-PPS model in Table 4-7 may seem small (though it exceeds the R-squared difference of 0.5 percentage points). However, it is important to put this R-squared difference in perspective with respect to alternative per diem cost models that retain the same basic structure (with facility, LOS, age, ECT use, DRG, and separate co-morbidity adjustors). We estimated two “benchmark” models that attempt to estimate an upper bound on the maximum explanatory power possible with this type of model. We restricted the possible alternative co-morbidity adjustors to “reasonable” adjustors (e.g., not a set of indicators for each possible ICD-9-CM code, which number in the thousands) used in payment systems. The alternatives we selected are indicators for whether a secondary diagnosis is in each CMS Hierarchical Condition Category (HCC) and also indicators for each DxGroup, the constituent components of the CMS-HCCs. These two diagnosis classification schemes are used for Medicare Advantage risk adjustment. To achieve maximum explanatory power, we included the IPF-PPS co-morbidity category and RTI co-morbid group indicators in the model as explanatory variables.

Figure 4-1 plots the adjusted R-squared for the eight per diem cost regressions presented earlier in this report as well as for the regressions that use the CMS-HCCs and the DxGroups as co-morbidity adjustors against the number of co-morbidity adjustors. When the CMS-HCCs, IPF-PPS co-morbidity categories, and RTI co-morbid groups (a total of 210 co-morbidity adjustors) are used, the adjusted R-squared rises only 0.012 units from the RTI co-morbid group model without interactions. This increase is approximately equal to the R-squared improvement of the RTI co-morbid groups over that of the IPF-PPS co-morbidity categories. When all 792 DxGroups plus the IPF-PPS and RTI adjustors are included (a total of 825 adjustors), the “feasible” R-squared rises to 0.381. Therefore, any feasible set of co-morbidity adjustors is unlikely to achieve more than a 0.068 R-squared improvement. Stated this way, the RTI co-morbid groups achieve about 25 percent of the “feasible” R-squared improvement over no co-morbidities, whereas the IPF-PPS co-morbidity categories achieve less than eight percent of the feasible maximum, or about one-third of the improved explanatory power of the RTI co-morbid groups. The RTI co-morbid group model, with one fewer adjustor, closes the gap between actual and feasible explanatory power three times as much as do the IPF-PPS categories.

Figure 4-1
Relationship between Number of Co-morbidity Adjustors and R-squared Improvement for
IPF-PPS, RTI Alternative, and CMS-HCC and DxGroup Benchmark Per Diem Cost
Models



NOTES: Percentage of Feasible R-squared is the difference between a particular model’s R-squared and the R-squared for the model without co-morbidity adjustors divided by the difference between the DxGroup adjustor model and the no co-morbidities model, expressed as a percentage.

SOURCE: RTI International analysis of discharges from inpatient psychiatric units and hospitals using the 2004 100% MedPAR file.

4.7 Implications for the IPF-PPS Co-morbidity Adjustments

The results in this section demonstrate that the existing IPF-PPS co-morbidity adjustors do identify especially high-cost patients, but may be too restrictive and ignore many other patients with significantly higher-than-average costs. RTI’s alternative co-morbidity adjustors not only improve the overall model explanatory power, but also reduce some of the over- or underestimation of cost for several subgroups of patients. However, this improvement significantly increases in the number of patient claims that would be affected by co-morbidities, 41 percent versus 11 percent in the CMS payment system. In light of the findings in Section 2, the number of patients ultimately indicated as having an RTI co-morbid condition, were they used for payment, could be significantly higher. Also, patients with multiple co-morbidities are less costly to treat than would be predicted from per diem cost models that treat each co-morbidity’s extra cost as independent. In the seven co-morbidity combinations with prevalence greater than 0.1 percent of the psychiatric inpatient population (about 500 patients), the overestimate of per diem cost was about 5 percent.

REFERENCES

- Cromwell J., B. Gage, E.M. Drozd, J. Maier, D.S. Osber, C. Evensen, E.M. Richter, H.H. Goldman: "Psychiatric Inpatient Routine Cost Analysis, Final Report." Waltham, MA: RTI International, CMS Contract No. 500-95-0058, T.O. 13, February 2005.
- Frank R.G. and Lave J.R.: "A Comparison of Hospital Responses to Reimbursement Policies for Medicaid Psychiatric Patients," *Rand Journal of Economics* 20(4):588–600, 1989.
- Froot K.A.: "Consistent Covariance Matrix Estimation with Cross-Sectional Dependence and Heteroskedasticity in Financial Data," *Journal of Financial and Quantitative Analysis* 24(3): 333–55, September 1989.
- Greene W.H.: *Econometric Analysis*, 5th Ed. Upper Saddle River, NJ: Prentice Hall, 2002.
- Huber P.J.: "The Behavior of Maximum Likelihood Estimates Under Nonstandard Conditions," in *Proceedings of the Fifth Berkeley Symposium on Mathematical Statistics and Probability*. Berkeley, CA: University of California Press, vol. 1: 221–3, 1967.
- Mitchell, J. B., Dickey, B., Liptzin, B., and Sederer, L. I. "Bringing psychiatric patients into the Medicare prospective payment system: Alternatives to DRGs," *American Journal of Psychiatry*, 144(5): 610–615, 1987.
- Research Triangle Institute: *SUDAAN User Manual Release 8.0, Volume I*. Research Triangle Park, NC: Research Triangle Institute, 2002.
- White H.: "A Heterskeasticity-Consistent Covariance Matrix Estimator and a Direct Test of Heteroskedasticity," *Econometrica* 48(4): 817–38, May 1980.