Methodology for Developing a Basic Case Mix Adjustment for the Medicare ESRD Prospective Payment System

Addendum
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Kidney Epidemiology and Cost Center
The University of Michigan
315 West Huron, Suite 240
Ann Arbor, MI 48103-4262

I. Summary

The Medicare Prescription Drug Improvement and Modernization Act of November 2003 (MMA) required that the Secretary of Health and Human Services develop "a basic case-mix adjusted prospective payment system…for a limited number of patient characteristics" to be implemented in 2005 (MMA 2003). The Centers for Medicare and Medicaid Services (CMS) of HHS has contracted with the Kidney Epidemiology and Cost Center (KECC) of the University of Michigan to conduct analyses for CMS to use in selecting a basic case-mix adjustment methodology that fulfills the MMA's requirements.

This report summarizes the research that was used to assist CMS in the development of the basic case-mix adjustment methodology that will be implemented starting in 2005 (Federal Register 2004a). The research presented here was performed subsequent to KECC's May 19, 2004, report (KECC 2004 and Appendix 1). The analyses in that report informed the publication of the proposed rule (Federal Register 2004b). Based on comments from the public on the proposed rule and further guidance from CMS, KECC performed several analyses to inform the development of a case-mix adjustment methodology for the final rule. This report provides a summary of these analyses.

While the databases and statistical models employed in these subsequent analyses are the same as those described in KECC's May 19, 2004, report (Appendix 1), we repeat some of that description here for the reader's convenience.

Consistent with legislative requirements, our analyses resulted in a model with a limited number of case-mix factors that explained variation in reported costs for composite rate (CR) services. Analyses of other case-mix factors that were evaluated as potential risk adjusters using several criteria but were not included by CMS in the initial case-mix adjustment methodology are also presented here. Some of these factors might be considered as part of any future expansions or refinements of the case-mix adjustment for the composite rate. KECC will be conducting further analyses that may be informative in updating and refining the risk adjustment model. The implications of the basic case-mix adjustment for Medicare payments to dialysis facilities and other issues related to its implementation are briefly discussed.

II. Methods

Because measures of the costs incurred by dialysis facilities in providing composite rate services are not available at the patient-level, analyses relating costs and case mix had to be carried out at the facility-level (see the subsection on data limitations below for a more detailed discussion of the limitations arising from the unavailability of patient-level cost data for CR services).

Identifying Factors for Case-mix Adjustment

An evaluation of individual case-mix factors as potential risk adjusters was performed using several criteria, most notably their ability to explain variation in facility costs. However, consideration was also given to the validity of their relationship with costs based on clinical judgment, the stability of the relationship over time, the objectivity and accuracy with which the factors would likely be measured, the reliability of information reported by different providers, and the feasibility of including them as risk adjusters, especially if changes in data collection would be necessary.

Case-mix factors that explained statistically significant variation in facility costs were identified based on a regression model that used a stepwise selection method implemented in the REG procedure using SAS software (SAS Institute Inc. 1999). Unless otherwise specified, case-mix measures represent the fraction of Medicare dialysis sessions in each facility that was provided to patients having the relevant characteristic or comorbidity. Case-mix measures that were considered for selection by the model included age/sex groups, less than one year of renal replacement therapy, average weight among adult dialysis patients (ages $\geq$18), low body mass index among adult dialysis patients (BMI<18.5 kg/m^2), body surface area, body mass index, and the presence of individual comorbidities that are described below and are based on a combination of data from the Medical Evidence Form (CMS 2728-U4) and several types of Medicare claims. In addition, analyses that further explored the relationship between individual case-mix factors and facility costs were performed, and results from many of these analyses are provided below.

Data and Measures

The data sources and measures that were used to examine the relationship between case-mix measures and facility costs are described below. KECC's May 19, 2004, report contains additional details regarding these data sources (Appendix 1).

Average Facility Costs

Facility-level cost and treatment data were obtained from The Centers for Medicare and Medicaid Services (CMS) Medicare Independent Renal Dialysis Facility Cost Reports (Form CMS 265-94) and the Medicare Hospital Cost Reports (Form CMS 2552-96). We used 2000-02 facility cost reports from CMS' June 30th, 2004, quarterly update of the Cost Report Data Files (CMS 2004a). For most facilities, a single cost report encompasses the entire calendar year. In cases where cost reports spanned two calendar years (e.g., October through September rather than January through December), data from multiple cost reports spanning the same calendar year were used to calculate a weighted average of the numerical values from those cost reports, where the weight was the fraction of the reporting period that spanned the calendar year.

For each year from 2000-02, average Medicare allowable treatment costs at each facility were calculated by dividing the total reported cost for composite rate services (Worksheet

B, column 11, rows 7-16 on CMS 265-94; Worksheet I-2, column 11, rows 2-11 on CMS 2552-96) by the total number of dialysis treatments (Worksheet C, column 1, rows 1-10 on CMS 265-94; Worksheet I-4, column 1, rows 1-10 on CMS 2552-96). CAPD and CCPD patient weeks were multiplied by 3 to yield hemodialysis- (HD) equivalent sessions, as other researchers have done (Dor, Held and Pauly 1992; Hirth et al. 1999; Ozgen and Ozcan 2002).

Facility Cost-to-Payment Ratio

The case-mix adjusted payment rate that is developed will be a multiple of the current composite rate payment for each facility, exclusive of any "exceptions" the facility may have received to the standard composite rate calculation. We therefore analyzed a cost-to-payment ratio defined as the ratio of average treatment costs at each facility to the composite rate for that facility. Composite rates were calculated by applying a wage index to the designated labor share of the appropriate base rate, which varies by year and is different for freestanding and hospital-based facilities. These wage index values are a blend of the Bureau of Labor Statistics (BLS) wage index and the CMS hospital wage index, and were obtained from CMS for each metropolitan statistical area (MSA) or rural area in each state. The county location of each facility was determined using the CMS Annual Facility Survey, and the corresponding MSA classification was then determined.

Facility Case-Mix Measures

Patient-specific case-mix data were obtained for Medicare dialysis patients for whom Medicare paid for dialysis treatments (Medicare Outpatient Claims Version I of type '72') from July 2000 through December 2002. Case-mix data for patients treated in hospital satellite facilities were linked to the parent hospital, since cost reports are only submitted by the parent facility. Patient characteristics were obtained from the Renal Beneficiary and Utilization System (REBUS/REMIS), Medical Evidence Form (CMS 2728-U4) and Master Patient File Records, and Medicare claims. Patient age was defined on January 1 of the year for prevalent patients and on the date renal replacement therapy (RRT) was begun for incident patients.

All case-mix measures that are described below were based on data for adults ($\geq$18 years) only. There were too few pediatric Medicare dialysis patients (0.2 percent of all Medicare patients) to develop a reliable payment adjustment for pediatric patients based on these analyses. Because of CMS plans to develop a pediatric adjuster using a separate approach, case-mix data for pediatric patients were not used in defining facility case-mix measures, although the proportion of pediatric patients was accounted for as a control variable (see next section).

Patient weight (kg) and height (m) recorded at the start of RRT were obtained from CMS Form 2728 and were used to calculate body mass index (BMI, kg/m^2) and in the calculation of several measures of body size. Body surface area (BSA) was calculated as a function of height (H) and weight (W) using the following formula (Dubois and Dubois 1916):

$$BSA = 0.007184 \times H^{0.725} \times W^{0.425}.$$

Patient BSA values were also calculated using alternative formulas, and results were compared (Boyd 1935; Gehan and George 1970; Haycock et al. 1978; Mosteller 1987). Total body water (TBW) was calculated using the Chertow formula (Chertow et al. 1997) as a function of height, weight, age, sex and the presence of diabetes. BMI values below 18.5 kg/m^2 were used to identify patients who were underweight (CDC 2004; NIH 2004).

The presence of a comorbidity was established if it was reported in either of two sources. The 2728 Form was used to determine the presence of the following comorbidities reported as of the start of RRT: diabetes, congestive heart failure, ischemic heart disease/coronary artery disease, myocardial infarction, cardiac arrest, cardiac dysrhythmias, pericarditis, cerebrovascular disease (including cerebrovascular accident and transient ischemic attack), peripheral vascular disease (PVD), chronic obstructive pulmonary disease, malignant neoplasm, alcohol dependence, drug dependence, HIV positive status, AIDS, tobacco use (current smoker), inability to ambulate, and inability to transfer.

ICD-9 diagnoses reported on Medicare claims represent the second source of patient comorbidity data. This includes diagnoses from inpatient, skilled nursing facility (SNF), outpatient hospital, hospice, home health and physician claims for 1999-2002. Diagnoses from claims for laboratory services were not used, since these services were often used to test whether or not a condition was present.

An initial mapping of diagnoses into 2728 Form comorbidities based on the 2728 Form instructions was compared with the mapping used by the Hierarchical Condition Category model for Medicare+Choice plans, now known as Medicare Advantage (CMS 2004b). When discrepancies existed, they were reconciled by a team of nephrologists. A list of the diagnoses that were mapped to each comorbidity was published in KECC's May 19, 2004 (Appendix 1). Only three of the comorbidities listed on the 2728 Form could not be identified using claims-based diagnoses: tobacco use, inability to ambulate, and inability to transfer. Therefore, information for these three comorbidities was based entirely on 2728 Form data while information for all other comorbidities were based on both sources. Among Medicare dialysis patients treated during 2002, 99.9 percent had either a 2728 Form or a sufficient Medicare claims history to ascertain their comorbidity status.

In addition, we used Medicare claims to identify specific types of two comorbidities, PVD and diabetes, that might be distinguished by their severity. Diagnoses from Medicare claims that were consistent with arterial PVD, venous PVD or an unspecified type of PVD were identified. However, since the distinction between Type I and Type II diabetes could not be ascertained based on the available data sources, we used the presence of any diabetes among patients ages 18-44 years as a proxy for Type I diabetes. We also used diagnoses from Medicare claims to identify six types of cancer: metastatic;

lung, upper digestive tract, and other severe cancers; multiple myeloma; leukemia; lymphoma; and lymphatic system, head, and other major cancers.

For each year from 2000-02, facility-level case-mix measures were defined by calculating average values across all patients treated in each facility during the year. All measures were weighted by the number of Medicare HD-equivalent dialysis sessions each patient received. For patients receiving peritoneal dialysis (PD), HD-equivalent sessions were calculated by multiplying the number of peritoneal dialysis patient days reported on Medicare outpatient dialysis claims by 3/7. This process yielded facility-level measures that reflect how case-mix is distributed across individual Medicare treatments.

Control Variables

In addition to the case-mix factors that are potential risk adjusters, the models also include several control variables that are not being considered for case-mix adjustment. Control variables are included to provide a more accurate estimate of the causal effect of the case-mix measures on composite rate costs. Models that included only the case-mix measures would have suffered from omitted variables bias, in which case the coefficients would have captured not only the causal effect of case-mix but also part of the effect of those control variables that are correlated with case-mix.

Control variables include the CMS wage index used to adjust Medicare payments to SNFs for fiscal year 2002 (Federal Register 2001) in order to account more accurately for differences in labor costs, since the blended wage index that is used in calculating the composite rate for each facility has not been updated since it was developed in 1987 and is truncated at 0.9 and 1.3 (relative to a national average of 1.0). Facility size was included to account for differences in efficiency due to economies of scale, as the lower average costs among larger facilities are well documented (Dor et al. 1992; Hirth et al. 1999). Since this relationship was nonlinear, the log-transformed number of HD-equivalent dialysis sessions from the cost reports was used to more accurately account for differences in cost due to facility size.

The model also controlled for whether the facility was hospital based or freestanding, and for chain ownership (indicators for the six largest chains and smaller chains versus independent). Hospital-based providers tend to have substantially higher self-reported costs than freestanding providers, which may partly reflect the methods used to allocate joint costs to hospital outpatient dialysis units. Chain membership was used to account for differences across chains (e.g., due to differences in reporting) as well as similarities among facilities within chains.

The percentage of Medicare patients achieving the DOQI guideline for urea reduction ratio (URR $\geq$ 65 percent) was used to account for the quality of care at each facility. URR values were obtained from Medicare outpatient dialysis claims, and were weighted by the number of HD-equivalent dialysis sessions reported on the claim. The resulting case-mix coefficients will be less biased by any relationship that exists between quality of care and facility costs.

The model also controlled for whether the facility was granted a payment exception to the composite rate system (e.g., as a pediatric facility or isolated essential provider). The resulting higher reimbursement levels may enable facilities to sustain higher average costs relative to those that would be sustainable by an otherwise similar facility that did not receive an except to the CR payment calculation. Facilities that were granted a payment exception between November 1993 and July 2001 were identified using a list obtained from CMS. The percent of Medicare HD-equivalent sessions provided to pediatric patients was included as a control variable. As noted above, there are too few Medicare pediatric dialysis patients to develop a reliable pediatric risk adjuster based on these facility-level analyses. Instead, CMS has developed a pediatric risk adjuster using an alternative approach that was based on the payment exception amounts that have previously been granted for facilities treating pediatric patients (Federal Register 2004a).

Data Limitations

As noted above, these analyses are inherently limited by the nature of the available data. The most important limitation of the data arises because costs for CR services are observed only at the facility level, not at the level of the individual dialysis patient. In the case of services that are billable separately from the CR (e.g, EPO, iron, and Vitamin D), Medicare paid claims would provide a measure of service utilization (though based on payments rather than on the actual costs incurred to deliver care) that varies at the patient level. Because CR payments vary only at the facility level on the basis of the wage index value applied to the facility, the facility type (hospital-based vs. free-standing), or the receipt of an exception to the CR payment formula, patient level claims data do not provide a useful measure of the costs incurred when treating a particular individual. Therefore, Cost Report data at the facility level are the only nationally available data on the costs incurred when providing CR services.

These costs are self-reported and certified by facilities to be accurate, but most Cost Reports are not formally audited by CMS. Further, CMS places several restrictions on cost that are "allowable" for reporting on the Cost Reports. While these restrictions may reduce the extent to which reported costs reflect all costs incurred by dialysis facilities, these restrictions are not likely to seriously affect the utility of the basic case mix analysis for two reasons. First, the restrictions reflect CMS policies regarding which input costs they will and will not reimburse. These policies are reflected in the overall average payment for CR services, but they are functions of whether or not the CR is case-mix adjusted (case-mix adjustment is being applied on a revenue neutral basis). Second, most of the areas in which CMS restricts allowable costs are related to fixed costs of facility operations (e.g., medical director fees and other administration expenses). Such expenses are likely to be related to the size of the facility, but not the demographic and comorbid conditions of its patients. Those costs that are most likely to vary at the patient level on the basis of factors such as patient frailty, illness, or size (e.g., patient care staffing, supplies), are not limited in terms of their allowability on the Cost Reports. Therefore, the variation in costs that may directly reflect variation in patient mix is likely to be reflected in the Cost Reports.

The primary consequence of observing costs at the facility level rather than the patient level is that we are forced to aggregate patient characteristics to the facility level in order to estimate empirical relationships. The actual case mix adjustment is then applied at the patient level. Hence, the application of the BCMA requires an extrapolation from the facility level to the patient level. For example, the multipliers applied to patients aged 70-79 are based not on direct estimates that such individuals are more costly to dialyze than the reference group of patients aged 60-69. Instead, the multipliers must be based on an extrapolation from the empirical finding that facilities with a higher percentage of their patients in the age 70-79 group have higher average costs than facilities serving a lower percentage of such patients.

A secondary limitation arising from the use of facility level costs is that facility level costs of providing CR services reflect the cost of providing those services to all patients, whereas case mix measures reflect case mix among Medicare patients. However, for the typical US dialysis facility, Medicare patients represent the vast majority of their patients.

Because of the non-existence of a large, nationally representative data set that measures the costs of providing CR services at the patient level, these limitations are likely to persist unless a large, representative study is developed to account for the specific supply costs attributable to patients with specific clinical and demographic characteristics along with a time and motion study to measure the amount of labor resources devoted to providing CR services to patients with specific characteristics.

There also exist several limitations associated with the case mix measures. First, there is evidence that some comorbidities are underreported on CMS Form 2728 (Ashby et al. 1998; Longenecker et al. 2000). This is not likely to be a problem for patients with a substantial Medicare claims history, for whom any clinically significant, current comorbidities would likely be reflected in diagnosis codes appearing on Medicare claims. However, it is potentially a limitation for newly Medicare eligible patients for whom Form 2728 is the primary source of data, and for the variables that are not available on Medicare claims (tobacco using, inability to ambulate, and inability to transfer). For these variables, any underreporting is likely to introduce measurement error that makes it more difficult to statistically verify the existence of a systematic relationship to costs. The other variables available only from Form 2728 (height and weight) appear to be well reported (except for patient initiating RRT prior to 1995, when the collection of height and weight became part of Form 2728). However, they may not accurately reflect patients' current conditions as weight may be changed since the onset of renal failure. Because height and weight will now be reported on dialysis claims in order to implement the BCMA, future analyses to refine and revise the BCMA will be based on body size data that will be complete and current.

Models

Models were estimated using ordinary least squares (OLS) regression. We estimated separate models for each year from 2000-02 and also a single model using pooled data that included up to three observations for each facility and controlled for overall trends in

cost (binary variables for each year). The characteristics of facility j are measured by a vector of values, denoted by X_j, that includes both case-mix measures and control variables. Secondary analyses, not shown here, indicated that a log transformation of the cost-to-payment ratio was less skewed and was better fit by the model. The log of the cost-to-payment ratio is denoted by $Y_j=\log(C_j/R_j)$. The model equation is

$$Y_j = X_j \beta + \varepsilon_j,$$

where β is the vector of coefficients for the predictor variables and ε_j is an error term. This model is equivalent to the following model for patient i, with a vector of individual characteristics X_{ij}, at facility j: $C_{ij} = R_j e^{X_{ij}\beta}$. Case-mix factors that explained statistically significant variation in costs ($p<0.05$) were identified based on a regression model that used a stepwise selection method, as implemented in the REG procedure in SAS (SAS Institute Inc. 1999).

We considered a mixed (random effects) model to account for clustering by facility in the pooled model, which includes up to three observations for each facility during 2000-02. The mixed model estimates primarily reflect the relationships between case-mix and costs over time within each facility, unlike the OLS estimates, which reflect variation across facilities. However, facilities may have a limited ability to rapidly adjust resources to changes in patient mix (e.g., re-scheduling to accommodate longer treatment times for new patients). As a result, the mixed model results are likely to be biased towards showing a weaker relationship than would exist in steady state. We therefore used the OLS method as the preferred approach.

Study Population

The study population was defined so that models would characterize the patterns seen among a broad spectrum of facilities, rather than being influenced by a few non-representative facilities that have exceptional costs or an exceptional case-mix. Facilities with extremely high or low costs may face unique circumstances other than an atypical patient mix. Observations with $Y_j < -0.5$ or $Y_j > 1.0$ were excluded based on an analysis of studentized residuals. In addition, individual observations with outlier values for case-mix or control variables or that were determined to be potentially influential in estimating the case-mix coefficients were also excluded. Outlier values were identified using statistical methods (outer fences), and influence was measured using the dfbeta statistic calculated by the REG procedure in SAS (SAS Institute Inc. 1999). Analyses also excluded facilities whose case-mix measures are based on relatively few patients (<20) and are likely to reflect relatively large measurement error. Some analyses also excluded facilities that were granted a payment exception, since they may be unique with regard to their costs, payments and/or case-mix. Below we describe the analyses conducted to determine the sensitivity of the results to the criteria that were used to restrict the study sample.

III. Results

Of the 4,165 dialysis facilities that submitted Medicare outpatient dialysis claims during 2000-02, 3,254 facilities (78 percent) were included in the study population. As shown in Table 1, facilities for which not all data were available, there were relatively few Medicare patients to measure case-mix or there were outlier values for one or more characteristics were not included in the principal analyses of case-mix and facility costs. Freestanding dialysis facilities were more likely to be included in the study population, largely because cost report data were less likely to be available for hospital-based facilities (Table 1). Thus, the study population included 78 percent of dialysis facilities submitting Medicare outpatient dialysis claims, including 83 and 50 percent of freestanding and hospital-based facilities, respectively. The principal analyses use data for 360,098 Medicare dialysis patients treated in 3,254 dialysis facilities during 2000-02.

Table 1
Study Population, 2000-02

	Number of Dialysis Facilities		
	Freestanding	**Hospital-based[1]**	**Total**
Facilities with Medicare outpatient dialysis claims	3,602	563	4,165
Type of data not available[2]			
Average treatment cost from facility cost reports	112	101	213
Wage index (blended or SNF)[3]	111	27	138
URR from Medicare outpatient dialysis claims	71	53	124
Reason for excluding from analyses[2,4]			
<20 patients with case-mix data	293	64	357
Outlier	43	36	79
Study population	2,972	282	3,254

[1]Data for most hospital satellite facilities are combined with data for the parent facility, so together they are treated as one facility.

[2]Each row shows the number excluded by this criterion from among those not previously excluded.

[3]Wage index (blended or SNF) was not available due to unknown facility location (county or MSA), or the composite rate calculated using the blended wage index differs from the composite rate reported in the claims by more than $3/session.

[4]These exclusions were made in order to more accurately estimate the coefficients relating costs to case mix variables. See Methods for further explanation of these exclusion criteria.

Basic Case-mix Adjustment for the Composite Rate in the New Payment Rule

Analyses of average reported treatment costs are presented in Table 2 using a model that includes five age groups, BSA, underweight (BMI < 18.5 kg/m^2) and control variables. This model was used as the basis for the case-mix adjustment in the CMS final rule (Federal Register 2004a). The case-mix effects in Table 2 are reported as factors that can be applied multiplicatively to a facility's current non-exception composite rate to derive a case-mix adjusted payment rate for each patient.

Table 2
The Basic Case-mix Adjustment for the Composite Rate, 2000-02[1]

Case-Mix Factor	Estimated Multiplier	P-value	95% CI
Age			
18-44	1.223	<0.001	(1.142, 1.308)
45-59	1.055	0.115	(0.987, 1.127)
60-69	1.000	Reference	
70-79	1.094	0.005	(1.028, 1.164)
80+	1.174	<0.001	(1.089, 1.264)
Body surface area (per 0.1 Δm^2)	1.037	<0.001	(1.029, 1.044)
Body mass index			
<18.5 kg/m^2	1.112	0.043	(1.003, 1.232)
≥18.5 kg/m^2	1.000	Reference	
		R-square	
All covariates: case-mix and control variables		0.3595	
Control variables only		0.3488	

[1]n=8,236. Facility control variables include: SNF wage index, facility size, hospital based (versus freestanding), chain ownership, % with URR≥65, % pediatric, payment exception status, and year of cost report.

There is a U-shaped relationship between age and reported facility costs, with higher costs at both younger and older adult ages (e.g., 22.3% higher costs for ages 18-44 versus ages 60-69 based on the pooled model in Table 2).

Average patient BSA was a statistically significant and consistent predictor of average treatment costs, indicating higher costs for larger adult patients. The estimated increment in cost was 3.7 percent for every 0.1 m^2 increase in patient BSA. In the same models that included BSA, underweight status was found to be an independent predictor of treatment costs. Average treatment costs are an estimated 11.2 percent higher for patients who are considered to be underweight, independent of the lower average treatment costs that were observed based on their smaller body size. These results suggest that average treatment costs are lowest for patients who are smaller but are not considered to be underweight.

The model that was estimated using pooled data from 2000-02 was also estimated for each individual year (Table 3) to assess whether these multipliers are consistent over time. The basic U-shaped pattern of age with costs was maintained for each of the three

years, although the two age groups that surround the reference group (45-59 and 70-79 years) are not statistically significant for any individual year (Table 3). Separate models for each of the three years estimated similar BSA multipliers that correspond to between a 3.6 and a 3.9 percent increase in treatment costs for every 0.1 m^2 increase in BSA (Table 3). The multiplier for underweight status corresponded to between 5 and 16 percent higher costs for each of the three years, but was statistically significant only in the pooled model. The basic case-mix adjustment was based on the model that uses pooled data, since it is expected to yield more stable estimates than the separate analyses by year.

Table 3
Yearly Case-Mix Multipliers for Factors Included in the Basic Case-mix Adjustment, 2000-02[1]

	2000 (n=2,717)		2001 (n=2,759)		2002 (n=2,760)	
Case-Mix Factor	**Multiplier**	**P-value**	**Multiplier**	**P-value**	**Multiplier**	**P-value**
Age						
18-44	1.12	0.046	1.28	<0.001	1.29	<0.001
45-59	1.03	0.617	1.09	0.136	1.05	0.395
60-69	1.00	Reference	1.00	Reference	1.00	Reference
70-79	1.08	0.135	1.11	0.055	1.08	0.153
80+	1.17	0.022	1.19	0.006	1.18	0.012
Body surface area (per 0.1 Δm^2)	1.04	<0.001	1.04	<0.001	1.04	<0.001
Body mass index						
<18.5 kg/m^2	1.16	0.095	1.11	0.232	1.05	0.642
$\geq$18.5 kg/m^2	1.00	Reference	1.00	Reference	1.00	Reference
	R-square		**R-square**		**R-square**	
Case-mix and control variables	0.3365		0.3721		0.3438	
Control variables only	0.3271		0.3592		0.3317	

[1]Facility control variables include: SNF wage index, facility size, hospital based (versus freestanding), chain ownership, % with URR$\geq$65, % pediatric, and payment exception status.

Further Analyses of Age and Body Size

The relationship between case-mix and average treatment costs was explored further for several factors, including age, body size, PVD and diabetes. All models included facility control variables and, unless noted otherwise, age (five groups), BSA and underweight.

U-shaped Age Effect

The relationship between age and average treatment costs was explored using more narrowly defined age groups than those described above. As with the 5 adult age groups in Table 2, the multipliers for 10 more narrowly defined adult age groups in Table 4 show a pronounced U-shaped relationship of age with average treatment costs. Facilities with larger percentages of patients in the youngest (18-34 years) and oldest age groups (85+ years) had higher costs. For several of the youngest and oldest age groups, the lower 95

percent confidence limit is well above 1.00. For several of the middle age groups where the lower 95 percent confidence limit is less than 1.00, we are unable to reject the possibility that average treatment costs are either no different from or even lower than the reference age group of 65-69 years.

Table 4
Patient Age Multipliers, 2000-02[1]

Age group	Multiplier	P-value	95% CI
18-34 years	1.254	<0.001	(1.11, 1.41)
35-44	1.209	<0.001	(1.08, 1.34)
45-54	1.078	0.127	(0.97, 1.18)
55-59	1.047	0.428	(0.93, 1.17)
60-64	1.000	Reference	
65-69	1.013	0.797	(0.91, 1.12)
70-74	1.163	0.002	(1.05, 1.27)
75-79	1.070	0.165	(0.97, 1.17)
80-84	1.149	0.011	(1.03, 1.27)
85+	1.266	0.001	(1.09, 1.46)

[1] n=8,158. Facility control variables include: SNF wage index, facility size, hospital based (versus freestanding), chain ownership, % with URR≥65, % pediatric, payment exception status, year of cost report, average BSA and % underweight.

The confidence intervals for some of the age multipliers in Table 4 were relatively large based on these facility-level analyses. We therefore defined broader age groups that both reflect the observed U-shaped relationship of age with costs and are likely to be more stable. We did this by combining several adjacent age groups that had similar multipliers (18-34 and 35-44 years; 45-54 and 55-59 years; 60-64 and 65-69 years; 70-74 and 75-79 years; 80-84 and 85+ years). This process yielded the five age groups that were used as the basis for the final rule (Table 2). In addition, we defined even broader age groups and estimated a model with just three age categories (18-44, 45-79, and over 80 years of age). This model also yielded a U-shaped age effect. See Appendix Tables A1.1 and A1.2 for comparisons of results for three and five age categories.

Alternative Body Size Measures

We studied the relationship between body size and average treatment costs using several body size measures, including weight, five alternative formulas for calculating BSA (Du Bois and Du Bois 1916; Boyd 1935; Gehan and George 1970; Haycock, Schwartz and Wisotsky 1978; Mosteller 1987), total body water (TBW) calculated using the Chertow formula (Chertow et al. 1997) and BMI. The ability of each body size measure to explain variation in average treatment costs was evaluated by comparing R-square values from models that added a measure of average body size to a base model that included facility control variables, age (5 groups) and underweight. The results of these analyses as well as one where BSA is employed as a categorized variable are presented in Appendix Tables A2.1 through A2.8.

All body size measures that were tested were statistically significant predictors of cost. Compared to a base model that did not include a body size measure (R^2=33.01 percent), models that included average body size yielded R^2 values that ranged from a low of 33.06 for BMI to a high of 33.73 percent for TBW (Table 5). TBW was slightly more predictive of costs than was BSA (R^2=33.69 percent). Given the typical patient-to-patient variation in each of these measurements, the magnitudes of the effects were similar for BSA (4 percent higher costs for every 0.1 m^2 increase in BSA), weight (5 percent per 10 kg) and TBW (4 percent per 4.0 L.), while a smaller effect was observed for BMI (1 percent per 3 kg/m^2). However, calculation of TBW using Chertow's method requires information about the patient's age, sex and diabetic status in addition to measurements of height and weight, which are sufficient for calculating BSA. BSA calculated using the Du Bois and Du Bois formula (1916) was slightly more predictive of costs than BSA calculated using one of the other four formulas (Boyd 1935; Gehan and George 1970; Haycock, Schwartz and Wisotsky 1978; Mosteller 1987). Therefore, this measure was employed in the model in the final rule.

Table 5
Analyses of Alternative Measures of Body Size, 2000-02[1]

Body size measure	R^2	Multiplier	P-value
None	0.3301	N/A	N/A
Body surface area (per 0.1 Δm^2)	0.3369	1.04	<0.001
Weight (per 10 kg)	0.3353	1.05	<0.001
Total Body Water (per 4.0 ΔL)	0.3373	1.04	<0.001
BMI (per 3 kg/m^2)	0.3306	1.01	0.013

[1]n=8,471. Other covariates include: SNF wage index, facility size, hospital based (versus freestanding), chain ownership, % with URR≥65, year of cost report, % by age group (pediatric and five adult age groups) and % underweight.

Alternative Underweight Measures

A standard clinical definition of underweight status, BMI < 18.5 kg/m^2 (NIH 2004; CDC 2004), was used in testing whether patients who are underweight or malnourished may be more costly to treat. We also tested whether higher costs are also observed for patients with BMI values that are relatively low but slightly exceed 18.5 kg/m^2. While the average facility had 4.6% of patients with a BMI < 18.5, there were an additional 5.4 percent of patients with a BMI between 18.5 and 20, which is the low end of the normal BMI range of 18.5 to 25 (NIH 2004; CDC 2004). As shown in Table 6, treatment costs were not significantly elevated for BMI values between 18.5 and 20 kg/m^2 relative to BMI > 20 (4% higher costs, p=0.46). This result does not support expanding the range for the upward payment adjustment for underweight patients to include those with a BMI between 18.5 and 20. A model that combines all patients with BMI < 20 estimates a single multiplier that is marginally significant (7% higher costs, p=0.06). However, this multiplier represents the average effect across two BMI groups that do not appear to have

similar effects on cost, and the model is slightly less predictive overall (slightly lower R^2). See Appendix Tables A3.1 and A3.2 for estimated models without low BMI and with low BMI at <20.

Table 6

Low BMI Multipliers, 2000-02[1]

BMI category	Average % of patients	Multiplier	P-value	R^2
<18.5	4.6	1.11	0.043	0.3595
≥18.5	95.4	1.00	Reference	
<18.5	4.6	1.12	0.039	0.3595
18.5 to 20	5.4	1.04	0.459	
≥20	90.0	1.00	Reference	
<20	10.0	1.07	0.060	0.3594
≥20	90.0	1.00	Reference	

[1]n=8,236. Other covariates include: SNF wage index, facility size, hospital based (versus freestanding), chain ownership, % with URR≥65, year of cost report, payment exception status, % by age group (pediatric and five adult age groups), and average BSA.

Analyses of Potential Comorbidity Measures

We performed stepwise regression analysis to evaluate the utility of including measures of comorbidity in the case mix adjustment model. Descriptive statistics for facility cost-to-payment ratios and the principal case-mix measures that were considered for the basic case-mix adjustment are reported in Table 7. The study sample reflected substantial variation in both cost-to-payment ratios and case-mix, based on the relatively large standard deviations in Table 7. The average cost-to-payment ratio of 1.18 indicates that on average, treatment costs per session were 18 percent higher than the composite rate.

The comorbidity measures that were selected by the stepwise model as statistically significant ($p<0.05$) predictors of average treatment costs are drug dependence, HIV positive status, MI, pericarditis and PVD (Table 8). The control variables, five age groups, BSA, and low BMI explained 36.43 percent of the variation in average treatment costs across facilities. The addition of the case-mix factors that were selected by the stepwise model accounted for an additional 1.69 percent of the total cost variation explained by the model (resulting in a total R^2 of 38.12 percent).

The age, BSA and underweight multipliers in Table 8 are similar to those from the more parsimonious model in Table 2. The comorbidity multipliers ranged from 1.04 for PVD to 1.33 for HIV positive status, corresponding to 4 percent and 33 percent higher costs for patients reported to have PVD and to be HIV positive, respectively. None of the statistically significant factors in Table 8 was highly correlated with the others. Factors that did not have a statistically significant relationship with average treatment costs included sex, first year of RRT and 13 comorbidities (see footnote to Table 8).

Table 7
Descriptive Statistics for Facility Cost-to-Payment Ratios and Case-mix Factors, 2000-02

Variable	Mean	Standard Deviation
Cost-to-payment ratio[1]	1.18	0.25
Age		
18-44 years	14.7%	7.1
45-59 years	24.4%	8.7
60-69 years	23.7%	6.7
70-79 years	26.3%	9.2
≥80 years	10.8%	6.5
Female	47.6%	8.4
Body size		
Weight (kg)	75.2	3.8
Body surface area (m^2)	1.84	0.05
Total body water (m^2)	41.4	1.8
BMI (kg/m^2)	26.8	1.2
BMI <18.5 kg/m^2	4.6%	3.5
First year of RRT	12.6%	6.4
Inability to ambulate[2]	2.4%	2.9
Inability to transfer[2]	0.6%	1.3
Current smoker[2]	4.9%	4.3
Drug dependence[3]	3.7%	3.1
Alcohol dependence[3]	1.3%	1.9
AIDS[3]	2.5%	4.7
HIV positive status[3]	1.6%	2.6
Cancer[3]	19.2%	8.1
Diabetes[3]	69.1%	12.2
Heart disease		
Cardiac arrest[3]	5.0%	3.1
Cardiac failure[3]	71.7%	10.8
Cerebrovascular disease[3]	41.2%	10.5
Cardiac dysrhythmia[3]	49.5%	13.6
Ischemic heart disease[3]	65.0%	13.5
Myocardial infarction[3]	21.0%	9.1
Pericarditis[3]	3.6%	2.9
COPD[3]	39.6%	11.6
Peripheral vascular disease[3]	62.5%	11.9

n=7,859.

[1]Defined as the ratio of average reported treatment costs to the composite rate. The log of this ratio is the dependent variable for all analyses (see Methods).

[2]Comorbidities that are identified using the 2728 Form only.

[3]Comorbidities that are identified using either the 2728 Form or diagnoses from Medicare claims (see Methods).

The stepwise regression model was estimated using pooled data that includes up to three observations for each facility during 2000-02. We explored the stability of these results by estimating separate models for each of the three years. Each model included the case-mix factors that were selected by the stepwise regression and the control variables. The yearly multipliers for the comorbidities vary to differing degrees. The three yearly multipliers range from 1.02 to 1.06 for PVD, 1.03 to 1.12 for MI, 1.17 to 1.30 for drug dependence and 1.09 to 1.32 for pericarditis (Table 9).

Table 8

Results from Stepwise Regression of Dialysis Facility Costs, 2000-02[1]

Case-mix factor[2]	Multiplier	P-value	95% CI
Age			
18-44	1.21	<0.001	(1.13, 1.3)
45-59	1.05	0.170	(0.98, 1.12)
60-69	1.00	Reference	
70-79	1.10	0.003	(1.03, 1.17)
80+	1.15	<0.001	(1.07, 1.24)
Body surface area (per 0.1 ΔBSA)	1.03	<0.001	(1.03, 1.04)
BMI <18.5 kg/m^2	1.15	0.008	(1.04, 1.27)
Drug dependence	1.26	<0.001	(1.12, 1.41)
HIV positive status	1.33	<0.001	(1.16, 1.54)
Myocardial infarction	1.08	0.002	(1.03, 1.13)
Pericarditis	1.22	0.001	(1.08, 1.38)
PVD	1.04	0.025	(1.01, 1.08)
		R-square	
Case-mix and control variables		0.3812	
Control variables only		0.3643	

[1]n=7,859. Control variables include: SNF wage index, facility size, hospital based (versus freestanding), chain ownership, % with URR≥65, % pediatric, payment exception status, and year of cost report.

[2]The following case-mix factors were not selected by the model as statistically significant ($p<0.05$) predictors of average treatment costs: sex, first year of RRT, AIDS, alcohol dependence, inability to ambulate or transfer, current smoker, cardiac arrest, congestive heart failure, cerebrovascular disease, cardiac dysrhythmia, ischemic heart disease, cancer, chronic obstructive pulmonary disease, and diabetes.

The HIV multiplier ranged from 1.10 to 1.60 over the three years (Table 9). The HIV multiplier is not estimated very precisely because of the relatively small number of HIV-positive patients in most facilities (an average of 1.6 percent in Table 7). Since facility-level measures of HIV positive status and AIDS are highly correlated, they were not included in the same stepwise model. Based on a separate stepwise regression model that replaced HIV positive status with AIDS but was otherwise identical, however, AIDS was not a statistically significant predictor of average treatment costs. This result differs

slightly from the result reported in the May 19 report (Appendix 1). See Appendix Tables A4.1 and A4.2 for estimated models including diagnoses of HIV and AIDS.

Table 9
Yearly Multipliers for Case-mix Factors Selected by the Stepwise Regression of Dialysis Facility Costs, 2000-02[1]

	2000 (n=2,588)		2001 (n=2,624)		2002 (n=2,647)	
Case-mix Factor	**Multiplier**	**P-value**	**Multiplier**	**P-value**	**Multiplier**	**P-value**
Age						
18-44	1.11	0.080	1.29	<0.001	1.26	<0.001
45-59	1.01	0.916	1.12	0.056	1.03	0.573
60-69	1.00	Reference	1.00	Reference	1.00	Reference
70-79	1.08	0.160	1.14	0.013	1.07	0.238
80+	1.13	0.073	1.25	<0.001	1.11	0.118
Body surface area (per 0.1 ΔBSA)	1.03	<0.001	1.04	<0.001	1.03	<0.001
BMI <18.5 kg/m^2	1.21	0.024	1.20	0.035	1.00	0.962
Drug dependence	1.30	0.017	1.28	0.010	1.17	0.121
HIV positive status	1.60	<0.001	1.10	0.435	1.39	0.008
Myocardial infarction	1.03	0.432	1.09	0.031	1.12	0.005
Pericarditis	1.09	0.428	1.32	0.007	1.27	0.034
PVD	1.06	0.041	1.04	0.198	1.02	0.543
	R-square		**R-square**		**R-square**	
Case-mix and control variables	0.3649		0.3952		0.3597	
Control variables only	0.3478		0.3734		0.3418	

[1]The pooled model shown in Table 8 was estimated for each year from 2000-02. Control variables include: SNF wage index, facility size, hospital based (versus freestanding), chain ownership, % with URR$\geq$65, % pediatric, and payment exception status.

The presence of cancer of any type was not a statistically significant predictor of costs in the stepwise regression. Using diagnoses from Medicare claims, we identified six specific types of cancer to determine whether they may uniquely affect costs. Based on a separate stepwise regression analysis that included these cancer categories, only multiple myeloma was a statistically significant predictor of cost. See Appendix Table A4.3 for estimated models that include a diagnosis of multiple myeloma.

Arterial versus Venous PVD

While the 2728 Form does not distinguish the specific type of PVD that is present at start of RRT, the diagnoses from Medicare claims can be used to identify arterial and venous PVD for many patients. For some patients, only a non-specific ICD-9 code indicating PVD is reported, in which case it is not possible to determine whether a specific type of PVD is present. Where possible, the diagnoses from Medicare claims were used to test whether arterial and venous PVD may have different associations with cost. The ICD-9 codes that were classified as arterial, venous or unspecified PVD are listed in Appendix 2.

In the average facility during 2000-02, 42.3 percent of Medicare dialysis patients were reported to have arterial PVD based on diagnoses from the claims. This figure is lower than the average 62.5 percent of patients reported in Table 7 to have any type of PVD from either data source (2728 Form or claims). Arterial PVD was found to be a statistically significant predictor of average treatment costs in a pooled model that included control variables, age, BSA and underweight. However, there was no evidence that the incremental cost associated with PVD was elevated for arterial PVD relative to venous PVD. Comparison of models including the Heinsche definition of PVD are presented in Appendix Tables A4.4 through A4.6.

Type I Diabetes

The stepwise regression revealed no overall association between the percentage of patients with diabetes and average treatment costs (Table 8). It should be noted that the costs we are trying to explain are only for those services that are reimbursed by Medicare through the composite rate system. For the current analyses, we are therefore not attempting to identify an association between diabetes and other separately billable services that are provided by dialysis facilities (e.g., injectable drugs) or other services that are provided to dialysis patients in inpatient or non-dialysis outpatient settings. There may, however, be pronounced differences in the severity medical complications in subcategories of patients with diabetes that have implications for the costs of composite rate services. We therefore attempted to distinguish between Type I and Type II diabetes to test whether differences in severity lead to differences in cost.

For both data sources that are used to identify diabetes (2728 Form and Medicare claims), the distinction between Type I diabetes and Type II diabetes is at least somewhat ambiguous. We therefore tested whether diabetes is associated with cost at ages 18-44, where Type I diabetes is likely to be present more frequently than in the age 45 and older group. In some analyses, diabetes was a significant predictor of average treatment costs at ages 18-44, but not at ages 45 and older. See Appendix Table A4.7. The results for this measure of Type I diabetes (diabetic and age 18-44) may provide a partial explanation for the higher costs that are observed among younger patients relative to the middle age groups in the basic case-mix adjustment model that includes only age, BSA and low BMI.

Sensitivity Analyses

A variety of sensitivity analyses were performed, three of which are summarized here. We tested the sensitivity of the results to how the study population was defined (Table 10). First, the estimated case-mix multipliers were generally not sensitive to whether the study population included facilities that were granted payment exceptions (n=221, or 7 percent of facilities). In particular, the age, BSA and underweight multipliers estimated by models that did not include facilities with payment exceptions (Table 10) were similar to the multipliers reported in Table 2, which are based on a model that included these facilities.

In addition, we considered the impact of including statistical outliers, which may reflect differences in reporting or a unique case-mix. This sensitivity analysis includes facilities having exceptional case mix with respect to age, BSA, or low BMI. As shown in Appendix Tables A1.1 through A4.7, multipliers estimated by models that included statistical outliers were generally similar to those described above that excluded these observations, except that the coefficient for low BMI was higher in the analysis that included statistical outliers (Table 10).

Table 10
Sensitivity Analyses: Changes in the Study Population, 2000-02[1]

	Basic Case-mix Model[2] (n=8,236)		Change in the Study Population (vs. the "Basic Case-mix Model")[3]					
			Exclude facilities with payment exceptions (n=7,650)		Include outliers (n=8,471)		Include small facilities[4] (n=9,078)	
Case-Mix Factor	**Multiplier**	**P-value**	**Multiplier**	**P-value**	**Multiplier**	**P-value**	**Multiplier**	**P-value**
Age								
18-44	1.22	< 0.001	1.24	< 0.001	1.24	< 0.001	1.20	<0.001
45-59	1.05	0.115	1.06	0.092	1.07	0.041	1.08	0.017
60-69	1.00	Reference	1.00	Reference	1.00	Reference	1.00	Reference
70-79	1.09	0.005	1.08	0.014	1.11	0.002	1.08	0.007
80+	1.17	< 0.001	1.19	< 0.001	1.17	< 0.001	1.13	<0.001
Body surface area (per 0.1 Δm^2)	1.04	< 0.001	1.04	< 0.001	1.04	< 0.001	1.03	<0.001
Body mass index								
<18.5 kg/m^2	1.11	0.043	1.12	0.035	1.18	0.002	1.14	0.010
$\geq$18.5 kg/m^2	1.00	Reference	1.00	Reference	1.00	Reference	1.00	Reference

[1]Facility control variables include: SNF wage index, facility size, hospital based (versus freestanding), chain ownership, % with URR$\geq$65, % pediatric, payment exception status, and year of cost report.

[2]This is the model used to determine the basic case-mix adjustment in the final rule, and is identical to Table 2. Includes facilities with payment exceptions, but does not include outliers or small facilities (see footnote 3). See methods for further details.

[3]Each of these three models is identical to the "Basic Case-mix Model" except for the reported change in the study population that corresponds to that particular model. Each of these three models should be compared with the "Basic Case-mix Model."

[4]Facilities having <20 patients with case-mix data.

Another sensitivity analysis included small facilities having relatively few patients (<20) with available case-mix data. Case-mix multipliers tended to be smaller in magnitude when the small facilities were included, consistent with possible measurement error, leading to attenuation bias.

Applying the Basic Case-mix Adjustment

The multipliers reported in Table 2 can be used to derive case-mix adjusted payment rates for individual patients in the following way. The principal step is to calculate a patient-specific multiplier that will be applied to the facility's composite rate. This requires both the estimated multipliers, or proportionate payment amounts, that correspond to each case-mix factor (Table 2), and the patient's age, BSA and underweight status. The necessary patient-specific information, which includes age, weight and height, will be collected on Medicare outpatient dialysis facility claims starting January 1, 2005 (Federal Register 2004a).

A patient-specific multiplier, PM, can then be calculated as

$$PM = M_{Age} * M_{Underweight} * M_{BSA},$$

where M_{Age} is the relevant age multiplier for the patient (1.223 for ages 18-44, 1.055 for ages 45-59, 1.000 for ages 60-69, 1.094 for ages 70-79, and 1.174 for ages 80+), $M_{Underweight}$ is the relevant underweight multiplier (1.112 if underweight and 1.000 if not underweight), and the BSA multiplier, M_{BSA}, reflects a payment adjustment of 1.037 for every 0.1 m^2 increase in a patient's BSA (see Methods for BSA formula). That is,

$$PM = M_{Age} * M_{Underweight} * 1.037^{((BSA-1.84)/0.1)}.$$

Note that the BSA multiplier is calculated such that a patient having exactly the average BSA value of 1.84 m^2 that was observed among Medicare dialysis patients in 2002 will have a BSA multiplier of 1.000, or will have no payment adjustment based on BSA. Patients having BSA values that are above average (>1.84 m^2) and below average (<1.84 m^2) will have BSA multipliers that are above and below 1.000, respectively.

For example, using the formula above, the case-mix multiplier for a 47-year old person (M_{Age} = 1.055) who is not underweight ($M_{Underweight}$=1.000) and has a BSA of 2.0 m^2 is calculated as:

$$PM = 1.055 * 1.000 * 1.037^{((2.0-1.84)/0.1)} = 1.055 * 1.000 * 1.060 = 1.118.$$

For this patient, there is an upward payment adjustment of 5.5 percent based on age, no payment adjustment for being underweight, and an upward payment adjustment of 6.0 percent based on having a larger than average BSA.

Similarly, the case-mix multiplier for an 82-year old person who is considered to be underweight (BMI<18.5 kg/m^2) and has a body surface area of 1.7 m^2 is calculated as:

$$PM = 1.174 * 1.112 * 1.037^{((1.7-1.84)/0.1)} = 1.174 * 1.112 * 0.950 = 1.240.$$

For this patient, there is an upward payment adjustment of 17.4 percent based on age, an upward payment adjustment of 11.2 percent for being underweight, and a downward payment adjustment of 5 percent based on having a smaller than average body surface area.

Patient-specific case-mix multipliers such as these can then be applied to the facility's composite rate. As described in the CMS final rule, the composite rates that are applicable in 2005 will reflect other adjustments, including a statutory increase of 1.6 percent, an upward adjustment due to changes in pricing for separately billable drugs, an increase in payment for hospital-based dialysis facilities, and a budget neutrality

adjustment as required by the MMA (Federal Register 2004a). If the multipliers of 1.118 and 1.240 for the two hypothetical patients described above are applied to a composite rate of $145 per session, the case-mix adjusted payment rates for these two patients are $156.52 per session (1.118*$145) and $179.80 per session (1.240*$145), respectively. Since the case-mix multipliers are applied multiplicatively to a facility's composite rate, the dollar increase in payment due to the case-mix adjustment will be relatively greater for facilities having relatively higher composite rates. This includes facilities with a larger wage adjustment (i.e., a higher wage index) and hospital-based facilities, which have a slightly higher base rate.

Further Analyses

In accordance with Task Order #500-96-0007, #3, KECC will conduct additional analyses to support recommendations to CMS regarding potential variables that could be used for refinement and updating purposes. In addition, KECC will make recommendations regarding any potential special studies or analyses that should be completed as part of the implementation of the basic case mix adjusted PPS and regarding a monitoring system that could be used to monitor and assess the basic case mix adjusted PPS. KECC has also prepared a forthcoming article that examines the economic impact of applying the basic case-mix adjustment to the composite rate (Hirth et al. 2005).

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Methodology for Developing a Basic Case Mix Adjustment for the Medicare ESRD Prospective Payment System

Addendum
February 14, 2005

Appendix 1

Methodology for Developing a Basic Case Mix Adjustment for the Medicare ESRD Prospective Payment System,
May 19, 2004

Methodology for Developing a Basic Case Mix Adjustment for the Medicare ESRD Prospective Payment System

May 19, 2004

For the Design, Development, and Implementation of an Improved Medicare Outpatient End Stage Renal Disease Prospective Payment System
Contract No. N-12004-11-504200
For the Centers for Medicare and Medicaid Services

Kidney Epidemiology and Cost Center
The University of Michigan
315 West Huron, Suite 240
Ann Arbor, MI 48103-4262

I. Summary

The Medicare Prescription Drug Improvement and Modernization Act of November 2003 (MMA) requires that the Secretary of Health and Human Services develop "a basic case-mix adjusted prospective payment system (PPS), for a limited number of patient characteristics and adjusted by a geographic index." The Centers for Medicare and Medicaid Services of HHS has contracted with the Kidney Epidemiology and Cost Center (KECC) of the University of Michigan to conduct analyses leading to recommendations about the specific structure of a basic case-mix adjusted ESRD PPS. This report describes the analyses KECC has conducted related to the basic case-mix adjustment and summarizes the results of these analyses.

The purpose of designing an adjustment system based on patient case-mix factors is to target greater payments to efficient facilities that treat patients who are more costly than average. Patient characteristics and reported costs both vary substantially across dialysis facilities. This paper identifies existing case-mix measures that systematically explain variation in reported costs for composite rate services and which might be effectively employed in a risk-adjusted payment system.

We analyzed the average cost per dialysis session from national data gathered for the years 2000, 2001, and 2002 for each ESRD provider using self-reported ESRD facility cost reports. These analyses included both hemodialysis sessions and method 1 peritoneal dialysis converted to the equivalent of 3 hemodialysis sessions per week. The analyses of case-mix measures also controlled for several other facility characteristics that influence facility costs, reflecting input costs, efficiencies due to economies of scale, accounting practices and quality of care. These measures include skilled nursing facility (SNF) Wage Index, the natural log of the number of dialysis sessions provided annually by the facility, facility type (freestanding versus hospital-based), chain affiliation, and the percentage of patients with urea reduction ratio (URR, which is a measure of dialysis dose) equal to or greater than 65 percent (this provides a marker for quality of care). The results reported here are based on extensive model-checking and sensitivity analyses carried out over a number of months.

The analyses result in equations that show how cost per treatment varies across facilities relative to the case-mix at each facility. The list of case-mix measures retained in the final model is based not only on the predictive power of these measures, but also upon criteria related to objectivity, clinical plausibility, and practicality of data collection. A model with age/sex, AIDS and peripheral vascular disease is described in detail. We calculated the variation in predicted facility-level costs per session based on the reported variation in these case-mix measures to determine the extent to which payments would vary across facilities under a case-mix adjusted payment system. We describe our analyses and key results below.

The objective of the analyses was to estimate how costs vary with case-mix measures, on average, among different facilities. For each pattern of case-mix (e.g., a particular age-

sex distribution of patients), the resulting models are intended to estimate the typical cost per session among all facilities with that particular case-mix.

The analyses are based on the principle that each facility efficiently adjusts the level of treatment resources to reflect appropriate care for the type of patients being treated at that facility. In fact, the ability to tailor treatment levels to the case-mix at each facility is constrained by the current composite rate payment system, which reimburses the same amount regardless of the characteristics of the patients. Thus, the estimates from the analyses reported here are likely to underestimate the actual variation in costs associated with delivery of ideal care to various case-mix patterns. The resulting payment adjustments for case-mix are thus likely to only partially account for the variation in the cost of delivering ideal treatment to various types of patients. However, with the revision to payments resulting from such a partial case-mix adjustment, facilities would become less fiscally constrained than in the past in terms of their ability to respond to the case-mix of their patients. Future revisions to the case-mix adjustment are thus likely to even better reflect the costs of ideal treatment, based upon cost reports after the implementation of a basic case-mix adjustment.

II. Data and Measures

The case-mix adjustment models that are reported here use both cost data and patient case-mix data. Data describing patient characteristics are available at the patient level. While the case-mix adjustors that are developed here are designed to be applied to individual patient claims, there are no patient-specific data available related to costs of delivering composite rate services. In particular, the cost reports are available only at the facility level by year and do not include any patient-specific information. This section describes how cost data at the facility level were combined with patient characteristics and were aggregated to the facility level by year to derive a case-mix adjustment method.

Average Costs at Each Facility

Facility costs are based on Medicare allowable costs reported by facilities for dialysis and related services for which they are reimbursed through the composite rate. The sources of the cost data are the Medicare Independent Renal Dialysis Facility Cost Reports (Form CMS 265-94) and the Medicare Hospital Cost Reports (Form CMS 2552-96). CMS updates the cost reports approximately every 3 months, and we used the most current set of facility cost reports available from CMS (cost reports updated through December 2003 and made publicly available in March 2004).[1]

All cost reports spanning any part of calendar years 2000, 2001 or 2002 were included. For most facilities, especially independent (freestanding) facilities, a single cost report encompasses the entire calendar year. However, for some facilities, most notably those whose reporting period spans two calendar years (e.g., October through September rather

[1] http://www.cms.hhs.gov/data/download/hcris_rnl/default.asp for independent dialysis facilities and http://www.cms.hhs.gov/data/download/hcris_hospital/default.asp for hospital-based dialysis facilities

than January through December), data from successive cost reports that spanned one calendar year were pro-rated to calculate the average treatment cost during that calendar year. For these facilities, the measure corresponding to an entire calendar year was computed as the weighted average of the measures from the cost reports spanning any part of the calendar year. The weight was determined by dividing the number of days in the calendar year that the cost report spanned by the total number of days in the cost report. For example, if a facility cost report spanned the period from Feb. 1, 2000 to Jan. 31, 2001, the weight applied to numerical variables for calendar year 2000 is 335/366 (the spanned period includes the leap day of leap year 2000) and the weight applied to numerical variables for calendar year 2001 is 31/366.

There were some instances (N=88) where there was overlap of cost reports (i.e., a facility reported costs for the same months on two different cost reports) or duplicate cost reports for the same facility. In such instances, the cost reports were manually coded/analyzed to determine if one of the cost reports should be omitted or to determine how the dates should be changed to remove the overlap (for example, the most common overlap occurred when one cost report ended on the same day as the next began). In some instances it was clear that an earlier version of a cost report was replaced by a corrected version and when that situation occurred the correction was accepted and the earlier report was deleted.

The resulting numbers of facilities with cost reports for each year (using the weighting procedure described above) are shown in Table 1. These counts reflect cost reports with non-missing cost data. There are fewer facilities with cost reports available for analysis in 2002 because some facilities have not yet submitted cost reports for that year.

Table 1
Number of Dialysis Facilities with
at Least One Cost Report, 2000-02[1]

Facility Type	2000	2001	2002
Freestanding	3,027	3,034	2,508
Hospital-based	477	466	456

[1]Source: Medicare Independent Renal Dialysis Facility Cost Reports and Medicare Hospital Cost Reports (see methods).

The average treatment cost per dialysis session for each facility was calculated by dividing the total reported cost for dialysis and related services (Worksheet B, column 11, rows 7-16 on CMS 265-94; Worksheet I-2, column 11, rows 2-11 on CMS 2552-96) by the total number of dialysis treatments (Worksheet C, column 1, rows 1-10 on CMS 265-94; Worksheet I-4, column 1, rows 1-10 on CMS 2552-96). For CMS 2552-96, both "Renal Dialysis Department" and "Home Program Dialysis" values were used in the cost

and treatment calculations. Both CMS 265-94 and CMS 2552-96 report "Home Program–CAPD" and "Home Program–CCPD" treatments in terms of patient weeks (Worksheet C, column 1, rows 9 and 10 and Worksheet I-4, column 1, rows 9 and 10, respectively) rather than number of treatments. Therefore, as has been done in other research,[2,3,4] these cells were multiplied by 3 to make them hemodialysis- (HD) equivalent sessions.

This process yielded an average Medicare allowable cost per dialysis session for each facility-year of observation. Both costs and numbers of treatments correspond to care delivered to all patients treated in the facility during the reporting period, regardless of Medicare eligibility or reimbursement for individual patients. Nationally, approximately 75 percent of all dialysis sessions are reimbursed by Medicare.

The cost report data were linked to Medicare claims data based on the Medicare billing number. For some facilities, more than one billing number appears on claims, and a list of correspondences among billing numbers was used to link the claims to the cost report facility identifiers. As described below, this linkage was sometimes ambiguous for hospital facilities with satellite centers.

Composite Rate

The models were used to calculate a case-mix adjusted rate that is a multiple of the current non-exception composite rate payment for each facility. Therefore, we calculated the composite rate for each facility using the standard formula used to generate payment amounts (not accounting for payment exceptions). Base rates are given in Table 2 for freestanding and hospital-based facilities separately for each of several time periods. Approximately 40 percent of the base rate is designated as the labor share. The labor share is multiplied by the wage index for each facility and then the remaining non-labor share is added to produce the payment rate for dialysis services. The wage index used in this calculation is a blend of the Bureau of Labor Statistics (BLS) wage index and the CMS wage index for each metropolitan statistical area (MSA) and is truncated at 0.9 and 1.3. The resulting "blended" wage index is used by fiscal intermediaries and by CMS to calculate the payment rate for each facility. Rural areas that are not assigned to an MSA use the blended wage index for non-MSA areas of the state. The list of blended wage index values corresponding to each MSA and to rural areas in each state was obtained from CMS for use in our analyses.

[2] Dor A, Held PJ, Pauly MV. The Medicare cost of renal dialysis: Evidence from a statistical cost function. *Medical Care. 30(10): 879-91, 1992 Oct.*

[3] Hirth RA, Held PJ, Orzol SM, Dor A. Practice patterns, case-mix, Medicare payment policy, and dialysis facility costs. *Health Services Research. 33(6):1567-92, 1999 Feb.*

[4] Ozgen H, Ozcan YA. A national study of efficiency for dialysis centers: an examination of market competition and facility characteristics for production of multiple dialysis outputs. *Health Services Research. 37(3):711-32, 2002 June.*

Table 2
Base Rates for Medicare Composite Rate Payments to Dialysis Facilities

Starting Date for Implementation	Facility Type	Labor Share	Non-Labor Share	Total
January 1, 2000	Freestanding	$50.15	$73.22	$123.37
	Hospital-based	$46.81	$80.46	$127.27
January 1, 2001	Freestanding	$50.75	$74.10	$124.85
	Hospital-based	$47.37	$81.43	$128.80
April 1, 2001	Freestanding	$51.55	$75.27	$126.82
	Hospital-based	$48.12	$82.71	$130.83

Cost-to-Payment Ratio

Using the average cost and composite rate information, a cost-to-payment ratio was defined as the natural log of the ratio of reported costs to the composite rate that was calculated for each facility. By expressing reported treatment costs at each facility relative to the composite rate, this ratio identifies facilities with higher or lower costs than expected based on their "blended" wage index and facility type (hospital versus freestanding). This cost-to-payment ratio was used as the dependent variable in models of facility costs (see details in Section III: Statistical Models).

Patient Claims Data

The KECC database contains Medicare claims from many settings (e.g. outpatient, inpatient, hospice, skilled nursing facilities, home health care) for patients who are receiving Medicare coverage for ESRD or renal transplant. All analyses were carried out using data extracted from CMS by KECC through Data Use Agreements 9155 and 10671. For the current analyses we have focused on data from Medicare Outpatient Claims (Version I) dated between July 2000 and December 2002, the CMS-2728-U4 Medical Evidence Form (2728 Form), Independent Renal Dialysis Facility Cost Reports, and Hospital Cost Reports. ESRD patients were identified using the Renal Beneficiary and Utilization System (REBUS), Medical Evidence and Master Patient File Records, the United Network for Organ Sharing (UNOS) transplantation records, and the three most current years of available Medicare claims. Dialysis-related services (e.g. the number of dialysis sessions) are identified for ESRD patients by billing source (renal dialysis facility bills of type 72), revenue center codes, and HCFA common procedure coding system (HCPCS) codes.

Patient Comorbidities for Case-mix Adjustment

The presence of comorbidities was determined for each patient based on two primary sources. The 2728 Form is one source for patient characteristics and comorbidities for these analyses. For implementation of a basic case-mix adjustment, the presence of comorbidities could be noted on dialysis bills. These comorbidities include diabetes (any diabetes or a measure of Type I diabetes), congestive heart failure, ischemic heart disease/coronary artery disease (CAD), myocardial infarction (a type of ischemic heart disease), cardiac arrest, cardiac dysrhythmias, pericarditis, cerebrovascular disease (including CVA and TIA), peripheral vascular disease, chronic obstructive pulmonary disease, tobacco use (current smoker), malignant neoplasm, alcohol dependence, drug dependence, HIV positive status, AIDS, inability to ambulate, and inability to transfer. Note that peripheral vascular disease (PVD) includes both arterial and venous diseases from CMS claims codes as shown in Appendix I.

For this study, the second source of comorbidity data was derived by mapping diagnoses from Medicare claims into the set of 2728 Form comorbidities. A list provided with the 2728 Form instructions was used to develop the first version of the mapping. Of the comorbidities used on the 2728 Form, tobacco use, inability to ambulate, and inability to transfer are unavailable through diagnoses on claims.

For each patient we identified diagnoses in the inpatient hospital Statistical Analytical File (SAF), the skilled nursing facility SAF, the outpatient hospital SAF, the hospice SAF, and the home health agencies SAF for the years 1997-2002. In addition, we identified diagnoses from the carrier claims from the National Claims History database to include diagnoses from physician claims for the years 1999-2002. Diagnoses reported from claims for laboratory services were excluded, as such laboratory services were often used only to test for a condition and do not indicate whether the condition was present or not.

CMS had developed a set of comorbidities for Capitation Payment under the ESRD Risk Adjustment Model for a demonstration project derived from the Hierarchical Condition Category (HCC) model used for the Medicare + Choice plans. The CMS list was compared with the mapping of diagnoses into 2728 Form comorbidities. When discrepancies existed, they were reconciled by a team of nephrologists. Appendix I contains a list of the diagnoses that were mapped to each comorbidity.

We compared the comorbidities found through claims to the 2728 Form comorbidities by considering the subset of Medicare beneficiaries who were at least 67 years old at time of ESRD onset. For most of these patients we should have at least two years of Medicare claims. We tried to predict the comorbidities from the 2728 Form using comorbidities mapped from diagnoses on claims. With the exception of diabetes (where there was fairly close agreement), many more comorbidities were found using claims than were entered on the 2728 Forms. This result is to be expected, since the 2728 Form describes patient condition at initiation of renal replacement therapy, whereas claims data also capture changes in patient condition after the start of renal replacement therapy. In

addition, the 2728 Form has been subject to underreporting of comorbidities.[5] Finally, some 2728 Form comorbidities did not appear in the claims data but that can be expected as the 2728 Form requests any current comorbid conditions as well as any that applied within the last 10 years.

The presence of a comorbidity was established if it was either reported on the 2728 Form or indicated in the previous three years of Medicare claims data for each patient. Patients for whom a 2728 Form was not available and for whom there were insufficient Medicare claims to ascertain whether a comorbidity was present were not included in facility-level comorbidity measures. Of the 269,656 patients with Medicare outpatient dialysis claims during 2002, 269,439 patients (99.9 percent) had either a 2728 Form or Medicare claims available to ascertain comorbidity status.

A different approach was used to determine both AIDS and HIV positive status, the reporting of which on the 2728 Form is incomplete in some states due to confidentiality restrictions. The overall prevalence of AIDS based on Medicare claims diagnoses was approximately 10 times larger than the estimate based on the 2728 Form. For patients who also have a limited period of Medicare eligibility, the 2728 Form and Medicare claims together may be insufficient to conclude that AIDS or HIV are not present. Patients with a limited Medicare claims history for establishing the absence of AIDS and HIV were those under age 65 who had less than one year of renal replacement therapy for which Medicare Secondary Payer (MSP) status was not indicated in the Medicare Enrollment Database. For each analysis year from 2000 to 2002, 7 to 8 percent of patients were excluded from the construction of AIDS and HIV measures due to insufficient data for establishing AIDS and HIV status. It should be noted that other characteristics of these patients, including age, sex and other comorbidities, were used in developing facility-level case-mix measures. Among the remaining 92 to 93 patients, a positive response for AIDS or HIV on the 2728 Form or on any Medicare claim was used to indicate the presence of each of these conditions, respectively. AIDS and HIV were each coded as absent only if no AIDS or HIV diagnosis was recorded in Medicare claims, respectively, and at least one year of claims data were available.

Developing Case-mix Measures at Each Facility Based on Patient-Specific Data

Facility-level case-mix measures were defined as the average demographic and comorbidity indicators for the Medicare dialysis patients in that facility for each calendar year from 2000 to 2002. In aggregating patient data to the facility level, case-mix measures for each patient were weighted by the number of hemodialysis-equivalent dialysis sessions received in each facility. This process gives approximately 12 times as much weight to the characteristics of patients receiving a full year of dialysis care at a particular facility as a patient receiving only one month of care at that facility. The resulting facility-level case-mix measures reflect how case-mix is distributed across

[5] Longenecker JC, Coresh J, Klag MJ, Levey AS, Martin AA, Fink NE, Powe NR. Validation of comorbid conditions on the end-stage renal disease Medical Evidence Report: the CHOICE study. *J Am Soc Nephrol. 11(3):520-529, 2000 March.*

individual treatments provided by the facility for Medicare dialysis patients. The number of dialysis sessions for each patient in each facility was obtained from Medicare outpatient institutional dialysis claims. The number of peritoneal dialysis patient days reported on each claim was multiplied by 3/7 to yield the number of hemodialysis-equivalent dialysis sessions provided during the time period covered by each claim.

Primary Study Sample of Facilities

Regression models for the average cost per session were used to estimate the typical cost per session for each pattern of case-mix. Since the average cost per session can be influenced by facilities with exceptional costs or with exceptional case-mix measures, the sample was restricted so that the resulting models would characterize the patterns seen among a broad spectrum that included most facilities, rather than being influenced by a few exceptional, non-representative facilities.

In order to describe the relationship between case-mix and facility costs, we first excluded from our primary analyses very small facilities for which it may not be possible to discern a relationship between case-mix and facility costs. This is because case-mix measures for very small facilities are based on relatively few patients and are therefore likely to reflect relatively large measurement error. Very small facilities were identified as either having less than 20 full patient years of dialysis during the year according to the cost reports (for both Medicare and non-Medicare patients) or having fewer than 20 Medicare patients for whom data from either the 2728 Form or Medicare claims were available to ascertain the comorbidity status of patients in the facility. As Table 3 shows, 221 facilities (6.9 percent) were excluded from the primary analyses on this basis.

Table 3

Study Sample for the Primary Analyses[1]

	Freestanding	Hospital-based	Total
Facilities included in primary analyses	2,550	118	2,668
Facilities excluded [2]			
Small (<=20 patients)	196	25	221
Payment exceptions [3]	193	46	239
Outlier costs (dependent variable <-0.5 or >1)	2	10	12
Outlier covariates [4]	37	15	52
Facilities with complete data available[5]	2,978	214	3,192
Percent included	86%	55%	84%

[1]These exclusions were made in order to more accurately estimate the coefficients relating costs to case mix variables.

[2]Each row shows the number excluded by this criterion from among those not previously excluded.

[3]See methods for an explanation of how facilities with payment exceptions were identified.

[4]Count of facilities identified as having outlier values for covariates or high dfbeta statistics (see explanation in methods).

[5] Facilities must have cost data from cost reports, area wage indices, URR, and case mix measures in order to be included in the analyses

The primary study sample also excluded facilities with exceptional reimbursement levels. In the past CMS has allowed facilities to apply for exceptions to the composite rate payment system. For example, facilities that have an atypical patient mix (particularly pediatric facilities) or that are isolated essential providers were in some cases approved for higher composite rate payments than would be administered under the wage index-adjusted base rate. However, the exceptions process was suspended for a time and there is some discretion on the part of CMS and fiscal intermediaries as to whether or not a facility will continue to receive higher composite rate payments.

For our analyses, CMS provided a list of all facilities that were granted exceptions during November 1993 to July 2001. Facilities on this list were excluded from the analyses because they are not representative of the general population of providers. In particular, these facilities are likely to be able to sustain higher costs due to increased revenue resulting from their exception to the composite rate. Some facilities on this list were no longer in operation, and some may have discontinued exceptional status. However, the high likelihood that these facilities still fall outside the norm of costs, payments, and/or case-mix of the general efficient provider was used as an exclusion criterion for our primary analyses.

Further, some facilities were identified based on Medicare outpatient dialysis claims as having average payments that are higher than the calculated composite rate for that facility (the method used to calculate the composite rate for each facility is described above). For the majority of facilities, average composite rate payments exactly equaled the calculated amount. For the remaining facilities, those for which the payment was more than $3.00 higher than predicted were excluded since they are likely either to either reflect data errors or to represent facilities that were granted payment exceptions. A total of 239 facilities (7.5 percent) were identified as having a payment exception using at least one of these two methods and were therefore excluded from the primary analyses.

Extremely high or low average costs may reflect unique circumstances that are likely to reflect factors other than an atypical patient mix, yet could be unduly influential in assessing the relationship between case-mix and facility costs that prevails across facilities. Facilities having values for the natural log of the ratio of reported costs to the composite rate of less than –0.5 or greater than 1.0 were therefore excluded. These limits were determined based on an evaluation of studentized residuals and correspond to average costs that are at least 39 percent lower than the composite rate or 172 percent higher than the composite rate, respectively. This restriction resulted in the exclusion of 12 facilities (<1 percent) from the primary analyses for 2000-02 (Table 3).

Some facilities also had extremely high or low values of certain characteristics, such as the percent of patients having a specific comorbidity. As with average costs, outlier values do not represent typical variation in case-mix across facilities. Parameter estimates that are strongly influenced by individual observations with outlier values for the corresponding case-mix measure may not be reliable. Facilities with outlier values for case-mix measures and other facility characteristics (facility size, URR) or that were highly influential in the cost model also were excluded from the primary analyses. The

process of identifying such facilities with outlier or unduly influential values for one or more of their characteristics was performed in two steps. First, individual facility characteristics that surpassed thresholds used to identify extreme outliers were identified. These upper and lower thresholds for each covariate were determined using an established definition for the upper and lower outer fences. These outer fences represent a somewhat more conservative definition of outliers in order to limit the number of facilities that are excluded from the analyses and to preserve heterogeneity in a sample where costs and case-mix vary substantially among providers. The distribution of seven facility characteristics was highly skewed, resulting in more than 0.5 percent of facilities having values beyond the outer fence. In these cases, an upper bound of 0.5 percent of facilities was established to limit the number of observations that were excluded based on any one factor. Factors with highly skewed distributions were alcohol dependency, drug dependency, inability to ambulate, inability to transfer, AIDS, HIV and URR$\geq$65 (each expressed as a percent of patients in the facility).

We then employed another statistical tool to limit the impact of any one provider on the coefficients estimated by the models. Using a log-linear regression model of facility costs that included both control variables and the case-mix factors, we tested the sensitivity of the estimated coefficients to the inclusion of individual observations in the analysis. A standard measure of influence, dfbeta, was calculated based on the change in individual coefficient estimates (e.g., the increment in cost associated with higher patient weight) that results from dropping a single observation from the analysis (SAS Institute Inc., Cary, NC, USA). Observations having abs(dfbeta)>10/sqrt(n) associated with any of the control variables or case-mix factors were identified as excessively influential observations and were not included in the analyses.[6] An additional 52 facilities (1.6 percent) with outlier or excessively influential values for one or more of their characteristics were excluded from the primary analyses (Table 3).

The final study sample includes n=2,668 facilities (Table 3). As the descriptive statistics for a select group of covariates in Table 4 demonstrate, the facilities in the primary study sample exhibit substantial variation in case-mix.[7]

[6] Sensitivity analyses that considered other criteria for establishing individual observations as excessively influential, including abs(dfbeta)>2/sqrt(n), abs(dfbeta)>6/sqrt(n) ,and abs(dfbeta)>8/sqrt(n), are described below.

[7] Note that the sample size in Table 4 (n=6,521) includes up to three observations for each of the 2,668 facilities in the final study sample, with one observation for each year from 2000 to 2002 that the facility met the above criteria for inclusion in the study sample.

Table 4
Descriptive Statistics Regarding Dialysis Costs per Session, Demographic Characteristics, and Comorbidities, 2000-2002 (N=6,521)

Variable	Mean	Std. Dev.	Min.	25th Pctl	50th Pctl	75th Pctl	Max.
Average cost/session (composite rate services only) [1]	$ 148.05	$ 29.89	$ 75.47	$ 128.14	$ 143.21	$ 162.62	$ 345.99
Cost-to-payment ratio (see definition below [1,2])	0.13	0.18	-0.50	0.00	0.11	0.23	0.87
Number of dialysis patient years [1]	74.14	46.87	20.00	41.57	62.85	92.96	676.75
# HD-equivalent treatments, log transformed [1]	2.3	0.6	1.1	1.9	2.3	2.7	4.7
URR > 65 (%) [3]	88.9	7.1	51.8	85.2	90.2	94.0	100.0
Age<65 years, Female (%) [4]	21.7	8.1	0.0	16.3	21.5	27.0	57.5
Age<65 years, Male (%) [4]	28.0	9.4	0.3	21.3	27.4	33.8	70.6
Age 65-79, Female (%) [4]	20.6	6.9	0.0	16.2	20.4	24.9	49.7
Age 65-79, Male (%) [4]	19.1	7.7	0.0	13.6	18.5	23.9	54.9
Age 80+ years, Female (%) [4]	5.3	3.8	0.0	2.6	4.7	7.4	21.6
Age 80+ years, Male (%) [4]	5.3	4.2	0.0	2.1	4.4	7.4	23.2
Average weight (in kilograms) [5]	75.0	3.8	57.9	72.7	75.2	77.6	91.3
Underweight patients (BMI <18.5), (%) [5]	4.8	3.6	0.0	2.1	4.2	6.9	20.6
AIDS (%) [6]	2.6	4.8	0.0	0.0	1.1	3.4	67.5
Peripheral vascular disease (%) [6]	63.0	11.9	19.9	55.0	63.1	71.2	100.0

[1]Calculated using Cost Reports for freestanding and hospital-based facilities.

[2]Average cost as the % difference from the composite rate payment. See methods for further explanation.

[3]Source: Medicare outpatient dialysis claims.

[4]Source: CMS REMIS database, formerly known as the REBUS database.

[5]Source: 2728 Form.

[6]Source: 2728 Form and diagnoses in Medicare claims (see methods).

III. Statistical Models

Choice of Estimation Method

We fitted separate log-linear ordinary least squares regression models for each year from 2000 to 2002 to predict the natural log of the ratio of reported costs to the composite rate based on patient characteristics. Exponentiation of the estimated coefficient of a comorbid condition yields the multiplicative adjustment factor for the rate for patients with the corresponding co-morbidity condition. The sets of estimated coefficients from the three years generally showed similar patterns. Based on this similarity, we fitted a single model to data pooled from all three years with year dummy variables, yielding 6,521 observations for 2,668 facilities (Tables 3 and 4). This pooling of data results in more stable estimates.

In a secondary analysis, we also fitted a mixed (random effects) model with all three years of data, which resulted in a single set of overall estimates. The estimates from the mixed model approach primarily reflect the relationships between costs and comorbidities across years *within* each facility (versus the ordinary least squares models, which estimate the variation *across* facilities). If facilities have a limited ability to rapidly adjust resources to changes in patient mix, the mixed model results would be biased towards showing a weaker relationship than would exist in steady state. For example, facilities that experience an influx of patients who have more severe comorbidities or require longer treatment times may not have the resources or scheduling slack available in the short term to provide a high level of care to these new patients. We used the ordinary least squares estimates because the mixed model results are likely to be more biased towards zero (showing no relationship). As expected, the mixed model generally indicated a weaker relationship between case mix and costs than the ordinary least squares models.

Control Variables

In addition to the case-mix variables that are candidates for use in the case-mix adjustment system, the models also control for several other variables that are *not* being proposed for use in the case-mix adjustment system. The objective of including these control variables in the models is to provide an accurate estimate of the causal effect of the case-mix measures on composite rate costs. Each of the control variables is intended to account for a portion of the cost at each facility that is not related to case-mix but can be attributed to these facility characteristics. Models that included only the case-mix measures would suffer from omitted variables bias, in which case the coefficients would then capture not only the causal effect of case-mix but also part of the effects of those control variables that are correlated with case-mix.

The specific control variables included in the analyses are: skilled nursing facility (SNF) wage index; the natural log of facility size (number of dialysis treatments from the cost reports); hospital-based (versus freestanding); chain ownership (indicators for the six largest chains and smaller chains versus independent); and percent of Medicare patients

with a urea reduction ratio (URR) $\geq$ 65 percent based on Medicare outpatient dialysis claims (weighted by the number of Medicare dialysis sessions provided to each patient).

Although the current composite rate is adjusted for the blended wage index, that index has not been updated since 1980 and the adjustment is truncated at 0.9 and 1.3. In other words, facilities in areas where the wage index value is less than 90 percent of the national average in 1980 are paid as if their wage index value was 0.9, and facilities in areas where the wage index value exceeds 130 percent of the national average in 1980 are paid as if their wage index value was 1.3. Therefore, the 2001 SNF wage index was included as a control variable to account more accurately for differences among facilities in wage costs.

Facility size is an important factor in accounting for facility costs. On average, larger facilities have lower per session costs than smaller facilities, indicating economies of scale. However, the relationship is nonlinear, and a log-transformation of the number of sessions more accurately accounts for differences in cost due to facility size. Hospital-based providers, as a group, tend to have substantially higher self-reported costs than freestanding providers. This may partly reflect the methods used to allocate costs to hospital outpatient dialysis units. Therefore, an indicator for hospital versus freestanding provider is included in the model. Further, chain membership is included in the model to account for differences across chains (e.g., due to differences in reporting) as well as similarities between facilities within chains. Finally, the percentage of patients in each facility that achieve the DOQI guideline for URR (65%) is included in the model to account for the quality of care at each facility. This means that the resulting coefficients will be less biased by any relationship that exists between costs and quality of care.

The Log-linear Model for Facility Costs

There are two objectives of our current analysis:

1. Identify a limited number of comorbidities that are strong predictors of cost.
2. Provide an estimated adjustment factor for each of these comorbidities.

In order to yield an adjustor that can be multiplied with the composite rate payment, the model was used to estimate the natural log of the ratio of reported costs to the composite rate (i.e., the cost-to-payment ratio defined above) that was calculated for each facility. The resulting ratio was modeled using case-mix and control variables. Secondary analyses, not shown here, indicated that a log transformation of this ratio was less skewed and was better fit by the model (i.e. predicted values were closer to actual values using the log transformation, especially for high cost facilities). Therefore, the log-transformed ratio was used.

The characteristics of facility j are measured by a vector of values, denoted by X_j. These values include both control variables and case-mix measures. The log of the ratio of cost per session (C_j) to composite rate (R_j) is denoted by $Y_j=\log(C_j/R_j)$. The multiple observations for three years are not indicated explicitly. The model equation is

$$Y_j = X_j \beta + \varepsilon_j,$$

where β is the vector of coefficients for the predictor variables and ε_j is an error term. This model is equivalent to the following model for cost for patient i, with a vector of individual characteristics X_{ij}, at facility j: $C_{ij} = R_j e^{X_{ij}\beta}$.

Identifying Factors for Case-mix Adjustment

An evaluation of individual case-mix factors as potential risk adjusters was performed using several criteria, notably their ability to explain variation in facility costs. However, consideration was also given to the validity of their relationship with costs based on clinical judgment, the stability of this relationship over time, the objectivity and accuracy with which the factors would likely be measured, the reliability of information reported by different providers, and the feasibility of including them as risk adjusters, especially if changes in data collection would be necessary.

Case-mix factors that explained statistically significant variation in facility costs were identified based on a regression model that used a stepwise selection method implemented in the REG procedure using SAS software (SAS Institute Inc., Cary, NC, USA). Unless otherwise specified, case-mix measures represent the fraction of dialysis sessions in each facility that was provided to patients having the relevant characteristic or comorbidity. Case-mix measures that were considered for selection by the model included age/sex groups, less than one year of renal replacement therapy, average weight among adult dialysis patients (ages$\geq$20), low body mass index among adult dialysis patients (BMI<18.5 kg/m^2) and the presence of individual comorbidities that were described previously and are based on a combination of data from the 2728 Form and several types of Medicare claims.

IV. Results

Costs varied across facilities according to the age and sex distribution in each facility. For both sexes, age categories were defined as <65 years, 65 to 79 years and 80 years and older. Relatively higher costs were observed for both the younger and older age groups of both sexes, while the lowest costs were observed for female patients in the middle age group (see Tables 5 and 6). The relationship between age and facility costs was relatively weak for 2000 but was relatively similar for the other two years. In addition to being strong predictors of cost, age and sex are readily available, objective, and accurately measured. Age and sex are routinely used for risk adjustment in other prospective payment systems (e.g., Medicare+Choice).

Table 5
Estimated Adjustment Factors for Basic Case Mix Measures, 2000 to 2002[1]
Accounts for Age, Sex, AIDS, and PVD

		Time Period			
		2000	2001	2002	2000-02 (pooled)
Number of facility cost reports		2,348	2,343	1,830	6,521
Age <65 years					
	Female	0.99	1.19	1.21	1.11
	Male	1.09	1.30	1.29	1.21
Age 65-79 years					
	Female (ref)	1.00	1.00	1.00	1.00
	Male	1.05	1.24	1.25	1.17
Age 80+ years					
	Female	1.13	1.17	1.26	1.16
	Male	1.12	1.27	1.36	1.23
AIDS		1.30	1.06	1.10	1.15
Peripheral Vascular Disease		1.07	1.10	1.03	1.07
Adjusted R-squared					
	Control variables	28.9%	32.1%	34.7%	32.4%
	Case mix	0.6%	0.9%	0.7%	0.6%
Standard deviation of case mix multipliers					
	Patient level	9.7%	9.7%	9.6%	9.7%
	Facility level	2.7%	2.6%	2.5%	2.4%

[1]Based on log-linear models of the ratio of reported facility costs to the actual composite rate for each each facility (calculated using the CMS/BLS wage index). All models also included control variables: SNF Wage Index, log (# dialysis sessions), hospital-based, chain affiliation, & URR>= 65. The model that was estimated using the pooled data for 2000-02 also includes control variables for calendar year.
Not Significant at p <0.05

The prevalence of peripheral vascular disease (PVD) was also strongly related to facility costs. A diagnosis of PVD was associated with approximately seven percent higher costs (Tables 5 and 6). The relationship between PVD and facility costs appeared to be especially robust, and was relatively insensitive to changes in how the model was specified (see the section discussing sensitivity analyses for further details). As with other comorbidities, PVD was more commonly identified using the Medicare claims than the 2728 Form (Table 7). Diagnoses of PVD were typically found on multiple types of claims, as the majority of patients with PVD identified using the claims data had some combination of inpatient, outpatient, physician and other claims with a diagnosis of PVD (Table 8).[8] Physician claims were especially instrumental in identifying PVD, as they alone were responsible for approximately one third of cases (Table 8). We are currently

[8] "Other" claims include Medicare claims for skilled nursing facility, hospice and home health care.

defining specific types of PVD to determine their relationship with costs and to establish more specific clinical criteria that may improve the objectivity with which PVD is measured.

Table 6

Estimated Adjustment Factors for Basic Case Mix Measures, 2000 to 2002[1]
Alternative Model: Adds Measures of Body Size

		Time Period			
					2000-02
		2000	2001	2002	(pooled)
Number of facility cost reports		2,348	2,343	1,830	6,521
Age <65 years					
	Female	0.98	1.18	1.20	1.09
	Male	1.06	1.28	1.28	1.19
Age 65-79 years					
	Female (ref)	1.00	1.00	1.00	1.00
	Male	1.02	1.22	1.22	1.14
Age 80+ years					
	Female	1.16	1.21	1.31	1.20
	Male	1.12	1.28	1.37	1.23
AIDS		1.30	1.07	1.11	1.16
Peripheral Vascular Disease		1.07	1.10	1.03	1.07
Weight (per 10 kg)		1.04	1.03	1.03	1.04
Low Body Mass Index		1.18	1.20	0.95	1.13
Adjusted R-squared					
	Control variables	28.9%	32.1%	34.7%	32.4%
	Case mix	1.1%	1.3%	1.0%	1.0%
Standard deviation of case mix multipliers					
	Patient level[2]	16.7%	16.9%	16.9%	16.9%
	Facility level[2]	4.6%	4.6%	4.3%	4.2%

[1]Based on log-linear models of the ratio of reported facility costs to the actual composite rate for each each facility (calculated using the CMS/BLS wage index). All models also included control variables: SNF Wage Index, log (# dialysis sessions), hospital-based, chain affiliation, & URR>= 65. The model that was estimated using the pooled data for 2000-02 also includes control variables for calendar year.

[2]Multipliers for pediatric patients were based on weight and BMI values correspondding to the average adult patient.

Not Significant at p <0.05

Separate indicators of AIDS and HIV positive status were both found to be significant predictors of facility costs, though not independently significant when both variables appeared in the same model. HIV was significant in the stepwise results, but the estimated coefficients were less stable over time than for AIDS. An indicator for AIDS is therefore included in the final model results in Tables 5 and 6. Relatively few patients

were identified as having AIDS based on the 2728 Form, as the prevalence rate was approximately 10 times higher when relying on diagnoses in Medicare claims (Table 7).

Table 7
The Reported Prevalence of PVD and AIDS
Varies by Data Source:
2728 Form Versus Medicare Claims (2002)[1]

PVD

2728 Form	**Percent of Patients with Diagnosis in Medicare Claims**		
	Yes	No	Total
Yes	10.4	2.1	12.5
No	53.5	34.1	87.5
Total	63.9	36.1	100.0

AIDS

2728 Form	**Percent of Patients with Diagnosis in Medicare Claims**		
	Yes	No	Total
Yes	0.2	<0.1	0.2
No	2.6	97.2	99.8
Total	2.8	97.2	100.0

[1]N=236,053 patients with both a 2728 Form and a Medicare claims history available for determining the presence of comorbidities (see methods).

As mentioned earlier, the low reporting of AIDS on the 2728 Form likely reflects legal restrictions on the reporting of AIDS and HIV positive status. While diagnosis codes indicating AIDS were often found on several types of Medicare claims, physician claims alone identified the majority of patients with AIDS (Table 8).

Table 8
Types of Medicare Claims Used to Identify
PVD and AIDS Among Dialysis Patients, 2002

Percent of patients with:	PVD	AIDS
No diagnosis in claims data	36.1	97.2
Diagnosis in Claims data:		
Inpatient claims only	2.1	<0.1
Outpatient claims only	2.8	0.2
Physician claims only	22.3	1.5
Other claims only[1]	0.2	<0.1
More than one claim source	36.4	1.1

[1]"Other" claims include Medicare claims for skilled nursing facility, hospice and home health care.

Other Statistically Significant Case-mix Factors

Several other case-mix factors were identified by the stepwise selection model as being associated with higher facility costs but have other limitations as potential risk adjusters for the basic case-mix adjustment system that will be implemented starting January 1, 2005. A summary of these factors and the criteria other than predictive power that may limit their use as part of the basic case-mix adjustment is provided in Table 9a.

Average patient weight was a consistently strong predictor of facility costs, with a typical four percent increase in costs for every 10 kg increase in weight (Table 6). This result might suggest longer treatment times, more expensive dialyzers, or other additional resources being used for heavier patients. Another measure of body size, low BMI (<18.5 kg/m^2), was also found in many analyses to be independently associated with higher costs while simultaneously controlling for patient weight (Table 6). This suggests that, independent of the observed positive relationship between patient weight and facility costs, additional resources may be needed to care for patients who are underweight or malnourished (however, this finding was not as robust as with higher patient weight).

While the current data collection system allows ICD-9 codes to be entered on the UB92 Form without difficulty, the reporting of values for patient weight and height (to ascertain low BMI status) may require more extensive programmatic changes to inform providers and fiscal intermediaries how and where to report the necessary values on the claim form. It therefore might be difficult to incorporate serial data on patient weight and height into the current data collection process for implementation of a limited case-mix adjustment starting in January 2005, as required by the MMA. Given the consistent importance of weight and height as explanatory factors, the objectivity of their measurement, and the clinical face validity of the relationship between weight and costs, collecting data on weight and height and adding them to the case-mix adjustment system should be considered as a subsequent refinement, if including the measures in the initial limited system is deemed infeasible.

Table 9a
Factors That Explained Significant Variation in Facility Costs
But Have Other Limitations as Factors for the Basic Case Mix Adjustment*

Variable	Data Source(s)	Limitations
Weight (kg)	2728 only	Feasibility - more difficult to collect serial data in short term
Underweight patients (BMI <18.5)	2728 only	Feasibility - more difficult to collect serial data in short term
First year of renal replacement therapy	2728 only	Feasibility; result was less robust
Drug dependence	2728 and Claims	Subjective; privacy issues
Pericarditis	2728 and Claims	Subjective; clinically implausible increment in costs
Malignant neoplasm	2728 and Claims	Inadequately defined in current form
HIV positive status	2728 and Claims	Estimated coefficient very unstable over time

*These factors may be evaluated for inclusion in a broader case mix adjustment model.

Criteria for selection:
1. Must be a significant independent predictor
2. Must not be highly correlated with other predictors
3. Must be objectively measurable
4. Must be feasible to implement
5. Must have a clinically plausible relationship with costs

Table 9b
Factors That Were Not Significantly Associated with Higher Facilit

Variable	Data Source(s)
Alcohol dependence	2728 only
Inability to ambulate	2728 only
Inability to transfer	2728 only
Current smoker	2728 only
Cardiac arrest	2728 and Claims
Congestive heart failure	2728 and Claims
Cerebrovascular disease	2728 and Claims
Cardiac dysrhythmia	2728 and Claims
Ischemic heart disease/Coronary artery disease	2728 and Claims
Myocardial infarction	2728 and Claims
Chronic obstructive pulmonary disease	2728 and Claims
Diabetes	2728 and Claims

Some models indicated higher costs for patients in their first year of renal replacement therapy. However, this factor was not a consistently strong predictor of facility costs, and therefore is not included in the final model.

Patients who were identified as being drug dependent had approximately 28 percent higher costs based on the model. However, there is no standardization based on either the 2728 Form or the Medicare claims regarding the specific types of drugs that are under consideration. A diagnosis of drug dependence is likely to be highly subject to interpretation depending on the types of drugs being considered and the specific criteria that were used to establish drug dependence. Health care providers may also have liability concerns in making diagnoses that have a social stigma. Because of concerns that such a diagnosis may be highly subjective and unreliable, it was not considered to be a strong candidate for risk adjustment.

Pericarditis was also found to have an association with facility costs. However, the process of ascertaining whether pericarditis is present may be somewhat subjective. A diagnosis of pericarditis can be made using various clinical and electrocardiographic or echocardiographic criteria. The relatively large increment in costs that was observed for pericarditis was also unexpected, which suggests that this result may at least partially reflect differences in reporting. Because of concerns for both the accuracy with which this diagnosis is made and the validity of this result, pericarditis was also not considered to be a strong candidate for case-mix adjustment.

A history of any type of cancer (within last 10 years based on the 2728 Form, last three years based on claims) was strongly associated with costs (approximately 6 percent), but this cancer measure is too broadly defined to be clinically meaningful. We have begun to evaluate specific types of cancer recorded in the Medicare claims for their relationship with costs. Depending on the results of these analyses, a payment adjustment for certain types of cancer could represent one possible future refinement to the basic case-mix adjustment system that is implemented in 2005.

Case-mix Factors That Were Not Associated with Higher Facility Costs

Table 9b lists the case-mix factors that were not found to have the hypothesized relationship with facility costs ($p<0.05$) and includes diabetes (type I or type II), laboratory measures at the time treatment for ESRD was initiated (serum albumin, GFR, serum creatinine and BUN), congestive heart failure, ischemic heart disease/CAD, myocardial infarction, cardiac arrest, cardiac dysrhythmias, cerebrovascular disease/CVA/TIA, chronic obstructive pulmonary disease, tobacco use (current smoker), and alcohol dependence.

Because of the importance of diabetes among ESRD patients, a number of additional analyses were carried out to confirm the finding that diabetes did not play an important role in explaining composite rate costs. Analyses of cost components other than composite rate services show higher costs for diabetics than for non-diabetics (Table 10). Payments for services provided to dialysis patients with diabetes (versus those without

diabetes) were 5 percent higher for separately billable (non-composite rate) dialysis services, 30 percent higher for inpatient services, and 23 percent higher for non-dialysis outpatient services. Given these strong relationships between diabetes and non-dialysis health care spending, it was somewhat surprising that diabetes had such a weak link with composite rate costs.

Table 10
Medicare Payments for Services Other Than Dialysis, by Diabetes Status, 2002

	Medicare Payments for:		
Diabetes Status	Separately Billable Services Provided in Outpatient Dialysis Facilities [1] ($ per dialysis session)	Inpatient Hospital Stays [2] ($ per dialysis patient year at risk)	Outpatient Hospital Visits [3] ($ per dialysis patient year at risk)
Diabetic [4]	$68.35	$32,672	$2,672
Non-Diabetic [4]	$64.94	$25,183	$2,169

[1]Source: Medicare outpatient claims submitted by dialysis facilities.

[2]Source: Medicare inpatient claims.

[3]Source: other Medicare outpatient institutional claims (i.e., submitted by institutions other than dialys facilities).

[4]Source: 2728 Form and diagnoses in Medicare claims (see methods).

The predictive power of diabetes in the case-mix adjustment models depended upon how it was measured and whether or not PVD was also in the model. As mentioned above, the presence of any diabetes (regardless of type) was not strongly associated with facility costs in models that included other case-mix factors that were independent predictors of costs, including PVD. The presence of PVD was always statistically significant, and diabetics are more likely to have PVD than non-diabetics (70.4 and 50.2 percent, respectively), so the relationship between diabetes and facility costs was stronger when PVD was not also included as a predictor.

A measure of Type I diabetes, defined as being under age 45 and diabetic, was included in a cost model similar to that shown in Table 5, except the youngest and middle age groups were separated at age 45 instead of age 65. In this model, the estimated coefficient for diabetes under age 45 was positive but not statistically significant (8 percent higher costs for diabetics under age 45 than for non-diabetics under age 45, p=0.13). When PVD was omitted from this model, the estimated coefficient was slightly larger and of borderline significance (10 percent higher costs, p=0.07). These results suggest a weak positive relationship between Type I diabetes and cost that is partially captured by the inclusion of PVD in the model. This measure of Type I diabetes was

used because it was not possible to fully distinguish Type I versus Type II diabetes using either the 2728 Form (which only identifies insulin-dependent diabetes) or the Medicare claims (where many patients have both claims that indicate Type I and claims that indicate Type II). The overall weak relationship between measures of diabetes and facility costs is consistent with prior analyses that indicated that composite rate costs were not significantly higher with diabetes.[3]

Interpretation: Using the Model to Apply a Patient-Specific Case-mix Adjustment to the Composite Rate

The coefficients that are estimated by the facility cost model can be used to apply a patient-specific case-mix adjustment to the composite rate. This is accomplished by re-transforming the estimated coefficients to obtain relative factors for case-mix adjustment. Based on the facility level cost model, where X is the proportion of patients in a facility having a specific characteristic (e.g., a specific comorbidity), a one unit change in X can be used to characterize the difference between having and not having a specific patient characteristic. For each X, the corresponding coefficient estimates the change in the dependent variable (the natural log of the ratio of reported costs to the composite rate) corresponding to whether or not a patient has that characteristic. The estimated coefficients can be re-transformed as $e^{X_p \beta_p}$ to obtain relative factors for case-mix factors p=1 to n measures included in the model.

The estimated relative factors can then be applied multiplicatively to the composite rate in order to derive a case-mix adjusted composite rate for each patient. For patient i in facility j, a case-mix adjusted composite rate, AR_{ij} is calculated as a function of two factors. The first factor is the current composite rate, R_j, which varies across facilities based on a wage index but not across patients within a facility. The second component is the case-mix adjustment, A_i, which varies by patient but is the same regardless of which facility treats the patient. A case-mix adjusted composite rate is the product of these two factors:

$$AR_{ij} = R_j * A_i,$$
$$R_j = (\rho B_j W_j + (1-\rho) B_j),$$

and

$$A_i = e^{X_i \beta}.$$

In the above equations, ρ is the fraction of costs attributed to labor (and therefore subject to an adjustment for geographic differences in wages), $1-\rho$ is the fraction of costs attributed to non-labor inputs, B_j is the base rate for facility j, W_j is the CMS/BLS wage index for facility j (with 0.9 and 1.3 representing the minimum and maximum values for W_j, respectively), X_i is a vector of case-mix measures for patient i and β is the vector of coefficients estimated by the regression model. Parameters ρ_j and B_j vary according to whether facilities are freestanding or hospital-based and may also vary over time, while W_j is determined either by the MSA in which each facility is located or by the state location for facilities not in an MSA.

As suggested by the equations above, the coefficients estimated by the cost model can be used to derive an aggregate relative adjustment factor for each patient (A_i) based on their individual characteristics (X_i). By applying this factor in a multiplicative fashion to the composite rate, it is also being applied multiplicatively to the wage index, so that the case-mix adjustment also varies across facilities according to regional differences in labor costs. That is, the case-mix adjustment will be larger in magnitude for facilities that face relatively high labor costs. This is appropriate if we expect the higher level of care that may be necessary for certain types of patients, such as those with peripheral vascular disease, to require additional staff time or more highly trained staff whose wages vary by region.

An overall relative case-mix adjustment factor (i.e., case-mix multiplier) for patient i, A_i, can be calculated based on the model as

$$A_i = e^{X_i \beta} = e^{X_{1i}\beta_1 + X_{2i}\beta_2 + \ldots + X_{pi}\beta_p}.$$

However, since this is equivalent to

$$A_i = e^{X_i \beta} = e^{X_{1i}\beta_1} * e^{X_{2i}\beta_2} * \ldots * e^{X_{pi}\beta_p},$$

the overall relative case-mix adjustment factor can be calculated by multiplying together the relative adjustment factors for each case-mix measure. For every case-mix factor p=1 to n, X_{pi} corresponds to a 1 if that characteristic is present and a 0 if that characteristic is not present.[9] For any characteristic that is not present, $X_{pi}=0$ and $e^{X_{pi}\beta_p}=1$, such that the calculation can be simplified by multiplying only those factors that are relevant for each patient. For characteristics that are present, $X_{pi}=1$, such that the relative adjustment factor for case-mix measure p is simply calculated as e^{β_p}.

Based on the results in Table 5 where the individual factors for case-mix adjustment are age/sex, peripheral vascular disease and AIDS, the equation used to calculate a patient-specific relative factor for case-mix adjustment can then be expressed as

$$A_i = e^{X_i \beta} = e^{X_{AS}\beta_{AS}} * e^{X_{PVD}\beta_{PVD}} * e^{X_{AIDS}\beta_{AIDS}}$$

where $e^{\beta_{AS}}$ is the relative adjustment factor for the appropriate age and sex category (one of six age/sex groups), $e^{\beta_{PVD}}$ is the relative adjustment factor for the presence of PVD and $e^{\beta_{AIDS}}$ is the relative adjustment factor for the presence of AIDS.

Example

To illustrate, suppose the coefficients in Table 5 were used to derive a case-mix multiplier for a 71-year old male who has been diagnosed with peripheral vascular

[9] The measure of patient weight that was included in some models (including Table 6) is continuous rather than discrete, so the multiplier would be a relative adjustment factor per kilogram of weight multiplied by the number of kilograms above or below the average patient weight.

disease but not AIDS and is treated in a facility with a composite rate of R=$125 per treatment. Using the "2000-02, pooled" coefficients in Table 5 that correspond to males between the ages of 65 and 79 years and the presence of peripheral vascular disease, the overall case-mix multiplier for this patient is calculated as

$$A = e^{ß_{AS}} * e^{ß_{PVD}} = 1.17 * 1.07 = 1.25.$$

The relative adjustment factor for AIDS does not enter this calculation since $X_{AIDS}=0$ for this hypothetical patient without AIDS, such that $e^{X_{AIDS}ß_{AIDS}}=1.00$ and this term is therefore not needed to derive the overall case-mix multiplier, A. The case-mix adjusted composite rate for this patient can then be calculated as

$$AR = R * A = \$125 * 1.25 = \$156.25.$$

Impact Analysis

The impact of the variation in case-mix adjustment multipliers across groups of facilities was analyzed in order to assess which, if any, groups of facilities on average might be adversely affected by a case-mix adjusted payment rate. Facility group comparisons included

- freestanding versus hospital-based,
- chain versus non-chain,
- urban versus rural,
- small (< 5k treatments per year) versus medium versus large (> 10k treatments per year),
- for-profit versus not-for-profit,
- and each of the 9 census regions.

Data used to conduct the main analysis were also used for the impact analysis. However, the impact analysis includes all facilities for which case-mix information could be obtained, while the main analysis was restricted as described previously. Facilities reporting zero Medicare dialysis sessions were excluded from the impact analysis. In all, 4,349 facilities were represented over the three-year period. Case-mix multipliers for each facility were calculated using the coefficients generated by the "2000-02, pooled" coefficients in Table 5 based on the average case-mix (weighted by number of treatments) over the three-year period.

Results are shown in Tables 11 and 12. The average case-mix multiplier for all facilities as well as for various sub-groups of facilities is approximately 1.19, ranging from 1.0 to 1.5, with a standard deviation of 0.02. The multiplier is always greater than or equal to 1.00, since all coefficient estimates are positive because of the conventions used in model construction (i.e., the lowest cost groups are defined as the "reference" groups). As the average percent of patients in each age, gender, and comorbidity group appears relatively stable over each of the three years, the resulting case-mix multipliers from year to year are quite similar (not reported).

Table 11
Estimated Ratio of Case Mix Adjusted Composite Rate Payments to Current Composite Rate Based on Facility Case Mix for 2000 - 2002

Facility Type	Number of Facilities	Average Case Mix Multiplier	Standardized[1] Average Case Mix Multiplier	% Change Due to CM Multiplier
All	3945	1.1900	1.0000	0.00%
Freestanding	3501	1.1917	1.0014	0.14%
Hospital Based	429	1.1934	1.0029	0.29%
Chain	2750	1.1903	1.0003	0.03%
Non-Chain	1195	1.1961	1.0051	0.51%
Urban	2865	1.1934	1.0029	0.29%
Rural	1065	1.1874	0.9978	-0.22%
Small <5k tx per yr	1215	1.1913	1.0011	0.11%
Medium 5 - 10k tx	1212	1.1910	1.0008	0.08%
Large > 10k tx	1518	1.1929	1.0024	0.24%
Not-For-Profit	755	1.1913	1.0011	0.11%
For-Profit	3175	1.1920	1.0017	0.17%
Census Region				
New England	129	1.1933	1.0028	0.28%
Middle Atlantic	524	1.2019	1.0100	1.00%
East North Central	569	1.1905	1.0004	0.04%
West North Central	255	1.1876	0.9980	-0.20%
South Atlantic	938	1.1930	1.0025	0.25%
East South Central	331	1.1840	0.9950	-0.50%
West South Central	521	1.1910	1.0008	0.08%
Mountain	196	1.1863	0.9969	-0.31%
Pacific	444	1.1900	1.0000	0.00%

[1] Standardization is accomplished by dividing by the average multiplier.

We then standardized the multipliers to enable an assessment of the average change in composite rate payments due to the case-mix adjustment methodology. As indicated in Table 11, across the three years, none of the groups on average experiences more than a one percent increase or decrease in composite rate payment. The largest increase is for dialysis providers in the Middle Atlantic states, where composite rate payments would increase by 1.00%. The largest decline is for providers in the East South Central states, where composite rate payments would decline 0.50%. Other differences in the average case-mix multiplier by facility sub-group are relatively small in magnitude. As reported in Table 11, urban providers would benefit slightly, compared to rural providers; providers in a non-chain would benefit slightly, compared to chain providers; not-for-profit providers would benefit slightly, relative to for-profit providers; and large providers would benefit slightly, relative to medium and small providers.

Table 12

Percentage of Patients in Each Category by Type of Facility[1]

		Percent of patients							
Facility Type	**Number of Facilities**	**Age<65 years, Female**	**Age<65 years, Male**	**Age 65-79, Female**	**Age 65-79, Male**	**Age 80+ years, Female**	**Age 80+ years, Male**	**AIDS (%)**	**PVD (%)**
All	3945	21.6	28.4	20.1	18.7	5.6	5.6	3.1	65.4
Freestanding	3501	21.9	28.6	20.1	18.6	5.5	5.4	3.2	65.2
Hospital Based	429	19.3	26.9	20.2	20.2	6.5	7.0	2.3	67.3
Chain	2750	22.1	28.8	20.1	18.3	5.4	5.3	2.6	64.6
Non-Chain	1195	20.2	27.3	20.1	19.8	6.1	6.5	4.4	67.7
Urban	2865	21.7	28.7	19.9	18.5	5.5	5.6	3.4	65.6
Rural	1065	21.4	27.1	21.0	19.5	5.7	5.4	1.7	64.7
Small	1215	19.4	25.6	20.7	21.2	6.3	6.8	2.5	66.4
Medium	1212	21.4	27.2	20.4	19.5	5.7	5.9	2.8	65.9
Large	1518	22.2	29.5	19.9	17.9	5.4	5.2	3.3	65.0
Not-For-Profit	755	20.9	28.3	19.9	18.9	5.9	6.1	2.6	65.2
For-Profit	3175	21.8	28.4	20.2	18.7	5.5	5.5	3.2	65.4
Census Region		22.2	40.4	12.0	20.4	1.9	3.2	1.6	65.4
New England	129	16.4	22.2	21.7	22.7	7.7	9.3	1.9	70.2
Middle Atlantic	524	18.5	26.9	20.0	20.7	6.9	7.0	4.2	73.3
East North Central	569	18.5	25.6	21.8	20.9	6.4	6.7	2.0	68.3
West North Central	255	19.5	24.2	20.9	20.6	7.5	7.4	1.4	63.4
South Atlantic	938	23.5	29.2	19.9	17.7	5.0	4.8	4.2	64.2
East South Central	331	24.2	30.7	20.2	16.5	4.7	3.8	1.9	60.4
West South Central	521	25.5	31.4	19.4	15.8	4.3	3.6	2.9	64.6
Mountain	196	24.0	28.9	18.0	19.8	3.9	5.3	1.3	58.6
Pacific	444	21.4	29.1	20.3	17.8	5.6	5.9	3.8	60.6

[1]Calculated as the average value over the 3-year period weighted by the number of dialysis sessions in each year.

Within categories, there would be winners and losers in terms of composite rate payments. The standard deviation of the facility multiplier is 0.03 for each year and 0.02 for all three years. Facility multipliers were 1.16, 1.18, 1.19, 1.20 and 1.23 at the 5th, 25th, 50th, 75th and 95th percentiles of facilities, respectively, during 2000-02.

Sensitivity Analyses

The results for the limited number of comorbidities in the main model were shown to be fairly robust over multiple modeling approaches and over time for a number of years. However, it is important that our results capture, to the greatest extent possible, only the variation due to these comorbidities and related patient conditions, and *not* variation that is actually due to confounding, non-patient factors. It is also important to verify that the results do not change dramatically under different conditions or given different restrictions. This will be especially true for the two comorbidities in the recommended models (PVD and AIDS). Specific areas of concern include:

1. The choice of control variables
2. Alternative case-mix variables
3. Alternative sample definition

<u>The choice of control variables</u>

Extensive data cleaning and hypothesis testing resulted in numerous models that were informative to and supportive of the "2000-02, pooled" coefficients in Table 5. We tested alternative methods of controlling for facility size (based on the total number of dialysis treatments provided), which was one of the strongest independent predictors of facility costs. Models that were weighted by facility size or included facility size as a covariate in various functional forms (log-transformed, linear, categorical) yielded case-mix coefficients similar to those reported in Tables 5 and 6. These models were also robust across a variety of other specifications, including models that excluded chain status or URR >65% as control variables.

The inclusion of certain control variables in the model did affect case-mix coefficients in some cases. This was true for two of the strongest predictors of facility costs: facility size and an indicator of whether the facility was hospital-based. First, we observed that older patients (65 years of age or older), especially older male patients, were slightly more likely to be treated in smaller facilities. Since facility size is a strong independent predictor of costs, this relatively weak selection pattern was sufficient to lead the estimated increment in cost for older patients to be sensitive to the inclusion of facility size as a control variable in the model. Because smaller facilities have on average higher treatment costs, a model that omitted facility size yielded higher relative adjustment factors for male patients over age 65 and female patients over age 80 than the estimates reported in Tables 5 and 6. A case-mix adjustment system that was developed using a model that did not account for differences in facility size would therefore lead to higher

payments for older patients because they are somewhat more likely to be treated in smaller facilities rather than because there is a direct link between age and treatment cost.

Similarly, the relationship between AIDS and facility costs was sensitive to whether the model controlled for differences in costs between facilities that are hospital-based or freestanding. Specifically, the AIDS case-mix coefficient became smaller and lost significance when this control variable was omitted from the model regardless of whether or not patient body size variables were also included in the model. This was because on average, AIDS patients were more likely to be treated in freestanding facilities than in hospital-based facilities, and hospital-based facilities report substantially higher costs per treatment. Based on a separate model that included freestanding facilities only, the incremental cost of treating a patient with AIDS was very similar to that reported in Tables 5 and 6. These findings support our method of including control variables in the model that are not used to adjust payment levels, for in doing so we reduce omitted variables bias and produce more accurate estimates of the relationship between case-mix and facility costs.

Alternative case-mix variables

In addition to the analyses of diabetes discussed above, other case-mix measures also were considered after stepwise regression was used to identify the strongest predictors of cost. An alternative measure of AIDS used the data reported on the 2728 Form for the 7 to 8 percent of patients with an incomplete Medicare claims history for establishing the presence of comorbidities (age <65 years and less than one year of replacement therapy without MSP). That is, for these patients, the presence or absence of AIDS was established solely based on the 2728 Form despite substantial underreporting of AIDS status that likely reflects confidentiality issues. Using an alternative facility-level measure of AIDS that represented 99.9 percent (rather than 92 to 93 percent) of patients with Medicare outpatient dialysis claims, the estimated increment in cost associated with AIDS was very similar to the estimates reported in Tables 5 and 6.

As discussed above, body size indicators (average weight and BMI<18.5) were also examined for their relationship with reported treatment costs. These case-mix variables were typically significant predictors of facility costs (Table 6). However, it is unlikely that such data can be mandated to be collected on claims in the short timeframe allotted by the MMA legislation. Therefore, if the data collection required for such adjustments is not feasible by January 1, 2005, we recommend adding weight and low BMI at the earliest practicable date.

Alternative sample definition

Finally, we also performed sensitivity analyses that each employed an alternative study sample that was either slightly larger or smaller then the primary study sample described above. The models presented in Tables 5 and 6 were estimated to include facilities granted higher composite rate payments based on their exceptional status (e.g., atypical patient mix, isolated essential provider), facilities treating fewer than 20 patients, and

exclude facilities with less extreme dfbeta values for the variables in the model (refer to discussion of primary study sample above). For all three permutations, the results in both Tables 5 and 6 were still robust, as the parameter estimates for most of these case-mix factors were very similar and remained statistically significant. The main exception was for the increment in cost observed for females 80 years of age and older (relative to females 65 to 79 years of age), which based on these sensitivity analyses was smaller in magnitude (ranging from 6 to 14 percent higher cost) than the estimate reported in Table 5 (16 percent higher cost) and in some cases statistically insignificant.

V. Conclusions and Recommendations

The following conclusions and recommendations pertain to both the initial development of a basic case-mix adjustment for the ESRD PPS as well as to future refinements to this system. First, a parsimonious model with six age/sex groups and two comorbidities is proposed as the basis for a case-mix adjustment system that can readily be implemented by January 1, 2005. Second, based on our analyses, the ESRD PPS would more accurately reflect treatment costs if weight and low BMI were added as factors for case-mix adjustment. We therefore recommend incorporating these factors at the earliest practicable date if the data collection required for such adjustments is not feasible by January 1, 2005. Third, other refinements to the basic case-mix adjustment system may be based on further analyses that address the limitations of existing comorbidity measures. As discussed above, additional analyses are needed regarding the impact on costs of both specific types of PVD as well as specific types of cancer.

Finally, the magnitude of the payment adjustments for each case-mix factor (i.e., case-mix multipliers) was determined using a model that pooled the most recent three years of data, which provides stability to the estimates. These case-mix multipliers could be updated annually, in which case we recommend replacing the oldest year of data with a new year of data as soon as the new data become available. Thus, two-thirds of the data used in the cost models will be the same from year-to-year, enhancing the stability and predictability of reimbursement levels while ensuring that the system is based on data that are as current as possible.

Appendix I

List of ICD-9 Diagnosis Codes
That Were Used to Identify Patient Comorbidities in Medicare Claims

AIDS

042 Human immunodeficiency disease

Cardiac arrest

4275 Cardiac Arrest

Cardiac dysrhythmias

4260 Conduction disorders, atrioventricular block, complete
427 Cardiac dysrhythmias
4270 Cardiac dysrhythmias, paroxysmal supraventricular tachycardia
4271 Cardiac dysrhythmias, paroxysmal ventricular tachycardia
4272 Cardiac dysrhythmias, paroxysmal tachycardia, unspecified
4273 Cardiac dysrhythmias, atrial fibrilation and flutter
42731 Cardiac dysrhythmias, atrial fibrilation
42732 Cardiac dysrhythmias, atrial flutter
4274 Cardiac dysrhythmias, ventricular fibrillation and flutter
42741 Cardiac dysrhythmias, ventricular fibrillation and flutter, ventricular fibrillation
42742 Cardiac dysrhythmias, ventricular fibrillation and flutter, ventricular flutter
4276 Cardiac dysrhythmias, premature beats
42760 Cardiac dysrhythmias, premature beats, unspecified
42761 Cardiac dysrhythmias, supraventricular premature beats
42769 Cardiac dysrhythmias, premature beats, other
4278 Other specified cardiac dysrhythmias
42781 Cardiac dysrhythmias, sinoatrial node dysfunction
42789 Other specified cardiac dysrhythmias, other
4279 Cardiac dysrhythmia, unspecified

Cerebrovascular disease

430 Subarachnoid hemorrhage
431 Intracerebral hemorrhage
432 Other and unspecified intracranial hemorrhage
4320 Non-traumatic extradural hemorrhage
4321 Subdural hemorrhage
4329 Unspecified intracranial hemorrhage
433 Occlusion and Stenosis of precerebral arteries
4330 Occlusion and Stenosis of precerebral arteries, Basilar artery

43300 Occlusion and Stenosis of precerebral arteries, Basilar artery, without mention of cerebral infarction
43301 Occlusion and Stenosis of precerebral arteries, Basilar artery, with cerebral infarction
43331 Occlusion and Stenosis of precerebral arteries, Carotid artery
43310 Occlusion and Stenosis of precerebral arteries, Carotid artery, without mention of cerebral infarction
43311 Occlusion and Stenosis of precerebral arteries, Carotid artery, with cerebral infarction
4332 Occlusion and Stenosis of precerebral arteries, Vertebral artery
43320 Occlusion and Stenosis of precerebral arteries, Vertebral artery, without mention of cerebral infarction
43321 Occlusion and Stenosis of precerebral arteries, Vertebral artery, with cerebral infarction
4333 Occlusion and Stenosis of precerebral arteries, Multiple and bilateral
43330 Occlusion and Stenosis of precerebral arteries, Multiple and bilateral, without mention of cerebral infarction
43331 Occlusion and Stenosis of precerebral arteries, Multiple and bilateral, with cerebral infarction
4338 Occlusion and Stenosis of precerebral arteries, Other specified precerebral artery
43380 Occlusion and Stenosis of precerebral arteries, Other specified precerebral artery, without mention of cerebral infarction
43381 Occlusion and Stenosis of precerebral arteries, Other specified precerebral artery, with cerebral infarction
4339 Occlusion and Stenosis of precerebral arteries, Unspecified precerebral artery
43390 Occlusion and Stenosis of precerebral arteries, Unspecified precerebral artery, without mention of cerebral infarction
43391 Occlusion and Stenosis of precerebral arteries, Unspecified precerebral artery, with cerebral infarction
434 Occlusion of cerebral arteries
4340 Occlusion of cerebral arteries, cerebral thrombosis
43400 Occlusion of cerebral arteries, cerebral thrombosis, without mention of cerebral infarction
43401 Occlusion of cerebral arteries, cerebral thrombosis, with cerebral infarction
4341 Occlusion of cerebral arteries, Cerebral embolism
43410 Occlusion of cerebral arteries, Cerebral embolism, without mention of cerebral infarction
43411 Occlusion of cerebral arteries, Cerebral embolism, with cerebral infarction
4349 Occlusion of cerebral arteries, Cerebral artery occlusion unspecified
43490 Occlusion of cerebral arteries, Cerebral artery occlusion unspecified, without mention of cerebral infarction
43491 Occlusion of cerebral arteries, Cerebral artery occlusion unspecified, with cerebral infarction
435 Transient cerebral ischemia
4350 Transient cerebral ischemia, Basilar artery syndrome
4351 Transient cerebral ischemia, Vertebral artery syndrome

4352 Transient cerebral ischemia, Subclavian steal syndrome
4353 Transient cerebral ischemia, vertebrobasilar artery syndrome
4358 Transient cerebral ischemia, Other specified transient cerebral ischemias
4359 Transient cerebral ischemia, Unspecified transient cerebral ischemias
436 Acute, but ill-defined, cerebrovascular disease
437 Other and ill-defined cerebrovascular disease
4370 Cerebral atherosclerosis
4371 Other generalized ischemic cerebrovascular diseases
4372 Hypertensive encephalopathy
4373 Cerebral aneurysm, nonruptured
4374 Cerebral arteritis
4375 Moyamoya disease
4376 Nonpyrogenic thrombosis of intracranial venous sinus
4377 Transient global amnesia
4378 Other cerebrovascular disease
4379 Unspecified cerebrovascular disease
438 Late effects of cerebrovascular diseases
4380 Cognitive deficits
4381 Speech and language deficits
43810 Speech and language deficits, Unspecified
43811 Speech and language deficits, Aphasia
43812 Speech and language deficits, Dysphasia
43819 Speech and language deficits, Other
4382 Hemiplegia/hemiparesis
43820 Hemiplegia affecting unspecified side
43821 Hemiplegia affecting dominant side
43822 Hemiplegia affecting nondominant side
4383 Monoplegia of upper limb
43830 Monoplegia of upper limb affecting unspecified side
43831 Monoplegia of upper limb affecting dominant side
43832 Monoplegia of upper limb affecting nondominant side
4384 Monoplegia of lower limb
43840 Monoplegia of lower limb affecting unspecified side
43841 Monoplegia of lower limb affecting dominant side
43842 Monoplegia of lower limb affecting nondominant side
4385 Other paralytic syndrome
43850 Other paralytic syndrome affecting unspecified side
43851 Other paralytic syndrome affecting dominant side
43852 Other paralytic syndrome affecting nondominant side
43853 Other paralytic syndrome, bilateral
43881 Apraxia
43882 Dysphagia
43883 Other late effects of cerebrovascular diseases, Facial weakness
43884 Other late effects of cerebrovascular diseases, Ataxia
43885 Other late effects of cerebrovascular diseases, Vertigo
43889 Other late effects of cerebrovascular diseases

4389 Unspecified late effects of cerebrovascular disease

Congestive heart failure

40201 Hypertensive heart disease, malignant, with heart failure
40211 Hypertensive heart disease, benign, with heart failure
40291 Hypertensive heart disease, unspecified, with heart failure
40401 Hypertensive heart and renal disease, malignant, with heart failure
40403 Hypertensive heart and renal disease, malignant, with heart and renal failure
40411 Hypertensive heart and renal disease, benign, with heart failure
40413 Hypertensive heart and renal disease, benign, with heart and renal failure
40491 Hypertensive heart and renal disease, unspecified, with heart failure
40493 Hypertensive heart and renal disease, unspoecified, with heart and renal failure
415 Acute pulmonary heart disease
4150 Acute pulmonary heart disease, acute cor pulmonale
416 Chronic pulmonary heart disease
4160 Chronic pulmonary heart disease, primary pulmonary hypertension
4161 Chronic pulmonary heart disease, Kyphoscoliotic heart disease
4168 Chronic pulmonary heart disease, other chronic pulmonary heart diseases
4169 Chronic pulmonary heart disease, unspecified
417 Other diseases of pulmonary circulation
4170 Other diseases of pulmonary circulation, arteriovenous fistula of pulmonary vessels
4171 Other diseases of pulmonary circulation, aneurysm of pulmonary artery
4178 Other diseases of pulmonary circulation, other specified disease of pulmonary circulation
4179 Other diseases of pulmonary circulation, Unspecified disease of pulmonary circulation
425 Cardiomyopathy
4250 Endomyocardial fibrosis
4251 Hypertrophic obstructive cardiomyopathies
4252 Obscure cardiomyopathy of Africa
4253 Endocardial fibroelastosis
4254 Other primary cardiomyopathies
4255 Alcoholic cardiomyopathy (I'm using as a diagnosis indicating alcohol dependence)
4257 Nutritional and metabolic cardiomyopathy
4258 Cardiomyopathy in other diseases classified elsewhere
4259 Secondary cardiomyopathy, unspecified
428 Heart failure
4280 Congestive heart failure, unspecified
4281 Left heart failure
4282 Systolic heart failure
42820 Systolic heart failure, unspecified
42821 Systolic heart failure, acute
42822 Systolic heart failure, chronic

42823 Systolic heart failure, acute on chronic
4283 Diastolic heart failure
42830 Diastolic heart failure, unspecified
42831 Diastolic heart failure, acute
42832 Diastolic heart failure, chronic
42833 Diastolic heart failure, acute on chronic
4284 Combined systolic and diastolic heart failure
42840 Combined systolic and diastolic heart failure, unspecified
42841 Combined systolic and diastolic heart failure, acute
42842 Combined systolic and diastolic heart failure, chronic
42843 Combined systolic and diastolic heart failure, acute on chronic
4289 Heart failure, unspecified
4290 Myocarditis, unspecified
4291 Myocardial degeneration

Chronic obstructive pulmonary disease

490 Bronchitis, not specified as acute or chronic
491 Chronic bronchitis
4910 Simple chronic bronchitis
4911 Mucopurulent chronic bronchitis
4912 Obstructive chronic bronchitis
49120 Obstructive chronic bronchitis without exacerbation
49121 Obstructive chronic bronchitis with (acute) exacerbation
4918 Other chronic bronchitis
4919 Unspecified chronic bronchitis
492 Emphysema
4920 Emphysematous bleb
4928 Other emphysema
493 Asthma
4930 Asthma, extrinsic asthma
49300 Asthma, extrinsic asthma, unspecified
49301 Asthma, extrinsic asthma, with status asthmaticus
49302 Asthma, extrinsic asthma, with (acute) exacerbation
4931 Asthma, intrinsic asthma
49310 Asthma, intrinsic asthma, unspecified
49311 Asthma, intrinsic asthma, with status asthmaticus
49312 Asthma, intrinsic asthma, with (acute) exacerbation
4932 Asthma, chronic obstructive asthma
49320 Asthma, chronic obstructive asthma, unspecified
49321 Asthma, chronic obstructive asthma, with status asthmaticus
49322 Asthma, chronic obstructive asthma, with (acute) exacerbation
4938 Asthma, other forms of asthma
49381 Asthma, other forms of asthma, exercise induced bronchspasm
49382 Asthma, other forms of asthma, cough variant asthma
4939 Asthma, unspecified

49390 Asthma, unspecified, unspecified
49391 Asthma, unspecified, with status asthmaticus
49392 Asthma, unspecified, with (acute) exacerbation
494 Bronchiectasis
4940 Bronchiectasis without acute exacerbation
4941 Bronchiectasis with acute exacerbation
496 Chronic airway obstruction, not elsewhere classified
5181 Other diseases of lung, interstitial emphysema
5182 Other diseases of lung, compensatory emphysema

Diabetes mellitus, Type I

25001 Diabetes mellitus, without mention of complication, Type I not stated as uncontrolled
25003 Diabetes mellitus, without mention of complication, Type I, uncontrolled
25011 Diabetes mellitus, diabetes with ketoacidosis, Type I not stated as uncontrolled
25013 Diabetes mellitus, diabetes with ketoacidosis, Type I, uncontrolled
25021 Diabetes mellitus, diabetes with hyperosmolarity, Type I not stated as uncontrolled
25023 Diabetes mellitus, diabetes with hyperosmolarity, Type I, uncontrolled
25031 Diabetes mellitus, diabetes with other coma, Type I not stated as uncontrolled
25033 Diabetes mellitus, diabetes with other coma, Type I, uncontrolled
25041 Diabetes mellitus, diabetes with renal manifestations, Type I not stated as uncontrolled
25043 Diabetes mellitus, diabetes with renal manifestations, Type I, uncontrolled
25051 Diabetes mellitus, Diabetes with ophthalmic manifestations, Type I not stated as uncontrolled
25053 Diabetes mellitus, Diabetes with ophthalmic manifestations, Type I, uncontrolled
25061 Diabetes mellitus, diabetes with neurological manifestations, Type I not stated as uncontrolled
25063 Diabetes mellitus, diabetes with neurological manifestations, Type I, uncontrolled
25071 Diabetes mellitus, Diabetes with peripheral circulatory disorders, Type I not stated as uncontrolled
25073 Diabetes mellitus, Diabetes with peripheral circulatory disorders, Type I, uncontrolled
25081 Diabetes mellitus, with other specified manifestations, Type I not stated as uncontrolled
25083 Diabetes mellitus, with other specified manifestations, Type I, uncontrolled
25091 Diabetes mellitus, Diabetes with unspecified manifestations, Type I not stated as uncontrolled
25093 Diabetes mellitus, Diabetes with unspecified manifestations, Type I, uncontrolled

Diabetes mellitus, Type II

250 Diabetes mellitus
2500 Diabetes mellitus without mention of complication

25000 Diabetes mellitus without mention of complication, type II or unspecified, not stated as uncontrolled
25002 Diabetes mellitus without mention of complication, type II or unspecified, uncontrolled
2501 Diabetes mellitus with ketoacidosis
25010 Diabetes mellitus with ketoacidosis, type II or unspecified, not stated as uncontrolled
25012 Diabetes mellitus with ketoacidosis, type II or unspecified, uncontrolled
2502 Diabetes mellitus with hyperosmolarity
25020 Diabetes mellitus with hyperosmolarity, type II or unspecified, not stated as uncontrolled
25022 Diabetes mellitus with hyperosmolarity, type II or unspecified, uncontrolled
2503 Diabetes mellitus with other coma
25030 Diabetes mellitus with other coma, type II or unspecified, not stated as uncontrolled
25032 Diabetes mellitus with other coma, type II or unspecified, uncontrolled
2504 Diabetes mellitus with renal manifestations
25040 Diabetes mellitus with renal manifestations, type II or unspecified, not stated as uncontrolled
25042 Diabetes mellitus with renal manifestations, type II or unspecified, uncontrolled
2505 Diabetes mellitus with opthalmic manifestations
25050 Diabetes mellitus with opthalmic manifestations, type II or unspecified, not stated as uncontrolled
25052 Diabetes mellitus with opthalmic manifestations, type II or unspecified, uncontrolled
2506 Diabetes mellitus with neurological manifestations
25060 Diabetes mellitus with neurological manifestations, type II or unspecified, not stated as uncontrolled
25062 Diabetes mellitus with neurological manifestations, type II or unspecified, uncontrolled
2507 Diabetes mellitus with peripheral circulatory disorders
25070 Diabetes mellitus with peripheral circulatory disorders, type II or unspecified, not stated as uncontrolled
25072 Diabetes mellitus with peripheral circulatory disorders, type II or unspecified, uncontrolled
2508 Diabetes mellitus with other specified manifestations
25080 Diabetes mellitus with other specified manifestations, type II or unspecified, not stated as uncontrolled
25082 Diabetes mellitus with other specified manifestations, type II or unspecified, uncontrolled
2509 Diabetes mellitus with unspecified complication
25090 Diabetes mellitus with unspecified complication, type II or unspecified, not stated as uncontrolled
25092 Diabetes mellitus with unspecified complication , type II or unspecified, uncontrolled

Drug dependence

304 Drug dependence
3040 Drug dependence, opioid type dependence
30400 Drug dependence, opioid type dependence, unspecified
30401 Drug dependence, opioid type dependence, continuous
30402 Drug dependence, opioid type dependence, episodic
30403 Drug dependence, opioid type dependence, in remission
3041 Drug dependence, barbiturate and similarly acting sedative or hypnotic dependence
30410 Drug dependence, barbiturate and similarly acting sedative or hypnotic dependence, unspecified
30411 Drug dependence, barbiturate and similarly acting sedative or hypnotic dependence, continuous
30412 Drug dependence, barbiturate and similarly acting sedative or hypnotic dependence, episodic
30413 Drug dependence, barbiturate and similarly acting sedative or hypnotic dependence, in remission
3042 Drug dependence, cocaine dependence
30420 Drug dependence, cocaine dependence, unspecified
30421 Drug dependence, cocaine dependence, continuous
30422 Drug dependence, cocaine dependence, episodic
30423 Drug dependence, cocaine dependence, in remission
3043 Drug dependence, Cannabis dependence
30430 Drug dependence, Cannabis dependence, unspecified
30431 Drug dependence, Cannabis dependence, continuous
30432 Drug dependence, Cannabis dependence, episodic
30433 Drug dependence, Cannabis dependence, in remission
3044 Drug dependence, amphetamine and other psychostimulant dependence
30440 Drug dependence, amphetamine and other psychostimulant dependence, unspecified
30441 Drug dependence, amphetamine and other psychostimulant dependence, continuous
30442 Drug dependence, amphetamine and other psychostimulant dependence, episodic
30443 Drug dependence, amphetamine and other psychostimulant dependence, in remission
3045 Drug dependence, hallucinogen dependence
30450 Drug dependence, hallucinogen dependence, unspecified
30451 Drug dependence, hallucinogen dependence, continuous
30452 Drug dependence, hallucinogen dependence, episodic
30453 Drug dependence, hallucinogen dependence, in remission
3046 Drug dependence, other specified drug dependence
30460 Drug dependence, other specified drug dependence, unspecified
30461 Drug dependence, other specified drug dependence, continuous
30462 Drug dependence, other specified drug dependence, episodic
30463 Drug dependence, other specified drug dependence, in remission

3047 Drug dependence, combinations of opioid type drug with any other
30470 Drug dependence, combinations of opioid type drug with any other, unspecified
30471 Drug dependence, combinations of opioid type drug with any other, continuous
30472 Drug dependence, combinations of opioid type drug with any other, episodic
30473 Drug dependence, combinations of opioid type drug with any other, in remission
3048 Drug dependence, combinations of drug dependence excluding opioid type drug
30480 Drug dependence, combinations of drug dependence excluding opioid type drug, unspecified
30481 Drug dependence, combinations of drug dependence excluding opioid type drug, continuous
30482 Drug dependence, combinations of drug dependence excluding opioid type drug, episodic
30483 Drug dependence, combinations of drug dependence excluding opioid type drug, in remission
3049 Drug dependence, unspecified drug dependence
30490 Drug dependence, unspecified drug dependence, unspecified
30491 Drug dependence, unspecified drug dependence, continuous
30492 Drug dependence, unspecified drug dependence, episodic
30493 Drug dependence, unspecified drug dependence, in remission
292 Drug psychoses
2920 Drug withdrawal syndrome
2921 Paranoid and/or hallucinatory states induced by drugs
29211 Paranoid and/or hallucinatory states induced by drugs, drug-induced organic delusional syndrome
29212 Paranoid and/or hallucinatory states induced by drugs, drug-induced hallucinosis
2922 Pathological drug intxication
2928 Other specified drug-induced mental disorders
29281 Other specified drug-induced mental disorders, drug-induced delirium
29282 Other specified drug-induced mental disorders, drug-induced dementia
29283 Other specified drug-induced mental disorders, drug-induced amnestic syndrome
29284 Other specified drug-induced mental disorders, drug-induced organic affective syndrome
29289 Other specified drug-induced mental disorders, other
2929 Unspecified drug-induced mental disorder

Human immunodeficiency virus

V08 Asymptotic human immunodeficiency virus [HIV] infection status
07953 Human Immunodeficiency virus, type 2 [HIV-2]
79571 Nonspecific serological evidence of human immunodeficiency virus [HIV]

Ischemic heart disease

410 Acute myocardial infarction
4100 Acute myocardial infarction, of anterolateral wall
41000 Acute myocardial infarction, of anterolateral wall, episode of care unspecified

41001 Acute myocardial infarction, of anterolateral wall, initial episode of care
41002 Acute myocardial infarction, of anterolateral wall, subsequent episode of care
4101 Acute myocardial infarction, of other anterior wall
41010 Acute myocardial infarction, of other anterior wall, episode of care unspecified
41011 Acute myocardial infarction, of other anterior wall, initial episode of care
41012 Acute myocardial infarction, of other anterior wall, subsequent episode of care
4102 Acute myocardial infarction, of inferolateral wall
41020 Acute myocardial infarction, of inferolateral wall, episode of care unspecified
41021 Acute myocardial infarction, of inferolateral wall, initial episode of care
41022 Acute myocardial infarction, of inferolateral wall, subsequent episode of care
4103 Acute myocardial infarction, of inferoposterior wall
41030 Acute myocardial infarction, of inferoposterior wall, episode of care unspecified
41031 Acute myocardial infarction, of inferoposterior wall, initial episode of care
41032 Acute myocardial infarction, of inferoposterior wall, subsequent episode of care
4104 Acute myocardial infarction, of other inferior wall
41040 Acute myocardial infarction, of other inferior wall, episode of care unspecified
41041 Acute myocardial infarction, of other inferior wall, initial episode of care
41042 Acute myocardial infarction, of other inferior wall, subsequent episode of care
4105 Acute myocardial infarction, of other lateral wall
41050 Acute myocardial infarction, of other lateral wall, episode of care unspecified
41051 Acute myocardial infarction, of other lateral wall, initial episode of care
41052 Acute myocardial infarction, of other lateral wall, subsequent episode of care
4106 Acute myocardial infarction, true posterior wall infarction
41060 Acute myocardial infarction, true posterior wall infarction, episode of care unspecified
41061 Acute myocardial infarction, true posterior wall infarction, initial episode of care
41062 Acute myocardial infarction, true posterior wall infarction, subsequent episode of care
4107 Acute myocardial infarction, subendocardial infarction
41070 Acute myocardial infarction, subendocardial infarction, episode of care unspecified
41071 Acute myocardial infarction, subendocardial infarction, initial episode of care
41072 Acute myocardial infarction, subendocardial infarction, subsequent episode of care
4108 Acute myocardial infarction, of other specified sites
41080 Acute myocardial infarction, of other specified sites, episode of care unspecified
41081 Acute myocardial infarction, of other specified sites, initial episode of care
41082 Acute myocardial infarction, of other specified sites, subsequent episode of care
4109 Acute myocardial infarction, unspecified site
41090 Acute myocardial infarction, unspecified site, episode of care unspecified
41091 Acute myocardial infarction, unspecified site, initial episode of care
41092 Acute myocardial infarction, unspecified site, subsequent episode of care
411 Other acute and subacute forms of ischemic heart disease
4110 Postmyocardial infarction syndrome
4111 Intermediate coronary syndrome
4118 Other ischemic heart disease
41181 Acute coronary occlusion without myocardial infarction

41189 Other ischemic heart disease
412 Old myocardial infarction
413 Angina pectoris
4130 Angina decubitus
4131 Prinzmetal angina
4139 Other and unspecified angina pectoris
414 Other forms of chronic ischemic heart disease
4140 Coronary atherosclerosis
41400 Coronary atherosclerosis, of unspecified type of vessel, native or graft
41401 Coronary atherosclerosis, of native coronary artery
41402 Coronary atherosclerosis, of autologous vein bypass graft
41403 Coronary atherosclerosis, of nonautologous biological bypass graft
41404 Coronary atherosclerosis, of artery bypass graft
41405 Coronary atherosclerosis, of unspecified type of bypass graft
41406 Coronary atherosclerosis, of native coronary artery of transplanted heart
41407 Coronary atherosclerosis, of bypass graft (artery) (vein) of transplanted heart
4148 Other specified forms of chronic ischemic heart disease
4149 Chronic ischemic heart disease, unspecified

Malignant neoplasm

1400 Malig neo upper vermilion
1401 Malig neo lower vermilion
1403 Malig neo upper lip inner
1404 Malig neo lower lip inner
1405 Malig neo lip inner unspec
1406 Malig neo lip commissure
1408 Malig neo lip ot
1409 Malig neo lip/vermil unspec
141 Malignant neoplasm of tongue
1410 Malignant neoplasm of tongue, base
1411 Malignant neoplasm of tongue, dorsal surface
1412 Malignant neoplasm of tongue, tip and lateral border
1413 Malignant neoplasm of tongue, ventral surface
1414 Malignant neoplasm of tongue, anterior two-thirds, part unspecified
1415 Malignant neoplasm of tongue, junctional zone
1416 Malignant neoplasm of tongue, lingual tonsil
1418 Malignant neoplasm of tongue, other sites
1419 Malignant neoplasm of tongue, unspecified
142 Malignant neoplasm of major salivary glands
1420 Malignant neoplasm of major salivary glands, parotid
1421 Malignant neoplasm of major salivary glands, submandibular
1422 Malignant neoplasm of major salivary glands, sublingual
1428 Malignant neoplasm of major salivary glands, other
1429 Malignant neoplasm of major salivary glands, unspecified
143 Malignant neoplasm of gum

1430 Malignant neoplasm of gum, upper
1431 Malignant neoplasm of gum, lower
1438 Malignant neoplasm of gum, other sites
1439 Malignant neoplasm of gum, unspecified
144 Malignant neoplasm of floor of mouth
1440 Malignant neoplasm of floor of mouth, anterior portion
1441 Malignant neoplasm of floor of mouth, lateral portion
1448 Malignant neoplasm of floor of mouth, other sites
1449 Malignant neoplasm of floor of mouth, part unspecified
145 Malignant neoplasm of other and unspecified parts of mouth
1450 Malignant neoplasm of other and unspecified parts of mouth, cheek mucosa
1451 Malignant neoplasm of other and unspecified parts of mouth, vestibule
1452 Malignant neoplasm of other and unspecified parts of mouth, hard palate
1453 Malignant neoplasm of other and unspecified parts of mouth, soft palate
1454 Malignant neoplasm of other and unspecified parts of mouth, uvula
1455 Malignant neoplasm of other and unspecified parts of mouth, palate, unspecified
1456 Malignant neoplasm of other and unspecified parts of mouth, retromolar area
1458 Malignant neoplasm of other and unspecified parts of mouthother specified parts
1459 Malignant neoplasm of other and unspecified parts of mouth, unspecified
146 Malignant neoplasm of oropharynx
1460 Malignant neoplasm of oropharynx, tonsil
1461 Malignant neoplasm of oropharynx, tonsillar fossa
1462 Malignant neoplasm of oropharynx, tonsillar pillars
1463 Malignant neoplasm of oropharynx, vallecula
1464 Malignant neoplasm of oropharynx, anterior aspect of epiglottis
1465 Malignant neoplasm of oropharynx, junctional region
1466 Malignant neoplasm of oropharynx, lateral wall
1467 Malignant neoplasm of oropharynx, posterior wall
1468 Malignant neoplasm of oropharynx, other specified sites
1469 Malignant neoplasm of oropharynx.unspecified
147 Malignant neoplasm of nasopharynx
1470 Malignant neoplasm of nasopharynx, superior wall
1471 Malignant neoplasm of nasopharynx, posterior wall
1472 Malignant neoplasm of nasopharynx, lateral wall
1473 Malignant neoplasm of nasopharynx, anterior wall
1478 Malignant neoplasm of nasopharynx, other specified sites
1479 Malignant neoplasm of nasopharynx, unspecified
148 Malignant neoplasm of hypopharynx
1480 Malignant neoplasm of hypopharynx, postcricoid regiion
1481 Malignant neoplasm of hypopharynx, pyriform sinus
1482 Malignant neoplasm of hypopharynx, aryepiglottic fold, hypopharyngeal aspect
1483 Malignant neoplasm of hypopharynx, posterior hypopharyngeal wall
1488 Malignant neoplasm of hypopharynx, other specified sites
1489 Malignant neoplasm of hypopharynx, unspecified
149 Malignant neoplasms of other and ill-defined sites within the lip, oral cavity and pharynx

1490 Malignant neoplasms of other and ill-defined sites within the lip, oral cavity and pharynx, pharynx unspecified
1491 Malignant neoplasms of other and ill-defined sites within the lip, oral cavity and pharynx, Waldeyer's ring
1498 Malignant neoplasms of other and ill-defined sites within the lip, oral cavity and pharynx, other
1499 Malignant neoplasms of other and ill-defined sites within the lip, oral cavity and pharynx, ill-defined
150 Malignant neoplasm of the esophagus
1500 Malignant neoplasm of the cervical esophagus
1501 Malignant neoplasm of the thoracic esophagus
1502 Malignant neoplasm of the abdominal esophagus
1503 Malignant neoplasm of the upper third of the esophagus
1504 Malignant neoplasm of the middle third of the esophagus
1505 Malignant neoplasm of the lower third of the esophagus
1508 Malignant neoplasm of the esophagus, other specified part
1509 Malignant neoplasm of the esophagus unspecified
151 Malignant neoplasm of the stomach
1510 Malignant neoplasm of the stomach, cardia
1511 Malignant neoplasm of the stomach, pylorus
1512 Malignant neoplasm of the stomach, pyloric antrum
1513 Malignant neoplasm of the stomach, fundus of stomach
1514 Malignant neoplasm of the stomach, body of stomach
1515 Malignant neoplasm of the stomach, lesser curvature, unspecified
1516 Malignant neoplasm of the stomach, greater curvature, unspecified
1518 Malignant neoplasm of the stomach, other specified site
1519 Malignant neoplasm of the stomach, unspecified
152 Malignant neoplasm of the small intestine including duodenum
1520 Malignant neoplasm of the small intestine including duodenum, duodenum
1521 Malignant neoplasm of the small intestine including duodenum, jejunum
1522 Malignant neoplasm of the small intestine including duodenum, ileum
1523 Malignant neoplasm of the small intestine including duodenum, Meckel's diverticulum
1528 Malignant neoplasm of the small intestine including duodenum, other specified site
1529 Malignant neoplasm of the small intestine including duodenum, unspecified
153 Malignant neoplasm of colon
1530 Malig neo hepatic flexure
1531 Malig neo transverse colon
1532 Malig neo descend colon
1533 Malig neo sigmoid colon
1534 Malig neoplasm cecum
1535 Malig neo appendix
1536 Malig neo ascend colon
1537 Malig neo splenic flexure
1538 Malig neo colon ot

1539 Malig neo colon unspec
154 Mal neo rectum/rectosig/anus
1540 Malig neo rectosigmoid jct
1541 Malig neo rectum
1542 Malig neo anal canal
1543 Malig neo anus unspec
1548 Malig neo rectum/anus ot
155 Malignant neoplasm of the liver and intrahepatic bile ducts
1550 Malignant neoplasm of the liver and intrahepatic bile ducts, liver, primary
1551 Malignant neoplasm of the liver and intrahepatic bile ducts, intrahepatic bile ducts
1552 Malignant neoplasm of the liver and interhepatic bile ducts, liver, not specified as primary or secondary
156 Malignant neoplasm of gall bladder and extrahepatic bile ducts
1560 Malignant neoplasm of gall bladder and extrahepatic bile ducts, gallbladder
1561 Malignant neoplasm of gall bladder and extrahepatic bile ducts, extrahepatic bile ducts
1562 Malignant neoplasm of gall bladder and extrahepatic bile ducts, ampulla of Vater
1568 Malignant neoplasm of gall bladder and extrahepatic bile ducts, other specified sites
1569 Malignant neoplasm of gall bladder and extrahepatic bile ducts, biliary tract, part unspecified
157 Malignant neoplasm of pancreas
1570 Malignant neoplasm of pancreas, head
1571 Malignant neoplasm of pancreas, body
1572 Malignant neoplasm of pancreas, tail
1573 Malignant neoplasm of pancreas, pancreatic duct
1574 Malignant neoplasm of pancreas, islets of Langerhans
1578 Malignant neoplasm of pancreas, other specified site
1579 Malignant neoplasm of pancreas, part unspecified
158 Malignant neoplasm of retroperitoneum and peritoneum
1580 Malignant neoplasm of retroperitoneum and peritoneum, retroperitoneum
1588 Malignant neoplasm of retroperitoneum and peritoneum, specified part of peritoneum
1589 Malignant neoplasm of retroperitoneum and peritoneum, unspecified
159 Ot/uns mal neo digestive org
1590 Malig neo intestine unspec
1591 Malig neo spleen ot
1598 Malig neo gi/intra abd ot
1599 Malig neo gi tract ill def
160 Malignant neoplasm of nasal cavities, middle ear, and accessory sinuses
1600 Malignant neoplasm of nasal cavities, middle ear, and accessory sinuses, nasal cavities
1601 Malignant neoplasm of nasal cavities, middle ear, and accessory sinuses, auditory tube, middle ear, and mastoid air cells
1602 Malignant neoplasm of nasal cavities, middle ear, and accessory sinuses, maxillary sinus

1603 Malignant neoplasm of nasal cavities, middle ear, and accessory sinuses, aethmoidal sinus
1604 Malignant neoplasm of nasal cavities, middle ear, and accessory sinuses, frontal sinus
1605 Malignant neoplasm of nasal cavities, middle ear, and accessory sinuses, sphenoidal sinus
1608 Malignant neoplasm of nasal cavities, middle ear, and accessory sinuses, other
1609 Malignant neoplasm of nasal cavities, middle ear, and accessory sinuses, accessory sinus, unspecified
161 Malignant neoplasm of larynx
1610 Malignant neoplasm of larynx, glottis
1611 Malignant neoplasm of larynx, supraglottis
1612 Malignant neoplasm of larynx, subglottis
1613 Malignant neoplasm of larynx, laryngeal cartilages
1618 Malignant neoplasm of larynx, other specified sites
1619 Malignant neoplasm of larynx, unspecified
162 Malignant neoplasm of trachea, bronchus, and lung
1620 Malignant neoplasm of trachea, bronchus, and lung, trachea
1622 Malignant neoplasm of trachea, bronchus, and lung, main bronchus
1623 Malignant neoplasm of trachea, bronchus, and lung, upper lobe, bronchus or lung
1624 Malignant neoplasm of trachea, bronchus, and lung, middle lobe, bronchus or lung
1625 Malignant neoplasm of trachea, bronchus, and lung, lower lobe, bronchus or lung
1628 Malignant neoplasm of trachea, bronchus, and lung, other specified parts
1629 Malignant neoplasm of trachea, bronchus, and lung, unspecified
163 Malignant neoplasm of pleura
1630 Malignant neoplasm of pleura, parietal pleura
1631 Malignant neoplasm of pleura, visceral pleura
1638 Malignant neoplasm of pleura, other specified sites
1639 Malignant neoplasm of pleura, unspecified
164 Malignant neoplasm of thymus, heart and mediastinum
1640 Malignant neoplasm of thymus, heart and mediastinum, thymus
1641 Malignant neoplasm of thymus, heart and mediastinum, heart
1642 Malignant neoplasm of thymus, heart and mediastinum, anterior mediastinum
1643 Malignant neoplasm of thymus, heart and mediastinum, posterior mediastinum
1648 Malignant neoplasm of thymus, heart and mediastinum, other
1649 Malignant neoplasm of thymus, heart and mediastinum, part unspecified
165 Malignant neoplasm of other and ill-defined sites within the respiratory system and intrathoracic organs
1650 Malignant neoplasm of other and ill-defined sites within the respiratory system and intrathoracic organs, upper respiratory trace, part unspecified
1658 Malignant neoplasm of other and ill-defined sites within the respiratory system and intrathoracic organs, other
1659 Malignant neoplasm of other and ill-defined sites within the respiratory system and intrathoracic organs, ill-defined sites
170 Malignant neoplasm of bone and articular cartilage

1700 Malignant neoplasm of bone and articular cartilage, bones of skull and face, except mandible
1701 Malignant neoplasm of bone and articular cartilage, mandible
1702 Malignant neoplasm of bone and articular cartilage, vertebral column, excluding sacrum and coccyx
1703 Malignant neoplasm of bone and articular cartilage, ribs, sternum, and clavicle
1704 Malignant neoplasm of bone and articular cartilage, scapula and long bones of upper limb
1705 Malignant neoplasm of bone and articular cartilage, short bones of upper limb
1706 Malignant neoplasm of bone and articular cartilage, pelvic bones, sacrum, and coccyx
1707 Malignant neoplasm of bone and articular cartilage, long bones of lower limb
1708 Malignant neoplasm of bone and articular cartilage, short bones of lower limb
1709 Malignant neoplasm of bone and articular cartilage, site unspecified
171 Malignant neoplasm of connective and other soft tissue
1710 Malignant neoplasm of connective and other soft tissue, head, face, and neck
1712 Malignant neoplasm of connective and other soft tissue, upper limb, including shoulder
1713 Malignant neoplasm of connective and other soft tissue, lower limb, including hip
1714 Malignant neoplasm of connective and other soft tissue, thorax
1715 Malignant neoplasm of connective and other soft tissue, abdomen
1716 Malignant neoplasm of connective and other soft tissue, pelvis
1717 Malignant neoplasm of connective and other soft tissue, trunk, unspecified
1718 Malignant neoplasm of connective and other soft tissue, other specified sites
1719 Malignant neoplasm of connective and other soft tissue, site unspecified
172 Malignant melanoma of skin
1720 Malig melanoma lip
1721 Malig melanoma eyelid
1722 Malig melanoma ear
1723 Malig melanom face ot/unspec
1724 Malig melanoma scalp/neck
1725 Malig melanoma trunk
1726 Malig melanoma arm
1727 Malig melanoma leg
1728 Malig melanoma skin ot
1729 Malig melanoma skin unspec
173 Oth malignant neoplasm skin
1730 Malig neo skin lip
1731 Malig neo skin eyelid
1732 Malig neo skin ear
1733 Malig neo skin face ot
1734 Malig neo scalp/skin neck
1735 Malig neo skin trunk
1736 Malig neo skin arm
1737 Malig neo skin leg

1738 Malig neo skin ot
1739 Malig neo skin unspec
174 Malignant neo female breast
1740 Malig neo nipple
1741 Malig neo breast central
1742 Malig neo breast up inner
1743 Malig neo breast low inner
1744 Malig neo breast up outer
1745 Malig neo breast low outer
1746 Malig neo breast axillary
1748 Malig neo breast ot
1749 Malig neo breast unspec
175 Malignant neo male breast
1750 M alig neo male nipple
1759 Malig neo male breast ot
176 Kaposi's sarcoma
1760 Kaposi's sarcoma, skin
1761 Kaposi's sarcoma, soft tissue
1762 Kaposi's sarcoma, palate
1763 Kaposi's sarcoma, gastrointestinal sites
1764 Kaposi's sarcoma, lung
1765 Kaposi's sarcoma, lymph nodes
1768 Kaposi's sarcoma, other specified sites
1769 Kaposi's sarcoma, unspecified
179 Malig neo uterus unspec
180 Malignant neoplasm cervix
1800 Malig neo endocervix
1801 Malig neo exocervix
1808 Malig neo cervix ot
1809 Malig neo cervix uteri unsp
181 Malignant neoplasm of placenta
182 Malignant neoplasm uterus
1820 Malig neo corpus uteri
1821 Malig neo uterine isthmus
1828 Malig neo body uterus ot
183 Malignant neoplasm of ovary and other uterine adnexa
1830 Malignant neoplasm of ovary and other uterine adnexa, ovary
1832 Malignant neoplasm of ovary and other uterine adnexa, Fallopian tube
1833 Malignant neoplasm of ovary and other uterine adnexa, broad ligament
1834 Malignant neoplasm of ovary and other uterine adnexa, parametrium
1835 Malignant neoplasm of ovary and other uterine adnexa, round ligament
1838 Malignant neoplasm of ovary and other uterine adnexa, other specified sites
1839 Malignant neoplasm of ovary and other uterine adnexa, unspecified
184 Mal neo female genital org
1840 Malig neo vagina
1841 Malig neo labia majora

1842 Malig neo labia minora
1843 Malig neo clitoris
1844 Malig neo vulva unspec
1848 Malig neo female genit ot
1849 Malig neo female genit unsp
185 Malig neo prostate
186 Malignant neoplasm of testis
1860 Malig neo undescend testis
1869 Malig neo testis ot
187 Mlignant neoplasm penis/gen
1871 Malig neo prepuce
1872 Malig neo glans penis
1873 Malig neo penis body
1874 Malig neo penis unspec
1875 Malig neo epididymis
1876 Malig neo spermatic cord
1877 Malig neo scrotum
1878 Malig neo male genital ot
1879 Malig neo male genital unsp
188 Malignant neoplasm bladder
1880 Malig neo bladder trigone
1881 Malig neo bladder dome
1882 Malig neo bladder lateral
1883 Malig neo bladder anterior
1884 Malig neo bladder post
1885 Malig neo bladder neck
1886 Malig neo ureteric orifice
1887 Malig neo urachus
1888 Malig neo bladder ot
1889 Malig neo bladder unspec
189 Malignant neoplasm of kidney
1890 Malig neo kidney
1891 Malig neo renal pelvis
1892 Malig neo ureter
1893 Malig neo urethra
1894 Malig neo paraurethral
1898 Malig neo urinary ot
1899 Malig neo urinary unspec
190 Malignant neoplasm of eye
1900 Malig neo eyeball
1901 Malig neo orbit
1902 Malig neo lacrimalig gland
1903 Malig neo conjunctiva
1904 M alig neo cornea
1905 M alig neo retina
1906 Malig neo choroid

1907 Malig neo lacrimalig duct
1908 Malig neo eye ot
1909 Malig neo eye unspec
191 Malignant neoplasm of brain
1910 Malignant neoplasm of brain, cerebrum, except lobes and ventricles
1911 Malignant neoplasm of brain, frontal lobe
1912 Malignant neoplasm of brain, temporal lobe
1913 Malignant neoplasm of brain, parietal lobe
1914 Malignant neoplasm of brain, occipital lobe
1915 Malignant neoplasm of brain, ventricles
1916 Malignant neoplasm of brain , cerebellum NOS
1917 Malignant neoplasm of brain, brain stem
1918 Malignant neoplasm of brain, other parts
1919 Malignant neoplasm of brain, unspecified
192 Malignant neoplasm of other and unspecified parts of nervous system
1920 Malignant neoplasm of other and unspecified parts of nervous system, cranial nerves
1921 Malignant neoplasm of other and unspecified parts of nervous system, cerebral meninges
1922 Malignant neoplasm of other and unspecified parts of nervous system, spinal cord
1923 Malignant neoplasm of other and unspecified parts of nervous system, spinal meninges
1928 Malignant neoplasm of other and unspecified parts of nervous system, other specified sites
1929 Malignant neoplasm of other and unspecified parts of nervous system, part unspecified
193 Malig neo thyroid
194 Mal neo endocrine gland
1940 Malignant neoplasm of other endocrine glands and related structures
1941 Malig neo parathyroid
1943 Malignant neoplasm of other endocrine glands and related structures, adrenal gland
1944 Malignant neoplasm of other endocrine glands and related structures, pineal gland
1945 Malig neo carotid body
1946 Malig neo paraganglia ot
1948 Malig neo endocrine ot
1949 Malig neo endocrine unspec
195 Mal neo other sites
1950 Malig neo head/face/neck
1951 Malig neo thorax
1952 Malig neo abdomen
1953 Malig neo pelvis
1954 Malig neo arm
1955 Malig neo leg
1958 Malig neo site ot
196 Secondary and unspecified malignant neoplasm of lymph nodes

1960 Secondary and unspecified malignant neoplasm of lymph nodes, head, face, and neck
1961 Secondary and unspecified malignant neoplasm of lymph nodes, intrathoracic
1962 Secondary and unspecified malignant neoplasm of lymph nodes, intra-abdominal
1963 Secondary and unspecified malignant neoplasm of lymph nodes, axilla and upper limb
1965 Secondary and unspecified malignant neoplasm of lymph nodes, inguinal region and lower limb
1966 Secondary and unspecified malignant neoplasm of lymph nodes, intrapelvic
1968 Secondary and unspecified malignant neoplasm of lymph nodes, multiple sites
1969 Secondary and unspecified malignant neoplasm of lymph nodes, site unspecified
197 Secondary malignant neoplasm of respiratory and digestive systems
1970 Secondary malignant neoplasm of respiratory and digestive systems, lung
1971 Secondary malignant neoplasm of respiratory and digestive systems, mediastinum
1972 Secondary malignant neoplasm of respiratory and digestive systems, pleura
1973 Secondary malignant neoplasm of respiratory and digestive systems, other respiratory organs
1974 Secondary malignant neoplasm of respiratory and digestive systems, small intestine, including duodenum
1975 Secondary malignant neoplasm of respiratory and digestive systems, large intestine and rectum
1976 Secondary malignant neoplasm of respiratory and digestive systems, retroperitoneum and peritoneum
1977 Secondary malignant neoplasm of respiratory and digestive systems, liver, specified as secondary
1978 Secondary malignant neoplasm of respiratory and digestive systems, other digestive organs and spleen
198 Secondary malignant neoplasm of other specified sites
1980 Secondary malignant neoplasm of other specified sites, kidney
1981 Secondary malignant neoplasm of other specified sites, other urinary organs
1982 Secondary malignant neoplasm of other specified sites, skin
1983 Secondary malignant neoplasm of other specified sites, brain and spinal cord
1984 Secondary malignant neoplasm of other specified sites, other parts of nervous system
1985 Secondary malignant neoplasm of other specified sites, bone and bone marrow
1986 Secondary malignant neoplasm of other specified sites, ovary
1987 Secondary malignant neoplasm of other specified sites, adrenal gland
1988 Secondary malignant neoplasm of other specified sites, other specified sites
19881 Secondary malignant neoplasm of other specified sites, other specified sites, breast
19882 Secondary malignant neoplasm of other specified sites, other specified sites, genital organs
19889 Secondary malignant neoplasm of other specified sites, other specified sites, other
199 Malig neoplasm unspec site
1990 Malignant neoplasm without specification of site, disseminated
1991 Malignant neoplasm unspec
200 Lymphosarcoma and reticulosarcoma

2000 Lymphosarcoma and reticulosarcoma, reticulosarcoma
20000 Lymphosarcoma and reticulosarcoma, reticulosarcoma, unspecified site, extranodal and solid organ sites
20001 Lymphosarcoma and reticulosarcoma, reticulosarcoma, lymph nodes of head, face, and neck
20002 Lymphosarcoma and reticulosarcoma, reticulosarcoma, intrathoracic lymph nodes
20003 Lymphosarcoma and reticulosarcoma, reticulosarcoma, intra-abdominal lymph nodes
20004 Lymphosarcoma and reticulosarcoma, reticulosarcoma, lymph nodes of axilla and upper limb
20005 Lymphosarcoma and reticulosarcoma, reticulosarcoma, lymph nodes of inguinal region and lower limb
20006 Lymphosarcoma and reticulosarcoma, reticulosarcoma, intrapelvic lymph nodes
20007 Lymphosarcoma and reticulosarcoma, reticulosarcoma, spleen
20008 Lymphosarcoma and reticulosarcoma, reticulosarcoma, lymph nodes of multiple sites
2001 Lymphosarcoma and reticulosarcoma, Lymphosarcoma
20010 Lymphosarcoma and reticulosarcoma, Lymphosarcoma, unspecified site, extranodal and solid organ sites
20011 Lymphosarcoma and reticulosarcoma, Lymphosarcoma, lymph nodes of head, face, and neck
20012 Lymphosarcoma and reticulosarcoma, Lymphosarcoma, intrathoracic lymph nodes
20013 Lymphosarcoma and reticulosarcoma, Lymphosarcoma, intra-abdominal lymph nodes
20014 Lymphosarcoma and reticulosarcoma, Lymphosarcoma, lymph nodes of axilla and upper limb
20015 Lymphosarcoma and reticulosarcoma, Lymphosarcoma, lymph nodes of inguinal region and lower limb
20016 Lymphosarcoma and reticulosarcoma, Lymphosarcoma, intrapelvic lymph nodes
20017 Lymphosarcoma and reticulosarcoma, Lymphosarcoma, spleen
20018 Lymphosarcoma and reticulosarcoma, Lymphosarcoma, lymph nodes of multiple sites
2002 Lymphosarcoma and reticulosarcoma, Burkitt’s tumor or lymphoma
20020 Lymphosarcoma and reticulosarcoma, Burkitt’s tumor or lymphoma, unspecified site, extranodal and solid organ sites
20021 Lymphosarcoma and reticulosarcoma, Burkitt’s tumor or lymphoma, lymph nodes of head, face, and neck
20022 Lymphosarcoma and reticulosarcoma, Burkitt’s tumor or lymphoma, intrathoracic lymph nodes
20023 Lymphosarcoma and reticulosarcoma, Burkitt’s tumor or lymphoma, intra-abdominal lymph nodes
20024 Lymphosarcoma and reticulosarcoma, Burkitt’s tumor or lymphoma, lymph nodes of axilla and upper limb
20025 Lymphosarcoma and reticulosarcoma, Burkitt’s tumor or lymphoma, lymph nodes of inguinal region and lower limb

20026 Lymphosarcoma and reticulosarcoma, Burkitt's tumor or lymphoma, intrapelvic lymph nodes
20027 Lymphosarcoma and reticulosarcoma, Burkitt's tumor or lymphoma, spleen
20028 Lymphosarcoma and reticulosarcoma, Burkitt's tumor or lymphoma, lymph nodes of multiple sites
2008 Lymphosarcoma and reticulosarcoma, other named variants
20080 Lymphosarcoma and reticulosarcoma, other named variants, unspecified site, extranodal and solid organ sites
20081 Lymphosarcoma and reticulosarcoma, other named variants, lymph nodes of head, face, and neck
20082 Lymphosarcoma and reticulosarcoma, other named variants, intrathoracic lymph nodes
20083 Lymphosarcoma and reticulosarcoma, other named variants, intra-abdominal lymph nodes
20084 Lymphosarcoma and reticulosarcoma, other named variants, lymph nodes of axilla and upper limb
20085 Lymphosarcoma and reticulosarcoma, other named variants, lymph nodes of inguinal region and lower limb
20086 Lymphosarcoma and reticulosarcoma, other named variants, intrapelvic lymph nodes
20087 Lymphosarcoma and reticulosarcoma, other named variants, spleen
20088 Lymphosarcoma and reticulosarcoma, other named variants, lymph nodes of multiple sites
201 Hodgkin's disease
2010 Hodgkin's disease, Hodgkin's paragranuloma
20100 Hodgkin's disease, Hodgkin's paragranuloma, unspecified site, extranodal and solid organ site
20101 Hodgkin's disease, Hodgkin's paragranuloma, lymph nodes of head, face, and neck
20102 Hodgkin's disease, Hodgkin's paragranuloma, intrathoracic lymph nodes
20103 Hodgkin's disease, Hodgkin's paragranuloma, intra-abdominal lymph nodes
20104 Hodgkin's disease, Hodgkin's paragranuloma, lymph nodes of axilla and upper limb
20105 Hodgkin's disease, Hodgkin's paragranuloma, lymph nodes of inguinal region and lower limb
20106 Hodgkin's disease, Hodgkin's paragranuloma, intrapelvic lymph nodes
20107 Hodgkin's disease, Hodgkin's paragranuloma, spleen
20108 Hodgkin's disease, Hodgkin's paragranuloma, lymph nodes of multiple sites
2011 Hodgkin's disease, Hodgkin's granuloma
20110 Hodgkin's disease, Hodgkin's granuloma, unspecified site, extranodal and solid organ site
20111 Hodgkin's disease, Hodgkin's granuloma, lymph nodes of head, face, and neck
20112 Hodgkin's disease, Hodgkin's granuloma, intrathoracic lymph nodes
20113 Hodgkin's disease, Hodgkin's granuloma, intra-abdominal lymph nodes
20114 Hodgkin's disease, Hodgkin's granuloma, lymph nodes of axilla and upper limb

20115 Hodgkin's disease, Hodgkin's granuloma, lymph nodes of inguinal region and lower limb
20116 Hodgkin's disease, Hodgkin's granuloma, intrapelvic lymph nodes
20117 Hodgkin's disease, Hodgkin's granuloma, spleen
20118 Hodgkin's disease, Hodgkin's granuloma, lymph nodes of multiple sites
2012 Hodgkin's disease, Hodgkin's sarcoma
20120 Hodgkin's disease, Hodgkin's sarcoma, unspecified site, extranodal and solid organ site
20121 Hodgkin's disease, Hodgkin's sarcoma, lymph nodes of head, face, and neck
20122 Hodgkin's disease, Hodgkin's sarcoma, intrathoracic lymph nodes
20123 Hodgkin's disease, Hodgkin's sarcoma, intra-abdominal lymph nodes
20124 Hodgkin's disease, Hodgkin's sarcoma, lymph nodes of axilla and upper limb
20125 Hodgkin's disease, Hodgkin's sarcoma, lymph nodes of inguinal region and lower limb
20126 Hodgkin's disease, Hodgkin's sarcoma, intrapelvic lymph nodes
20127 Hodgkin's disease, Hodgkin's sarcoma, spleen
20128 Hodgkin's disease, Hodgkin's sarcoma, lymph nodes of multiple sites
2014 Hodgkin's disease, Lymphocytic-histiocytic predominance
20140 Hodgkin's disease, Lymphocytic-histiocytic predominance, unspecified site, extranodal and solid organ site
20141 Hodgkin's disease, Lymphocytic-histiocytic predominance, lymph nodes of head, face, and neck
20142 Hodgkin's disease, Lymphocytic-histiocytic predominance, intrathoracic lymph nodes
20143 Hodgkin's disease, Lymphocytic-histiocytic predominance, intra-abdominal lymph nodes
20144 Hodgkin's disease, Lymphocytic-histiocytic predominance, lymph nodes of axilla and upper limb
20145 Hodgkin's disease, Lymphocytic-histiocytic predominance, lymph nodes of inguinal region and lower limb
20146 Hodgkin's disease, Lymphocytic-histiocytic predominance, intrapelvic lymph nodes
20147 Hodgkin's disease, Lymphocytic-histiocytic predominance, spleen
20148 Hodgkin's disease, Lymphocytic-histiocytic predominance, lymph nodes of multiple sites
2015 Hodgkin's disease, Nodular sclerosis
20150 Hodgkin's disease, Nodular sclerosis, unspecified site, extranodal and solid organ site
20151 Hodgkin's disease, Nodular sclerosis, lymph nodes of head, face, and neck
20152 Hodgkin's disease, Nodular sclerosis, intrathoracic lymph nodes
20153 Hodgkin's disease, Nodular sclerosis, intra-abdominal lymph nodes
20154 Hodgkin's disease, Nodular sclerosis, lymph nodes of axilla and upper limb
20155 Hodgkin's disease, Nodular sclerosis, lymph nodes of inguinal region and lower limb
20156 Hodgkin's disease, Nodular sclerosis, intrapelvic lymph nodes
20157 Hodgkin's disease, Nodular sclerosis, spleen

20158 Hodgkin’s disease, Nodular sclerosis, lymph nodes of multiple sites
2016 Hodgkin’s disease, Mixed cellularity
20160 Hodgkin’s disease, Mixed cellularity, unspecified site, extranodal and solid organ site
20161 Hodgkin’s disease, Mixed cellularity, lymph nodes of head, face, and neck
20162 Hodgkin’s disease, Mixed cellularity, intrathoracic lymph nodes
20163 Hodgkin’s disease, Mixed cellularity, intra-abdominal lymph nodes
20164 Hodgkin’s disease, Mixed cellularity, lymph nodes of axilla and upper limb
20165 Hodgkin’s disease, Mixed cellularity, lymph nodes of inguinal region and lower limb
20166 Hodgkin’s disease, Mixed cellularity, intrapelvic lymph nodes
20167 Hodgkin’s disease, Mixed cellularity, spleen
20168 Hodgkin’s disease, Mixed cellularity, lymph nodes of multiple sites
2017 Hodgkin’s disease, Lymphocytic depletion
20170 Hodgkin’s disease, Lymphocytic depletion, unspecified site, extranodal and solid organ site
20171 Hodgkin’s disease, Lymphocytic depletion, lymph nodes of head, face, and neck
20172 Hodgkin’s disease, Lymphocytic depletion, intrathoracic lymph nodes
20173 Hodgkin’s disease, Lymphocytic depletion, intra-abdominal lymph nodes
20174 Hodgkin’s disease, Lymphocytic depletion, lymph nodes of axilla and upper limb
20175 Hodgkin’s disease, Lymphocytic depletion, lymph nodes of inguinal region and lower limb
20176 Hodgkin’s disease, Lymphocytic depletion, intrapelvic lymph nodes
20177 Hodgkin’s disease, Lymphocytic depletion, spleen
20178 Hodgkin’s disease, Lymphocytic depletion, lymph nodes of multiple sites
2019 Hodgkin's disease, unspecified
20190 Hodgkin's disease, unspecified, unspecified site, extranodal and solid organ sites
20191 Hodgkin's disease, unspecified, lymph nodes of head, face, and neck
20192 Hodgkin's disease, unspecified, intrathoracic lymph nodes
20193 Hodgkin's disease, unspecified, intra-abdominal lymph nodes
20194 Hodgkin's disease, unspecified, lymph nodes of axilla and upper limb
20195 Hodgkin's disease, unspecified, lymph nodes of inguinal region and lower limb
20196 Hodgkin's disease, unspecified, intrapelvic lymph nodes
20197 Hodgkin's disease, unspecified, spleen
20198 Hodgkin's disease, unspecified, lymph nodes of multiple sites
202 Other malignant neoplasms of lymphoid and histiocytic tissue
2020 Nodular lymphoma
20200 Nodular lymphoma, unspecified site, extranodal and solid organ sites
20201 Nodular lymphoma, lymph nodes of head, face, and neck
20202 Nodular lymphoma, intrathoracic lymph nodes
20203 Nodular lymphoma, intra-abdominal lymph nodes
20204 Nodular lymphoma, lymph nodes of axilla and upper limb
20205 Nodular lymphoma, lymph nodes of inguinal region and lower limb
20206 Nodular lymphoma, intrapelvic lymph nodes
20207 Nodular lymphoma, spleen
20208 Nodular lymphoma, lymph nodes of multiple sites

2021 Other malignant neoplasms of lymphoid and histiocytic tissue, Mycosis fungoides
20210 Other malignant neoplasms of lymphoid and histiocytic tissue, Mycosis fungoides, extranodal and solid organ site
20211 Other malignant neoplasms of lymphoid and histiocytic tissue, Mycosis fungoides, lymph nodes of head, face, and neck
20212 Other malignant neoplasms of lymphoid and histiocytic tissue, Mycosis fungoides, intrathoracic lymph nodes
20213 Other malignant neoplasms of lymphoid and histiocytic tissue, Mycosis fungoides, intra-abdominal lymph nodes
20214 Other malignant neoplasms of lymphoid and histiocytic tissue, Mycosis fungoides, lymph nodes of axilla and upper limb
20215 Other malignant neoplasms of lymphoid and histiocytic tissue, Mycosis fungoides, lymph nodes of inguinal region and lower limb
20216 Other malignant neoplasms of lymphoid and histiocytic tissue, Mycosis fungoides, intrapelvic lymph nodes
20217 Other malignant neoplasms of lymphoid and histiocytic tissue, Mycosis fungoides, spleen
20218 Other malignant neoplasms of lymphoid and histiocytic tissue, Mycosis fungoides, lymph nodes of multiple sites
2022 Other malignant neoplasms of lymphoid and histiocytic tissue, Sezary's disease
20220 Other malignant neoplasms of lymphoid and histiocytic tissue, Sezary's disease, extranodal and solid organ site
20221 Other malignant neoplasms of lymphoid and histiocytic tissue, Sezary's disease, lymph nodes of head, face, and neck
20222 Other malignant neoplasms of lymphoid and histiocytic tissue, Sezary's disease, intrathoracic lymph nodes
20223 Other malignant neoplasms of lymphoid and histiocytic tissue, Sezary's disease, intra-abdominal lymph nodes
20224 Other malignant neoplasms of lymphoid and histiocytic tissue, Sezary's disease, lymph nodes of axilla and upper limb
20225 Other malignant neoplasms of lymphoid and histiocytic tissue, Sezary's disease, lymph nodes of inguinal region and lower limb
20226 Other malignant neoplasms of lymphoid and histiocytic tissue, Sezary's disease, intrapelvic lymph nodes
20227 Other malignant neoplasms of lymphoid and histiocytic tissue, Sezary's disease, spleen
20228 Other malignant neoplasms of lymphoid and histiocytic tissue, Sezary's disease, lymph nodes of multiple sites
2023 Other malignant neoplasms of lymphoid and histiocytic tissue, malignant histiocytosis
20230 Other malignant neoplasms of lymphoid and histiocytic tissue, malignant histiocytosis, extranodal and solid organ site
20231 Other malignant neoplasms of lymphoid and histiocytic tissue, malignant histiocytosis, lymph nodes of head, face, and neck
20232 Other malignant neoplasms of lymphoid and histiocytic tissue, malignant histiocytosis, intrathoracic lymph nodes

20233 Other malignant neoplasms of lymphoid and histiocytic tissue, malignant histiocytosis, intra-abdominal lymph nodes
20234 Other malignant neoplasms of lymphoid and histiocytic tissue, malignant histiocytosis, lymph nodes of axilla and upper limb
20235 Other malignant neoplasms of lymphoid and histiocytic tissue, malignant histiocytosis, lymph nodes of inguinal region and lower limb
20236 Other malignant neoplasms of lymphoid and histiocytic tissue, malignant histiocytosis, intrapelvic lymph nodes
20237 Other malignant neoplasms of lymphoid and histiocytic tissue, malignant histiocytosis, spleen
20238 Other malignant neoplasms of lymphoid and histiocytic tissue, malignant histiocytosis, lymph nodes of multiple sites
2024 Other malignant neoplasms of lymphoid and histiocytic tissue, leukemic reticuloendotheliosis
20240 Other malignant neoplasms of lymphoid and histiocytic tissue, leukemic reticuloendotheliosis, extranodal and solid organ site
20241 Other malignant neoplasms of lymphoid and histiocytic tissue, leukemic reticuloendotheliosis, lymph nodes of head, face, and neck
20242 Other malignant neoplasms of lymphoid and histiocytic tissue, leukemic reticuloendotheliosis, intrathoracic lymph nodes
20243 Other malignant neoplasms of lymphoid and histiocytic tissue, leukemic reticuloendotheliosis, intra-abdominal lymph nodes histiocytosis
20244 Other malignant neoplasms of lymphoid and histiocytic tissue, leukemic reticuloendotheliosis, lymph nodes of axilla and upper limb
20245 Other malignant neoplasms of lymphoid and histiocytic tissue, leukemic reticuloendotheliosis, lymph nodes of inguinal region and lower limb
20246 Other malignant neoplasms of lymphoid and histiocytic tissue, leukemic reticuloendotheliosis, intrapelvic lymph nodes
20247 Other malignant neoplasms of lymphoid and histiocytic tissue, leukemic reticuloendotheliosis, spleen
20248 Other malignant neoplasms of lymphoid and histiocytic tissue, leukemic reticuloendotheliosis, lymph nodes of multiple sites
2025 Other malignant neoplasms of lymphoid and histiocytic tissue, Letterer-Siwe disease
20250 Other malignant neoplasms of lymphoid and histiocytic tissue, Letterer-Siwe disease, extranodal and solid organ site
20251 Other malignant neoplasms of lymphoid and histiocytic tissue, Letterer-Siwe disease, lymph nodes of head, face, and neck
20252 Other malignant neoplasms of lymphoid and histiocytic tissue, Letterer-Siwe disease, intrathoracic lymph nodes
20253 Other malignant neoplasms of lymphoid and histiocytic tissue, Letterer-Siwe disease, intra-abdominal lymph nodes histiocytosis
20254 Other malignant neoplasms of lymphoid and histiocytic tissue, Letterer-Siwe disease, lymph nodes of axilla and upper limb
20255 Other malignant neoplasms of lymphoid and histiocytic tissue, Letterer-Siwe disease, lymph nodes of inguinal region and lower limb

20256 Other malignant neoplasms of lymphoid and histiocytic tissue, Letterer-Siwe disease, intrapelvic lymph nodes
20257 Other malignant neoplasms of lymphoid and histiocytic tissue, Letterer-Siwe disease, spleen
20258 Other malignant neoplasms of lymphoid and histiocytic tissue, Letterer-Siwe disease, lymph nodes of multiple sites
2026 Other malignant neoplasms of lymphoid and histiocytic tissue, malignant mast cell tumors
20260 Other malignant neoplasms of lymphoid and histiocytic tissue, malignant mast cell tumors, extranodal and solid organ site
20261 Other malignant neoplasms of lymphoid and histiocytic tissue, malignant mast cell tumors, lymph nodes of head, face, and neck
20262 Other malignant neoplasms of lymphoid and histiocytic tissue, malignant mast cell tumors, intrathoracic lymph nodes
20263 Other malignant neoplasms of lymphoid and histiocytic tissue, malignant mast cell tumors, intra-abdominal lymph nodes histiocytosis
20264 Other malignant neoplasms of lymphoid and histiocytic tissue, malignant mast cell tumors, lymph nodes of axilla and upper limb
20265 Other malignant neoplasms of lymphoid and histiocytic tissue, malignant mast cell tumors, lymph nodes of inguinal region and lower limb
20266 Other malignant neoplasms of lymphoid and histiocytic tissue, malignant mast cell tumors, intrapelvic lymph nodes
20267 Other malignant neoplasms of lymphoid and histiocytic tissue, malignant mast cell tumors, spleen
20268 Other malignant neoplasms of lymphoid and histiocytic tissue, malignant mast cell tumors, lymph nodes of multiple sites
2028 Other lymphomas
20280 Other lymphomas, unspecified site, extranodal and solid organ sites
20281 Other lymphomas, lymph nodes of head, face, and neck
20282 Other lymphomas, intrathoracic lymph nodes
20283 Other lymphomas, intra-abdominal lymph nodes
20284 Other lymphomas, lymph nodes of axilla and upper limb
20285 Other lymphomas, lymph nodes of inguinal region and lower limb
20286 Other lymphomas, intrapelvic lymph nodes
20287 Other lymphomas, spleen
20288 Other lymphomas, lymph nodes of multiple sites
2029 Other malignant neoplasms of lymphoid and histiocytic tissue, other and unspecified
20290 Other malignant neoplasms of lymphoid and histiocytic tissue, other and unspecified, extranodal and solid organ site
20291 Other malignant neoplasms of lymphoid and histiocytic tissue, other and unspecified, lymph nodes of head, face, and neck
20292 Other malignant neoplasms of lymphoid and histiocytic tissue, other and unspecified, intrathoracic lymph nodes
20293 Other malignant neoplasms of lymphoid and histiocytic tissue, other and unspecified, intra-abdominal lymph nodes histiocytosis

20294 Other malignant neoplasms of lymphoid and histiocytic tissue, other and unspecified, lymph nodes of axilla and upper limb
20295 Other malignant neoplasms of lymphoid and histiocytic tissue, other and unspecified, lymph nodes of inguinal region and lower limb
20296 Other malignant neoplasms of lymphoid and histiocytic tissue, other and unspecified, intrapelvic lymph nodes
20297 Other malignant neoplasms of lymphoid and histiocytic tissue, other and unspecified, spleen
20298 Other malignant neoplasms of lymphoid and histiocytic tissue, other and unspecified, lymph nodes of multiple sites
2030 Multiple myeloma
20300 Multiple myeloma without mention of remission
20301 Multiple myeloma in remission
2031 Plasma cell leukemia
20310 Plasma cell leukemia without mention of remission
20311 Plasma cell leukemia in remission
2038 Other immunoproliferative neoplasms
20380 Other immunoproliferative neoplasms without mention of remission
20381 Other immunoproliferative neoplasms in remission
204 Lymphoid leukemia
2040 Lymphoid leukemia, acute
20400 Lymphoid leukemia, acute without mention of remission
20401 Lymphoid leukemia, acute in remission
2041 Lymphoid leukemia, chronic
20410 Lymphoid leukemia, chronic without mention of remission
20411 Lymphoid leukemia, chronic in remission
2042 Lymphoid leukemia, subacute
20420 Lymphoid leukemia, subacute without mention of remission
20421 Lymphoid leukemia, subacute in remission
2048 Lymphoid leukemia, other
20480 Lymphoid leukemia, other without mention of remission
20481 Lymphoid leukemia, other in remission
2049 Lymphoid leukemia, unspecified
20490 Lymphoid leukemia, unspecified without mention of remission
20491 Lymphoid leukemia, unspecified in remission
205 Myeloid leukemia
2050 Myeloid leukemia, acute
20500 Myeloid leukemia, acute without mention of remission
20501 Myeloid leukemia, acute in remission
2051 Myeloid leukemia, chronic
20510 Myeloid leukemia, chronic without mention of remission
20511 Myeloid leukemia, chronic in remission
2052 Myeloid leukemia, subacute
20520 Myeloid leukemia, subacute without mention of remission
20521 Myeloid leukemia, subacute in remission
2053 Myeloid leukemia, myeloid sarcoma

20530 Myeloid leukemia, myeloid sarcoma without mention of remission
20531 Myeloid leukemia, myeloid sarcoma in remission
2058 Myeloid leukemia, other
20580 Myeloid leukemia, other without mention of remission
20581 Myeloid leukemia, other in remission
2059 Myeloid leukemia, unspecified
20590 Myeloid leukemia, unspecified without mention of remission
20591 Myeloid leukemia, unspecified in remission
206 Monocytic leukemia
2060 Monocytic leukemia, acute
20600 Monocytic leukemia, acute without mention of remission
20601 Monocytic leukemia, acute in remission
2061 Monocytic leukemia, chronic
20610 Monocytic leukemia, chronic without mention of remission
20611 Monocytic leukemia, chronic in remission
2062 Monocytic leukemia, subacute
20620 Monocytic leukemia, subacute without mention of remission
20621 Monocytic leukemia, subacute in remission
2068 Monocytic leukemia, other
20680 Monocytic leukemia, other without mention of remission
20681 Monocytic leukemia, other in remission
2069 Monocytic leukemia, unspecified
20690 Monocytic leukemia, unspecified without mention of remission
20691 Monocytic leukemia, unspecified in remission
207 Other specified leukemia
2070 Other specified leukemia, Acute erythremia and erythroleukemia
20700 Other specified leukemia, Acute erythremia and erythroleukemia without mention of remission
20701 Other specified leukemia, Acute erythremia and erythroleukemia in remission
2071 Other specified leukemia, Chronic erythremia
20710 Other specified leukemia, Chronic erythremia without mention of remission
20711 Other specified leukemia, Chronic erythremia in remission
2072 Other specified leukemia, Megakaryocytic leukemia
20720 Other specified leukemia, Megakaryocytic leukemia without mention of remission
20721 Other specified leukemia, Megakaryocytic leukemia in remission
2078 Other specified leukemia, Other
20780 Other specified leukemia, Other without mention of remission
20781 Other specified leukemia, Other in remission
208 Leukemia of unspecified cell type
2080 Leukemia of unspecified cell type, acute
20800 Leukemia of unspecified cell type, acute without mention of remission
20801 Leukemia of unspecified cell type, acute in remission
2081 Leukemia of unspecified cell type, chronic
20810 Leukemia of unspecified cell type, chronic without mention of remission
20811 Leukemia of unspecified cell type, chronic in remission
2082 Leukemia of unspecified cell type, subacute

20820 Leukemia of unspecified cell type, subacute without mention of remission
20821 Leukemia of unspecified cell type, subacute in remission
2088 Leukemia of unspecified cell type, other
20880 Leukemia of unspecified cell type, other without mention of remission
20881 Leukemia of unspecified cell type, other in remission
2089 Leukemia of unspecified cell type, unspecified
20890 Leukemia of unspecified cell type, unspecified without mention of remission
20891 Leukemia of unspecified cell type, unspecified in remission
225 Benign neoplasm of brain and other parts of the nervous system
2250 Benign neoplasm of brain and other parts of the nervous system, brain
2251 Benign neoplasm of brain and other parts of the nervous system , cranial nerves
2252 Benign neoplasm of brain and other parts of the nervous system , cerebral meninges
2253 Benign neoplasm of brain and other parts of the nervous system , spinal cord
2254 Benign neoplasm of brain and other parts of the nervous system , spinal meninges
2258 Benign neoplasm of brain and other parts of the nervous system , other specified sites of nervous system
2259 Benign neoplasm of brain and other parts of the nervous system , nervous system, part unspecified
2273 Benign neoplasm of pituitary gland and craniopharyngal duct (pouch)
2274 Benign neoplasm of pineal gland
22802 Hemangioma if intracranial structures
2370 Neoplasm of uncertain behavior of pituitary gland and craniopharyngal duct
2371 Neoplasm of uncertain behavior of pineal gland
2373 Paraganglia
2375 Neoplasm of uncertain behavior of brain and spinal cord
2376 Neoplasm of uncertain behavior of meninges
2377 Neurofibromatosis
23770 Neurofibromatosis, unspecified
23771 Neurofibromatosis, Type I (von Recklinhausen's disease)
23772 Neurofibromatosis, Type II (acoustic neurofibromatosis)
2379 Neoplasm of uncertain behavior of other and unspecified parts of nervous system
2387 Neoplasms of other lymphatic and hematopoietic tissues [includes myelodysplastic syndrome]
2396 Neoplasm of unspecified nature of brain
2592 arcinoid syndrome
2731 Monoclonal paraproteinemia [includes monoclonal gammopathy]
28989 Other specified diseases of blood and blood-forming organs [includes myelofibrosis]
7595 Tuberous sclerosis
7596 Other hamartoses, not elsewhere classified

<u>Myocardial infarction</u>

410 Acute myocardial infarction
4100 Acute myocardial infarction, of anterolateral wall

41000 Acute myocardial infarction, of anterolateral wall, episode of care unspecified
41001 Acute myocardial infarction, of anterolateral wall, initial episode of care
41002 Acute myocardial infarction, of anterolateral wall, subsequent episode of care
4101 Acute myocardial infarction, of other anterior wall
41010 Acute myocardial infarction, of other anterior wall, episode of care unspecified
41011 Acute myocardial infarction, of other anterior wall, initial episode of care
41012 Acute myocardial infarction, of other anterior wall, subsequent episode of care
4102 Acute myocardial infarction, of inferolateral wall
41020 Acute myocardial infarction, of inferolateral wall, episode of care unspecified
41021 Acute myocardial infarction, of inferolateral wall, initial episode of care
41022 Acute myocardial infarction, of inferolateral wall, subsequent episode of care
4103 Acute myocardial infarction, of inferoposterior wall
41030 Acute myocardial infarction, of inferoposterior wall, episode of care unspecified
41031 Acute myocardial infarction, of inferoposterior wall, initial episode of care
41032 Acute myocardial infarction, of inferoposterior wall, subsequent episode of care
4104 Acute myocardial infarction, of other inferior wall
41040 Acute myocardial infarction, of other inferior wall, episode of care unspecified
41041 Acute myocardial infarction, of other inferior wall, initial episode of care
41042 Acute myocardial infarction, of other inferior wall, subsequent episode of care
4105 Acute myocardial infarction, of other lateral wall
41050 Acute myocardial infarction, of other lateral wall, episode of care unspecified
41051 Acute myocardial infarction, of other lateral wall, initial episode of care
41052 Acute myocardial infarction, of other lateral wall, subsequent episode of care
4106 Acute myocardial infarction, true posterior wall infarction
41060 Acute myocardial infarction, true posterior wall infarction, episode of care unspecified
41061 Acute myocardial infarction, true posterior wall infarction, initial episode of care
41062 Acute myocardial infarction, true posterior wall infarction, subsequent episode of care
4107 Acute myocardial infarction, subendocardial infarction
41070 Acute myocardial infarction, subendocardial infarction, episode of care unspecified
41071 Acute myocardial infarction, subendocardial infarction, initial episode of care
41072 Acute myocardial infarction, subendocardial infarction, subsequent episode of care
4108 Acute myocardial infarction, of other specified sites
41080 Acute myocardial infarction, of other specified sites, episode of care unspecified
41081 Acute myocardial infarction, of other specified sites, initial episode of care
41082 Acute myocardial infarction, of other specified sites, subsequent episode of care
4109 Acute myocardial infarction, Unspecified site
41090 Acute myocardial infarction, Unspecified site, episode of care unspecified
41091 Acute myocardial infarction, Unspecified site, initial episode of care
41092 Acute myocardial infarction, Unspecified site, subsequent episode of care

Pericarditis

420 Acute pericarditis
4200 Acute pericarditis in diseases classified elsewhere
4209 Other and unspecified pericarditis
42090 Other and unspecified pericarditis, acute pericarditis, unspecified
42091 Other and unspecified pericarditis, acute idiopathic paricarditis
42099 Other and unspecified pericarditis, other

Peripheral vascular disease

0400 Gas gangrene
4151 Pulmonary embolism and infarction
41511 Pulmonary embolism and infarction, iatrogenic pulmonary embolism and infarction
440 Atherosclerosis
4400 Atherosclerosis of aorta
4401 Atherosclerosis of renal artery
4402 Atherosclerosis of native arteries of the extremities
44020 Atherosclerosis of native arteries of the extremities, unspecified
44021 Atherosclerosis of native arteries of the extremities, with intermittent claudication
44022 Atherosclerosis of native arteries of the extremities, with rest pain
44023 Atherosclerosis of the extremities with ulceration
44024 Atherosclerosis of the extremities with gangrene
44029 Atherosclerosis of native arteries of the extremities, with ulceration
4403 Atherosclerosis of bypass graft of the extremities
44030 Atherosclerosis of bypass graft of the extremities of unspecified graft
44031 Atherosclerosis of bypass graft of the extremities of autologous vein bypass graft
44032 Atherosclerosis of bypass graft of the extremities of nonautologous biological bypass graft
441 Aortic aneurysm and dissection
4410 Aortic aneurysm and dissection,dissection of aorta
44100 Aortic aneurysm and dissection,dissection of aorta, unspecified site
44101 Aortic aneurysm and dissection,dissection of aorta, thoracic
44102 Aortic aneurysm and dissection,dissection of aorta, abdominal
44103 Aortic aneurysm and dissection,dissection of aorta, thoracoabdominal
4411 Thoracic aneurysm, ruptured
4412 Thoracic aneurysm without mention of rupture
4413 Abdominal aneurysm, ruptured
4414 Abdominal aneurysm without mention of rupture
4415 Aortic aneurysm of lunspecified site, ruptured
4416 Thoracoabdominal aneurysm, ruptured
4417 Thoracoabdominal aneurysm without mention of rupture
4419 Aortic aneurysm and dissection of unspecified site without mention of rupture
442 Other aneurysm
4420 Other aneurysm of artery of upper extremity
4421 Other aneurysm of renal artery
4422 Other aneurysm of iliac artery

4423 Other aneurysm of artery of lower extremity
4428 Other aneurysm of other specified artery
44281 Other aneurysm of other specified artery, artery of neck
44282 Other aneurysm of other specified artery, subclavian artery
44283 Other aneurysm of other specified artery, splenic artery
44284 Other aneurysm of other specified artery, other visceral artery
44289 Other aneurysm of other specified artery, other
4429 Other aneurysm of unspecified site
443 Other peripheral vascular disease
4430 Other peripheral vascular disease, Raynaud's syndrome
4431 Other peripheral vascular disease, thromboangiitis obliterans [Buerger's disease]
4432 Other peripherovascular diseases, other arterial dissection
44321 Other peripherovascular diseases, other arterial dissection, dissection of carotid artery
44322 Other peripherovascular diseases, other arterial dissection, dissection of iliac artery
44323 Other peripherovascular diseases, other arterial dissection, dissection of renal artery
44324 Other peripherovascular diseases, other arterial dissection, dissection of vertebral artery
44329 Other peripherovascular diseases, other arterial dissection, dissection of other artery
4438 Other peripheral vascular disease, other specified peripheral vascular disease
44381 Other peripheral vascular disease, other specified peripheral vascular disease, peripheral angiopathy in diseases classified elsewhere
44389 Other peripheral vascular disease, other specified peripheral vascular disease, other
4439 Peripheral vascular disease, unspecified
444 Arterial embolism and thrombosis
4440 Arterial embolism and thrombosis, of abdominal aorta
4441 Arterial embolism and thrombosis, of thoracic aorta
4442 Arterial embolism and thrombosis, of arteries of the extremities
44421 Arterial embolism and thrombosis, of arteries of the extremities, upper extremity
44422 Arterial embolism and thrombosis, of arteries of the extremities, lower extremity
4448 Arterial embolism and thrombosis, of other specified artery
44481 Arterial embolism and thrombosis, of other specified artery, upper extremity
44489 Arterial embolism and thrombosis, of other specified artery, lower extremity
449 Arterial embolism and thrombosis, of unspecified artery
4450 Atheroembolism, of extremities
44501 Atheroembolism, of extremities, upper extremity
44502 Atheroembolism, of extremities, lower extremity
446 Polyarteritis nodosa and allied conditions
4460 Polyarteritis nodosa and allied conditions, polyarteritis nodosa
451 Phlebitis and thrombophlebitis
4510 Phlebitis and thrombophlebitis of superficial vessels of lower extremities
4511 Phlebitis and thrombophlebitis, of deep vessels of lower extermities

45111 Phlebitis and thrombophlebitis, of deep vessels of lower extermities, femoral vein
45119 Phlebitis and thrombophlebitis, of deep vessels of lower extermities, other
4512 Phlebitis and thrombophlebitis, of lower extremities, unspecified
45181 Phlebitis and thrombophlebitis, of other, sites iliac vein
45182 Phlebitis and thrombophlebitis, of other sites, of superficial veins of upper extremities
45183 Phlebitis and thrombophlebitis, of other sites, of deep veins of upper extremities
45184 Phlebitis and thrombophlebitis, of upperextremities, unspecified
45189 Phlebitis and thrombophlebitis, other
4519 Phlebitis and thrombophlebitis, unspecified
453 Other venous embolism and thrombosis
4530 Other venous embolism and thrombosis, Budd-Chiari syndrome
4531 Other venous embolism and thrombosis, Thrombophlebitis migrans
4532 Other venous embolism and thrombosis of vena cava
4533 Other venous embolism and thrombosis of renal vein
4538 Other venous embolism and thrombosis of other specified sites
4539 Other venous embolism and thrombosis of unspecified site

Basic CM model

	Pooled		Pooled, No Outliers*	
N	8,471		8,236	
R-square**	0.3369		0.3595	
	Multiplier	**P-value**	**Multiplier**	**P-value**
Age 18-44	1.236	<.0001	1.223	<.0001
Age 45-59	1.072	0.0406	1.055	0.115
Age 60-69 (ref)	1.000	N/A	1.000	N/A
Age 70-79	1.106	0.0018	1.094	0.005
Age 80+	1.170	<.0001	1.174	<.0001
Body surface area (per 0.1 DBSA)	1.037	<.0001	1.037	<.0001
Body Mass Index				
<18.5 kg/m^2	1.183	0.0015	1.112	0.043
=18.5 kg/m^2 (ref)	1.000	N/A	1.000	N/A

*Excludes facilities identified as having outlier values for covariates in the model or being highly influential in the model based on high dfbeta statistics.

**Control variables for all models include: SNF wage index, facility size, hospital based vs. freestanding, % patients with URR>65, chain ownership, year of cost report, and % pediatric.

Table A1.1 Replace 5 age categories with 3 age categories.

	Pooled		Pooled, No Outliers*	
N	8,471		8,248	
R-square**	0.3362		0.3583	
	Multiplier	**P-value**	**Multiplier**	**P-value**
Age 18-44	1.161	<.0001	1.162	<.0001
Age 45-79 (ref)	1.000	N/A	1.000	N/A
Age 80+	1.130	0.0001	1.161	<.0001
Body surface area (per 0.1 DBSA)	1.037	<.0001	1.037	<.0001
Body Mass Index				
<18.5 kg/m^2	1.185	0.0013	1.114	0.0392
=18.5 kg/m^2 (ref)	1.000	N/A	1.000	N/A

Table A1.2 Replaces 5 age categories with detailed ages.

	Pooled		Pooled, No Outliers*	
N	8,471		8,158	
R-square**	0.3373		0.3614	
	Multiplier	**P-value**	**Multiplier**	**P-value**
Age 18-34	1.255	0.0002	1.254	0.000
Age 35-44	1.262	<.0001	1.209	0.000
Age 45-54	1.097	0.0619	1.078	0.127
Age 55-59	1.084	0.165	1.047	0.428
Age 60-64 (ref)	1.000	N/A	1.000	N/A
Age 65-69	1.034	0.527	1.013	0.797
Age 70-74	1.165	0.002	1.163	0.002
Age 75-79	1.090	0.0779	1.070	0.165
Age 80-84	1.140	0.0185	1.149	0.011
Age 85+	1.306	0.0001	1.266	0.001
Body surface area (per 0.1 DBSA)	1.037	<.0001	1.037	<.0001
Body Mass Index				
<18.5 kg/m^2	1.185	0.0013	1.124	0.026
=18.5 kg/m^2 (ref)	1.000	N/A	1.000	N/A

*Excludes facilities identified as having outlier values for covariates in the model or being highly influential in the model based on high dfbeta statistics.

**Control variables for all models include: SNF wage index, facility size, hospital based vs. freestanding, % patients with URR>65, chain ownership, year of cost report, and % pediatric.

Table A2.1 Replaces BSA-DuBois with BSA-Boyd in Basic CM model.

	Pooled		Pooled, No Outliers*	
N	8,471		8,231	
R-square**	0.3360		0.3580	
	Multiplier	**P-value**	**Multiplier**	**P-value**
Age 18-44	1.250	<.0001	1.252	<.0001
Age 45-59	1.075	0.035	1.068	0.051
Age 60-69 (ref)	1.000	N/A	1.000	N/A
Age 70-79	1.114	0.001	1.112	0.001
Age 80+	1.179	<.0001	1.206	<.0001
BSA (Boyd)				
(per 0.1 DBSA)	1.033	<.0001	1.034	<.0001
Body Mass Index				
<18.5 kg/m^2	1.214	0.000	1.151	0.008
=18.5 kg/m^2 (ref)	1.000	N/A	1.000	N/A

Table A2.2 Replaces BSA-DuBois with BSA-Gehan in Basic CM model.

	Pooled		Pooled, No Outliers*	
N	8,471		8,232	
R-square**	0.3363		0.3582	
	Multiplier	**P-value**	**Multiplier**	**P-value**
Age 18-44	1.246	<.0001	1.245	<.0001
Age 45-59	1.074	0.037	1.064	0.065
Age 60-69 (ref)	1.000	N/A	1.000	N/A
Age 70-79	1.112	0.001	1.106	0.002
Age 80+	1.178	<.0001	1.197	<.0001
BSA (Gehan)				
(per 0.1 DBSA)	1.034	<.0001	1.034	<.0001
Body Mass Index				
<18.5 kg/m^2	1.207	0.001	1.139	0.014
=18.5 kg/m^2 (ref)	1.000	N/A	1.000	N/A

Table A2.3 Replaces BSA-DuBois with BSA-Haycock in Basic CM model.

	Pooled		Pooled, No Outliers*	
N	8,471		8,232	
R-square**	0.3362		0.3581	
	Multiplier	**P-value**	**Multiplier**	**P-value**
Age 18-44	1.247	<.0001	1.246	<.0001
Age 45-59	1.074	0.036	1.065	0.064
Age 60-69 (ref)	1.000	N/A	1.000	N/A
Age 70-79	1.113	0.001	1.107	0.001
Age 80+	1.178	<.0001	1.197	<.0001
BSA (Haycock)				
(per 0.1 DBSA)	1.033	<.0001	1.033	<.0001
Underweight BMI				
<18.5 kg/m^2	1.208	0.000	1.141	0.013
=18.5 kg/m^2 (ref)	1.000	N/A	1.000	N/A

*Excluded facilities identified as having outlier values for covariates in the model or being potentially highly influential in the model based on high dfbeta statistics.

**Control variables for all models include: SNF wage index, facility size, hospital based vs. freestanding, % patients with URR>65, chain ownership, year of cost report, and % pediatric.

Table A2.4 Replaces BSA-DuBois with BSA-Mosteller in Basic CM model.

	Pooled		Pooled, No Outliers*	
N	8,471		8,231	
R-square**	0.3365		0.3577	
	Multiplier	**P-value**	**Multiplier**	**P-value**
Age 18-44	1.244	<.0001	1.242	<.0001
Age 45-59	1.074	0.038	1.065	0.064
Age 60-69 (ref)	1.000	N/A	1.000	N/A
Age 70-79	1.111	0.001	1.105	0.002
Age 80+	1.176	<.0001	1.196	<.0001
BSA (Mosteller) (per 0.1 DBSA)	1.034	<.0001	1.035	<.0001
Underweight BMI				
<18.5 kg/m^2	1.202	0.001	1.134	0.017
=18.5 kg/m^2 (ref)	1.000	N/A	1.000	N/A

Table A2.5 Replaces BSA with weight in Basic CM model.

	Pooled		Pooled, No Outliers*	
N	8,471		8,233	
R-square**	0.3353		0.3577	
	Multiplier	**P-value**	**Multiplier**	**P-value**
Age 18-44	1.256	<.0001	1.261	<.0001
Age 45-59	1.077	0.03	1.070	0.045
Age 60-69 (ref)	1.000	N/A	1.000	N/A
Age 70-79	1.120	0.0005	1.119	0.000
Age 80+	1.184	<.0001	1.213	<.0001
Weight (per 10 kg)	1.047	<.0001	1.049	<.0001
Body Mass Index				
<18.5 kg/m^2	1.210	0.0004	1.145	0.012
=18.5 kg/m^2 (ref)	1.000	N/A	1.000	N/A

Table A2.6 Replaces BSA with total body water (Chertow) in Basic CM model.

	Pooled		Pooled, No Outliers*	
N	8,471		8,234	
R-square**	0.3373		0.3589	
	Multiplier	**P-value**	**Multiplier**	**P-value**
Age 18-44	1.228	<.0001	1.221	<.0001
Age 45-59	1.069	0.05	1.059	0.090
Age 60-69 (ref)	1.000	N/A	1.000	N/A
Age 70-79	1.102	0.0027	1.096	0.004
Age 80+	1.164	<.0001	1.175	<.0001
Total Body water (per 4.0 DL)	1.044	<.0001	1.045	<.0001
Body Mass Index				
<18.5 kg/m^2	1.164	0.0036	1.095	0.081
=18.5 kg/m^2 (ref)	1.000	N/A	1.000	N/A

*Excludes facilities identified as having outlier values for covariates in the model or being highly influential in the model based on high dfbeta statistics.

**Control variables for all models include: SNF wage index, facility size, hospital based vs. freestanding, % patients with URR>65, chain ownership, year of cost report, and % pediatric.

Table A2.7 Replaces BSA with BMI in Basic CM model.

	Pooled		Pooled, No Outliers*	
N	8,471		8,243	
R-square**	0.3306		0.3541	
	Multiplier	**P-value**	**Multiplier**	**P-value**
Age 18-44	1.281	<.0001	1.283	<.0001
Age 45-59	1.082	0.022	1.082	0.020
Age 60-69 (ref)	1.000	N/A	1.000	N/A
Age 70-79	1.126	0.000	1.130	0.000
Age 80+	1.158	0.000	1.195	<.0001
Body Mass Index (per 3 kg/m^2)	1.013	0.014	1.018	0.001
Body Mass Index				
<18.5 kg/m^2	1.107	0.067	1.057	0.318
=18.5 kg/m^2 (ref)	1.000	N/A	1.000	N/A

Table A2.8 Replaces continuous BSA with categorical BSA (quartiles) in Basic CM model.

	Pooled		Pooled, No Outliers*	
N	8,471		8,223	
R-square**	0.3369		0.3597	
	Multiplier	**P-value**	**Multiplier**	**P-value**
Age 18-44	1.237	<.0001	1.236	<.0001
Age 45-59	1.073	0.040	1.064	0.068
Age 60-69 (ref)	1.000	N/A	1.000	N/A
Age 70-79	1.105	0.002	1.101	0.003
Age 80+	1.170	<.0001	1.186	<.0001
BSA as categorical variable				
1st-25th percentile	0.876	<.0001	0.875	<.0001
26th-50th percentile	0.960	0.192	0.944	0.062
51st-75th percentile	1.000	N/A	1.000	N/A
76th-100th percentile	1.105	0.001	1.108	0.001
Body Mass Index	1.000	N/A	1.000	N/A
<18.5 kg/m^2	1.168	0.004	1.094	0.087
=18.5 kg/m^2 (ref)	1.000	N/A	1.000	N/A

*Excludes facilities identified as having outlier values for covariates in the model or being highly influential in the model based on high dfbeta statistics.

**Control variables for all models include: SNF wage index, facility size, hospital based vs. freestanding, % patients with URR>65, chain ownership, year of cost report, and % pediatric.

Table A3.1 Basic Case-mix model, without low BMI

	Pooled		Pooled, No Outliers*	
N	8,471		8,254	
R-square**	0.3361		0.3594	
	Multiplier	**P-value**	**Multiplier**	**P-value**
Age 18-44	1.245	<.0001	1.235	<.0001
Age 45-59	1.076	0.0327	1.062	0.075
Age 60-69 (ref)	1.000	N/A	1.000	N/A
Age 70-79	1.107	0.0015	1.098	0.003
Age 80+	1.175	<.0001	1.191	<.0001
Body surface area (per 0.1 DBSA)	1.034	<.0001	1.034	<.0001

Table A3.2 Replaces low BMI <18.5 with low BMI <20 in Basic CM model.

	Pooled		Pooled, No Outliers*	
N	8,471		8,239	
R-square**	0.3368		0.3591	
	Multiplier	**P-value**	**Multiplier**	**P-value**
Age 18-44	1.231	<.0001	1.225	<.0001
Age 45-59	1.072	0.0434	1.057	0.099
Age 60-69 (ref)	1.000	N/A	1.000	N/A
Age 70-79	1.104	0.0023	1.095	0.004
Age 80+	1.166	<.0001	1.179	<.0001
Body surface area (per 0.1 DBSA)	1.038	<.0001	1.038	<.0001
Body Mass Index				
<20 kg/m^2	1.117	0.0028	1.089	0.021
=20 kg/m^2 (ref)	1.000	N/A	1.000	N/A

*Excludes facilities identified as having outlier values for covariates in the model or being highly influential in the model based on high dfbeta statistics.

**Control variables for all models include: SNF wage index, facility size, hospital based vs. freestanding, % patients with URR>65, chain ownership, year of cost report, and % pediatric.

Table A4.1 Adds HIV diagnosis to Basic CM model.

	Pooled		Pooled, No Outliers*	
N	8,471		8,179	
R-square**	0.3372		0.3641	
	Multiplier	**P-value**	**Multiplier**	**P-value**
Age 18-44	1.232	<.0001	1.215	<.0001
Age 45-59	1.071	0.0453	1.051	0.143
Age 60-69 (ref)	1.000	N/A	1.000	N/A
Age 70-79	1.108	0.0014	1.107	0.001
Age 80+	1.171	<.0001	1.191	<.0001
Body surface area (per 0.1 DBSA)	1.037	<.0001	1.037	<.0001
Body Mass Index				
<18.5 kg/m^2	1.182	0.0016	1.133	0.017
=18.5 kg/m^2 (ref)	1.000	N/A	1.000	N/A
HIV	1.074	0.0877	1.416	<.0001

Table A4.2 Adds AIDS diagnosis to Basic CM model.

	Pooled		Pooled, No Outliers*	
N	8,471		8,170	
R-square**	0.3375		0.3634	
	Multiplier	**P-value**	**Multiplier**	**P-value**
Age 18-44	1.232	<.0001	1.231	<.0001
Age 45-59	1.069	0.050	1.060	0.083
Age 60-69 (ref)	1.000	N/A	1.000	N/A
Age 70-79	1.108	0.002	1.113	0.001
Age 80+	1.171	<.0001	1.201	<.0001
Body surface area (per 0.1 DBSA)	1.037	<.0001	1.037	<.0001
Body Mass Index				
<18.5 kg/m^2	1.185	0.001	1.126	0.023
=18.5 kg/m^2 (ref)	1.000	N/A	1.000	N/A
AIDS	1.072	0.007	1.123	0.003

*Excludes facilities identified as having outlier values for covariates in the model or being highly influential in the model based on high dfbeta statistics.

**Control variables for all models include: SNF wage index, facility size, hospital based vs. freestanding, % patients with URR>65, chain ownership, year of cost report, and % pediatric.

Table A4.3 Adds multiple myeloma diagnosis to Basic CM model.

	Pooled		Pooled, No Outliers*	
N	8,471		8,193	
R-square**	0.3370		0.3598	
	Multiplier	**P-value**	**Multiplier**	**P-value**
Age 18-44	1.237	<.0001	1.230	<.0001
Age 45-59	1.073	0.0398	1.057	0.102
Age 60-69 (ref)	1.000	N/A	1.000	N/A
Age 70-79	1.105	0.002	1.088	0.008
Age 80+	1.169	<.0001	1.177	<.0001
Body surface area (per 0.1 DBSA)	1.037	<.0001	1.035	<.0001
Body Mass Index				
<18.5 kg/m^2	1.182	0.0016	1.099	0.071
=18.5 kg/m^2 (ref)	1.000	N/A	1.000	N/A
Multiple myeloma	1.075	0.3696	1.266	0.020

Table A4.4 Adds any PVD diagnosis to Basic CM model.

	Pooled		Pooled, No Outliers*	
N	8,471		8,230	
R-square	0.3388		0.3607	
	Multiplier	**P-value**	**Multiplier**	**P-value**
Age 18-44	1.276	<.0001	1.288	<.0001
Age 45-59	1.090	0.012	1.087	0.014
Age 60-69 (ref)	1.000	N/A	1.000	N/A
Age 70-79	1.100	0.003	1.101	0.002
Age 80+	1.164	<.0001	1.186	<.0001
Body surface area (per 0.1 DBSA)	1.037	<.0001	1.037	<.0001
Body Mass Index				
<18.5 kg/m^2	1.184	0.001	1.116	0.036
=18.5 kg/m^2 (ref)	1.000	N/A	1.000	N/A
Any PVD	1.089	<.0001	1.090	<.0001

Table A4.5 Adds arterial PVD diagnosis to Basic CM model.

	Pooled		Pooled, No Outliers*	
N	8,471		8,230	
R-square	0.3378		0.3595	
	Multiplier	**P-value**	**Multiplier**	**P-value**
Age 18-44	1.259	<.0001	1.267	<.0001
Age 45-59	1.082	0.022	1.079	0.025
Age 60-69 (ref)	1.000	N/A	1.000	N/A
Age 70-79	1.105	0.002	1.106	0.001
Age 80+	1.163	<.0001	1.185	<.0001
Body surface area (per 0.1 DBSA)	1.037	<.0001	1.037	<.0001
Body Mass Index				
<18.5 kg/m^2	1.185	0.001	1.116	0.036
=18.5 kg/m^2 (ref)	1.000	N/A	1.000	N/A
Arterial PVD	1.056	0.001	1.055	0.001

*Excludes facilities identified as having outlier values for covariates in the model or being highly influential in the model based on high dfbeta statistics.

**Control variables for all models include: SNF wage index, facility size, hospital based vs. freestanding, % patients with URR>65, chain ownership, year of cost report, and % pediatric.

Table A4.6 Adds Arterial or Unspecified PVD diagnosis to Basic CM model.

	Pooled		Pooled, No Outliers*	
N	8,471		8,229	
R-square**	0.3388		0.3611	
	Multiplier	**P-value**	**Multiplier**	**P-value**
Age 18-44	1.278	<.0001	1.284	<.0001
Age 45-59	1.090	0.0123	1.084	0.018
Age 60-69 (ref)	1.000	N/A	1.000	N/A
Age 70-79	1.104	0.0022	1.101	0.003
Age 80+	1.166	<.0001	1.188	<.0001
Body surface area (per 0.1 DBSA)	1.037	<.0001	1.037	<.0001
Body Mass Index				
<18.5 kg/m^2	1.189	0.0011	1.124	0.026
=18.5 kg/m^2 (ref)	1.000	N/A	1.000	N/A
Arterial or Unspecified PVD	1.084	<.0001	1.081	<.0001

Table A4.7 Adds diabetes diagnosis (ages 18 -44 only) to Basic CM model.

	Pooled		Pooled, No Outliers*	
N	8,471		8,215	
R-square**	0.3372		0.3602	
	Multiplier	**P-value**	**Multiplier**	**P-value**
Age 18-44 non-diabetic	1.184	<.0001	1.197	<.0001
Age 18-44 diabetic	1.313	<.0001	1.281	<.0001
Age 45-59	1.075	0.0343	1.064	0.069
Age 60-69 (ref)	1.000	N/A	1.000	N/A
Age 70-79	1.107	0.0016	1.099	0.003
Age 80+	1.174	<.0001	1.184	<.0001
Body surface area (per 0.1 DBSA)	1.037	<.0001	1.038	<.0001
Body Mass Index				
<18.5 kg/m^2	1.192	0.0009	1.126	0.024
=18.5 kg/m^2 (ref)	1.000	N/A	1.000	N/A
Test: age 18-44 diabetic = age 18-44 non-diabetic:				
F value	3.75		1.58	
P > F	0.0529		0.2082	

**Control variables for all models include: SNF wage index, facility size, hospital based vs. freestanding, % patients with URR>65, chain ownership, year of cost report, and % pediatric.

*Excludes facilities identified as having outlier values for covariates in the model or being highly influential in the model based on high dfbeta statistics.

**Control variables for all models include: SNF wage index, facility size, hospital based vs. freestanding, % patients with URR>65, chain ownership, year of cost report, and % pediatric.

Methodology for Developing a Basic Case Mix Adjustment for the Medicare ESRD Prospective Payment System

Addendum
March 2005

Appendix 3

List of ICD-9 Diagnosis Codes
That Were Used to Identify Peripheral Vascular Disease in
Medicare Claims

PERIPHERAL ARTERIAL DISEASES

HCPCS	Description
440	Atherosclerosis
4400	Atherosclerosis of aorta
4401	Atherosclerosis of renal artery
4402	Atherosclerosis of native arteries of the extremities
44020	Atherosclerosis of native arteries of the extremities, unspecified
44021	Atherosclerosis of native arteries of the extremities, with intermittent claudication
44022	Atherosclerosis of native arteries of the extremities, with rest pain
44023	Atherosclerosis of the extremities with ulceration
44024	Atherosclerosis of the extremities with gangrene
44029	Atherosclerosis of native arteries of the extremities, with ulceration
4403	Atherosclerosis of bypass graft of the extremities
44030	Atherosclerosis of bypass graft of the extremities of unspecified graft
44031	Atherosclerosis of bypass graft of the extremities of autologous vein bypass graft
44032	Atherosclerosis of bypass graft of the extremities of nonautologous biological bypass graft
441	Aortic aneurysm and dissection
4410	Aortic aneurysm and dissection,dissection of aorta
44100	Aortic aneurysm and dissection,dissection of aorta, unspecified site
44101	Aortic aneurysm and dissection,dissection of aorta, thoracic
44102	Aortic aneurysm and dissection,dissection of aorta, abdominal
44103	Aortic aneurysm and dissection,dissection of aorta, thoracoabdominal
4411	Thoracic aneurysm, ruptured
4412	Thoracic aneurysm without mention of rupture
4413	Abdominal aneurysm, ruptured
4414	Abdominal aneurysm without mention of rupture
4415	Aortic aneurysm of lunspecified site, ruptured
4416	Thoracoabdominal aneurysm, ruptured
4417	Thoracoabdominal aneurysm without mention of rupture
4419	Aortic aneurysm and dissection of unspecified site without mention of rupture
442	Other aneurysm
4420	Other aneurysm of artery of upper extremity
4421	Other aneurysm of renal artery
4422	Other aneurysm of iliac artery
4423	Other aneurysm of artery of lower extremity
4428	Other aneurysm of other specified artery
44281	Other aneurysm of other specified artery, artery of neck
44282	Other aneurysm of other specified artery, subclavian artery
44283	Other aneurysm of other specified artery, splenic artery
44284	Other aneurysm of other specified artery, other visceral artery
44289	Other aneurysm of other specified artery, other

4432	Other peripherovascular diseases, other arterial dissection
44321	Other peripherovascular diseases, other arterial dissection, dissection of carotid artery
44322	Other peripherovascular diseases, other arterial dissection, dissection of iliac artery
44323	Other peripherovascular diseases, other arterial dissection, dissection of renal artery
44324	Other peripherovascular diseases, other arterial dissection, dissection of vertebral artery
44329	Other peripherovascular diseases, other arterial dissection, dissection of other artery
444	Arterial embolism and thrombosis
4440	Arterial embolism and thrombosis, of abdominal aorta
4441	Arterial embolism and thrombosis, of thoracic aorta
4442	Arterial embolism and thrombosis, of arteries of the extremities
44422	Arterial embolism and thrombosis, of arteries of the extremities, lower extremity
4448	Arterial embolism and thrombosis, of other specified artery
44481	Arterial embolism and thrombosis, of other specified artery, upper extremity
44489	Arterial embolism and thrombosis, of other specified artery, lower extremity
4449	Arterial embolism and thrombosis, of unspecified artery
4450	Atheroembolism, of extremities
44501	Atheroembolism, of extremities, upper extremity
44502	Atheroembolism, of extremities, lower extremity
446	Polyarteritis nodosa and allied conditions
4460	Polyarteritis nodosa and allied conditions, polyarteritis nodosa

PERIPHERAL VENOUS DISEASES

HCPCS	Description
4151	Pulmonary embolism and infarction
41511	Pulmonary embolism and infarction, iatrogenic pulmonary embolism and infarction
451	Phlebitis and thrombophlebitis
4510	Phlebitis and thrombophlebitis of superficial vessels of lower extremities
4511	Phlebitis and thrombophlebitis, of deep vessels of lower extermities
45111	Phlebitis and thrombophlebitis, of deep vessels of lower extermities, femoral vein
45119	Phlebitis and thrombophlebitis, of deep vessels of lower extermities, other
4512	Phlebitis and thrombophlebitis, of lower extremities, unspecified
45181	Phlebitis and thrombophlebitis, of other, sites iliac vein
45182	Phlebitis and thrombophlebitis, of other sites, of superficial veins of upper extremities
45183	Phlebitis and thrombophlebitis, of other sites, of deep veins of upper extremities
45184	Phlebitis and thrombophlebitis, of upperextremities, unspecified
45189	Phlebitis and thrombophlebitis, other

4519	Phlebitis and thrombophlebitis, unspecified
453	Other venous embolism and thrombosis
4530	Other venous embolism and thrombosis, Budd-Chiari syndrome
4531	Other venous embolism and thrombosis, Thrombophlebitis migrans
4532	Other venous embolism and thrombosis of vena cava
4533	Other venous embolism and thrombosis of renal vein
4538	Other venous embolism and thrombosis of other specified sites
4539	Other venous embolism and thrombosis of unspecified site

UNSPECIFIED PERIPHERAL VASCULAR DISEASES

HCPCS	Description
4429	Other aneurysm of unspecified site
443	Other peripheral vascular disease
4430	Other peripheral vascular disease, Raynaud's syndrome
4431	Other peripheral vascular disease, thromboangiitis obliterans [Buerger's disease]
4438	Other peripheral vascular disease, other specified peripheral vascular disease
44381	Other peripheral vascular disease, other specified peripheral vascular disease, peripheral angiopathy in diseases classified elsewhere
44389	Other peripheral vascular disease, other specified peripheral vascular disease, other
4439	Peripheral vascular disease, unspecified