July 2006

PGP Demonstration Report on Risk Adjustment

Final Report

Prepared for

John Pilotte
Centers for Medicare & Medicaid Services
7500 Security Boulevard
C4-17-27
Baltimore, MD 21244-1850

Prepared by

Eric Olmsted, Ph.D.
Gregory C. Pope, M.S.
John Kautter, Ph.D.
RTI International
411 Waverley Oaks Road, Suite 330
Waltham, MA 02452-8414

RTI Project Number 07964.013

RTI INTERNATIONAL

PGP DEMONSTRATION REPORT ON RISK ADJUSTMENT

Authors: Eric Olmsted, Ph.D.
Gregory C. Pope, M.S.
John Kautter, Ph.D.

Project Director: Gregory C. Pope, M.S.

Federal Project Officer: John Pilotte

RTI International*

CMS Contract No. 500-00-0024, T.O. No. 13

July 2006

This project was funded by the Centers for Medicare & Medicaid Services under Contract No. 500-00-0024, T.O. No. 13. The statements contained in this report are solely those of the authors and do not necessarily reflect the views or policies of the Centers for Medicare & Medicaid Services. RTI assumes responsibility for the accuracy and completeness of the information contained in this report. The authors thank Michael Trisolini for his comments and suggestions.

*RTI International is a trade name of Research Triangle Institute.

CONTENTS

List of Tables

List of Figures

SECTION 1
INTRODUCTION AND OVERVIEW

The Physician Group Practice (PGP) demonstration is intended to reward improvements in the efficiency of medical practice. The demonstration does this by creating a bonus pool based on the growth in Medicare spending per beneficiary assigned to a PGP compared to the growth in per beneficiary spending in a comparison group of beneficiaries. The rate of growth in per beneficiary spending can also be affected by changes in casemix, or the health status, of the beneficiaries in a group. As a result, the Benefits Improvement and Protection Act (BIPA) legislation that authorizes the PGP demonstration requires that the performance targets be adjusted for health "risk."

1.1 Purpose of Risk Adjustment

To adjust for health risk, the PGP demonstration uses a version of the CMS-Hierarchical Condition Category (HCC) model implemented for Medicare managed care risk adjustment. This model, developed by RTI International under contract to CMS, is used to adjust capitation payments to Medicare managed care Medicare Advantage (MA) plans (Pope et al., 2004). The CMS-HCC model uses demographic information and diagnoses on administrative claims to predict Medicare expenditures. The concurrent CMS-HCC model used in the PGP demonstration is a modification of the prospective CMS-HCC model used to adjust managed care capitation payments. The difference between the prospective and concurrent models is the prospective model predicts expenditures from prior year diagnoses whereas the concurrent model predicts expenditures from current year diagnoses. The reasons for this difference in risk adjustment between the PGP demonstration and MA payment are discussed in Section 4.

The average risk score from the CMS-HCC model is applied to the observed per capita expenditure growth rates to remove the effects of changes in health status. A PGP that treats a population in the first year of the demonstration that is sicker than the population it treated in the base year of the demonstration will have its per capita expenditure growth rate adjusted downward to account for this change in health status. Similarly, the PGP's expenditure growth rate is adjusted upwards if the measured health status of its assigned population improves over time. An example of these adjustments is presented in Section 3.

Risk adjustment in the PGP demonstration adjusts expenditure growth rates for changes in average health status over time in PGP-assigned beneficiaries separately from the adjustments made for comparison group beneficiaries. It is not an adjustment for differences at a point in time between the health status of PGP-assigned and comparison group beneficiaries. For this reason, even if casemix differs between PGP-assigned and comparison group beneficiaries, to the extent that it is stable over time in these two groups, it will not affect comparison of PGP and comparison group expenditure growth rates.

1.2 Overview of the Risk Adjustment Process

As previously mentioned, the model used in the PGP demonstration is a modification of the CMS-HCC model currently used to adjust managed care capitation payments. The reasons

for this modification are discussed in Section 4, and are due to the role of risk adjustment in the PGP demonstration.

Risk adjustment is used in the PGP demonstration according to the following steps:

- assign risk markers;
- predict expenditures;
- calculate risk scores;
- calculate population average risk scores;
- adjust growth rates for risk;
- calculate PGP expenditure target; and
- compute Medicare savings.

Medicare savings are used to calculate the PGP bonus pool as described in the PGP Demonstration Bonus Methodology Specifications report (Kautter et al., 2004). A PGP with a lower adjusted growth rate than its comparison group generates Medicare savings and therefore a bonus may be paid.

1.3 Structure of Report

This report describes the role of risk adjustment in the PGP demonstration, the CMS-HCC model that is applied, and the adaptation of the CMS-HCC model for the PGP demonstration. The next section describes how the CMS-HCC model uses diagnostic information to predict expenditures for each beneficiary. Section 3 illustrates the calculation of risk scores and how the risk scores are used to adjust expenditure growth rates. Section 4 provides an overview of how the CMS-HCC model has been adapted for the PGP demonstration. Sections 5 and 6 describe the CMS-HCC models that will be used in the PGP demonstration. Section 7 delineates the data requirements of the methodology, as well as how the model will be updated over the life of the demonstration. Section 8 provides a brief conclusion.

SECTION 2
THE CMS-HCC RISK ADJUSTMENT MODEL

The CMS-HCC model is an expenditure prediction method based on health risk markers. Risk markers are assigned using demographic and diagnostic information from health insurance enrollment and claims files to create predictions of health care expenditures for Medicare beneficiaries. These predictions are used to adjust per capita expenditure growth rates for any changes that occur in the health status of the population under consideration.

This section describes the CMS-HCC model, including how risk markers are assigned and used to generate health care expenditure predictions. The next section describes how health care expenditure predictions are utilized in the PGP demonstration. The operation of the CMS-HCC models and the model weights, are described in Sections 5 and 6.

2.1 Risk Marker Assignment

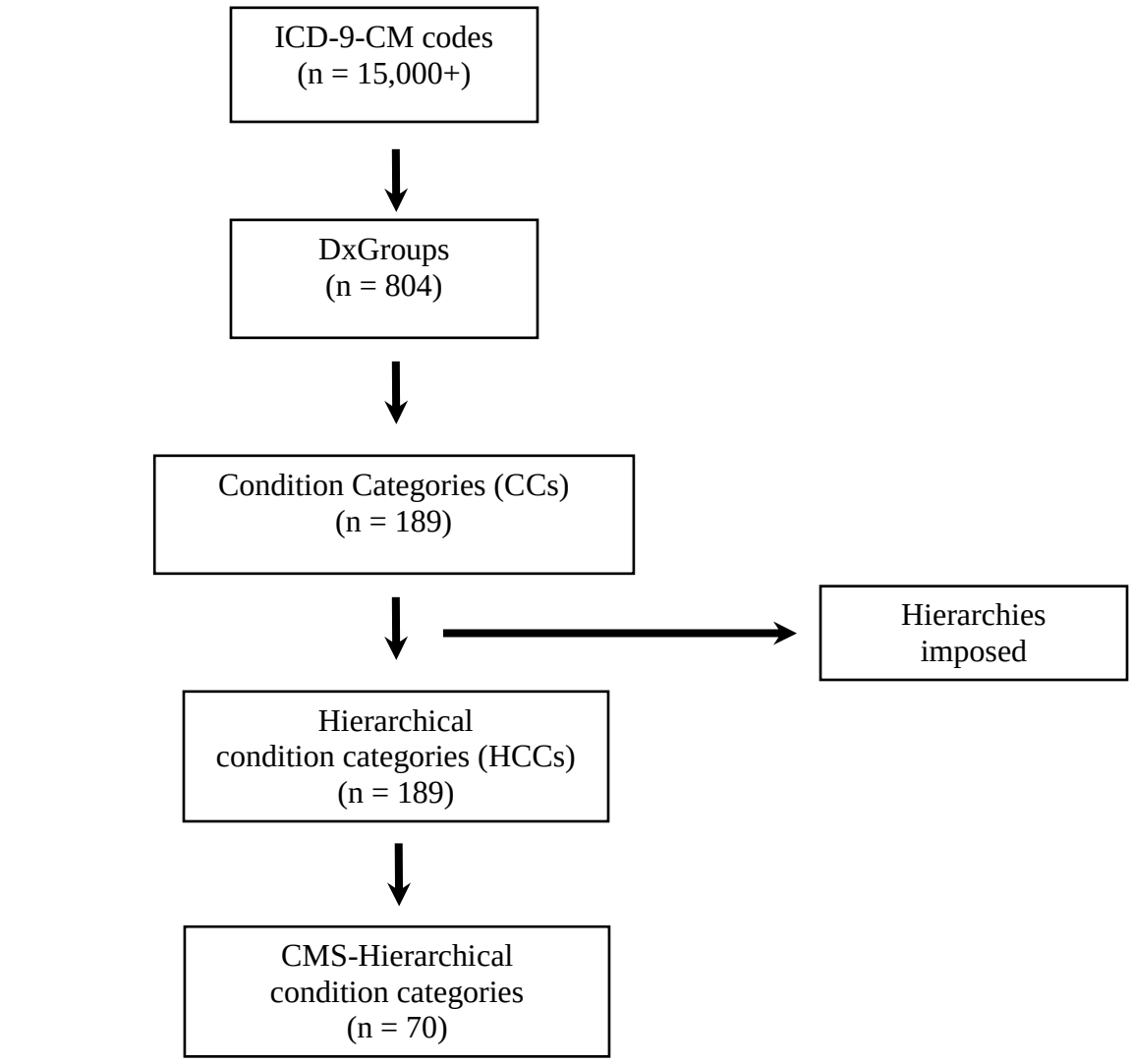
2.1.1 Diagnostic Classification System

The HCC diagnostic classification system begins by classifying each of the more than 15,000 ICD-9-CM diagnosis codes into 804 diagnostic groups, or DxGroups (see ***Figure 1***). Diagnosis codes are collected for each beneficiary over a twelve-month base period. Each ICD-9-CM code maps into one DxGroup, which represents a specific medical condition. An example is DxGroup 28.01 “acute liver disease”. DxGroups are further aggregated into 189 Condition Categories, or CCs that describe major diseases and are broadly organized into body systems, somewhat analogous to the ICD-9-CM major diagnostic categories. The CCs are designed to be both clinically- and cost-similar, although they are not as uniform as the DxGroups. An example is CC 28 “Acute Liver Failure/Disease” which includes DxGroups 28.01 and 28.02 “viral hepatitis, acute or unspecified, with hepatic coma”. In most cases, DxGroups are assigned to only one CC. However, in a few cases, a single ICD-9-CM code indicates more than one disorder, for example, ICD-9-CM 404.03 “hypertensive heart and renal disease with congestive heart failure and renal failure”. This code is assigned to DxGroup 131.03 “hypertensive heart/renal disease with heart/renal failure”, which has a primary CC assignment of 131 “Renal Failure,” but also receives a secondary or “duplicate” assignment to CC 80 “Congestive Heart Failure.”

2.1.2 Hierarchies

Hierarchies are imposed among related CCs so that a person is assigned only to one CC with the most severe manifestation of related diseases. For example, ICD-9-CM ischemic heart disease codes are organized into the “Coronary Artery Disease” hierarchy. The hierarchy consists of 4 CCs arranged in descending order of clinical severity and cost, from CC 81 “Acute Myocardial Infarction” to CC 84 “Coronary Athlerosclerosis/Other Chronic Ischemic Heart Disease.” A person with an ICD-9-CM code for CC 81 is excluded from CCs 82, 83 or 84 even if the person received ICD-9-CM codes that group for those categories. Similarly, a person with ICD-9-CM codes that group into CCs 82 “Unstable Angina and Other Acute Ischemic Heart Disease” and into 83 “Angina Pectoris/Old Myocardial Infarction” is assigned exclusively to CC 82.

Figure 1
HCC Aggregations of ICD-9-CM Codes



SOURCE: RTI International

After the hierarchies are imposed, the CCs become Hierarchical Condition Categories (see Figure 1). In this way, the 15,000+ diagnosis codes are used to assign values for each beneficiary for the full set of 189 HCCs. The value for each HCC can be either '1' indicating that the beneficiary has a diagnosis code for that condition, or '0' indicating that the beneficiary does not have a diagnosis code for that condition. A beneficiary can have multiple HCCs coded as '1', but not more than one in the same disease hierarchy.

2.1.3 CMS-HCCs

The CMS-HCC model selects only 70 of the original 189 HCCs for use in Medicare Advantage payment. (***Table 1*** lists the 70 HCCs in the CMS-HCC model.) Thus, the CMS-HCC model is a "selected significant diseases" model that focuses on adjusting for risk associated with selected high-cost diagnoses; it does not incorporate all diagnoses. The 70 HCCs in the CMS-HCC model:

- cover a broad spectrum of health disorders;
- contain well-defined diagnostic criteria;
- include non-discretionary diagnoses in that they are serious disorders that are likely to be diagnosed and treated when they occur; and
- identify conditions with significant expected health expenditures.

HCCs that represent discretionary diagnoses that may or may not be diagnosed and/or treated, and are subject to substantial diagnostic coding variations across providers were excluded from the CMS-HCC system. Typically excluded HCCs are diseases or conditions with a relatively low health and expenditure impact, such as HCC 24 "Other Endocrine/Metabolic/ Nutritional Disorders," or vague or nonspecific HCCs such as, HCC 167 "Minor Symptoms, Signs, Findings." Excluded HCCs also include diseases that are highly prevalent among Medicare beneficiaries but subject to erratic diagnosis and coding such as HCC 91 "Hypertension."

In addition to diagnosis based markers, the CMS-HCC model uses a variety of demographic markers. Demographic markers are based on the age, sex, and enrollment status of the beneficiary. The enrollment status includes whether the beneficiary is enrolled in Medicaid, or was originally qualified for Medicare due to disability. Medicare beneficiaries under 65 years of age qualify because of disability.

The CMS-HCC model greatly reduces administrative complexity while sacrificing little predictive power compared to the full 189 HCC model. Beneficiaries diagnosed with at least one CMS-HCC encompass 61% of all Medicare fee-for-service beneficiaries, but they account for 94% of total expenditures for all Medicare fee-for-service beneficiaries.[1] Also, the CMS-HCC model explains 92% of the variation in health care expenditures that is explained by including all 189 HCCs. The CMS-HCC model creates predictions that are more robust to diagnostic coding and treatment differences across providers than the full model.

2.2 Expenditure Prediction

Risk markers are the building blocks with which health care expenditure prediction is based. Each of the risk markers (including both HCCs and demographic markers) in the CMS-

[1] Costs of beneficiaries without any CMS-HCCs are predicted with demographic information (costs of beneficiaries with at least one CMS-HCC are predicted with both diagnostic and demographic information). Thus, expenditures are predicted for all beneficiaries and all costs are included in the model.

Table 1
CMS Hierarchical Condition Categories

HCC Number	HCC Label
HCC1	HIV/AIDS
HCC2	Septicemia/Shock
HCC5	Opportunistic Infections
HCC7	Metastatic Cancer and Acute Leukemia
HCC8	Lung, Upper Digestive Tract, and Other Severe Cancers
HCC9	Lymphatic, Head and Neck, Brain, and Other Major Cancers
HCC10	Breast, Prostate, Colorectal and Other Cancers and Tumors
HCC15	Diabetes with Renal or Peripheral Circulatory Manifestation
HCC16	Diabetes with Neurologic or Other Specified Manifestation
HCC17	Diabetes with Acute Complications
HCC18	Diabetes with Ophthalmologic or Unspecified Manifestation
HCC19	Diabetes without Complication
HCC21	Protein-Calorie Malnutrition
HCC25	End-Stage Liver Disease
HCC26	Cirrhosis of Liver
HCC27	Chronic Hepatitis
HCC31	Intestinal Obstruction/Perforation
HCC32	Pancreatic Disease
HCC33	Inflammatory Bowel Disease
HCC37	Bone/Joint/Muscle Infections/Necrosis
HCC38	Rheumatoid Arthritis and Inflammatory Connective Tissue Disease
HCC44	Severe Hematological Disorders
HCC45	Disorders of Immunity
HCC51	Drug/Alcohol Psychosis
HCC52	Drug/Alcohol Dependence
HCC54	Schizophrenia
HCC55	Major Depressive, Bipolar, and Paranoid Disorders
HCC67	Quadriplegia, Other Extensive Paralysis
HCC68	Paraplegia
HCC69	Spinal Cord Disorders/Injuries
HCC70	Muscular Dystrophy
HCC71	Polyneuropathy
HCC72	Multiple Sclerosis
HCC73	Parkinson's and Huntington's Diseases
HCC74	Seizure Disorders and Convulsions
HCC75	Coma, Brain Compression/Anoxic Damage
HCC77	Respirator Dependence/Tracheostomy Status
HCC78	Respiratory Arrest
HCC79	Cardio-Respiratory Failure and Shock
HCC80	Congestive Heart Failure

(continued)

Table 1 (continued)
CMS Hierarchical Condition Categories

HCC Number	HCC Label
HCC81	Acute Myocardial Infarction
HCC82	Unstable Angina and Other Acute Ischemic Heart Disease
HCC83	Angina Pectoris/Old Myocardial Infarction
HCC92	Specified Heart Arrhythmias
HCC95	Cerebral Hemorrhage
HCC96	Ischemic or Unspecified Stroke
HCC100	Hemiplegia/Hemiparesis
HCC101	Cerebral Palsy and Other Paralytic Syndromes
HCC104	Vascular Disease with Complications
HCC105	Vascular Disease
HCC107	Cystic Fibrosis
HCC108	Chronic Obstructive Pulmonary Disease
HCC111	Aspiration and Specified Bacterial Pneumonias
HCC112	Pneumococcal Pneumonia, Emphysema, Lung Abscess
HCC119	Proliferative Diabetic Retinopathy and Vitreous Hemorrhage
HCC130	Dialysis Status
HCC131	Renal Failure
HCC132	Nephritis
HCC148	Decubitus Ulcer of Skin
HCC149	Chronic Ulcer of Skin, Except Decubitus
HCC150	Extensive Third-Degree Burns
HCC154	Severe Head Injury
HCC155	Major Head Injury
HCC157	Vertebral Fractures without Spinal Cord Injury
HCC158	Hip Fracture/Dislocation
HCC161	Traumatic Amputation
HCC164	Major Complications of Medical Care and Trauma
HCC173	Major Organ Transplant Status (Procedure)
HCC174	Major Organ Transplant Status
HCC176	Artificial Openings for Feeding or Elimination
HCC177	Amputation Status, Lower Limb/Amputation Complications

SOURCE: RTI International

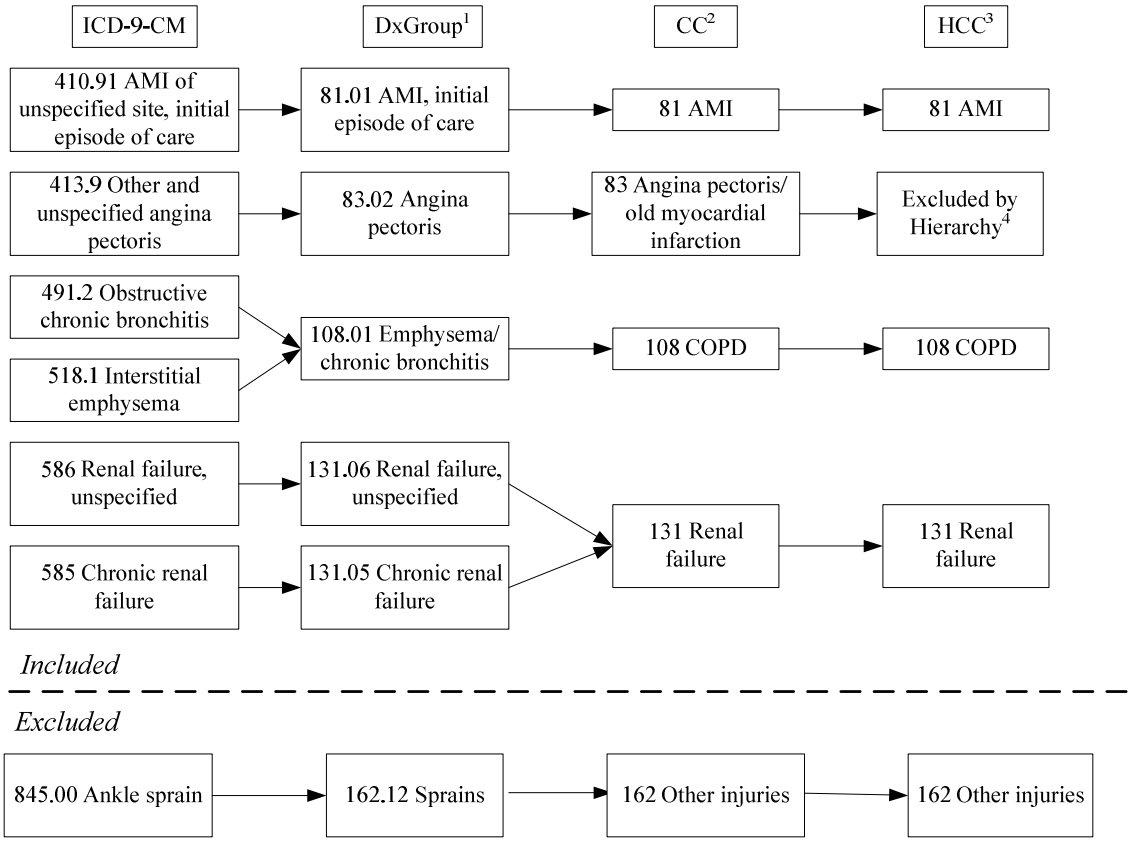
HCC model is assigned a dollar value based on its predicted impact on health care expenditures. A prediction is generated for every beneficiary by summing the dollar amounts for the corresponding HCC and demographic markers assigned to the beneficiary. The total is the beneficiary's predicted health care expenditure for the analysis year.[2]

As an example of expenditure prediction, consider our hypothetical scenario in ***Figure 2*** of a 79-year-old woman diagnosed with AMI, angina pectoris, COPD, renal failure, and an ankle sprain over a twelve month period. The seven reported diagnosis codes assign five HCCs which are used to create an expenditure prediction. The woman receives the incremental cost predictions from a preliminary version of the concurrent CMS-HCC model shown in ***Table 2***.

Note that not every diagnosis is used to generate the expenditure prediction. The CMS-HCC model is a hierarchical model, and the woman receives no incremental cost prediction for angina pectoris because AMI is ranked higher in the coronary artery disease hierarchy. No incremental prediction is made for ankle sprain because this diagnosis is not included in the CMS-HCC model. Ankle sprain is an example of a condition excluded because it has a relatively low impact on expenditure, and it may not always be diagnosed or treated. Her total expenditure prediction is the sum of the incremental predictions, or $21,870.

[2] For comparison of beneficiary groups, expenditure predictions are converted to risk scores. This process is described in Section 3. The models presented in Sections 5 and 6 present risk score coefficients, rather than dollar coefficients.

Figure 2
Clinical Vignette for CMS-HCC Classification
79 Year Old Woman with AMI, Angina Pectoris, COPD, Ankle Sprain, and Renal Failure



1. DxGroup - Diagnosis Group
2. CC - Condition Category
3. HCC - Hierarchical Condition Category
4. HCC 83 is superceded by HCC 81 within the coronary disease hierarchy. HCC 81 is the more severe manifestation and is, therefore, included.

SOURCE: RTI International

Table 2
Hypothetical Example of Expenditure Prediction

Risk Marker	Incremental Prediction
AMI (HCC 81)	$14,629
Angina pectoris (HCC 83)[1]	$0
COPD (HCC 108)	$2,465
Renal failure (HCC 131)	$4,776
Ankle sprain (HCC 162)[2]	$0
TOTAL	**$21,870**

[1] HCC 83, angina pectoris has an incremental prediction, but the amount is not added because HCC 81, AMI, is within the same hierarchy and is the more severe manifestation of cardiovascular disease.

[2] Ankle sprain is excluded due to its low impact on expenditures.

SOURCE: RTI International.

SECTION 3
RISK SCORES AND RISK ADJUSTMENT

Risk scores are comparisons of predicted expenditures for a beneficiary to the average expenditures of all Medicare beneficiaries. This section describes the calculation of risk scores, and discusses how risk scores are used to adjust expenditures and the calculation of Medicare savings. A hypothetical example is included to clarify the concepts and methodology.

3.1 Risk Scores

Each beneficiary in a sample population generates a total expenditure prediction based on the risk markers assigned, and each expenditure prediction is used to calculate an individual's risk score. Individual risk scores are then used to calculate average risk scores for the entire population.

The risk score is the ratio of the beneficiary's predicted expenditure and the average expenditures of all Medicare beneficiaries. The risk score expresses how expensive a beneficiary is predicted to be relative to the "average" Medicare beneficiary.

$$\textbf{Risk Score} = \frac{\text{Beneficiary's Predicted Expenditure}}{\text{National Average of Medicare Beneficiaries' Expenditures}}$$

The national average expenditure for the Medicare population was $7,728[3] in 2004 (the model is calibrated based on the experience of beneficiaries in the year 2004). Therefore, a beneficiary who has predicted expenditures of $7,728 will have a risk score of 1.000. A beneficiary who has predicted expenditures of $15,456 will have a risk score of 2.000, and has double the expenditure risk of the average Medicare beneficiary.

The average of risk scores for individual beneficiaries weighted by person years of eligibility generates the average risk score for the population under consideration. A PGP that is assigned 15,000 full-year-eligible beneficiaries has an average risk score equal to the sum of the 15,000 individual risk scores divided by 15,000.

$$\textbf{Average Risk Score}[4] = \frac{\text{Sum of Beneficiary Risk Scores for Group}}{\text{Number of Beneficiaries in Group}}$$

---

[3] The actual national average expenditure was calibrated using the PGP demonstration model calibration sample. The PGP sample includes only beneficiaries with at least one E&M visit during 2004. See Section 4 for a discussion of the PGP sample.

[4] This formula assumes that all beneficiaries have 12 months of enrollment. Actual average risk score calculations will use the sum of the fraction of months enrolled (i.e., full-year equivalents) for the beneficiaries as the denominator.

Population risk scores are interpreted similarly to individual risk scores. A population with a risk score greater than 1.000 indicates expected expenditures greater than average. A population with a risk score less than 1.000 indicates expected expenditures less than average.

3.2 Risk Adjustment of Expenditure Growth Rates and Medicare Savings Calculations

3.2.1 Expenditure Growth Rates

The average risk score for a performance year is compared to the average risk score for the base year[5] to create risk ratios, which are then used to adjust base year per capita expenditures. The risk ratio is created by dividing the average risk score for the population during the performance year by the population average risk score during the base year. Risk ratios are created separately for each PGP and each PGP's comparison group.

$$\textbf{Risk Ratio} = \frac{\text{Average Risk Score in Performance Year}}{\text{Average Risk Score in Base Year}}$$

A PGP's or comparison group's risk ratio adjusts the observed base year per capita expenditures which is then compared to the performance year per capita expenditures to calculate the risk adjusted growth rate. A PGP that is assigned a set of beneficiaries with a higher average risk score in the performance year than in the base year will have its base year expenditures adjusted higher, reducing the adjusted growth rate.

$$\textbf{Adjusted Base Year Per Capita Expenditures} = \text{Base Year Per Capita Expenditures} * \text{Risk Ratio}$$

Adjusted base year per capita expenditures are calculated for both the PGP and comparison group beneficiary populations. Adjusted comparison group per capita growth rates set the performance target for the PGP, and are used to evaluate PGP efficiency for that year.

$$\textbf{Adjusted Per Capita Growth Rate} = \frac{\text{(Actual Performance Year Per Capita Expenditures-Adjusted Base Year Per Capita Expenditures)}}{\text{Adjusted Base Year Per Capita Expenditures}}$$

The performance target for the PGP is equal to the adjusted per capita growth rate for the comparison group multiplied by the PGP's adjusted base year per capita expenditures. The difference between the PGP target per capita expenditures and actual per capita expenditures generates the bonus pool for the participating PGP.

[5] The base year for the PGP demonstration will be April 2004 to March 2005.

PGP Performance Target = Adjusted *Comparison Group* Per Capita Growth Rate * Adjusted *PGP* Base Year Per Capita Expenditures

The example provided in ***Table 3*** illustrates the importance of adjusting for health risk when comparing expenditure growth rates. The first row shows the observed expenditures and risk scores of a PGP during a demonstration performance year. Per capita expenditures have grown from $6,000 in the base year to $6,400 in the performance year, for an unadjusted growth rate of 6.7%.[6] The average risk score of the assigned beneficiaries has also risen, from 1.00 to 1.05, indicating that the average health status of the beneficiaries assigned to the PGP has declined. The risk ratio[7] is applied to the base year expenditures to adjust for the change in the health status of the beneficiaries assigned to the PGP. The adjusted base year expenditures are $6,300[8] resulting in a risk adjusted growth rate of only 1.6%.[9] The health status of beneficiaries assigned to the PGP in the performance year compared to the base year was such that per capita expenditures are expected to grow from $6,000 to $6,300 due only to differences in health status.

Table 3
Hypothetical Example of Risk Adjustment of Expenditure Growth

	Actual Per Capita Expenditures			**Average Risk Score**			**Risk Adjusted**		
	Base Year	Performance Year	Growth Rate	Base Year	Performance Year	Risk Ratio	Expenditures, Base	Expenditures, Performance	Growth Rate
PGP Beneficiaries	6,000	6,400	6.7%	1.000	1.050	1.05	6,300	6,400	1.6%
Comparison Group	6,500	6,630	2.0%	1.000	0.950	0.95	6,175	6,630	7.4%

The expenditures of beneficiaries in the comparison group grew at only a 2.0%[10] unadjusted rate. In contrast to the beneficiaries assigned to the PGP, the average risk score of the comparison group beneficiaries has declined from 1.000 to 0.950, indicating an improvement in the health status of those beneficiaries. As a result the comparison group risk ratio equals 0.95.[11]

---

6 (6,400 – 6,000) / 6,000 = 6.7%.

7 1.050 / 1.000 = 1.05.

8 6,000 * 1.050 = 6,300.

9 (6,400 – 6,300) / 6,300 = 1.6%.

10 (6,630 – 6,500) / 6,500 = 2.0%.

11 .950 / 1.000 = .95

This is applied to the comparison group base year expenditures, resulting in adjusted base year expenditures of $6,175.[12] The resulting risk adjusted comparison group growth rate is 7.4%.[13]

3.2.2. Medicare Savings

Medicare savings, which comprise the potential bonus pool, are calculated by comparing actual performance year expenditures to the PGP's target expenditures. Target expenditures are equal to the PGP's base year expenditures multiplied by the comparison group's growth rate. Consider the example in ***Table 4*** that shows this calculation with and without risk adjustment. The top row shows the calculation of per capita PGP target expenditures and Medicare savings without using risk adjustment. In this case, target expenditures would be simply equal to actual base year expenditures multiplied by the comparison group's actual expenditure growth rate, or $6,120.[14] Per capita Medicare savings without risk adjustment would be -$280, the difference between target expenditures and actual PGP performance year expenditures.[15]

Table 4
Hypothetical Example of Medicare Savings Calculation

	Per Capita				
	PGP Base Year Expenditures	Comparison Group Expenditure Growth Rate	PGP Target Expenditures	Actual PGP Performance Year Expenditures	Medicare Savings
Unadjusted	6,000	2.0%	6,120	6,400	–280
Risk Adjusted	6,300	7.4%	6,766	6,400	366

Risk adjusted expenditures provide a more accurate assessment of the performance of the PGP. Notice that PGP base year expenditures are 6,300 in the second (risk adjusted) row. As previously mentioned, this indicates that the change in health status from the base year to the performance year of PGP assigned beneficiaries would have driven per capita expenditures up $300. Risk adjusted target expenditures equal to $6,766 are now calculated as risk adjusted PGP base year expenditures multiplied by the risk adjusted comparison group growth rate.[16] Actual per capita Medicare savings are therefore $366, the difference between risk adjusted PGP target expenditures and actual PGP performance year expenditures.[17]

[12] 6,500 * .95 = 6,175.

[13] (6,630 – 6,175) / 6,175 = 7.4%.

[14] 6,000 * 1.020 = 6,120.

[15] 6,120 – 6,400 = -280.

[16] 6,300 * 1.074 = 6,766.

[17] 6,766 – 6,400 = 366.

The above method is used to calculate target expenditures and Medicare savings during each performance year of the demonstration. Comparison group expenditure growth rates are measured from the same base year (i.e., April 2004 to March 2005) for each Performance Year 1, 2, and 3. PGP performance in each Performance Year, therefore, depends on cumulative expenditure growth since the base year. The demonstration is not rebased during its three year duration. The base year for the demonstration is always used to calculate expenditure targets.

In the example presented in Table 4, unadjusted expenditures of PGP-assigned beneficiaries grew at a higher rate than expenditures of the comparison group. When adjusted for health risk the relative growth rates are reversed and the PGP may be eligible for a bonus, as seen by the positive Medicare savings. Conversely, in some cases, risk adjustment could also eliminate a PGP's eligibility for bonuses calculated using unadjusted data.

[This page left intentionally blank.]

SECTION 4
CUSTOMIZATION OF THE CMS-HCC MODEL FOR PGP DEMONSTRATION

The primary modification made to the prospective CMS-HCC model for the PGP demonstration was to develop a concurrent version of the model (concurrent models are discussed in Section 4.1). In addition, we refined the concurrent model to meet the needs of the PGP demonstration. These modifications fall into the following categories:

- recalibrating the model to reflect the expenditures and population eligible for the PGP demonstration;
- including beneficiaries entitled by end-stage renal disease (ESRD);
- identifying beneficiaries receiving a major organ transplant in a performance year; and
- including beneficiaries who are newly enrolled in Medicare during a performance year.

The PGP demonstration uses the same 70 HCCs in its concurrent model as are used by CMS for the prospective payment model, but additional risk markers are used to account for beneficiaries entitled by ESRD, and those that received a major organ transplant. ESRD beneficiaries will be included in the PGP demonstration so they must be accounted for in the concurrent risk adjustment model. Beneficiaries who have received organ transplants are included in the prospective CMS-HCC model calibration sample, but are not explicitly identified by a transplant procedure code in the year of their transplant. Transplant recipients are very expensive in the year they receive their transplant, so it is important to adjust for them in concurrent risk adjustment. In addition, a separate methodology is used to calculate predictions for new enrollees. Finally, the model is recalibrated to reflect expenditures of the beneficiary population eligible for the PGP demonstration. In particular, the recalibration sample is restricted to users of office or other outpatient evaluation and management (E&M) services.

The cost patterns of these groups need to be explicitly recognized in the concurrent risk adjustment model. The next section explains the need for the concurrent model in the PGP demonstration, while the succeeding sections describe the steps taken to adjust the concurrent CMS-HCC model for beneficiaries eligible for the demonstration.

4.1 Concurrent versus Prospective Risk Adjustment

The CMS-HCC model used for Medicare Advantage plan payment is “prospective” in that it uses prior year diagnoses to predict Medicare expenditures. The “concurrent” model applied in the PGP demonstration uses current year diagnoses to predict Medicare expenditures. A prospective risk adjustment model places more emphasis on chronic conditions that are likely to affect health care costs during future periods. This is preferable when making capitation payments in advance. In contrast, concurrent models capture acute illnesses (including acute exacerbations of chronic illnesses) that have higher costs during the performance year.

A beneficiary that experiences an acute event, such as a heart attack, is expected to have somewhat elevated expenditures in the following year, but will have significantly elevated expenditures during the year the heart attack occurs. The prospective model puts an MA plan at risk for the occurrence of the heart attack in a particular person. It compensates on average with payments for such events through dollars associated with the demographic profile and with chronic conditions associated with higher risk of heart attack in the following year. A concurrent model accounts for the higher current expenditures of current-year heart attack patients.

There are several reasons to use concurrent rather than prospective risk adjustment in the PGP demonstration. First, the PGP demonstration is a non-enrollment model, with assignment of beneficiaries to PGPs based on current-year utilization. Only concurrent risk adjustment can account for the non-random assignment of beneficiaries to PGPs based on current year health status. Consider triaging referral of acute care cases. Some PGPs participating in the demonstration may be tertiary care referral centers. The most serious, complex cases would be referred to them based on acute, emergent conditions. The health status and expenditure risk posed by these cases can be measured only by concurrent risk adjustment utilizing current diagnoses. Prospective risk adjustment using last year's diagnoses cannot measure emergent acuity and would be inadequate for the PGP demonstration.

Prospective risk adjustment is appropriate for MA risk adjustment because beneficiaries must enroll in MA plans, which are then responsible for all their care over a period of time. Assignment of beneficiaries to MA plans occurs at the beginning of the period (typically the beginning of the year), and is not changed based on emergent variations in health status. Thus, it is appropriate to adjust the risk of MA plans based on information known at the time of enrollment, which is the information used in prospective risk adjustment.

Second, concurrent models explain a much higher proportion of expenditure variation than do prospective models. The percentage of individual variation explained by a concurrent model is approximately 50%, versus approximately 10% for prospective models (Pope et al., 2000). This makes concurrent models more accurate in adjusting expenditure growth rates for health status. The reason for the higher explanatory power of concurrent models is that they explain expenditure variations associated with acute events in the current year that prospective models will miss. This means concurrent models greatly reduce performance risk related to health status variation compared with prospective models[18].

HMOs and other MA organizations are licensed risk-bearing entities that can assume the risk related to prospective risk adjustment. In contrast, PGPs participating in the PGP demonstration are provider groups that are not at risk in the demonstration, although they have an opportunity to earn a bonus. What is needed for the PGP demonstration is a “casemix” adjuster to control for the mix of cases actually seen in the present year, not a prospective “risk” adjuster to control for future risk based on prior information.[19]

---

[18] Concurrent models also give credit for complications that occur during the current year.

[19] The terms “casemix” adjustment and “risk” adjustment are often used somewhat loosely and interchangeably. A more consistent usage of the terms would associate “casemix” adjustment with concurrent risk adjustment for present time periods, and “risk” with prospective risk adjustment for future time periods.

Third, in practice, MA capitation rates are set at the beginning of the year. MA plans typically want to know what "budget" they have to manage within. Setting rates at the beginning of the year requires using information available at that time, which is the prior year diagnoses used in prospective risk adjustment. On the other hand, in the PGP demonstration, bonus calculations will occur retrospectively, after the end of each performance year when complete claims data are available. This retrospective time frame makes concurrent risk adjustment feasible for the PGP demonstration.

4.2 Recalibration of Model for PGP Demonstration Expenditures and Population

There are some differences between the expenditures and beneficiary population eligible for the PGP demonstration versus the expenditures and sample used in estimating risk adjustment models for Medicare managed care. Most importantly, in the PGP demonstration, annualized per beneficiary expenditures are capped at $100,000 and beneficiaries must have at least one office or other outpatient evaluation and management service to be eligible for the demonstration (PGP-assigned or comparison group) (Kautter et al., 2004). In managed care risk adjustment modeling, expenditures are not capped and the sample is not restricted according to beneficiary utilization. These differences can affect measured health risk and expenditure predictions. To account for the differences, RTI recalibrated the concurrent CMS-HCC model using the expenditure definition and sample eligible for the PGP demonstration. In the next section we present the model produced after modification and recalibration.

4.3 ESRD Population

Approximately 1% of Medicare beneficiaries are entitled by ESRD. Although this is a small proportion, ESRD eligibles are, on average, nearly 10 times more expensive than beneficiaries entitled by age or disability (an average annualized cost of approximately $60,000 for ESRD beneficiaries compared to close to $7,000 for aged/disabled beneficiaries). To account for these cost differences the concurrent PGP demonstration model was adjusted to capture the mean costs of:

- ESRD enrollees currently undergoing dialysis;
- ESRD enrollees undergoing a kidney transplant; and
- ESRD enrollees that have already had a kidney transplant (and are maintaining a functioning graft).

A separate prospective risk adjustment model has been developed by CMS for capitated MA payment for beneficiaries entitled by ESRD. We use a similar, though simpler version of the model for the PGP demonstration. This approach accounts for the high average and concurrent costs of ESRD beneficiaries and for their diagnostic profile.

4.4 Major Organ Transplants

Beneficiaries who receive a major organ transplant (bone marrow, heart, liver, lung, pancreas, intestines) are also substantially more expensive than an average Medicare beneficiary. The concurrent CMS-HCC model used for the PGP demonstration includes a HCC risk category

for major organ transplants to capture their very high current year expenditures. This category is based on CPT procedure codes recorded on claims, unlike the ICD-9 diagnosis codes used for most HCCs.

4.5 New Enrollee Population

We developed a demographic model to predict expenditures for new enrollees. The PGP demonstration requires that eligible beneficiaries have Part A and Part B coverage for all of the months they are enrolled in Medicare during a demonstration year. We therefore define new enrollees as beneficiaries eligible for the demonstration who are not continuously enrolled in both Part A and Part B Medicare for all of their months alive during a demonstration year. (New enrollees must have at least one month of A/B enrollment—and no months of A-only or B-only enrollment—during a demonstration year to be eligible for the demonstration.) A beneficiary is considered continuously enrolled:

- if they were enrolled in January of the demonstration year; and
- if their Part A and Part B coverage is continuous through December of that year, or until the death of the beneficiary.

All other beneficiaries eligible for the demonstration are considered new enrollees. For example, a beneficiary newly enrolling in the Medicare program at 65 years of age in the middle of a demonstration performance year is considered a new enrollee. Continuing enrollees are risk adjusted using the CMS-HCC model, new enrollees are not. Diagnosis-based risk adjustment requires a complete diagnostic profile, which is not available for new enrollees. New enrollees, therefore, receive an expenditure prediction from the Medicare Advantage (MA) demographic model, which has been recalibrated for the PGP demonstration population.[20] This model is currently used for risk adjustment of aged or disabled beneficiaries enrolling in MA plans for which the CMS-HCC model is inapplicable. The PGP demonstration model will apply a prediction based solely on the age, sex, and Medicaid status of the beneficiary, weighted for the number of months that the beneficiary was enrolled in both Part A and Part B Medicare.

[20] See Section 6.1, “PGP New Enrollee Model”.

SECTION 5
PGP CONCURRENT RISK ADJUSTMENT MODEL

This section describes the risk adjustment model used in the PGP demonstration for beneficiaries continuously enrolled in Medicare for an entire performance year (or until their death), and who do not have end stage renal disease (ESRD). We describe the model and its calibration and provide an example of risk score calculation.

5.1 Model Description

This section presents the PGP concurrent risk adjustment model for aged/disabled continuing enrollees without ESRD. This model is used to create risk scores for beneficiaries that are continuously enrolled in Medicare for the entire performance year (or until date of death), and are not identified as ESRD beneficiaries (risk adjustment for new Medicare enrollees and for ESRD beneficiaries is described in Section 6). Beneficiaries enrolled in Medicare because of age or disability at the beginning of a base or demonstration year will be given a risk score from this model. The PGP concurrent model incorporates the CMS-HCC risk markers described in Section 2.

Creating risk scores using the PGP concurrent model follows the four-step process below:

1. Assign risk markers and demographic category.
2. Attach relative weights.
3. Calculate initial risk score.
4. Modify risk score for demographic category.

5.1.1 Model Variables

The PGP concurrent model is built from the prospective CMS-HCC model used by Medicare to pay MA plans. Whereas the prospective CMS-HCC model uses CMS-HCCs based on last year's diagnoses to predict this year's expenditures, the PGP concurrent model uses CMS-HCCs based on this year's diagnoses to predict this year's expenditures. The CMS-HCC model uses 70 of the 189 hierarchical condition categories (HCCs). The 70 CMS-HCCs were selected based on the clinical expectation of beneficiaries with these conditions incurring significant medical expenditures. A list of these CMS-HCCs is provided as Table 1 in Section 2.

To reduce administrative burden, the prospective CMS-HCC model used to set payment rates for MA plans requires plans to report only diagnosis codes (not procedures). However, the PGP demonstration has access to FFS claims and therefore to procedure codes. The model developed for the PGP demonstration takes advantage of this by including an HCC whose assignment is based on transplant procedure codes found in the claims data.[21] Lung, heart, liver,

[21] As described in Section 4.

bone marrow, intestine, and pancreas transplants are indicative of very high expenditures and are therefore included in the model as HCC 173 Major Organ Transplant (Procedure). This results in a total of 71 CMS-HCCs that are included in the PGP concurrent model.[22]

In addition to the CMS-HCCs included in the model, we added a variable that indicates a beneficiary has none of the 71 CMS-HCCs, which we call the "NOCMSHCC" variable. Beneficiaries with at least one of the CMS-HCCs account for more than 90% of all Medicare expenditures, but beneficiaries without any of these diseases may be diagnosed with other conditions. These beneficiaries will utilize medical services, and therefore generate expenditures. The NOCMSHCC variable provides a constant prediction of beneficiary costs for those beneficiaries that have none of the significant diseases incorporated in the CMS-HCC model, but nevertheless incur medical costs during the year. The NOCMSHCC variable is only assigned to beneficiaries that do not have any of the 71 CMS-HCCs, and therefore represents the average cost for a beneficiary identified as having none of those conditions. Beneficiaries in this category therefore all receive the same relative weight.[23]

In summary, the PGP concurrent risk adjustment model uses 71 CMS-HCCs, as well as the NOCMSHCC variable, to predict expenditures and generate risk scores.

5.1.2 Sample Exclusions and Expenditures

To develop the PGP concurrent model, RTI analyzed Medicare claims from the year 2000 for a 5% national random sample of FFS Medicare beneficiaries. We restricted the estimation sample to beneficiaries with characteristics of those who will be eligible for the PGP assigned or comparison group beneficiaries in the demonstration. To mimic the specifications of the PGP demonstration, we applied the sample exclusions listed below (sample selection of new Medicare enrollees and ESRD beneficiaries eligible for the demonstration is discussed in Section 6).

To be eligible for the 2004 PGP concurrent risk adjustment model calibration sample, a beneficiary must:

- be alive and enrolled in Medicare on January 1, 2004;
- have a record in the Medicare enrollment file;
- be enrolled in both Part A and Part B for all months of Medicare enrollment during 2004;
- have at least one month of fee-for-service, aged/disabled, non-hospice Medicare enrollment in 2004;

[22] The PGP concurrent risk adjustment model includes the 70 CMS-HCCs from the Medicare Advantage (MA) risk adjustment model, plus HCC 173 Major Organ Transplant (Procedure). Technically, HCC 173 is not a CMS-HCC because it is not included in the MA model. However, for expository purposes, we will refer to 71 CMS-HCCs for the remainder of this report.

[23] A relative weight is the incremental contribution of a particular health status marker to the risk score.

- have no months of enrollment in a Medicare HMO during 2004;
- have no months of working aged status in 2004;
- be a U.S. resident during 2004; and
- have at least one office or other outpatient evaluation and management (E&M) visit[24] in 2004.

Expenditures are defined for risk adjustment model calibration as for the PGP demonstration. The dependent variable for the regression model is annualized expenditures capped at $100,000. All Medicare payments are incorporated into the dependent expenditure variable. Regression models are weighted by the fraction of months during 2004 each beneficiary is eligible for the sample. In addition to the sample exclusions listed above, the PGP concurrent model was calibrated for beneficiaries without ESRD, and who were continuing enrollees.[25]

5.1.3 Relative Weights

The PGP concurrent model uses multiple regression analysis to estimate the incremental expenditures associated with each CMS-HCC diagnostic category. When divided by national average per capita Medicare expenditures, incremental expenditures may be expressed as a "relative weight" for each CMS-HCC. For example, hypothetically, if the incremental expenditures associated with HCC 80, Congestive Heart Failure, is $2,000 and national average per capita Medicare expenditures are $5,000, then the relative weight for HCC 80 is 2,000/5,000 or 0.400. Relative weights represent the portion of a risk score associated with each of the model variables. A risk score is created by summing the relative weights for markers assigned to a beneficiary. ***Table 5*** shows the relative weights for the variables included in the risk adjustment model.

[24] CPT codes used to identify Office or Other Outpatient E&M visits are as follows: 99201, 99202, 99203, 99204, 99205, 99211, 99212, 99213, 99214, and 99215.

[25] Continuing enrollees in the calibration sample are enrolled in Medicare on January 1, 2004.

Table 5
PGP Concurrent Risk Adjustment Model for Continuing Enrollees Without ESRD

Variable	Label	Relative Weight[1]
NOCMSHCC	No CMS-HCC[2]	0.182
HCC1	HIV/AIDS	0.300
HCC2	Septicemia/Shock	1.440
HCC5	Opportunistic Infections	0.719
HCC7	Metastatic Cancer and Acute Leukemia	1.860
HCC8	Lung, Upper Digestive Tract, and Other Severe Cancers	1.860
HCC9	Lymphatic, Head and Neck, Brain, and Other Major Cancers	0.703
HCC10	Breast, Prostate, Colorectal and Other Cancers and Tumors	0.319
HCC15	Diabetes with Renal or Peripheral Circulatory Manifestation	0.302
HCC16	Diabetes with Neurologic or Other Specified Manifestation	0.302
HCC17	Diabetes with Acute Complications	0.268
HCC18	Diabetes with Ophthalmologic or Unspecified Manifestation[2]	0.182
HCC19	Diabetes without Complication[2]	0.182
HCC21	Protein-Calorie Malnutrition	1.525
HCC25	End-Stage Liver Disease	0.701
HCC26	Cirrhosis of Liver	0.211
HCC27	Chronic Hepatitis	0.211
HCC31	Intestinal Obstruction/Perforation	1.026
HCC32	Pancreatic Disease	0.597
HCC33	Inflammatory Bowel Disease	0.334
HCC37	Bone/Joint/Muscle Infections/Necrosis	0.968
HCC38	Rheumatoid Arthritis and Inflammatory Connective Tissue Disease	0.285
HCC44	Severe Hematological Disorders	0.929
HCC45	Disorders of Immunity	1.382
HCC51	Drug/Alcohol Psychosis	1.023
HCC52	Drug/Alcohol Dependence	0.512
HCC54	Schizophrenia	0.679
HCC55	Major Depressive, Bipolar, and Paranoid Disorders	0.472
HCC67	Quadriplegia, Other Extensive Paralysis[3]	1.102
HCC68	Paraplegia[3]	1.102
HCC69	Spinal Cord Disorders/Injuries[4]	0.676
HCC70	Muscular Dystrophy[2]	0.182
HCC71	Polyneuropathy	0.336
HCC72	Multiple Sclerosis	0.389
HCC73	Parkinson's and Huntington's Diseases	0.373
HCC74	Seizure Disorders and Convulsions	0.304
HCC75	Coma, Brain Compression/Anoxic Damage[5]	0.814
HCC77	Respirator Dependence/Tracheostomy Status	2.672
HCC78	Respiratory Arrest	1.656
HCC79	Cardio-Respiratory Failure and Shock	1.112
HCC80	Congestive Heart Failure	0.433
HCC81	Acute Myocardial Infarction	1.893
HCC82	Unstable Angina and Other Acute Ischemic Heart Disease	1.031
HCC83	Angina Pectoris/Old Myocardial Infarction	0.394
HCC92	Specified Heart Arrhythmias	0.420
HCC95	Cerebral Hemorrhage	1.350

(continued)

Table 5 (continued)
PGP Concurrent Risk Adjustment Model for Continuing Enrollees Without ESRD

Variable	Label	Relative Weight[1]
HCC96	Ischemic or Unspecified Stroke	0.477
HCC100	Hemiplegia/Hemiparesis[3]	1.102
HCC101	Cerebral Palsy and Other Paralytic Syndromes	0.375
HCC104	Vascular Disease with Complications	1.041
HCC105	Vascular Disease	0.330
HCC107	Cystic Fibrosis	0.435
HCC108	Chronic Obstructive Pulmonary Disease	0.319
HCC111	Aspiration and Specified Bacterial Pneumonias	1.078
HCC112	Pneumococcal Pneumonia, Emphysema, Lung Abscess	0.536
HCC119	Proliferative Diabetic Retinopathy and Vitreous Hemorrhage[2]	0.182
HCC130	Dialysis Status	0.618
HCC131	Renal Failure	0.618
HCC132	Nephritis[2]	0.182
HCC148	Decubitus Ulcer of Skin	1.090
HCC149	Chronic Ulcer of Skin, Except Decubitus[2]	0.182
HCC150	Extensive Third-Degree Burns	2.915
HCC154	Severe Head Injury[5]	0.814
HCC155	Major Head Injury	0.610
HCC157	Vertebral Fractures without Spinal Cord Injury[4]	0.676
HCC158	Hip Fracture/Dislocation	1.676
HCC161	Traumatic Amputation	1.661
HCC164	Major Complications of Medical Care and Trauma	1.457
HCC173	Major Organ Transplant (procedure)	5.375
HCC174	Major Organ Transplant Status	0.502
HCC176	Artificial Openings for Feeding or Elimination	0.981
HCC177	Amputation Status, Lower Limb/Amputation Complications	0.831

NOTES:

[1] The incremental predicted expenditures from the regression model were converted to relative risk scores by dividing by the sample national average of expenditures, $7,727.84.[26] The relative weights from all HCCs assigned to a beneficiary are summed to determine his/her risk score.

[2] The relative weights of these HCCs and NOCMSHCC were constrained to be equal.

[3] The relative weights of these HCCs were constrained to be equal.

[4] The relative weights of these HCCs were constrained to be equal.

[5] The relative weights of these HCCs were constrained to be equal.

SOURCE: RTI International analysis of 2004 Medicare 5% sample.

[26] The entire national sample of beneficiaries eligible for the PGP demonstration is used to compute this average, including new and continuing enrollees, and ESRD enrollees.

5.1.4 Constraints

Some of the regression coefficients for the PGP concurrent model were constrained to ensure that incremental expenditure predictions and relative weights have certain desirable properties (see Pope et al., 2004 for further discussion of model constraints). Clinical consultants to CMS suggested that metastatic cancer is not consistently correctly recorded on Medicare claims, so the relative weights for Metastatic Cancer and Acute Leukemia (HCC 7) and Lung, Upper Digestive Tract, and Other Severe Cancers (HCC 8) were constrained to be equal.

In addition, the relative weights of several CMS-HCCs were constrained to equal the relative weight of the NOCMSHCC variable because the unconstrained relative weights violate the principle that providers should not be penalized for recording additional diagnoses. That is, without constraint, a provider's risk score could be lower if it recorded one of the CMS-HCC diagnoses. We therefore constrained 6 CMS-HCCs (HCC 18, HCC 19, HCC 70, HCC 119, HCC132, and HCC 149) to have relative weights equal to the relative weight for the NOCMSHCC variable.

Lastly, six sets of CMS-HCCs were constrained because the unconstrained relative weights violate the principle that higher ranked conditions in a clinical disease hierarchy should have higher predicted costs. Each of these three pairs were constrained to have equal relative weights: HCC 15 and HCC16, HCC 26 and HCC 27, and HCC 130 and HCC131. Relative weights for Quadriplegia, Other Extensive Paralysis, Paraplegia, and Hemiplegia/Hemiparesis (HCCs 67, 68 and 100) were constrained to equal the relative weight for Quadriplegia, Other Extensive Paralysis (HCC 67). Similarly, the relative weights for Coma, Brain Compression/Anoxic Damage (HCC 75) was constrained to equal the relative weight for Severe Head Injury (HCC 514). Lastly, Spinal Cord Disorders/Injuries (HCC 69) was constrained to have an equal relative weight to Vertebral Fractures without Spinal Cord Injury (HCC 157).

5.2 Demographic Adjustment

A primary goal of risk adjustment for payment systems is to ensure that expenditures for beneficiaries with observable characteristics are correctly predicted. To ensure that mean predictions for beneficiaries by demographic subgroup are accurate, we created demographic multipliers to adjust mean expenditure predictions for demographic categories to the actual expenditure mean of each sub-population. The multipliers are calculated as the ratio of actual mean expenditures for a subgroup to mean expenditures for a subgroup predicted from the regression model described above.

Demographic modifiers were created for age, sex, and Medicaid status to ensure that on average, these demographic groups are predicted correctly.[27] Average predicted payments should

[27] We also investigated an adjuster for "originally disabled" status, that is, beneficiaries currently entitled by age who were originally entitled to Medicare by disability. This demographic factor is included in the prospective CMS-HCC model used for MA plan payment. However, we found that after controlling for age, sex, and Medicaid status, the incremental originally disabled adjuster appeared to be negligible and was difficult to estimate precisely with available sample sizes. We did not include an adjuster for originally disabled status in the final model.

equal average actual payments within each age/sex and Medicaid group. Modifiers adjust each individual's initial risk score multiplicatively based on their demographic information.

Beneficiary age was grouped into seven categories based on the age/sex cells used in the prospective CMS-HCC model. Certain prospective model cells for older and younger beneficiaries with relatively small sample sizes were merged to acquire stable modifiers. Each demographic category we defined has sufficient sample size for creating an accurate modifier. ***Table 6*** shows the modifiers for each demographic category. There are seven age/sex categories for males and females (0–54, 55–64, 65–69, 70–74, 75–79, 80–84, and 85+) in Medicaid and non-Medicaid status, resulting in a total of 28 demographic modifiers (7 x 2 x 2 = 28). Each beneficiary is assigned to one and only one demographic category.

Table 6
PGP Concurrent Risk Adjustment Model Demographic Modifiers

	Multiplier	
Demographic Group	Medicaid	Non-Medicaid
Female		
0-54 Years	1.012	0.946
55-64 Years	1.025	0.965
65-69 Years	1.061	1.001
70-74 Years	1.063	1.010
75-79 Years	1.048	1.007
80-84 Years	1.043	0.987
85 Years or Over	1.025	0.980
Male		
0-54 Years	0.892	0.817
55-64 Years	0.937	0.883
65-69 Years	0.993	0.963
70-74 Years	1.005	0.972
75-79 Years	1.010	0.966
80-84 Years	1.010	0.944
85 Years or Over	1.010	0.933

SOURCE: RTI International analysis of 2004 Medicare 5% sample.

5.3 Risk Score Calculation

CMS-HCC diagnostic categories contribute additively to expenditure prediction, weighted by their expected incremental contribution to expenditures. A beneficiary assigned multiple HCCs based on their claims history will receive the sum of the relative weights for those HCCs as their initial risk score. The demographic adjuster is applied to the initial score to produce the final risk score.

Consider the example from Section 2 of a 79 year-old female Medicaid enrollee who has been diagnosed with AMI, angina, COPD, renal failure, and ankle sprain. Recall that the first step of risk score calculation is to assign risk markers and a demographic category. This beneficiary would be assigned CMS-HCCs for AMI (HCC 81), COPD (HCC 108), and renal failure (HCC 131).[28] This beneficiary would not receive the NOCMSHCC marker due to the assignment of at least one CMS-HCC.

The next steps are to attach relative weights and calculate the initial risk score. ***Table 7*** describes the relative weights and calculation of the initial risk score. Note that Angina Pectoris (HCC 83) and Ankle Sprain (HCC 162) do not receive relative weights as they are not assigned as risk markers for this beneficiary.

Table 7
Hypothetical Example of Initial Risk Score Calculation

AMI (HCC 81)	1.893
Angina pectoris (HCC 83)[1]	0.000
COPD (HCC 108)	0.319
Renal failure (HCC 131)	0.618
Ankle sprain (HCC 162)[2]	0.000
TOTAL	**2.830**
Initial Risk Score = 2.830	

[1] HCC 83, angina pectoris has an incremental prediction, but the amount is not added because HCC 81, AMI, is within the same hierarchy and is the more severe manifestation of cardiovascular disease.

[2] HCC 162, ankle sprain is excluded from the CMS-HCC list due to its low impact on expenditures.

SOURCE: RTI International

The initial risk score for this beneficiary is equal to 2.830. As a final step, the risk score is modified by the appropriate demographic multiplier. The appropriate modifier for a 79 year-old female Medicaid enrollee from Table 6 is 1.048 (Age 75-79, Female, Medicaid). The final risk score is calculated as:

Final Risk Score = (Initial Risk Score) * (Demographic Modifier)

Final Risk Score = (2.830 * 1.048) = 2.966

This beneficiary's final risk score would be 2.966. Compared to an average Medicare enrollee eligible for the PGP demonstration, with a risk score of 1.000, this beneficiary is expected to be almost three times as expensive.

[28] See Section 2 for a full description of the CMS-HCC assignment process.

Note that beneficiaries with none of the 71 CMS-HCCs will be assigned an initial risk score of 0.182, corresponding to the relative weight of the NOCMSHCC variable. Beneficiaries with none of the significant diseases represented by the 71 CMS-HCCs are healthier than the average Medicare beneficiary eligible for the demonstration, and are expected to use less than 20% of the health care services a Medicare beneficiary on average would be expected to use during a year. Initial risk scores for beneficiaries without a CMS-HCC are also modified based on the demographic category assigned to the beneficiary.

5.4 Summary

The PGP concurrent risk adjustment model uses diagnosis, procedure, and demographic information to produce risk scores for aged/disabled continuing enrollees. Risk markers are assigned and their relative weights summed to produce an initial risk score. That unmodified risk score is then multiplied by the demographic multiplier to produce a final risk score. The final risk score is used in the PGP demonstration to adjust expenditures for health risk.

[This page left intentionally blank.]

SECTION 6
NEW ENROLLEE AND ESRD MODELS

In the last section, we document the development of the PGP concurrent risk adjustment model, which is applied to continuing, aged/disabled beneficiaries. In this section we describe the model designed for newly enrolled Medicare beneficiaries, and the model designed for ESRD beneficiaries. ESRD beneficiaries are subdivided into those currently treated with dialysis or a kidney transplant, or those with functioning grafts. New Medicare enrollees are those not enrolled in Medicare at the beginning of a performance year, and hence not having a full diagnostic profile with which to produce risk markers. Both of these models are based on models designed for and used by CMS for Medicare Advantage plan payments. The models have been calibrated for the PGP demonstration sample in a similar fashion to the PGP concurrent model presented in the preceding section. This section presents both models beginning with the PGP new enrollee model.

6.1 PGP New Enrollee Model

New Medicare enrollees are defined as beneficiaries enrolled at least one month in both Part A and Part B Medicare during a demonstration performance year, but not enrolled on the first day of the performance year. These beneficiaries do not have a twelve month history of diagnoses to generate a complete diagnostic profile. The PGP new enrollee model is therefore based only on demographic information available at the time of enrollment. The model uses age, gender, and Medicaid status to estimate expected expenditures.

6.1.1 Model Calibration and Variables

RTI calibrated the new enrollee model on the year 2004 5% national random sample of beneficiaries, the same data used to calibrate the continuing enrollee model described in Section 5.[29] The only difference in the sample was the inclusion of new enrollees in addition to continuing enrollees. Ideally, the new enrollee model would have been calibrated on a sample of new enrollees only. However, the vast majority of new Medicare enrollees are beneficiaries that age into Medicare at 65 years of age. Because of this, our sample of new enrollees is heavily weighted towards new enrollees who are 65 years of age. Although our calibration sample of age 65 new enrollees was sufficient to produce statistically reliable expenditure estimates for age 65 new enrollees, it was insufficient for the other age groups. To remedy this, the PGP new enrollee model was calibrated on the merged sample including both continuing and new enrollee PGP sample to gain enough sample size for the age groups above and below 65 years of age. The implicit assumption is that expenditures for new and continuing enrollees are similar for most ages, which prior analysis has shown to be a reasonable assumption (Pope et al., 2004).

[29] New enrollees with dialysis months are not included in the sample and are not given risk scores from the new enrollee model. See Section 6.2.2 for a discussion of how new enrollees undergoing dialysis treatment are given risk scores.

The new enrollee model was calibrated by regressing total annualized expenditures capped at $100,000 on a set of age/sex category variables and Medicaid status,[30] for the combined sample of new and continuing enrollees. The most common way to qualify for Medicare is by age. Because of the large proportion of new enrollees who are 65 years of age, separate relative weights are estimated for age 65 (and for ages 66, 67, 68, and 69). This allows the age 65 relative weights to be more accurate. The age-sex cells in the PGP new enrollee model are the same as those used in the CMS-HCC demographic model for new enrollees (Pope et al., 2004). In addition to age-sex cells, the PGP new enrollee model includes relative weights based on Medicaid status. The incremental Medicaid relative weights are differentiated by 10 age-sex ranges, including a separately estimated Medicaid effect for age 65.

A risk score for each mutually exclusive demographic category (age/sex and Medicaid) was derived from the regression model estimated coefficients and is shown in ***Table 8*****.** The risk score expresses predicted expenditures relative to the national mean expenditure in 2004.

To illustrate, consider a male beneficiary (*New Enrollee A*) that enrolls in Medicare at age 65. The beneficiary will receive a risk score of 0.646, compared to a Medicaid dual-eligible beneficiary of the same age and sex (*New Enrollee B*) who would receive a risk score of 1.235. Each beneficiary is assigned one risk score based on their age, sex, and Medicaid status.

6.1.2 Adjustment to Predict New Enrollee Mean Expenditures Accurately

The new enrollee regression model predicts the overall mean expenditures accurately for the merged sample of continuing and new enrollees used to estimate this model. It does not predict the correct mean for the new enrollee sub-population alone. Specifically, it underpredicts expenditures for the new enrollee sub-population by 1.1%. To predict new enrollee mean expenditures correctly, all beneficiaries receiving a risk score from the PGP new enrollees model are subject to a "multiplier" of 1.011 that scales expenditure predictions to the actual new enrollees mean. Continuing the example begun in Section 6.1.1, ***Figure 3*** provides an illustration of the application of the overall multiplier for the PGP new enrollee model.

6.1.3 Summary

The PGP new enrollee model provides an accurate prediction for beneficiaries that are new to Medicare without relying on an incomplete diagnosis profile. Beneficiary demographic characteristics available at the time of enrollment are all that is required to generate risk scores. This model is applied to all aged/disabled beneficiaries that are not enrolled in Medicare at the beginning of a base or performance year.

6.2 PGP ESRD Model

Beneficiaries with end stage renal disease (ESRD) are treated with dialysis and kidney transplants. To more precisely account for the higher average expenditures of Medicare

[30] We did not include originally disabled status among the predictive factors for the PGP new enrollee model because new Medicare enrollees are rarely in originally disabled status (by definition, a beneficiary cannot be originally disabled when he/she first enrolls in the Medicare program).

Table 8
PGP Demographic Model for New Enrollees[1] Initial Risk Scores

	Risk Score[2]	
	Non-Medicaid	Medicaid[3]
Female		
0-34 Years	0.587	0.857
35-44 Years	0.697	0.967
45-54 Years	0.843	1.113
55-59 Years	0.943	1.213
60-64 Years	1.029	1.299
65 Years	0.556	1.137
66 Years	0.582	1.139
67 Years	0.611	1.168
68 Years	0.628	1.185
69 Years	0.651	1.208
70-74 Years	0.731	1.250
75-79 Years	0.877	1.348
80-84 Years	0.991	1.462
85-89 Years	1.110	1.581
90-94 Years	1.210	1.681
95 Years or Over	1.264	1.735
Male		
0-34 Years	0.442	0.725
35-44 Years	0.646	0.929
45-54 Years	0.785	1.068
55-59 Years	0.930	1.213
60-64 Years	1.064	1.347
65 Years	0.646	1.235
66 Years[4]	0.687	1.276
67 Years[4]	0.687	1.276
68 Years	0.745	1.334
69 Years	0.767	1.356
70-74 Years	0.870	1.459
75-79 Years	1.048	1.578
80-84 Years	1.194	1.724
85-89 Years	1.332	1.862
90-94 Years	1.412	1.942
95 Years or Over	1.510	2.040

NOTES:

[1] Aged and disabled beneficiaries. Excludes ESRD and working aged beneficiaries.

[2] The predicted dollar amounts from the regression were converted to risk scores by dividing by the sample national average of expenditures, $7,727.84. Note that each category is mutually exclusive and therefore the relative weight for each category is presented as a risk score.

[3] Medicaid male beneficiaries 65 years of age were constrained to have their Medicaid coefficient equal to the Medicaid coefficient for male beneficiaries 66–69 years of age and male beneficiaries 70 to 74 years of age.

[4] Male beneficiaries aged 66 were constrained to have their coefficients equal to male beneficiaries 67 years of age.

Figure 3
Application of the Overall Multiplier for the PGP New Enrollees Model

New Enrollee Multiplier[1]	1.011

Therefore the final risk scores for *New Enrollees A and B* would be:

New Enrollee A: Initial Risk Score = 0.646
Final Risk Score = 0.646 * 1.011 = **0.653**
New Enrollee B: Initial Risk Score = 1.235
Final Risk Score = 1.235 * 1.011 = **1.249**

NOTES:

[1] Mean predicted expenditures for the new enrollees sub-population equals $5,541, and actual mean expenditures equals $5,603. The overall multiplier thus equals $5,603 / $5,541 = 1.011.

SOURCE: RTI International analysis of 2004 Medicare 5% sample.

beneficiaries with ESRD, RTI designed a separate concurrent risk adjustment model for ESRD beneficiaries. The PGP ESRD model is based on the prospective CMS-HCC ESRD model developed by CMS and currently used to set payment rates for ESRD beneficiaries enrolled in Medicare Advantage plans.[31] The PGP ESRD model is comprised of three submodels, including different treatments for dialysis, transplant, and functioning graft beneficiaries. The model adjusts based on the individual's actual course of treatment during a base or performance year. The PGP ESRD model has been calibrated for the PGP demonstration sample in a similar fashion to the PGP concurrent and new enrollee models presented in preceding sections.

6.2.1 Defining ESRD Beneficiaries

ESRD beneficiaries are identified by their enrollment and ESRD information recorded by Medicare. Beneficiaries identified by Medicare as having dialysis treatments or a kidney transplant[32] during a payment or base year are counted as ESRD beneficiaries. In addition, Medicare beneficiaries with kidney transplants in prior years are identified as ESRD beneficiaries. Medicare maintains an enrollment database (EDB) documenting dialysis and kidney transplant dates for all ESRD beneficiaries. This data is used to identify all ESRD beneficiaries.

The PGP ESRD model risk score depends on the number of months spent in each ESRD status during an analysis year. ESRD beneficiaries are treated with dialysis and kidney transplants, and the course of treatment determines the costs incurred by the beneficiary during

[31] The CMS-HCC ESRD prospective risk adjustment model is described in the following CMS 45-day notice: http://www.cms.hhs.gov/MedicareAdvtgSpecRateStats/Downloads/Advance2005.pdf. The final model coefficients are presented in this 2005 announcement: http://www.cms.hhs.gov/MedicareAdvtgSpecRateStats/downloads/Announcement2005.pdf.

[32] Including a simultaneous Kidney/Pancreas transplant.

the year. Beneficiaries are assigned to one of three ESRD statuses for every month of a base or performance year. An ESRD beneficiary can be categorized as a transplant, dialysis, or functioning graft beneficiary in any given month (certain ESRD beneficiaries will also have some months not spent in any ESRD status).

Transplant beneficiaries are identified by the date of their transplant surgery, and are included as transplant beneficiaries for the month of surgery and the two months following that surgery. Dialysis beneficiaries are identified by the dialysis start and end dates on the enrollment file. Functioning graft beneficiaries are enrollees that have had a kidney transplant, and are not currently being treated with dialysis.

An ESRD beneficiary's final risk score is dependent on:

- the number of months spent outside of ESRD status (i.e., aged/disabled);
- the number of months a beneficiary is treated with dialysis;
- whether a beneficiary receives a kidney transplant; and
- the number of months a beneficiary is "functioning graft," and how many months the beneficiary is post-transplant.

Dialysis Beneficiaries

Dialysis start and end dates recorded on the EDB define each beneficiary's dialysis status. A beneficiary with a dialysis start date is assigned to dialysis status beginning the first of the month after that dialysis start date. A beneficiary is continuously assigned to dialysis status until a dialysis end date is recorded on the EDB, or the beneficiary dies.[33] A beneficiary with both a transplant and dialysis period covering the same month will be assigned to transplant status for that month. A beneficiary with a dialysis start date of May 15, and dialysis end date of July 15 but no transplant will be assigned to dialysis status for June and July. A beneficiary with a dialysis start date of May 15 and transplant start date of July 15 will be assigned to dialysis status for June and transplant status for July.

Transplant Beneficiaries

Medicare records the date of each kidney transplant for beneficiaries with ESRD. Kidney transplants are associated with much higher medical expenditures for the month of transplant and the two following months. Therefore, all beneficiaries with a transplant record on the EDB are assigned to transplant status for the month of transplant and the two following months, or until the death of the beneficiary. A beneficiary with a transplant date of, for example, May 15 will be assigned to transplant status for May, June, and July.

[33] Beneficiaries that die during the demonstration do not have their months included in any calculations beginning the first of the month after the date of death.

Functioning Graft Beneficiaries

Beneficiaries who have undergone kidney transplant surgery and do not require dialysis or another transplant are considered "Functioning Graft" beneficiaries. These beneficiaries are assumed to have a working kidney transplant. Post-transplant beneficiaries are less expensive than either dialysis or transplant beneficiaries. Expenditures for functioning graft patients remain high, but have a cost pattern that is closer to the general population than to dialysis patients. Beneficiaries identified as functioning graft maintain that status from the fourth month post-transplant until they return to dialysis status, receive another kidney transplant, or die. A beneficiary with a transplant date of, for example, May 15 will be assigned to functioning graft status from August onwards.

Functioning graft beneficiaries are further delineated into two categories to better address the decreasing cost pattern after the transplant. The first months after transplant are associated with higher costs, but as the patient recovers, the higher costs of these beneficiaries are driven primarily by the Part B covered immunosuppressive drugs. The first functioning graft category, category I, covers the fourth month post-transplant through the tenth. This category covers the higher service intensity during this period. The second functioning graft category, category II, covers the eleventh month post-transplant onward. Functioning graft status is assigned as of the most recent transplant, as beneficiaries may undergo more than one transplant. A beneficiary that has transplant dates of May 15 and June 15 will be assigned to functioning graft category I in September and functioning graft category II in April of the following year.

6.2.2 PGP ESRD Dialysis Model

Dialysis beneficiaries incur monthly costs for dialysis and are more expensive across the entire spectrum of disease than beneficiaries entitled to Medicare by age or disability. Dialysis beneficiaries average close to $60,000 in annual expenditures compared to aged/disabled beneficiaries who have mean costs closer to $7,000 annually. To account for these higher expenditures a separate concurrent risk adjustment model was developed for beneficiaries identified in dialysis status.

The PGP ESRD model for dialysis patients is similar to the PGP concurrent risk adjustment model for aged/disabled enrollees. The PGP ESRD model for dialysis patients also uses CMS-HCCs to estimate health expenditures, but changes were made to incorporate differences between the ESRD and aged/disabled populations.

Certain CMS-HCCs were not included in the PGP ESRD model (see Table 1 for the list of CMS-HCCs). Dialysis Status (HCC 130), Renal Failure (HCC 131), and Nephritis (HCC 132) are excluded because they are conditions that have a lower ranking in the disease hierarchy than ESRD Dialysis Status (HCC 129), which all beneficiaries in the PGP ESRD dialysis model must have. The remaining 68 CMS-HCCs are included in the model.

Age-sex terms are included in the PGP ESRD dialysis model as interactions with dialysis status. There is no second stage adjustment for age, sex, and Medicaid status as occurs in the aged-disabled model. A total of eight age-sex interactions with dialysis status are included in the

model, two sets of four age groups for male and female (less than 55, 55 to 64, 65 to 74 years of age, and greater than or equal to 75 years of age).

The PGP ESRD dialysis model was created using a combined sample of aged/disabled and dialysis enrollees. Although estimating the dialysis model on a sample of ESRD beneficiaries alone would have been preferred, we did not have enough ESRD beneficiaries in our 5% national random sample to do so. The combined sample ensures that each HCC has sufficient sample size to generate an accurate prediction. The sample exclusions applied for this model were the same as those applied for the sample used to create the PGP concurrent model described in a previous section (see Section 5.1.2).

The combined sample model predicts mean expenditures for ESRD beneficiaries accurately (because of the inclusion of the age/sex intercepts), and allows some adjustment for their diagnostic profile. The estimated regression coefficients for the HCCs diagnostic categories in the model are very similar to the coefficients estimated for the aged/disabled model presented in Section 5 because aged/disabled beneficiaries account for 99 percent of the combined sample. Ideally the HCC coefficients would be customized for the ESRD population, but this was not feasible because of the small available sample size of ESRD beneficiaries in our data.

The relative weights for the PGP ESRD dialysis model are shown in ***Table 9***.

The PGP ESRD dialysis model is an additive model like the PGP concurrent risk adjustment model for aged/disabled beneficiaries. A dialysis beneficiary that was in dialysis status for an entire year would receive a risk score equal to the sum of the relative weight for the beneficiary's age-sex cell and the relative weights for the HCCs the beneficiary was diagnosed with during the year. Alternatively, a beneficiary with both dialysis months and aged/disabled months would have a final risk score equal to the weighted average of their aged/disabled and dialysis risk scores (weighted by the number of months spent in aged/disabled versus dialysis status). For example, if a beneficiary had 3 months of aged/disabled eligibility with an aged/disabled risk score of 2.000, and 9 months of dialysis treatment with a dialysis risk score of 10.000, then the beneficiary's final risk score would be 8.000[34].

New enrollees that are identified as having been treated with dialysis will not be given risk scores from the model above. New enrollees do not have a complete diagnostic profile to generate a risk score. These beneficiaries will be given an initial risk score equal to the average annualized payment for dialysis beneficiaries, 7.617[35]. This initial risk score is not modified for any demographic characteristics, but will be weighted by the number of months the enrollee is assigned to dialysis status.

[34] (0.25*2.000) + (0.75*10.000) = 8.000

[35] The mean annualized expenditure for dialysis beneficiaries from the PGP 2004 sample is equal to $58,865.35. This was converted to a risk score by dividing by the national average expenditures for all beneficiaries, $7,727.84.

Table 9
PGP ESRD Dialysis Model

Variable		Relative Weight[1]
Female		
Age Less Than 55		4.004
Age 55 to 64		3.904
Age 65 to 74		3.995
Age 75 or Greater		4.064
Male		
Age Less Than 55		3.974
Age 55 to 64		3.624
Age 65 to 74		3.813
Age 75 or Greater		3.789
Diseases		
HCC1	HIV/AIDS	0.325
HCC2	Septicemia/Shock	1.424
HCC5	Opportunistic Infections	0.717
HCC7	Metastatic Cancer and Acute Leukemia	1.861
HCC8	Lung, Upper Digestive Tract, and Other Severe Cancers	1.861
HCC9	Lymphatic, Head and Neck, Brain, and Other Major Cancers	0.707
HCC10	Breast, Prostate, Colorectal and Other Cancers and Tumors	0.318
HCC15	Diabetes with Renal or Peripheral Circulatory Manifestation	0.317
HCC16	Diabetes with Neurologic or Other Specified Manifestation	0.317
HCC17	Diabetes with Acute Complications	0.262
HCC18	Diabetes with Ophthalmologic or Unspecified Manifestation[2]	0.181
HCC19	Diabetes without Complication[2]	0.181
HCC21	Protein-Calorie Malnutrition	1.504
HCC25	End-Stage Liver Disease	0.717
HCC26	Cirrhosis of Liver	0.229
HCC27	Chronic Hepatitis	0.229
HCC31	Intestinal Obstruction/Perforation	1.010
HCC32	Pancreatic Disease	0.606
HCC33	Inflammatory Bowel Disease	0.334
HCC37	Bone/Joint/Muscle Infections/Necrosis	0.948
HCC38	Rheumatoid Arthritis and Inflammatory Connective Tissue Disease	0.285

(continued)

Table 9 (continued)
PGP ESRD Dialysis Model

Variable		Relative Weight[1]
HCC44	Severe Hematological Disorders	0.919
HCC45	Disorders of Immunity	1.364
HCC51	Drug/Alcohol Psychosis	1.014
HCC52	Drug/Alcohol Dependence	0.517
HCC54	Schizophrenia	0.681
HCC55	Major Depressive, Bipolar, and Paranoid Disorders	0.474
HCC67	Quadriplegia, Other Extensive Paralysis[3]	1.097
HCC68	Paraplegia[3]	1.097
HCC69	Spinal Cord Disorders/Injuries[4]	0.676
HCC70	Muscular Dystrophy[2]	0.202
HCC71	Polyneuropathy	0.337
HCC72	Multiple Sclerosis	0.387
HCC73	Parkinson's and Huntington's Diseases	0.372
HCC74	Seizure Disorders and Convulsions	0.305
HCC75	Coma, Brain Compression/Anoxic Damage[5]	0.768
HCC77	Respirator Dependence/Tracheostomy Status	2.585
HCC78	Respiratory Arrest	1.593
HCC79	Cardio-Respiratory Failure and Shock	1.120
HCC80	Congestive Heart Failure	0.443
HCC81	Acute Myocardial Infarction	1.885
HCC82	Unstable Angina and Other Acute Ischemic Heart Disease	1.030
HCC83	Angina Pectoris/Old Myocardial Infarction	0.391
HCC92	Specified Heart Arrhythmias	0.423
HCC95	Cerebral Hemorrhage	1.347
HCC96	Ischemic or Unspecified Stroke	0.476
HCC100	Hemiplegia/Hemiparesis[3]	1.097
HCC101	Cerebral Palsy and Other Paralytic Syndromes	0.374
HCC104	Vascular Disease with Complications	1.048
HCC105	Vascular Disease	0.335
HCC107	Cystic Fibrosis	0.454
HCC108	Chronic Obstructive Pulmonary Disease	0.318
HCC111	Aspiration and Specified Bacterial Pneumonias	1.063
HCC112	Pneumococcal Pneumonia, Emphysema, Lung Abscess	0.539
HCC119	Proliferative Diabetic Retinopathy and Vitreous Hemorrhage[2]	0.181

(continued)

Table 9 (continued)
PGP ESRD Dialysis Model

Variable		Relative Weight[1]
HCC148	Decubitus Ulcer of Skin	1.078
HCC149	Chronic Ulcer of Skin, Except Decubitus[2]	0.181
HCC150	Extensive Third-Degree Burns	2.942
HCC154	Severe Head Injury[5]	0.768
HCC155	Major Head Injury	0.609
HCC157	Vertebral Fractures without Spinal Cord Injury[4]	0.676
HCC158	Hip Fracture/Dislocation	1.661
HCC161	Traumatic Amputation	1.543
HCC164	Major Complications of Medical Care and Trauma	1.460
HCC173	Major Organ Transplant (procedure)	4.808
HCC174	Major Organ Transplant Status	0.448
HCC176	Artificial Openings for Feeding or Elimination	0.971
HCC177	Amputation Status, Lower Limb/Amputation Complications	0.859

NOTES:

1 The dollar amounts in this table were converted to relative risk scores by dividing by the national average of expenditures, $7,727.84.

2 These HCCs were constrained to equal the coefficient for NOCMSHCC. Note that ESRD beneficiaries can not receive the NOCMSHCC variable, as ESRD is considered a significant condition.

3 These HCCs were constrained to have equal coefficients.

4 These HCCs were constrained to have equal coefficients.

5 These HCCs were constrained to have equal coefficients.

SOURCE: RTI International analysis of 2004 Medicare 5% sample.

6.2.3 Transplant Adjustment

Beneficiaries that undergo a kidney transplant operation are treated differently from dialysis ESRD beneficiaries when calculating a risk score. A kidney transplant incurs a high dollar amount that does not vary drastically from patient to patient in a systematic way. The cost pattern for a transplant beneficiary reflects the high inpatient costs associated with the transplant surgery itself, as well as the higher service intensity for the 2 months after a transplant occurs. Relative weight adjustments for the month of transplant and the two months following were created from the average costs of these beneficiaries as estimated by CMS researchers.

An ESRD beneficiary that has a kidney transplant has the first month relative weight weighted into their risk score.[36] The same holds true for months 2 and 3, though the relative weight is lower for the second and third months. ***Table 10*** shows the transplant relative weight adjustments for each month of transplant. A beneficiary surviving the three months of transplant would receive an addition of 86.726 weighted into their final risk score, reflecting the extraordinarily high costs of kidney transplant operations and follow-up treatment.[37] These transplant relative weights are weighted into the final risk score based on their total months eligibility as described in Section 6.2.5.

Table 10
PGP ESRD Model—Transplant Relative Weights

Kidney Transplant	
Month 1 Relative Weight[1]	68.256
Month 2 Relative Weight[2]	9.235
Month 3 Relative Weight[3]	9.235

NOTES:

[1] Transplant payments are taken from the CMS MA payment ESRD model. See CMS website: http://www.cms.hhs.gov/MedicareAdvtgSpecRateStats/downloads/Announcement2005.pdf, accessed January 2005. We derived a PGP demonstration relative weight as follows, accounting for the relative frequency and cost of kidney (95.1%) versus kidney/pancreas transplants (4.9%), mean 2004 dialysis expenditures of $68,556.27 (the CMS transplant factors are relative to year 2000 mean dialysis expenditures) and our PGP sample average costs of $7,727.84. Transplant Month 1 = {[(7.510* 0.951) + (11.266 * 0.049) * 68,556.27]/7,727.84} = (527,474.96/7,727.84) = 68.256

[2] Transplant payments are taken from the CMS MA payment ESRD model. See CMS website: http://www.cms.hhs.gov/MedicareAdvtgSpecRateStats/downloads/Announcement2005.pdf, accessed January 2005. We derived a PGP demonstration relative weight as follows, accounting for the relative frequency and cost of kidney (95.1%) versus kidney/pancreas transplants (4.9%), mean 2004 dialysis expenditures of $68,556.27 (the CMS transplant factors are relative to year 2000 mean dialysis expenditures) and our PGP sample average costs of $7,727.84.

Transplant Month 2 = {[(1.016 * 0.951) + (1.525 * 0.049) * 68,556.27]/ 7,727.84} = (71,363.03/7,727.84) = 9.235

[3] Transplant payments are taken from the CMS MA payment ESRD model. See CMS website: http://www.cms.hhs.gov/MedicareAdvtgSpecRateStats/downloads/Announcement2005.pdf, accessed January 2005. We derived a PGP demonstration relative weight as follows, accounting for the relative frequency and cost of kidney (95.1%) versus kidney/pancreas transplants (4.9%), mean 2004 dialysis expenditures of $68,556.27 (the CMS transplant factors are relative to year 2000 mean dialysis expenditures) and our PGP sample average costs of $7,727.84.

Transplant Month 2 = {[(1.016 * 0.951) + (1.525 * 0.049) * 68,556.27]/ 7,727.84} = (71,363.03/7,727.84) = 9.235

[36] See Section 6.2.5 for a description of the weighting process used to create the final risk score for beneficiaries with ESRD.

[37] Note that this risk score would be weighted into the final risk score according to the process described in Section 6.2.5. If the beneficiary were eligible for Medicare for the full 12 months, the 68.256 would receive a 1/12 weight, and the 9.235 would receive a 2/12 weight. Please see Section 6.2.5 for a more thorough review of the final risk score calculation.

To illustrate the transplant adjustment, consider a beneficiary on dialysis with a risk score of 10.000 who also has a complete transplant period. Assume the beneficiary spent 9 months in dialysis, and received a transplant on October 1. The initial risk score from the PGP ESRD dialysis model (10.000) is weighted by the fraction of the year spent in dialysis status (9/12 or 0.75). The transplant adjustments, 68.256 and 9.235, are weighted by the fraction of the year spent in each transplant status (1/12 and 2/12 respectively) and then the transplant relative weight adjustments are weighted in to the initial risk score. The final risk score for this beneficiary is 14.727[38]

6.2.4 Functioning Graft Adjustment

Beneficiaries who have undergone kidney transplant surgery and do not require dialysis or another transplant are considered 'Functioning Graft' beneficiaries. These beneficiaries are assumed to have a working kidney transplant and are therefore less expensive than beneficiaries in other ESRD statuses. CMS estimated payments for these beneficiaries for the fourth through thirty-sixth month after the transplant was performed and found that functioning graft patients are more similar to the general aged/disabled population than to dialysis patients.[39] The functioning graft adjustment is therefore an adjustment to the PGP concurrent risk adjustment model, rather than the PGP ESRD dialysis model.

Functioning graft patients have a recognizable cost pattern based on the number of months the beneficiary is post-transplant. Costs immediately after transplant are relatively high but decline rapidly to a stable average by month 11. For this reason, two sets of relative weight adjustments were developed. The first relative weight adjustment is for the fourth through tenth month after the transplant was performed. Recall that the first three months (including the month of transplant) are treated as transplant months. Beneficiaries assigned to functioning graft status for the fourth through tenth month after transplant receive a substantial add-on to their aged/disabled risk score based on their age. The add-ons are smaller thereafter.

An adjustment is given to these beneficiaries to cover the additional costs of Part B immunosuppressive drugs covered by Medicare and additional services they receive to monitor and maintain the graft. ***Table 11*** describes the relative weight adjustments for functioning graft beneficiaries.

The functioning graft relative weight adjustment is an addition to the aged/disabled risk score (PGP concurrent risk adjustment model–Table 5) that reflects the cost of Part B immunosuppressive drugs. To illustrate, consider a 65-year-old beneficiary identified as Functioning Graft II (i.e., post-transplant months 11 or more) for an entire year. The beneficiary would receive an increase in their risk score of 1.691 (Table 11). Therefore a beneficiary with a risk score of 1.000 from the PGP concurrent risk adjustment model would receive a final risk score of 2.691 under the above assumptions.

---

[38] (0.75 * 10.000) + (68.256 * (1/12)) + (9.235 * 2/12) = 14.727.

[39] According to CMS ESRD research.
See CMS website: http://www.cms.hhs.gov/MedicareAdvtgSpecRateStats/Downloads/Advance2005.pdf, accessed March 2005.

Table 11
PGP ESRD Model—Functioning Graft Adjustment[1]

Functioning Graft I - Post-Transplant Months 4 to 10	
Beneficiaries < 65	3.091
Beneficiaries 65+	3.425
Functioning Graft II - Post-Transplant Months 11+	
Beneficiaries < 65	1.620
Beneficiaries 65+	1.691

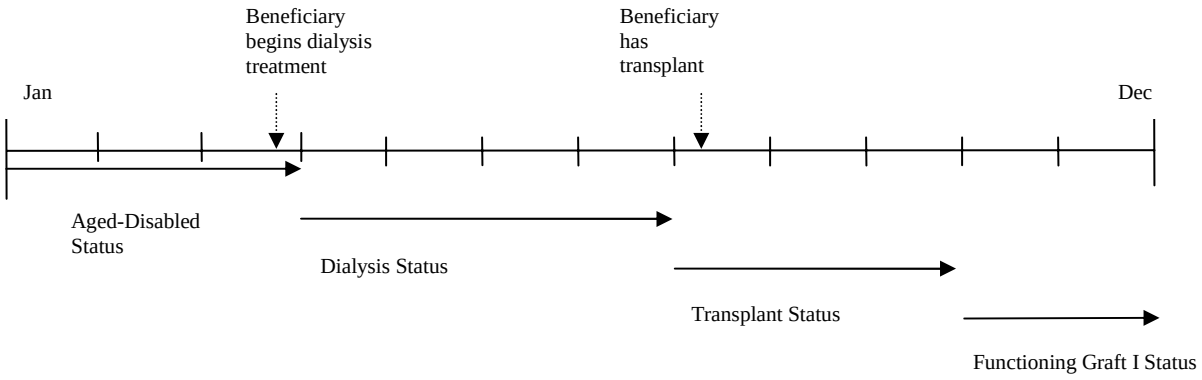
NOTES:

[1] Functioning graft factors are taken from the CMS MA payment ESRD model. See CMS website: http://www.cms.hhs.gov/MedicareAdvtgSpecRateStats/downloads/Announcement2005.pdf, accessed January 2005.

6.2.5 PGP ESRD Model Risk Score Calculation

Calculating a risk score for an ESRD beneficiary depends on the number of months a beneficiary spends in each status. As an example, consider a male beneficiary, 72 years of age, that begins the year enrolled in Medicare, qualifying through age. The beneficiary spends three months in this status, before being diagnosed with ESRD, and undergoing dialysis treatment. From April through July, the beneficiary is treated with dialysis and then undergoes a kidney transplant in August. After recovering from the transplant the beneficiary is treated as a functioning graft beneficiary for the remainder of the year based on the record indicating no additional transplant or dialysis treatment. Over the year, the beneficiary is diagnosed with Renal Failure (HCC 131), Vascular Disease with Complications (HCC 104), and Diabetes with Renal Manifestation (HCC 15). This beneficiary's assignment is shown in ***Figure 4***.

Figure 4
Hypothetical ESRD Status Assignment



SOURCE: RTI International

The assignment of months for this hypothetical beneficiary is shown in ***Table 12***.

Table 12
Hypothetical Example of ESRD Monthly Assignment

Aged-Disabled Months	3
Dialysis Months	4
Transplant Months	3
Functioning Graft Months I	2

To calculate the final risk score it is first necessary to calculate risk scores from the PGP concurrent risk adjustment model and the PGP ESRD Model. Recall from Table 5 that the initial risk score for this example beneficiary equals 1.961[40]. The beneficiary receives a demographic modifier of 0.972 (age 70–74, male, non-Medicaid)[41], resulting in an aged/disabled risk score of 1.906[42]. For the months the beneficiary has been identified as functioning graft I, the relative weight adjustment produces a risk score of 5.331 (1.906 + 3.425)[43]. Further, the PGP ESRD dialysis model (Table 9) produces a risk score of 5.178 for this beneficiary[44]. Lastly, the first month transplant risk score is 68.256, and the following two months are 9.235 (Table 10).

The next step to calculate the overall risk score is to take the weighted average of the individual risk scores. The weight for each score is equal to the number of months out of 12 to get an annual figure.

Risk Score = (1.906 * 3/12) + (5.178 * 4/12) + (68.256 * 1/12) + (9.235 * 2/12) + (5.331 * 2/12)

Final Risk Score = 10.318

6.2.6 Summary

The PGP ESRD Model is comprised of a separate dialysis model and adjustments for functioning graft and transplant beneficiaries. This model depends on the assignment of beneficiaries into the three ESRD statuses by month. The final risk score for an ESRD beneficiary depends on the months of aged/disabled eligibility, as well as the months spent in each of the ESRD statuses of dialysis, transplant, and functioning graft.

---

[40] Equal to the sum of HCCs assigned: 0.302 (HCC15) + 1.041 (HCC104) + 0.618 (HCC131) = 1.961.

[41] See Table 6.

[42] 1.961 * 0.972 = 1.906.

[43] Functioning graft factor for Graft Type I beneficiaries, Aged ≥ 65 from Table 11.

[44] Equal to the sum of markers assigned: 3.813 (Male, Age 70-74) + 0.317 (HCC15) + 1.048 (HCC104) + 0.000 (HCC131) = 5.178.

SECTION 7
DATA REQUIREMENTS & MODEL UPDATES

7.1 Data Requirements

For the PGP demonstration, diagnosis data will be taken from claims (bills) submitted by Medicare fee-for-service providers for reimbursement. These will include claims from the participating PGPs and from nonparticipating providers providing services to beneficiaries assigned to participating PGPs. Participating providers are not required to submit any additional data for risk adjustment beyond their normal fee-for-service claims to Medicare. ICD-9-CM diagnosis codes and demographics are the primary inputs of the CMS-HCC risk adjustment models. CPT procedure codes used to identify transplant patients and a few other high-cost patient types are taken from physician bills only (hospital bills will not be used to identify procedures). Diagnosis codes will be taken from the following four claim sources:

- inpatient hospital claims;
- hospital outpatient claims;
- physician claims; and
- clinically-trained non-physician claims.

Diagnoses submitted by sources not in this list (e.g., home health agencies) may be of questionable accuracy.

Diagnostic coding completeness and accuracy is important for accurate risk adjustment. For example, if a PGP manages an assigned beneficiary so as to avoid an unnecessary hospitalization, the same ICD-9-CM diagnostic markers need to be recorded by one of the accepted sources so that the health status of the beneficiary is accurately measured. Specifically, suppose that an admission for an assigned beneficiary with congestive heart failure is avoided. Congestive heart failure needs to be recorded as a diagnosis on a hospital outpatient or physician claim sometime during the performance year so that the actual health status risk of this beneficiary is measured.

It is important to note that chronic diagnoses need to be recorded at least once for each beneficiary in every performance year. The system has no “memory.” But recording the same diagnosis more than once in the same year has no effect on risk adjustment. Also, recording diagnoses not included in the CMS-HCC model does not affect risk adjustment. Diagnoses are not differentiated by setting--no greater health risk is assigned for an inpatient diagnosis than one from a physician's office. Also, the time of year a diagnosis is recorded does not matter.

Finally, Medicare enrollment information available to CMS is used to assign age, sex, and Medicaid status markers. They are also used to calculate risk scores. Those data are available from the Medicare enrollment files.

7.2 Model Updates

Throughout the demonstration, RTI will add newly implemented ICD-9-CM diagnosis codes and CPT procedure codes to the PGP risk adjustment model for the purposes of identifying CMS-HCCs for beneficiaries. RTI will use new codes identified by CMS annually for updates.

The PGP risk adjustment model will not be recalibrated during the course of the three-year demonstration.

7.3 Upward Trend in Risk Scores

It is likely that the average risk scores of beneficiaries assigned to the physician groups participating in the PGP demonstration will rise over time, independent of any actual increase in health status risk. An upward trend in national fee-for-service risk scores has been observed over time, presumably due to more complete coding of diagnoses on claims. But average risk scores of PGP comparison groups are expected to rise at the same rate. If risk scores for PGP assigned beneficiaries and comparison groups rise at the same rate over time due to more complete diagnostic coding, PGP performance payments will be unaffected. Thus, no adjustment for the nationwide upward trend in risk scores over time will be made in the PGP demonstration.

SECTION 8
CONCLUSION

The concurrent CMS-HCC risk adjustment model accounts for approximately 50% of the variation in health care expenditures among Medicare beneficiaries. Using concurrent risk adjustment in the PGP Demonstration provides an accurate assessment of changes in the health status of beneficiaries.

[This page left intentionally blank.]

REFERENCES

Pope, GC; Ellis, RP; Ash, AS; Ayanian, JZ; Bates, DW; Burstin, H; Iezzoni, LI; Marcantonio, E; Wu, B: "Diagnostic Cost Group Hierarchical Condition Category Models for Medicare Risk Adjustment" Final Report to the Health Care Financing Administration under Contract No. 500-95-048, December 21, 2000. Health Economics Research, Inc., Waltham, MA.

Pope, GC; Kautter, J; Ingber, MJ; Levy, JM; Robst, J; Ellis, RP; Ash, AS: "Risk Adjustment of Medicare Capitation Payments Using the CMS-HCC Model" Health Care Financing Review 25(4):119-141. Summer 2004.

Kautter, J; Pope, GC; Trisolini, M; et al.: "Physician Group Practice Bonus Methodology Specifications" Report to the Centers for Medicare and Medicaid Services under Contract No. 500-00-0024, T.O. No. 13, December, 2004. RTI International, Waltham, MA.