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# Diagnosis-Based Risk Adjustment for Medicare Prescription Drug Plan Payments

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*The 2003 Medicare Prescription Drug, Improvement, and Modernization Act (MMA) created Medicare Part D, a voluntary prescription drug benefit program. The benefit is a government subsidized prescription drug benefit within Medicare. This article focuses on the development of the prescription drug risk-adjustment model used to adjust payments to reflect the health status of plan enrollees.*

## INTRODUCTION

The 2003 MMA created Medicare Part D, a voluntary prescription drug benefit program. The benefit is a government subsidized prescription drug benefit within Medicare and is administered by private sector plans. Such plans may be stand-alone prescription drug plans (PDPs) or Medicare Advantage prescription drug plans (MA-PDs). While there are numerous important components determining how these plans are paid, this article focuses on the development of the prescription drug risk-adjustment model used to adjust payments to reflect the health status of plan enrollees. According to the MMA, payments are based on a standardized plan bid that represents the estimated cost for an enrollee with average risk and a score of 1.0. Payments for each enrollee are risk adjusted by multiplying the standardized bid by a person-level risk factor so that plan

payments reflect the projected health of actual enrollees. Higher standardized bids result in higher per enrollee revenues, but also higher premiums in the competitive market. The process of developing the prescription drug risk-adjustment model, CMS prescription drug hierarchical condition categories (RxHCC) are also described in this article.

## BACKGROUND

The basic Medicare prescription drug benefit structure partially covers the expenses of the majority of plan enrollees and has a catastrophic benefit for very high users. A Part D enrollee pays a premium, which was expected to be approximately \$35<sup>1</sup> a month. Enrollment is on a voluntary basis. There is a premium increase for those who enroll after their initial opportunity, as there is in Medicare Part B. The structure of the standard benefit for 2006 is shown in Figure 1.

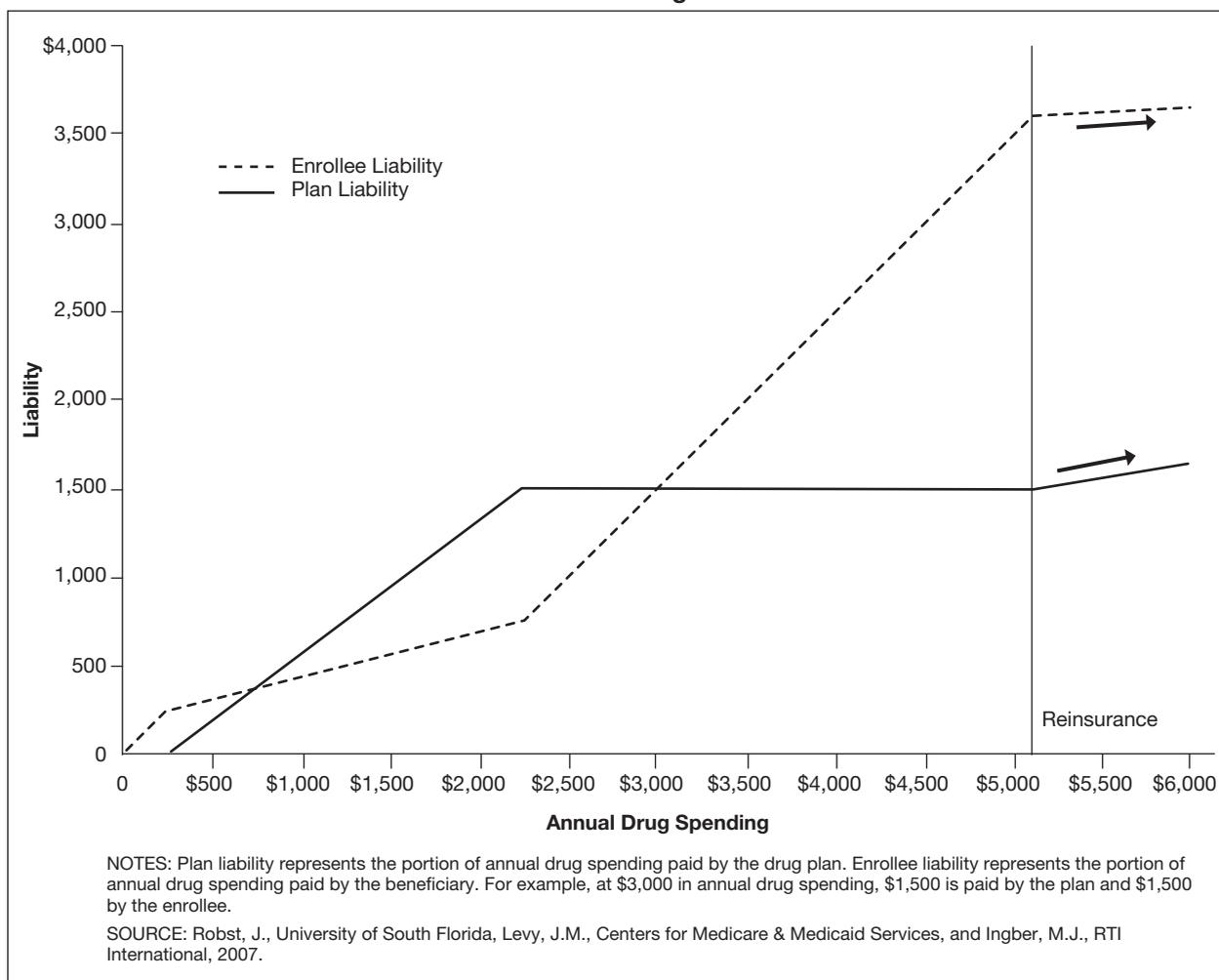
Enrollees are responsible for the first \$250 in drug expenditures. The standard benefit package covers 75 percent of the next \$2,000 in drug expenditures. Once total expenditures reach \$2,250, the beneficiary is responsible for all costs in what has become known as the “donut hole.” The 100 percent coinsurance continues until total drug expenditures reach \$5,100 (\$1,500 plan liability plus \$3,600 out-of-pocket expenses). The catastrophic portion of the benefit covers 95 percent of any additional drug expenditures: 15 percent of

<sup>1</sup> This amount was estimated by CMS' Office of the Actuary. The actual value for 2006 was about \$25.

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**Figure 1**  
**Medicare Standard Drug Benefit: 2006**



the cost is the plan's responsibility; 80 percent is reinsurance paid by Medicare. In the early years there is also plan-Medicare risk sharing for the difference between Medicare payments and actual plan operational costs computed in a year-end reconciliation. The coverage thresholds are to be indexed for inflation in future years. PDPs and MA-PDs have some flexibility in offering plans that differ from the standard benefit. In addition, formularies are set by the plans, subject to legislated requirements, and may vary across plans.

Payments to PDPs and MA-PDs are risk adjusted, since payments are based on a standardized bid amount, which assumes an enrollee with a risk factor of 1.0. Using

a standardized bid to determine the beneficiary premiums insulates the beneficiary from the variation in health status of plan enrollees. Medicare pays the adjustment for risk. The starting point for the bid is the projected monthly revenue requirements to provide defined standard drug coverage for an enrollee with the plan's projected average risk factor. The standardized bid is computed by dividing monthly revenue requirements by the plan's projected average risk factor. Payment adjustments above the risk-adjusted rate are made for low-income and long-term institutionalized beneficiaries due to their higher expected utilization.

The risk factor is derived from the model presented in this article. The CMS-HCC model used for the MA program served as the basis for our work here and is prospective. It uses diagnoses in a base year to predict medical costs in the following year. The CMS-HCC model groups the approximately 15,000 *International Classification of Diseases, Ninth Revision Clinical Modification* (ICD-9-CM) codes into 178 disease groups (Centers for Disease Control and Prevention, 2006). The 70 disease groups that are most predictive of future costs are included in the final 2005 payment model. Pope et al. (2004) discuss the primary criteria for grouping diseases together and for deciding on which diseases comprise the final model.

There are several prescription drug risk-adjustment models that have been developed. Some are based on the prior use of drugs to predict future medical costs or future prescription drug use. We could not use such a methodology to develop our model. In order to implement the program, we needed to compute risk scores for all Medicare beneficiaries. Since we lacked drug utilization data for most beneficiaries, we were unable to implement this type of model. Once the drug benefit is established, data on prior utilization will be available for use in calibration.

Gilmer et al. (2001) developed a model that predicts prospective Medicaid medical costs based on base year prescription drug utilization. Drug claims were analyzed, with national drug codes (NDCs) grouped together based on the disease they are typically used to treat. Thus, it is similar to other risk-adjustment models in that it uses diseases to predict future costs, but infers the diagnoses from prescription drug use, not ICD-9-CM codes.

Zhao et al. (2005) found that models using diagnoses and prior drug use predict future prescription drug costs better than

models using only diagnostic data. Such research highlights the need to consider prior use in future model development. Inclusion of utilization measures among predictor variables must be done with caution in payment models, in contrast to analytical models, as perverse incentives to increase utilization or to favor a particular mode of treatment can be generated.

While prior drug use may predict future drug use better than diagnostic data, additional work was needed to determine whether diagnostic data sufficiently predict future drug use to produce the desired drug risk-adjustment model. Wrobel et al. (2003/2004) used the Medicare Current Beneficiary Survey (MCBS) to analyze the ability of the CMS-HCC model to predict prescription drug expenditures. Demographic variables only explain 5 percent of the variation in drug expenditures, while adding diagnostic groups increases the explained variance to 10-24 percent. Adding lagged drug use increases the  $R^2$  to 55 percent. Overall, diagnoses are important predictors of future drug use and the results of their study indicate the CMS-HCC model is an appropriate starting point for a model to predict drug expenditures.

## DATA SOURCES AND MODEL OVERVIEW

### Data Sources

Development of a risk-adjustment model for drug spending depends on having appropriate data from which to create diagnosis groups and cost estimates. As there were no Part D data available, CMS used drug expenditure data for Federal retirees with Medicare in the Federal Employee Health Benefit plan run by Blue Cross<sup>®</sup> Blue Shield<sup>®</sup> (BCBS). The BCBS plan is national in scope, with uniform benefits. The BCBS pharmacy benefit plan is

an uncapped benefit with a coinsurance amount for retail purchases and two tiers of copayment for mail order purchases. Only those retirees age 65 were used from these data. For disabled beneficiaries under age 65, data on Medicare and Medicaid dually eligible beneficiaries from the Medicaid Statistical Information System (MSIS) were used. For each data set the development of the model used diagnoses from standard Medicare files and drug spending from each program's drug benefit. The BCBS plan spending year 2002 was used for calibration. For Medicaid, the latest available data linked to Medicare were for spending year 2000.

Next, we obtained information for these beneficiaries from the enrollee database (EDB). The EDB is the primary repository for Medicare current and historical enrollment and entitlement data. It was the source of demographic and Medicare Program information not available in the BCBS plan or Medicaid data. Critical data from the EDB includes Parts A and B coverage periods, hospice coverage, and managed care coverage periods.

We used diagnostic information from the Medicare Provider Analysis and Review (MEDPAR), hospital outpatient, and physician claims from the base years (2001 for the BCBS plan and 1999 for Medicaid). Diagnoses were accepted from the following five source records: (1) principal hospital inpatient; (2) secondary hospital inpatient; (3) a hospital outpatient; (4) physician; and the (5) clinically-trained non-physician (e.g., psychologist, podiatrist). The model does not distinguish among sources. These are the same data sources for diagnoses used in the CMS-HCC model.

The BCBS plan data provided to CMS contain annual prescription drug expenditures for each enrollee and annual copayments by enrollees. We converted the BCBS plan costs to total pharmacy costs for

each beneficiary by adding the beneficiary's cost sharing amounts to the BCBS plan costs. The BCBS plan offered two different types of benefits in 2002: standard benefits and basic. The standard pharmacy benefit included a 25 percent coinsurance on retail pharmacy purchases, while the mail order benefit had a two-tiered copayment. The basic benefit included a two-tiered copayment on retail purchases, and no mail order benefit. Retail pharmacy costs for enrollees in the standard BCBS plan were imputed using the BCBS plan costs and the 25 percent coinsurance.

Medicaid was more difficult, however. The Medicaid Program is very complex, varying across States. To create a reliable data file we removed individuals when uncertain about the completeness of diagnostic or cost data. We excluded individuals living in Arizona, Hawaii, and Tennessee due to high managed care penetration. We also removed managed care enrollees from other States, and individuals with other insurance coverage, since Medicaid is the payer of last resort. We also excluded individuals who did not have prescription drug coverage through their Medicaid Program. For example, some individuals eligible for Medicaid as qualified Medicare beneficiaries (QMBs), specified low-income Medicare beneficiaries (SLMBs), or qualifying individuals (QIs) did not receive prescription drug coverage through Medicaid.

Additional modifications to the data were necessary to remove certain drug claims from the data because Part D specifically does not cover certain drugs. Only prescription drugs are included, but with Medicare Part B covered drugs removed. Drugs covered by Part B, such as immuno-suppressives, will continue to be covered by Part B Medicare. Removal of the Part B drugs was straightforward in the Medicaid data as each claim has both an NDC and amount

paid. Adjusting the BCBS plan data was more complex. We had only total spending for each person, with no paid amount on the claims to be excluded. Using the Medicaid data we estimated the percentage reduction in spending associated with removal of Part B drugs for beneficiaries with conditions associated with high use, such as cancers and transplants. We then reduced spending for similar beneficiaries in the BCBS plan files in the same proportion. Other non-covered drugs, benzodiazepines, and barbiturates, were intentionally left in the file because their costs proxy for the costs of substitutes. This was deemed preferable to removing the claims and costs altogether.

At the conclusion of the data compilation, for each beneficiary we had demographic, programmatic, and diagnostic information for the base year along with prescription drug cost information for the payment year. Descriptive statistics for the BCBS plan and Medicaid samples are provided in Table 1. Given beneficiary cost sharing, a plan offering the standard benefit is liable for less than one-half total

drug expenditures. The Medicaid sample is younger on average than the BCBS plan sample because all ages, including the disabled under age 65 can be dually eligible beneficiaries, while there is no equivalent group in the BCBS plan data. Consequently, disease prevalence is different for the two samples.

We stratified each data set into two groups. The first group comprised those for whom we had sufficient information to include them in the risk-adjustment estimation model. For the purpose of calibrating a drug risk-adjustment model, we began with the population of fee-for-service Medicare beneficiaries with Medicare Parts A and B for the entire base calendar year. This allowed us to have a complete year of diagnostic information for these beneficiaries. We further required that individuals be enrolled in the BCBS plan or Medicaid Program for at least one day in the payment year. It is important to retain people with less than full payment year eligibility to capture the potentially different drug use pattern of decedents. Weighting is applied to partial year enrollees.

**Table 1**  
**Statistics for Selected Characteristics of the Estimation Samples**

Characteristic	Blue Cross®/Blue Shield®		Medicaid	
	Continuing Enrollees	New Enrollees	Continuing Enrollees	New Enrollees
Mean Annualized Payments <sup>1</sup>	2,287	1,917	3,003	2,587
Mean Annualized Plan Liability <sup>2</sup>	961	809	1,046	951
Mean Age	76.2	68.7	63.3	65.3
	Percent			
Male	40.1	45.6	36.4	33.2
Disabled	0.0	0.0	41.9	26.6
Originally Disabled	3.2	1.3	10.8	0.8
Diabetes	19.4	—	24.2	—
Congestive Heart Failure	25.2	—	14.9	—
Other Major Psychiatric Disorders	0.1	—	20.8	—
Disorders of Lipoid Metabolism	45.0	—	24.6	—
Observations	726,705	51,734	130,207	20,208

<sup>1</sup> Annualized payments equal actual payments divided by the proportion of year in fee-for-service.

<sup>2</sup> Annualized plan liability is equal to actual plan liability divided by the proportion of year in fee-for-service.

NOTES: Annualized payments and liability are projected to calendar year 2006. Data represent 1999/2000 Medicare and Medicaid beneficiaries and 2001/2002 BC®BS® enrollees.

SOURCE: Robst, J., University of South Florida, Levy, J.M., Centers for Medicare & Medicaid Services, and Ingber, M.J., RTI International, 2007.

The second group comprised those for whom we did not have a year of complete diagnostic information, but for whom we had prescription drug costs in the following year. These beneficiaries could not be used for model estimation. Nevertheless, they represent one group of enrollees who must be given a score based on information other than diagnoses. A model for these new enrollees is also created.

The initial model developed (on the BCBS plan data) to predict spending, omitted two groups that received special treatment at the end of the process—those who would receive the low income subsidy (LIS) and the long-term institutionalized (LTI).

## GROUPER

The model uses particular demographic characteristics and diagnoses to predict the following years expected costs for an individual. The ICD-9-CM diagnoses are clustered within groups homogeneous both clinically and in costs. Each included characteristic and condition present contributes to the total prediction for an individual through a formula that sums the incremental contributions. The groupings used to predict drug spending are variants of the groups used to predict Parts A and B spending.

We wanted to create a grouper that was similar to the grouper that was used to predict Parts A and B spending while being homogeneous for drug spending rather than non-pharmacy spending. We began by estimating a prospective model regressing spending in the payment year on the base year diagnosis grouping (DXG<sup>2</sup>) of diagnoses that are the basis of the CMS-HCC model. Results of this regression and some specific issues of the evaluation were: (1)

<sup>2</sup> DXGs are groupings of ICD-9-CM codes that are relatively narrow in clinical scope and cost variation. These are the building blocks of larger groups used in payment models.

whether there were DXGs that did not have implications for drug spending in the next year; (2) whether the grouping of DXGs into condition categories used in the CMS-HCC model was appropriate for a drug spending model; (3) whether the DXGs should be combined differently than in the CMS-HCC model; and (4) whether any CCs should not be included in the drug model. We re-estimated the model based on the received recommendations and had them reviewed by an interdisciplinary panel of clinicians. The clinicians reviewed the statistical results and assessed the groupings using the same criteria as previously mentioned. We re-estimated the model based on clinical input. Iterating this process with the clinicians ultimately resulted in a grouper that changed few of the narrow DXG building blocks. However, the DXGs are assembled into larger condition disease categories that often differ from the CMS-HCC groups. The relationship between diagnosis and costs is not the same for Parts A and B spending as for drug spending.

In development of the model's grouper, drug spending in dollars was the dependent variable of a linear regression that estimated the incremental spending related to each of the explanatory variables in the model. It was easier for clinicians to evaluate a model that predicts the total cost of drugs needed for a condition than plan liability, which is the result of a complex formula. In May 2004, based on these preliminary results, CMS announced the 5,542 ICD-9-CM codes under consideration for inclusion in the drug risk-adjustment model.

The RxHCC diagnostic classification system groups the more than 15,000 ICD-9-CM diagnosis codes into 197 condition categories, or RxCCs. As with the CMS-HCC model, all ICD-9-CM codes are classified into disease groups despite the limited number in the final model. RxCCs describe major diseases and are broadly

organized into body systems. As in the CMS-HCC model some of the disease groups are clustered in hierarchies. Clinical review found that drug regimens may get more intense, and more drugs may be added when a disease has a higher severity. In such a case, when the model has higher and lower severity categories, if the higher cost category of the related diseases is reported, coding of the lower cost category is ignored. Such is the case with diabetes: diabetes with complications overrides uncomplicated diabetes. If the drugs for diseases differ from one another, even if the diseases are related, the RxHCCs are not placed in the same hierarchy and remain additive. Conditions not in the same hierarchy contribute independently to the total prediction. After the hierarchies are imposed, the RxCCs become RxHCCs. The categories and hierarchies used in the model are presented in Tables 2 and 3.

### **Pooling BCBS Plan and Medicaid Data**

While the grouper was formed by estimating a spending model using only BCBS plan data, the final model was estimated using a pooled plan Medicaid data set. There were a number of problems in integrating the data sets: (1) the Medicaid group is low income and received drugs at out-of-pocket costs quite different from BCBS plan enrollees; (2) because of price differences, utilization would probably differ from that under the BCBS plan benefit, even for the same diseases; and (3) the cost data were from a different year and from many Medicaid Programs. In integrating the two data sets we converted the Medicaid data to spending patterns similar to that which would have occurred, on average, under a BCBS plan benefit.

First, since the data are for different years, inflation factors were applied to

eliminate spending differences due to price inflation. The spending in both data sets was multiplied by inflation factors calculated using the 2003 national health account prescription drug spending projections by CMS actuaries to project spending levels in 2006. We inflated to 2006 dollars because the cost-sharing ranges are defined in absolute dollar terms for 2006; thus, spending had to be projected to levels appropriate to 2006. Dollars from the year 2000 were multiplied by 2.039, while 2002 dollars were multiplied by 1.554.

Second, the model estimated with BCBS plan data for the aged, was applied to the dual eligible aged population to predict their spending as it would be under a BCBS plan benefit. This modeling incorporated the different demographic and disease profiles of the Medicaid population in the predictions. The actual spending in the Medicaid data was then compared to the predicted spending. The ratio of the predicted to the actual spending was used to convert the spending in the Medicaid files to levels compatible with BCBS plan. The conversion factor was analyzed across the age/sex groups appearing in both data sets and, except for the sparse age group 95 or over was quite stable. With the data sets merged it became possible to estimate a full model across all ages and include age-specific add-ons for some diseases. This sample represents beneficiaries all of whom are presumed to have the BCBS plan benefit structure. The data in the two samples were weighted to make the data representative of the Medicare population.

### **Computing Standard Benefit Plan Liability**

The requirement of the risk-adjustment model was to predict the cost of drugs to the Part D plans, not the total spending that was modeled thus far. The decision to

Table 2

**Medicare Part D Continuing Enrollee Risk-Adjustment Model Community Sample Not Low-Income Subsidy Eligible**

Characteristic Label	Spending Model <sup>1</sup>		Plan Liability Model <sup>1</sup>	
	Dollars <sup>2</sup>	Relative Factors	Dollars <sup>2</sup>	Relative Factors
<b>Disease Groups</b>	—	2336.64	—	993.330
RxHCC1 HIV/AIDS	12,314.00	5.270	2,028.28	2.042
RxHCC2 Opportunistic Infections	1,647.65	0.705	255.61	0.257
RxHCC3 Infectious Diseases	345.61	0.148	72.30	0.073
RxHCC8 Acute Myeloid Leukemia	1,689.53	0.723	290.98	0.293
RxHCC9 Metastatic Cancer, Acute Leukemia, and Severe Cancers	729.38	0.312	172.63	0.174
RxHCC10 Lung, Upper Digestive Tract, and Other Severe Cancers	111.55	0.048	49.27	0.050
RxHCC17 Diabetes with Complications	1,091.45	0.467	256.26	0.258
RxHCC18 Diabetes without Complication	658.61	0.282	188.51	0.190
RxHCC19 Disorders of Lipoid Metabolism	397.06	0.170	161.65	0.163
RxHCC20 Other Significant Endocrine and Metabolic Disorders	400.91	0.172	77.19	0.078
RxHCC21 Other Specified Endocrine/Metabolic/Nutritional Disorders	158.53	0.068	48.68	0.049
RxHCC24 Chronic Viral Hepatitis	516.44	0.221	91.58	0.092
RxHCC31 Chronic Pancreatic Disease	293.08	0.125	47.19	0.048
RxHCC33 Inflammatory Bowel Disease	753.96	0.323	180.85	0.182
RxHCC34 Peptic Ulcer and Gastrointestinal Hemorrhage	141.62	0.061	32.79	0.033
RxHCC37 Esophageal Disease	644.19	0.276	174.57	0.176
RxHCC39 Bone/Joint/Muscle Infections/Necrosis	202.75	0.087	23.33	0.023
RxHCC40 Behçet's Syndrome and Other Connective Tissue Disease	294.36	0.126	65.48	0.066
RxHCC41 Rheumatoid Arthritis and Other Inflammatory Polyarthropathy	931.89	0.399	196.62	0.198
RxHCC42 Inflammatory Spondylopathies	392.74	0.168	74.42	0.075
RxHCC43 Polymyalgia Rheumatica	136.31	0.058	42.32	0.043
RxHCC44 Psoriatic Arthropathy	695.26	0.298	148.78	0.150
RxHCC45 Disorders of the Vertebrae and Spinal Discs	456.69	0.195	139.89	0.141
RxHCC47 Osteoporosis and Vertebral Fractures	292.27	0.125	113.81	0.115
RxHCC48 Other Musculoskeletal and Connective Tissue Disorders	182.63	0.078	76.29	0.077
RxHCC51 Severe Hematological Disorders	624.40	0.267	111.81	0.113
RxHCC52 Disorders of Immunity	1,403.95	0.601	205.66	0.207
RxHCC54 Polycythemia Vera	320.79	0.137	91.08	0.092
RxHCC55 Coagulation Defects and Other Specified Blood Diseases	93.35	0.040	24.86	0.025
RxHCC57 Delirium and Encephalopathy <sup>3</sup>	168.96	0.072	0.00	0.000
RxHCC59 Dementia with Depression or Behavioral Disturbance	1,103.73	0.472	219.87	0.221
RxHCC60 Dementia/Cerebral Degeneration	558.69	0.239	140.65	0.142
RxHCC65 Schizophrenia	1,268.40	0.543	248.07	0.250
RxHCC66 Other Major Psychiatric Disorders	644.59	0.276	156.86	0.158
RxHCC67 Other Psychiatric Symptoms/Syndromes	477.69	0.204	126.42	0.127
RxHCC75 Attention Deficit Disorder	991.13	0.424	252.42	0.254
RxHCC76 Motor Neuron Disease and Spinal Muscular Atrophy	876.70	0.375	151.17	0.152
RxHCC77 Quadriplegia, Other Extensive Paralysis, and Spinal Cord Injuries	261.77	0.112	47.47	0.048
RxHCC78 Muscular Dystrophy	391.39	0.168	82.89	0.083
RxHCC79 Polyneuropathy, Except Diabetic	443.15	0.190	76.73	0.077
RxHCC80 Multiple Sclerosis	1,926.99	0.825	355.41	0.358
RxHCC81 Parkinson's Disease	1,377.19	0.589	317.80	0.320
RxHCC82 Huntington's Disease	269.28	0.115	54.14	0.055
RxHCC83 Seizure Disorders and Convulsions	497.65	0.213	125.91	0.127
RxHCC85 Migraine Headaches	542.02	0.232	105.16	0.106
RxHCC86 Mononeuropathy, Other Abnormal Movement Disorders	323.60	0.138	70.11	0.071
RxHCC87 Other Neurological Conditions/Injuries	147.75	0.063	31.25	0.031
RxHCC91 Congestive Heart Failure	717.49	0.307	249.73	0.251
RxHCC92 Acute Myocardial Infarction and Unstable Angina	436.02	0.187	139.45	0.140
RxHCC98 Hypertensive Heart Disease or Hypertension	469.14	0.201	221.01	0.222
RxHCC99 Specified Heart Arrhythmias	223.95	0.096	92.51	0.093
RxHCC102 Cerebral Hemorrhage and Effects of Stroke	232.31	0.099	62.57	0.063
RxHCC105 Pulmonary Embolism and Deep Vein Thrombosis	147.95	0.063	26.77	0.027
RxHCC106 Vascular Disease	134.53	0.058	35.04	0.035
RxHCC108 Cystic Fibrosis	637.90 a	0.273	162.07 c	0.163
RxHCC109 Asthma and COPD	637.90 a	0.273	162.07 c	0.163
RxHCC110 Fibrosis of Lung and Other Chronic Lung Disorders	341.15	0.146	76.62	0.077
RxHCC111 Aspiration and Specified Bacterial Pneumonias	158.65	0.068	43.08 d	0.043

Refer to footnotes at the end of the table.

Table 2—Continued

**Medicare Part D Continuing Enrollee Risk-Adjustment Model Community Sample Not Low-Income Subsidy Eligible**

Characteristic Label	Spending Model <sup>1</sup>		Plan Liability Model <sup>1</sup>		
	Dollars <sup>2</sup>	Relative Factors	Dollars <sup>2</sup>	Relative Factors	
<b>Disease Groups</b>					
RxHCC112	Empyema, Lung Abscess, and Fungal and Parasitic Lung Infections	222.96	0.095	43.08 d	0.043
RxHCC113	Acute Bronchitis and Congenital Lung/Respiratory Anomaly	115.26	0.049	43.08 d	0.043
RxHCC120	Vitreous/Retinal Hemorrhage and Vascular Retinopathy Except Diabetic	182.63	0.078	55.99	0.056
RxHCC121	Macular Degeneration and Retinal Disorders, Except Detachment and Vascular Retinopathies	101.03	0.043	39.53	0.040
RxHCC122	Open-Angle Glaucoma	446.49	0.191	159.74	0.161
RxHCC123	Glaucoma and Keratoconus	168.39	0.072	67.50	0.068
RxHCC126	Larynx/Vocal Cord Diseases	104.61	0.045	23.79	0.024
RxHCC129	Other Diseases of Upper Respiratory System	243.66	0.104	82.68	0.083
RxHCC130	Salivary Gland Diseases	281.75	0.121	49.62	0.050
RxHCC132	Kidney Transplant Status	882.63	0.378	213.23	0.215
RxHCC134	Chronic Renal Failure	328.48 b	0.141	73.67	0.074
RxHCC135	Nephritis	328.48 b	0.141	50.33	0.051
RxHCC137	Urinary Obstruction and Retention	156.29 c	0.067	48.02 e	0.048
RxHCC138	Fecal Incontinence	156.29 c	0.067	48.02 e	0.048
RxHCC139	Incontinence	395.50	0.169	101.00	0.102
RxHCC140	Impaired Renal Function and Other Urinary Disorders	72.71	0.031	22.74	0.023
RxHCC144	Vaginal and Cervical Diseases	66.85	0.029	33.06	0.033
RxHCC145	Female Stress Incontinence	228.45	0.098	66.82	0.067
RxHCC157	Chronic Ulcer of Skin, Except Decubitus	156.29	0.067	48.02	0.048
RxHCC158	Psoriasis	244.58	0.105	76.47	0.077
RxHCC159	Cellulitis and Local Skin Infection	162.37	0.069	48.02 f	0.048
RxHCC160	Bullous Dermatoses and Other Specified Erythematous Conditions	131.84	0.056	48.02 f	0.048
RxHCC165	Vertebral Fractures without Spinal Cord Injury	304.88	0.130	54.64	0.055
RxHCC166	Pelvic Fracture	250.06	0.107	39.63	0.040
RxHCC186	Major Organ Transplant Status	433.46	0.186	78.38 g	0.079
RxHCC187	Other Organ Transplant/Replacement	245.87	0.105	78.38 g	0.079
<b>Age/Disease Interactions</b>					
DRxHCC65	Age < 65 and RXHCC65	1,677.91	0.718	372.85	0.375
DRxHCC66	Age < 65 and RXHCC66	711.85	0.305	164.03	0.165
DRxHCC108	Age < 65 and RXHCC108	5,650.38	2.418	890.56	0.897
<b>Age/Sex Groups</b>					
<b>Female</b>					
	0-34 Years	976.33	0.418	418.55	0.421
	35-44 Years	1,569.12	0.672	572.38	0.576
	45-54 Years	1,659.47	0.710	607.30	0.611
	55-59 Years	1,518.63	0.650	579.49	0.583
	60-64 Years	1,171.04	0.501	528.10	0.532
	65-69 Years	817.34	0.350	455.68	0.459
	70-74 Years	736.87	0.315	444.13	0.447
	75-79 Years	660.60	0.283	431.41	0.434
	80-84 Years	576.10	0.247	413.39	0.416
	85-89 Years	488.31	0.209	391.90	0.395
	90-94 Years	412.62	0.177	368.22	0.371
	95 Years or Over	263.00	0.113	314.48	0.317
<b>Males</b>					
	0-34 Years	965.44	0.413	394.79	0.397
	35-44 Years	1,485.05	0.636	515.24	0.519
	45-54 Years	1,526.10	0.653	536.93	0.541
	55-59 Years	1,116.51	0.478	488.03	0.491
	60-64 Years	817.55	0.350	430.10	0.433
	65-69 Years	561.65	0.240	352.80	0.355
	70-74 Years	493.61	0.211	351.67	0.354
	75-79 Years	421.40	0.180	346.17	0.348
	80-84 Years	336.70	0.144	331.39	0.334
	85-89 Years	277.13	0.119	323.86	0.326

Refer to footnotes at the end of the table.

**Table 2—Continued**

**Medicare Part D Continuing Enrollee Risk-Adjustment Model Community Sample Not Low-Income Subsidy Eligible**

Characteristic Label	Spending Model <sup>1</sup>		Plan Liability Model <sup>1</sup>	
	Dollars <sup>2</sup>	Relative Factors	Dollars <sup>2</sup>	Relative Factors
<b>Age/Sex Groups</b>				
90-94 Years	200.39	0.086	298.66	0.301
95 Years or Over	97.12	0.042	264.59	0.266
<b>Originally Disabled Interactions with Sex</b>				
Female, age ≥ 65, originally entitled to Medicare due to disability	473.06	0.202	88.90	0.089
Male, age ≥ 65, male , originally entitled to Medicare due to disability	361.59	0.155	77.00	0.078

<sup>1</sup> Coefficients with the same letter are constrained to be equal.

<sup>2</sup> Mean dollars and plan liability are based on both continuing enrollees and new enrollees.

<sup>3</sup> This prescription drug hierarchical condition categories (RxHCC) is significant in the spending model, but not in the plan liability model.

NOTE: Data represent 1999/2000 Medicare and Medicaid beneficiaries and 2001/2002 BC<sup>®</sup>BS<sup>®</sup> enrollees.

SOURCE: Robst, J., University of South Florida, Levy, J.M., Centers for Medicare & Medicaid Services, and Ingber, M.J., RTI International, 2007.

**Table 3**

**Disease Hierarchies, Medicare Part D Risk-Adjustment Model: 1999-2002**

If the Disease Group is Listed in this column ... RxHCC	Disease Group Label	Then Drop the Related Disease Groups Listing in this column
1	HIV/AIDS	3
2	Opportunistic Infections	3, 112, 113
8	Acute Myeloid Leukemia	9, 10
9	Metastatic Cancer, Acute Leukemia, and Severe Cancers	10
17	Diabetes with Complications	18
37	Esophageal Disease	126
45	Disorders of the Vertebrae and Spinal Discs	48
51	Severe Hematological Disorders	54, 55
54	Polycythemia Vera	55
59	Dementia with Depression or Behavioral Disturbance	60, 67
65	Schizophrenia	67
66	Other Major Psychiatric Disorders	67
91	Congestive Heart Failure	98
108	Cystic Fibrosis	109, 110, 113
109	Asthma and COPD	110, 113
110	Fibrosis of Lung and Other Chronic Lung Disorders	113
111	Aspiration and Specified Bacterial Pneumonias	113
112	Empyema, Lung Abscess, and Fungal and Parasitic Lung Infections	113
120	Vitreous/Retinal Hemorrhage and Vascular Retinopathy except Diabetic	121
122	Open-Angle Glaucoma	123
132	Kidney Transplant Status	134, 135, 140, 187
134	Chronic Renal Failure	135, 140
135	Nephritis	140
138	Fecal Incontinence	137
139	Incontinence	137
157	Chronic Ulcer of Skin, Except Decubitus	138, 160
159	Cellulitis and Local Skin Infection	160
186	Major Organ Transplant Status	187

NOTES: If a beneficiary triggers RxHCC157 (Chronic Ulcer of the skin) and RxHCC160 (Bullous Dermatoses and Other Specified Erythematous Conditions) then RxHCC160 will be dropped. Payment will always be associated with the RxHCC if both an RxHCC and a code in the related disease group occur during the same collection period. Therefore, in this example, the Part D plan sponsor's payment will be based on RxHCC157 rather than RxHCC160. RxHCC is prescription drug hierarchical condition categories.

SOURCE: Robst, J., University of South Florida, Levy, J.M., Centers for Medicare & Medicaid Services, and Ingber, M.J., RTI International, 2007.

estimate a plan liability model based on the standard benefit was arrived at in consultation with industry actuaries after studying the difficulties, both technical and operational, in modeling an unknown spectrum of possible benefit variations. Despite the discontinuous pattern of plan liability as spending varies, a linear model based on plan liability produces reasonable results. The plan liability model uses the grouper developed for the total spending model. The coefficients were estimated, however, on data altered to reflect plan liability.

Before applying the cost sharing to create plan liability, the spending data went through one additional adjustment. It is generally observed that spending patterns are affected by income and prices. The model described thus far incorporated the cost-sharing patterns of the plan benefit. The cost sharing in Part D is somewhat higher than in plan for the non-LIS<sup>3</sup> population. CMS' Office of the Actuary estimated a 19-percent impact on spending from imposing the Part D benefit structure on these data. Thus, we reduced spending by 19 percent for non-institutionalized beneficiaries. Spending by institutionalized beneficiaries is assumed to be less discretionary and invariant to the change in benefit structure.

We used the benefit structure rules applied to the adjusted spending to derive plan liability for each beneficiary. Payments were annualized by dividing by the fraction of the payment year each beneficiary was eligible. In the regressions, the observations were weighted by the same eligibility fraction. Two models were estimated: (1) an overall spending model and (2) a plan liability model using the non-institutionalized beneficiaries.

<sup>3</sup> The low income subsidy reduces premiums, in some cases to \$0, and has low copayments.

## MODELS

### RxHCC

The RxHCC models have the specification:  $Cost_{it} = \beta_0 + \beta_1 Age/Sex_{it} + \beta_2 OrigDis_{it} + \beta_3 RXHCC_{it-1} + \beta_4 Disabled \cdot RXHCC_{it-1} + \epsilon_{it}$  where *Age/Sex* denotes 24 mutually exclusive age/sex cells, and *OrigDis* represents originally disabled status: those who are currently age 65 or over, but were first entitled to Medicare before age 65 by disability. *RxHCC* is a vector of diagnostic categories; and *Disabled RxHCC* denotes three potential incremental payments for beneficiaries entitled by disability. The model is additive across age/sex status, originally disabled status, and the *RxHCC* categories. The three disease groups with additional payments for the disabled are schizophrenia, other major psychiatric disorders, and cystic fibrosis. These amounts are added to the main entry for the diagnosis. In the spending model, *Cost* denotes total prescription drug expenditures, while in the payment model *Cost* denotes the plan liability.

### Risk-Adjustment Spending Model

A risk-adjustment model predicting total drug spending at the person level is displayed in Table 2. The final spending model is comprised of 84 *RxHCCs*. Similar to the development of the CMS-HCC model, the final spending model excludes diagnostic categories when the diagnoses were vague/nonspecific, discretionary in medical treatment or coding, not significant predictors of drug use, or transitory or not admitting of definitive treatment.

Because one cannot predict all of the next year diseases and drug consequences from prior year diagnoses, the demographic coefficients are significant in magnitude. The age/sex coefficients indicate

that drug expenditures not directly associated with the diseases in the model rise with age until they reach a peak for the age group 45-54. Older age groups tend to use fewer prescription drugs not accounted for by their known disease profile. The RxHCC coefficients reflect the average drug implications of different diseases to individuals. By far, the largest costs are associated with human immunodeficiency virus acquired immunodeficiency syndrome (HIV/AIDS), but other disease groups also have substantial drug implications including diabetes, schizophrenia (especially among the disabled), multiple sclerosis, Parkinson's disease, and cystic fibrosis. Total costs of a disease to the Medicare Program, however, are driven by disease prevalence as well as the coefficient size.

### **Risk-Adjustment Plan Liability Model**

Figure 1 illustrates that plan liability has a non-linear relationship to spending. If the coefficients from a spending model were applied to the plan liability amounts, the predictions would likely overestimate plan liability and be invalid. Consequently, we estimated the plan liability model using the adjusted spending data. The plan liability coefficients are smaller than the coefficients for the spending model, and as would be expected, some changed more than others. For example, the HIV/AIDS coefficient fell from \$12,314 to \$2,028. The plan liability coefficient is substantially smaller than the corresponding spending coefficient when the disease implies drug use reaches the donut hole or above. Plans are not responsible for any of the costs between \$2,250 and \$5,100 in total and only 15 percent of the cost above \$5,100. As such, diseases with high spending coefficients have much lower coefficients in the plan liability model.

The model is ultimately expressed not in dollars, but as relative factors. The incremental dollars associated with each variable in the model are divided by the mean predicted dollars to produce a relative costliness or risk factor. Summing the risk factors for an individual yields a total risk-adjustment factor that, when multiplied by a base rate, yields an individualized capitation payment.

When the coefficients in the two models are expressed as relative factors, the differences are smaller. This is because the conversion to relative factors entails dividing each coefficient by the national mean for spending or liability, as appropriate. Dividing a large spending coefficient by a large spending mean produces results similar to dividing the smaller liability coefficient by the smaller liability mean. The proportionality is not uniform, however. Diseases characterizing beneficiaries who tend to have a large proportion of spending in the 100 percent cost sharing range, have their factors reduced by a greater proportion than others. Much of drug spending can have a zero impact on plan liability.

Both the spending and the plan liability model have good predictive power. The  $R^2$  (i.e. the proportion of the total variation in the dependent variable that is explained by the model) exceeds 0.20. This is higher than the explanatory power for the models predicting the more variable Parts A and B costs and comparable to other diagnosis based models for drugs in the literature.

### **New Enrollee Model**

The new enrollee model is applied to those beneficiaries for whom a year of complete diagnostic information does not exist. This includes not only those beneficiaries newly entitled to Medicare, it also includes those who were entitled to only Part A during the data collection year or who were

in an MA-PD plan during any part of the data collection year.

The sample for the estimation of this model includes both those who are risk adjustable (i.e., those who were included in the prior regression) as well as those who lack full diagnosis data, but have eligible coverage and costs in the payment year. The estimation is based solely on demographic characteristics.

The results of the new enrollee regression are shown in Table 4. All cells are mutually exclusive. For example, the predicted drug expenditures for a male, age 65, who is not originally disabled are

\$748.16, while predicted expenditures are \$1,102.01 if he is originally disabled. The coefficients for both sexes indicate that beneficiaries originally entitled to Medicare due to disability have much higher drug utilization than beneficiaries originally entitled due to age. Coefficients for females are also consistently greater than for males.

## VALIDATION

Analyses have been made of the predictive ratios (plan predicted liability in the data divided by actual plan liability) for beneficiaries in deciles of predicted liability

**Table 4**

**New Enrollee Model Plan Liability Drug Model Community Sample Not Low-Income Subsidy Eligible**

Age/Sex	Not Originally Disabled <sup>1</sup>		Originally Disabled <sup>1</sup>	
	Dollars	Relative Factors	Dollars	Relative Factors
<b>Female</b>				
0-34 Years	867.90	0.874	—	—
35-44 Years	1,166.09	1.174	—	—
45-54 Years	1,278.57 a	1.287	—	—
55-59 Years	1,278.57 a	1.287	—	—
60-64 Years	1,278.57 a	1.287	—	—
65 Years	896.75	0.903	1,278.57 c	1.287
66 Years	916.16	0.922	1,278.57 c	1.287
67 Years	936.02	0.942	1,278.57 c	1.287
68 Years	942.80	0.949	1,278.57 c	1.287
69 Years	952.19	0.959	1,278.57 c	1.287
70-74 Years	988.29	0.995	1,278.57 c	1.287
75-79 Years	1,020.67	1.028	1,195.61 d	1.204
80-84 Years	1,023.02	1.030	1,195.61 d	1.204
85-89 Years	997.95	1.005	1,195.61 d	1.204
90-94 Years	939.66	0.946	1,050.17	1.057
95 Years and Over	829.91	0.835	940.42	0.947
<b>Male</b>				
0-34 Years	839.37	0.845	—	—
35-44 Years	1,102.01 b	1.109	—	—
45-54 Years	1,102.01 b	1.109	—	—
55-59 Years	1,102.01 b	1.109	—	—
60-64 Years	1,102.01 b	1.109	—	—
65 Years	748.16	0.753	1,102.01 e	1.109
66 Years	762.28	0.767	1,102.01 e	1.109
67 Years	790.50	0.796	1,102.01 e	1.109
68 Years	811.70	0.817	1,102.01 e	1.109
69 Years	829.35	0.835	1,102.01 e	1.109
70-74 Years	871.28	0.877	1,102.01 e	1.109
75-79 Years	921.21	0.927	1,015.20 f	1.022
80-84 Years	934.64	0.941	1,015.20 f	1.022
85-89 Years	928.25	0.934	1,015.20 f	1.022
90-94 Years	862.50	0.868	949.45	0.956
95 Years and Over	798.16	0.804	885.11	0.891

<sup>1</sup>Coefficients marked with the same letter are constrained to be equal.

NOTES: All cells are mutually exclusive. For example, a male age 65, who is originally disabled has a predicted value of \$1,102.01; if he is not originally disabled, the predicted value is \$748.16. Data represent 1999/2000 Medicare and Medicaid beneficiaries and 2001/2002 BC<sup>®</sup>BS<sup>®</sup> enrollees.

SOURCE: Robst, J., University of South Florida, Levy, J.M., Centers for Medicare & Medicaid Services, and Ingber, M.J., RTI International, 2007.

(Table 5). Predictive ratios above 1.0 indicate overprediction; ratios lower than 1.0 indicates underprediction. The model performed well for both the plan and Medicaid samples. The model over-predicts for the bottom and top deciles. Because a substantial portion of a person's risk factor is associated with age and sex, even when diseases are accounted for, the model tends to overpay for beneficiaries who are predicted to be in the lowest deciles of costs some of whom use no drugs. Unlike the case for Parts A and B, the model also overpredicts payment for the beneficiaries in the highest decile of predicted costs. This is because the coefficients cannot fully reflect the flattening of plan liability for high spenders. In the middle deciles of predicted costs there is a small degree of underprediction.

Predictive ratios from an age/sex model are also presented for comparison. The age/sex model underperforms the

RxHCC model for most of the deciles. The most notable differences exist in the bottom and top deciles. The age/sex model overpredicts more in the low deciles and underpredicts rather than overpredicts in the highest decile.

Table 5 also reports predictive ratios for individuals who were hospitalized in the base year. The comparison between the age/sex model and risk-adjustment model is particularly striking. The age/sex model overpredicts by 7 percent for individuals without hospitalizations, but underpredicts by 34 percent for individuals with four or more hospitalizations. The risk-adjustment model predicts very accurately for beneficiaries with fewer than four hospitalizations. Unlike the age/sex model, which underpredicts for the costliest enrollees, the risk model overpredicts for individuals with the most hospitalizations.

**Table 5**  
**Predictive Ratios for Selected Characteristics**

Characteristic	BlueCross® BlueShield® Sample			Medicaid Sample			Total		
	Observations	Age/Sex Model	RxHCC Model	Observations	Age/Sex Model	RxHCC Model	Observations	Age/Sex Model	RxHCC Model
All Enrollees	726,705	0.994	0.999	130,207	1.007	1.009	856,912	0.995	1.000
<b>Deciles—Year 2 Predicted Plan Liability</b>									
First (Lowest)	72,671	3.429	1.543	13,021	2.860	1.240	85,691	3.392	1.517
Second	72,671	1.668	1.054	13,021	2.434	1.262	85,691	1.750	1.076
Third	72,671	1.276	0.975	13,021	1.535	1.019	85,691	1.299	0.979
Fourth	72,671	1.100	0.952	13,021	1.228	0.966	85,691	1.109	0.952
Fifth	72,671	0.977	0.934	13,021	1.060	0.943	85,691	0.984	0.935
Sixth	72,670	0.901	0.935	13,021	0.941	0.939	85,691	0.901	0.934
Seventh	72,670	0.835	0.942	13,021	0.864	0.944	85,691	0.836	0.942
Eighth	72,670	0.782	0.961	13,020	0.797	0.974	85,691	0.783	0.964
Nine	72,670	0.731	0.994	13,020	0.734	1.015	85,691	0.731	0.998
Tenth (Highest)	72,670	0.666	1.088	13,020	0.590	1.072	85,691	0.656	1.087
<b>Hospitalizations—Year 1</b>									
0	584,530	1.072	1.001	98,163	1.077	0.991	685,693	1.072	1.000
1	91,685	0.818	0.983	18,170	0.809	1.025	109,555	0.817	0.988
2	31,465	0.746	0.998	6,969	0.738	1.054	38,434	0.745	1.006
3	10,802	0.691	1.012	3,142	0.688	1.058	13,944	0.690	1.020
4+	8,223	0.658	1.049	3,763	0.652	1.141	11,986	0.656	1.074

NOTES: Predictive ratios greater than 1.0 indicate overprediction; ratios less than 1 denote underprediction. RxHCC is prescription drug hierarchical condition categories. Data represent 1999/2000 Medicare and Medicaid beneficiaries and 2001/2002 BC®BS® enrollees.

SOURCE: Robst, J., University of South Florida, Levy, J.M., Centers for Medicare & Medicaid Services, and Ingber, M.J., RTI International, 2007.

## SPECIAL ADJUSTMENTS

### Medicare's LTI Subpopulations

It has been observed that the LTI (defined here as those in a nursing home for more than 90 days) are heavy users of drugs and that, to some extent, the pricing of their drugs is higher than pricing in the community. Many reasons related to pricing and utilization can be posited for the differences. Analysis of data from IMS, a leading collector of prescription drug sales data, has shown that for the most frequent drugs the mean price difference is about 2 percent. The difference is larger for generic drug than brand name drug, but the brand name drug dominates when the data are expenditure weighted. To measure empirically the overall effect of being in an institution rather than in the community, the pooled plan/Medicaid data for the LTI population were analyzed to determine how much capitated payments should be changed from that which is predicted by the model.

In developing a model that predicts drug use from knowledge of prior year diagnoses the LTI populations were intentionally omitted because CMS and the Department of Health and Human Services wished to have a clear and separate adjustment for institutionalized status. Other modeling methods could have integrated the institutionalized into the model or structured a separate model for them. However, the LTI sample size was relatively small. To derive

the adjustment, the community model was used to predict spending and plan liability for the institutionalized enrollees. The actual spending and plan liability were then compared to the predicted to derive an adjustment factor.

Table 6 shows the predicted and actual means for spending by the LTI. The results indicate that actual spending by LTI beneficiaries exceeds predicted spending in the aged and disabled groups by 22 and 40 percent respectively. Increments of these amounts would be corrective for spending predictions. It is important to note that the mean predicted and actual spending for LTI patients falls into the 100 percent coinsurance range for the aged, and that the mean actual spending for the disabled falls into the catastrophic range. Because the predicted mean for the aged using the community model is one-third of the distance through the 100 percent coinsurance range; increments to spending related to institutionalization will also fall largely within the 100 percent coinsurance range. The disabled model prediction is close to the catastrophic range and incremental spending related to institutionalization will tend to spill into the range for which plans have some liability. Spending changes in the 100 percent coinsurance range result in no change to plan liability.

Analysis of the effect of institutionalization on plan liability results in LTI adjustment factors consistent with the previous observations. The factors are smaller because 100 percent coinsurance

**Table 6**  
**Multipliers for Special Populations, Long-Term Institutionalized (LTI) Beneficiaries**

Regulation	LTI Drug Spending			LTI Plan Liability		
	Predicted	Actual	Multiplicative Factor	Predicted	Actual	Multiplicative Factor
Aged	3,274	3,995	1.22	1,183	1,273	1.08
Disabled	4,747	6,660	1.40	1,377	1,668	1.21
All	3,413	4,247	1.24	1,201	1,310	1.09

NOTE: Data represent 1999/2000 Medicare and Medicaid beneficiaries and 2001/2002 BC<sup>®</sup>BS<sup>®</sup> enrollees.

SOURCE: Robst, J., University of South Florida, Levy, J.M., Centers for Medicare & Medicaid Services, and Ingber, M.J., RTI International, 2007.

**Table 7**  
**Multipliers for Special Populations, Low Income Subsidy**

Subsidy Group	Multiplicative Factor
Low-Income Group 1 Medicaid dual eligibles, income < 100 percent FPL, assets < 2xSSI or income < 135 percent FPL and assets < 3xSSI	1.08
Low-Income Group 2 Income < 135 percent FPL and assets > 3xSSI but < \$10,000 single, < \$20,000 couple or income 135-150 percent FPL and assets < \$10,000 single, < \$20,000 couple	1.05

NOTES: FPL is Federal poverty level. SSI is supplemental security income.  
SOURCE: Centers for Medicare & Medicaid Services, Office of the Actuary; Data from the Medicare Current Beneficiary Survey.

reduces changes in plan liability. The aged liability increment multiplier is only 7.6 percent, down from the 22 percent for spending. The liability increment multiplier for the disabled is substantial at 21.1 percent, though one-half of that is for spending. If an individual is both a low-income subsidy eligible beneficiary and is in long-term care, only the long-term care multiplier applies to that beneficiary.

### Low-Income Subsidy

The populations eligible for the LIS subsidies are defined in the MMA. CMS' Office of the Actuary estimated multipliers for two groups spanning the LIS population (Table 7). They are 1.08 for Group 1 individuals and 1.05 for Group 2 individuals. Eligibility is defined on a concurrent basis. For example, if an individual is not defined as low income for January 2006, but is determined to be a Group 1 beneficiary for February 2006, the plan would receive the low income multiplier for February (and beyond), but not for January.

### CONCLUSION

This article has presented the development of the CMS-RxHCC prescription drug risk-adjustment model implemented in 2006. A major challenge to the work was finding and adapting data that would span the Medicare population and be reasonably geographically representative. Future

work, using actual program data, is needed to evaluate the performance of the model, to recalibrate on program data, and to develop next generation models that may incorporate prior drug use. One of the issues for any model for drug spending is the change of available products over time. New high-priced drugs are being brought to market as older drugs are becoming cheaper generics. How robust this type of model is in a dynamic market is a topic of great interest. The fact that the model is used for only a portion of the total payments to plans makes its absolute accuracy less critical and allows time to develop potential improvements.

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