Medicare Risk Adjustment Models: DxCG vs. CMS-HCC

Jing Chen[*], Randall P. Ellis[†*], Katherine H. Toro[*] and Arlene S. Ash[‡*]

[*] Verisk Health, Inc., Waltham, MA.
[†] Department of Economics, Boston University, Boston, MA.
[‡] Department of Quantitative Health Sciences, University of Massachusetts Medical School, Worcester, MA.

Corresponding author: Jing Chen, Ph.D, MBA, Verisk Health, Inc., 201 Jones Road, Waltham, MA 02451. Tel: (781)693-3728. Fax: (781)478-0217. Email: jchen@veriskhealth.com

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Complete Author Information:

Jing Chen, Ph.D, MBA, Verisk Health, Inc., 201 Jones Road, Waltham, MA 02451. Tel: (781) 693-3728. Fax: (781) 478-0217. Email: jchen@veriskhealth.com

Randall P. Ellis, Ph.D, Department of Economics, Room 442, Boston University, 270 Bay State Road, Boston, MA 02215. Tel: (617) 353-2741. Fax: (617) 353-4449. Email: ellisrp@bu.edu

Katherine H. Toro, M.A., Verisk Health, Inc., 6802 Paragon Place, Suite 500, Richmond, VA 23230. Tel: (781) 693-2986. Fax: (804) 254-4166. Email: katherine.toro@veriskhealth.com

Arlene S. Ash, Ph.D, University of Massachusetts Medical School, Department of Quantitative Health Sciences, ASC 9.2071, 368 Plantation St., Worcester, MA 01604. Tel: (508) 856-8922/8999. Fax: (508) 856-8993. Email: arlene.ash@umassmed.edu

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Background: The Center for Medicare and Medicaid Services hierarchical condition category (CMS-HCC) model was implemented in 2004 to adjust Medicare capitation payments to private health care plans for the health expenditure risk of their members. Although 184 HCCs were available, CMS implemented simplified models; even its expanded 2014 models recognize only 79 condition categories. DxCG Medicare models rely on its more granular and comprehensive diagnosis classification system, with 394 HCCs.

Objective: To compare the predictive performance of CMS-HCC and DxCG Medicare models.

Study Design: We applied CMS-HCC and DxCG Medicare models to Medicare's 2010 - 2011 Fee-For-Service (FFS) five-percent sample. Using off-the-shelf versions of each model, we compared cross-validated R^2s, the ability to identify future high-cost members, and observed-to-expected ratios for people with various medical conditions.

Principal Findings: DxCG's Medicare model is more powerful than the 2014 CMS-HCC model (R^2 = 16.5 vs. 14.3 percent); it identified higher cost "top groups" (e.g., mean 2011 cost of the 0.5% with highest predicted cost was $103 vs. $92 thousand).While both models misprice some conditions, the conditions underpaid by the CMS model usually affect more people, are more expensive per person and/or are more heavily underpaid than the DxCG model; the problem of overpaying for the healthiest people was much less for the DxCG model than for CMS model (with observed-to-expected ratios of 0.95 and 0.71, respectively).

Conclusions: CMS-HCC models seriously mispredict the future cost of many readily-identified subgroups; this creates unfair payments and strong selection incentives that the DxCG model largely avoids.

Keywords: Medicare, CMS-HCC, DxCG, cost prediction, k-fold cross-validation

Introduction

The U.S. Medicare program is a social insurance program providing health insurance coverage to people who are entitled by age greater than 64, disability or end stage renal disease (ESRD). In 2012, Medicare accounted for 16% ($536 billion) of the federal budget. Total Medicare spending is projected to nearly double from $592 billion in 2013 to $1.1 trillion in 2023 due to growth in the Medicare population and sustained increases in health care costs (Kaiser Family Foundation (KFF), 2012a). In 2012, there were 49 million Medicare beneficiaries (KFF, 2012b).

The Medicare program allows Medicare beneficiaries to enroll in a private sector option called Medicare Advantage (MA) rather than receive the traditional fee-for-service (FFS) benefit. In 2012, 27 percent of Medicare beneficiaries were enrolled in MA (KFF, 2013). Historically, capitation payments to MA plans were linked to FFS expenditures by geographic area, with payments set at 95 percent of an enrollee's county's adjusted average per capita cost (AAPCC). However, variations in the AAPCC explain only about 1-percent of the variation in expenditures and AAPCC-based rates do not pay more for sicker people (Pope et al., 2004). To address this deficiency, the Centers for Medicare and Medicaid Services (CMS), which administers Medicare, sought to adopt a diagnosis-based model for paying MA plans. It considered several, including ACGs (Weiner et al., 1996), the chronic disease and disability payment system (CDPS) (Kronick et al., 2000), clinical risk groups (CRGs) (Hughes et al., 2004), the clinically-detailed risk information system for cost (CD-RISC) (Kapur et al., 2003), and DCG/HCCs (Pope et al, 2000b). Kanika Kapur, a researcher at the RAND Corporation wrote: "CMS chose the

DCG/HCC model for Medicare risk adjustment, largely on the basis of transparency, ease of modification, and good clinical coherence.” (Kapur, 2005)

In this paper, we compare the performance of CMS-HCC and DxCG Medicare models by examining predictive accuracy for individuals (R^2), the actual costs of groups predicted to be most expensive, observed-to-expected (O/E) ratios for subgroups with various medical conditions, and O/E ratios for people with classes of diagnoses that are not recognized in the CMS-HCC model.

CMS-HCC Medicare Models

The CMS-HCC Medicare risk adjustment models are prospective—they use demographic information (age, sex, Medicaid dual eligibility, and current and original reasons for Medicare eligibility) and profiles of major medical conditions in a “base” year to predict costs that would be covered by Medicare’s Part A and Part B benefit in the following “target” year. Developing risk adjustment models requires detail on medical conditions (ICD-9 diagnosis codes) cared for in the base year and costs to Medicare in the target year. The FFS claims contain such data, which can also be derived from encounter records (known as “dummy claims”), that follow the same rules as claims for coding patient diagnoses and the medical procedures provided (CPT4 codes) for each encounter – from which Medicare payments can be inferred. However, when CMS was developing its models and even quite recently, some MA plans have argued against submitting dummy claims; indeed, until the Affordable Care Act, MA plans were exempted from doing so (CMS, 2011; Park, 2011). Instead, CMS agreed to build its models on FFS data and to make risk-adjusted payments to MAs based on a submitted “short list” of the medical conditions present for each person in each year. Determining which codes to include, how to group them, and what interactions to include were critical steps in developing the DCG/HCC models for CMS (Pope et al., 2011).

The framework for any HCC model is its diagnostic classification system. CMS-HCC models rely on classifying about 15,000 ICD-9-CM diagnosis codes into 184 Condition Categories, or CCs. Each CC contains groups of diagnoses, such as colon cancer and rectal cancer, which are clinically related and have similar cost implications. Hierarchies are then imposed, so that a person is coded for only the most severe manifestation among related diseases (e.g, a person with cystic fibrosis would not also be coded for “chronic obstructive lung disease”). After the hierarchies have been imposed, the CCs become Hierarchical Condition Categories, or HCCs (Pope et al., 2011).

CMS-HCC models also include some interactions between pairs of disease groups (e.g., diabetes and congestive heart failure (CHF)) and between diseases and disability status (e.g., disability and CHF), that make sense to clinicians and strongly predict additional costs (Pope et al., 2011).

The decision to pay MA plans based on a short list of conditions required that CMS drastically simplify its models. CMS’s original payment models included only 70 HCCs, and even in 2014, CMS’s model will include only 79 HCCs (87 HCCs for its ESRD models). The new HCCs are either previously unrecognized conditions (among the 184 HCCs available) or splits of previously included HCCs (Shafrin, 2011).

Medicare beneficiaries encompass several distinct subpopulations; thus, improving fairness and reducing selection incentives requires predicting expenditures accurately for policy-relevant subgroups. For example, CMS-HCC models differentiate among those entitled by age, disability and ESRD, between community-residing and long-term institutional (nursing home) enrollees, and between continuing and new Medicare enrollees, defined as members enrolled for less than 12 months in a base year (here, 2010). Additionally, there are important subgroups for whom a standard risk adjustment model does not fully predict expenditures (e.g., the frail elderly), and hence an additional risk adjustment factor is applied (Pope et al., 2011).

DxCG Risk Solutions Medicare Models

Verisk Health Version 7 DxCG Risk Solutions Medicare (henceforth, DxCG) models extend the original full (184 HCCs) CMS-HCC model, principally by relying on a more complete and granular classification system; these models currently include 394 HCCs and 86 disease interactions. Predictions are also modified within subgroups, e.g., separately for the disabled (age <65) and the elderly (age$\geq$65). The current models were developed on data for FFS beneficiaries with both hospital insurance (Part A) and supplementary medical insurance (Part B) in Medicare's 2005-2006 5-percent sample.

The Data

The study data pertains to about 1.5 million enrollees from Medicare's 2010-2011 FFS 5- percent sample, enrolled exclusively in FFS, present for at least one month in each year, and not currently entitled to the ESRD program[1]. (See Exhibit 1.)

<<Exhibit 1 about here>>

We used 2010 data to predict weighted annualized allowed cost (that is, expected Medicare allowed cost that would be covered by Part A and Part B benefit) in 2011, which is also the dependent variable in DxCG Medicare models. Weighting is used so that members who are eligible for only part of the target year, whether due to death or disenrollment, only contribute according to the fraction of the year that they are eligible. Annualization ensures that the weighted average of the dependent variable exactly matches the true sum of actual spending. The dependent variable used in CMS-HCC models is the weighted annualized paid amount for capitation payment purposes. The main reason that DxCG models use allowed amount rather than paid amount is that the paid amount is affected by cost-sharing (e.g. the distribution of allowed amount between the payer and the member) while allowed amount is less subject to variation due to member cost-sharing. Paid amount is highly correlated with allowed amount, (here, ρ=0.998); thus, predictions evaluated with either outcome can be expected to perform similarly with the other.

[1] Even after removing members with ESRD as their current reason for entitlement in 2010, the study sample still contains 10,428 members with an ESRD diagnosis in 2010.

Both the CMS and DxCG models generate relative risk scores (RRS) that must be converted to dollars. In practice, the CMS-HCC model needs to set the dollar weight (i.e. the payment associated with a risk score of 1.00) before actual costs are known, which introduces a forecasting error. In this study we eliminate this forecast error, and level the playing field among models, by choosing multiplicative factors that make each model's weighted mean predictions exactly match the weighted mean actual cost in the 2011 sample.

The CMS-HCC model software automatically generates three RRSs for each person: one each for new enrollees, continuing enrollees living in the community, and those living in institutions (generally, nursing homes), letting the user select the appropriate score for that person. We do not examine the institutional model. Instead, we evaluate the CMS model in two ways: 1) following CMS's approach of using the new enrollee model RRS for members enrolled for less than 12 months in 2010, and using the risk score from the community model for everyone else; or 2) using the RRS from the community model for every enrollee. Algorithm 1) is how CMS implements its risk scores. For simplicity, from now on in this paper, algorithm 1) using the 2013 classification system will be referred to as the "2013 CMS Implemented model", while the corresponding model using algorithm 2) will be named "2013 CMS Improved model." Analogous names are used for the 2014 CMS-HCC models. For the 2014 models, we ignore the fact that actual payments are calculated as 75% using the 2014 model, 25% using the 2013 model and use the fully-phased-in 2014 model prediction.

Two DxCG prospective Medicare models are evaluated. The "DxCG Dx model" uses only demographic and diagnostic information to predict the Medicare allowable cost for every enrollee (numbered DxCG Model 121 by the software), while the "DxCG Dx+Utilization model" uses spending information as well (DxCG Model 125). This model is not appropriate for payment, where the goal is to pay more for caring for sicker people, rather than for higher spending (van de Ven and Ellis, 2000). Still, this last model's predictions can be computed by anyone with access to encounter data, and a conscientious plan can use it to reduce costs and improve its members' health through proactive medical management. This model also provides a measure of the information readily available to plans to influence enrollments and disenrollments that may bias their Medicare enrolments.

Results

Exhibit 2 compares six models: CMS Implemented and Improved models from both year 2013 and 2014, plus the two DxCG models. The overall R^2 from the each model is shown in the first row, with subsequent rows showing the R^2 for subgroups of the sample: new enrollees and continuing enrollees, based on CMS's definition of new enrollees (less than 12 months of eligibility in the base year).

<<Exhibit 2 about here>>

The first row of the exhibit shows that there is negligible improvement in the R^2 made in the 2014 CMS Implemented model over the 2013 CMS Implemented model. Simple improvements in how new enrollee predictions are calculated (CMS Implemented model vs. CMS Improved model), discussed further below, would yield larger improvements (about 0.4 – 0.5 percentage points). In contrast, the DxCG Dx model has a 2 percentage point advantage in R^2 over CMS-HCC Implemented models, while the R^2 for the Dx+Utilitzation model is over 5 percentage points higher than that for either CMS-HCC Implemented model.

The R^2 improvement achieved by the DxCG models is mainly due to its use of a more detailed diagnostic classification (394 HCCs) and not to overfitting, since all results in Exhibit 2 are generated using regressions with just one degree of freedom; that is, they use a single number (the RRS) from off-the-shelf software to predict Medicare cost. To illustrate how insensitive these models are to overfitting, we compared the performance of linear regression models developed using four distinct HCC sets: 1) the 70 HCCs in the 2013 CMS-HCC model; 2) the 79 HCCs in the 2014 CMS-HCC model; 3) the 184 HCCs from which CMS developed their risk adjustment models; and, 4) the 394 HCCs used in DxCG models. We used K-fold cross-validation to examine the magnitude of overfitting associated with regressing Medicare cost on each HCC set plus the 18 age/gender band indicators that the DxCG models employ for this population (Stone, 1974; Ellis et al., 2009). Specifically, the research data were randomly split into K=10 equal, disjoint parts, from which we formed 10 distinct but overlapping "development" data sets, each containing all but one of the K parts (that is, 90% of the data). We then estimated a model on each of the 10 development data sets and used it to predict costs on the excluded (10%) validation sample; finally, we combined all ten validation samples to calculate an out-of-sample, validated R^2 measure.

Exhibit 3 shows results from the 10-fold validated regressions. The model built on the DxCG classification (394 HCCs) had a higher R^2 than the models using only some, or even all, of the 184 HCCs. The column “fitted minus validated R^2” quantifies model overfitting. While overfitting does increase with the number of parameters, for even the largest model (with 394 HCCs), overfitting contributes only about 1/10 of 1 percentage point. In Exhibit 3, we also evaluate a DxCG “full” model, which, in addition to 394 HCCs, includes interactions based on diseases, age-categories and the magnitude of a person’s prediction from an initial regression (for a total of 1286 degrees of freedom). Although this model has fully 1,304 degrees of freedom, only 2/10 of 1% of its development sample R^2 appears to be due to overfitting. Furthermore, its validated R^2 of 16.8% is only a little larger than the 16.5% R^2 achieved when the DxCG Dx model developed on 5-years-earlier data is applied to 2010-2011 data (Exhibit 2). This supports the plausibility that the new DxCG Dx model will be able to achieve an R^2 approaching 17% in a completely new sample.

<<Exhibit 3 about here>>

Medicare uses risk models to ensure that healthcare resources are distributed rationally and that plans that enroll members with serious conditions that predictably generate high costs receive adequate funds to care for them. With this in mind, we examined the ability of models to identify high cost members.

1) Mean Medicare cost (and mispricing) of those predicted to be high or low cost, using various predictive models. First, we examine model discrimination; at the top of the prediction range, the most predictive models identify “top group” of people who will cost the most next year, with the reverse being true for the “bottom groups” of the prediction range. Exhibit 4 shows the actual year-2 costs of those predicted to be highest cost using each of 3 models: CMS-HCC and DxCG Dx-only and Dx+Utilization. Both DxCG models identify “top groups” whose members cost more than the CMS-HCC-identified top groups (and low cost members in their “bottom groups”). For example, the groups of members thought to be “most costly” by the DxCG Dx and the Dx+Utilization models, are respectively, 13% (103,148/91,412) and 31% (119,372/91,412), more expensive, while their bottom groups are 12% (3,415/3,871) and 16% (3,253/3,871) less costly, than those identified using the 2014 CMS-HCC models. Another important measure of model performance is “calibration” – the extent to the model’s predictions across the range from low to high, agree with actual costs. An observed-to-expected (O/E) ratio shows how well a model’s total predictions’ for a subgroup match the group’s actual costs. Values of O/E greater than 1.0 indicate underpayment (e.g., 1.2 means that the actual costs are 20% higher than the model predicts) and values of O/E less than 1, overpayment. The three columns on the right of Exhibit 4 show O/Es for each of the models for the top- and bottom-predicted subgroups identified by each model. For example, the O/E ratio of 1.18 in the last row of the top block of numbers means that the CMS model overpays people that it identifies as being the 20% least costly, by 18%; it even more misprices those identified as most and least

likely to be costly by either DxCG model, underpaying the top 0.5% by 65% or more and underpaying the bottom 20% by 20 to 30%. Levels of mispricing are much lower for the DxCG models. The worst mispricing for the DxCG Dx-only model occurs when it underpays the Dx+Utilization's 0.5% top group by 15%.

<<Exhibit 4 about here>>

2) We also computed O/E ratios for people with various clinical conditions, as identified by each of the CMS HCC and DxCG HCC classifications, excluding HCCs experienced by less than 500 people (out of 1.5 million studied). For each classification system, we examined the 5 conditions with the highest O/E ratios by either the 2014 CMS-HCC Implemented model or the DxCG Dx model. Altogether 19 unique conditions were identified (see Exhibit 5). There are 19 rather than 20 conditions because hemophilia was among the conditions with the highest O/E ratio in both classification systems. Each model performs at least somewhat better than the other in about half the condition categories. However, on average, the conditions underpaid by the CMS model affect more people, are more expensive per person and/or are more heavily underpaid than those that are underpaid by the DxCG model.

<<Exhibit 5 about here>>

A final useful comparison is to calculate O/E ratios by models separately for members who have and do not have any diagnoses recognized by the CMS classification system. As shown in Exhibit 6, both the 2014 CMS-HCC model and the DxCG Dx model do about equally well on those members who can be classified using the CMS system (68 percent of all enrollees), with O/E ratios for either model being close to 1. For the 7% of members with no HCC in either system, the CMS model overpays much more than the DxCG model (with O/Es of 0.71 and 0.95, respectively). We split the remaining 25% of members with at least one DxCG diagnosis but no CMS diagnosis into two similarly-sized subgroups: one containing members with at least one of the next 100 most expensive conditions after the conditions also classified in the CMS system, and another containing members with none of the top 100 most expensive conditions. For the first subgroup, the CMS model underpaid by about 36% and the DxCG model overpaid them by about 6%; for the second subgroup, the CMS model overpaid by about 13%, and the DxCG model, by about 3%. Overall the O/E ratios for the DxCG model remain much closer to the desired value of 1.0, including for the 7% of members with no diagnoses recognized by either system.

<<Exhibit 6 about here>>

Discussion and Conclusions

We examined CMS and DxCG Medicare models in Medicare FFS data and identify two changes that Medicare could implement to significantly improve the predictive power (R^2) of their models. These are: using whatever diagnoses are present to calculate Medicare cost for enrollees with less than 12 months of base year data, and broadening the classification system to use 184, rather than 70 or 79, CMS-HCCs. The first change is purely administrative and could be implemented instantly, while the second would take more work, but is feasible now that MA plans are required to submit dummy claims. With full claims data available, the DxCG models that use more comprehensive and more granular condition categories can be applied. These models do an even better job of identifying people whose future costs will be particularly high and they meaningfully improve predictive power beyond what will be achieved with CMS' 2014 models. Indeed, the CMS-HCC models seriously under-predict costs for people with a range of common conditions, and lead to overpayments of nearly 30% for people with no recorded medical problems. Such prediction errors, which could be substantially dampened by using the DxCG models create unfair payments and undesirable selection incentives. Finally, we note that MA plans have access to their own dummy claims, enabling them to calculate not only the CMS payment for each enrollee, but also the much more accurate predictions of models such as the DxCG Dx+Utilization model. Unless CMS also has such data it will not even be able to detect plans that actively exploit weaknesses in its payment system.

Exhibit 1: Characteristics of the 2010 – 2011 Medicare Fee-For-Service, non-ESRD 5% sample (N=1,487,628)

	Mean	SD
Annualized 2010 Medicare cost	$10,153	22,907
Annualized 2011 Medicare cost	$11,943	29,453
Age in 2010	71.4	12.6
	N	%
Aged 65+ on December 31, 2010	1,229,140	82.6
Female	831,378	55.9
Enrolled 12 months in 2010[1]	1,418,862	95.4

SOURCE: Medicare Fee-For-Service (FFS) 5-percent sample, present in both 2010 and 2011, excluding those with 2010 ESRD.

Note:1. Members not enrolled for 12 months account for ~0.4% for each number of months of eligibility from 1 to 11.

Exhibit 2: Off-the-shelf R^2 for predicting Medicare cost: CMS-HCC vs. DxCG models (N = 1,487,628)

Model[1]	CMS-HCC				DxCG[2]	
	2013 models		2014 models			
	Implemented	Improved	Implemented	Improved	Dx[3]	Dx+Utilization[4]
All	14.1%	14.5%	14.1%	14.6%	16.5%	19.5%
New enrollees	1.6%	15.0%	1.7%	15.8%	17.5%	21.0%
Continuing enrollees	14.4%	14.4%	14.5%	14.5%	16.4%	19.4%

SOURCE: Medicare Fee-For-Service (FFS) 5-percent sample, present in both 2010 and 2011, excluding those with 2010 ESRD. All models use 2010 information to predict 2011 Medicare cost.

Note: 1. All models have 1 degree of freedom; each regresses cost on a formula-based risk score: cost = a + b*(risk score).

2. Both DxCG models were calibrated on the 2005 – 2006 Medicare Fee-For-Service (FFS) 5-percent sample, and use information that can be used from year-1 claims data to predict year-2 total inpatient + outpatient costs.

3. DxCG Dx only Medicare model (Model 121): The risk score from this model is a function of patient age, sex, and diagnoses from inpatient, outpatient and carrier-file claims.

4. DxCG Dx+Utililzation model (Model 125): In addition to the predictors included in the Dx model described above, this model's predictors include variables relating to year-1 utilization.

Exhibit 3: R^2 for predicting total cost to Medicare: CMS HCCs vs. DxCG HCCs (N = 1,487,628)

Model with demographic factors[1] and (variously specified) diagnoses	DF	Fitted R^2	Validated R^2	Fitted minus validated R^2
70 HCCs (CMS)	88	15.49%	15.45%	0.05%
79 HCCs (CMS)	97	15.68%	15.63%	0.05%
184 HCCs (CMS/DxCG)	202	16.14%	16.08%	0.06%
394 HCCs (DxCG)	412	16.78%	16.65%	0.12%
DxCG full model[2]	1,304	17.01%	16.79%	0.22%

SOURCE: Medicare Fee-For-Service (FFS) 5-percent sample, present in both 2010 and 2011, excluding those with 2010 ESRD. All models use 2010 information to predict 2011 Medicare cost.

Note: 1. Demographic factors are 18 age/gender categories.

2. The DxCG full model also includes 394 HCCs and interactions based on diseases, age-categories and the magnitude of a person's prediction from an initial regression.

3. Validated R^2 was generated using the K-fold cross validation (Stone, 1974), as discussed in the main text.

Exhibit 4: Mean Medicare Cost and Mispricing by Model-Predicted Percentile Groups

Percentile groups based on model predictions from 2010 data		Mean 2011 Medicare Cost	Over and underpayments (observed-to-expected ratios) under various payment models[1] CMS[2]	DxCG[3] Dx[4]	DxCG[3] Dx+Utilization[5]
CMS model					
Top	0.50%	$91,412	1.05	1.08	1.06
Top	1%	$79,458	1.04	1.08	1.05
Top	2%	$66,963	1.03	1.06	1.05
Top	5%	$51,105	1.01	1.05	1.05
Bottom	20%	$3,871	*1.18*	0.92	*0.89*
DxCG Dx model					
Top	0.50%	$103,148	**1.65**	0.92	0.94
Top	1%	$88,069	**1.52**	0.94	0.96
Top	2%	$73,666	**1.36**	0.97	0.98
Top	5%	$54,398	**1.19**	0.99	1.00
Bottom	20%	$3,415	**0.81**	1.01	0.98
DxCG Dx + Utilization model					
Top	0.50%	$119,372	**1.85**	*1.15*	1.00
Top	1%	$99,295	**1.70**	*1.13*	1.00
Top	2%	$80,011	**1.52**	*1.11*	1.00
Top	5%	$57,987	**1.31**	*1.10*	1.02
Bottom	20%	$3,253	**0.76**	0.94	0.96

SOURCE: Medicare Fee-For-Service (FFS) 5-percent sample, present in both 2010 and 2011, excluding those with 2010 ESRD. All models use 2010 information to predict 2011 Medicare cost. N = 1,487,628.

Note: 1. O/E ratios in **BOLD** are used to represent "mispricing" of a subgroup (by a particular model) of at least 20% (greater than 1.20 or less than 0.80). O/E greater than 1 represents underpayment; O/E less than 1 represents overpayment. For example, O/E = 1.20, means that actual costs for this group exceed what the model expects (and what a payment system based on it would pay) by 20%; O/E = 0.8 means that actual expenses were 20% lower than expected. Italics are used to highlight more moderate levels of mispricing, that is, O/E ratios that are either between 1.10 and 1.20 or between .80 and .90.

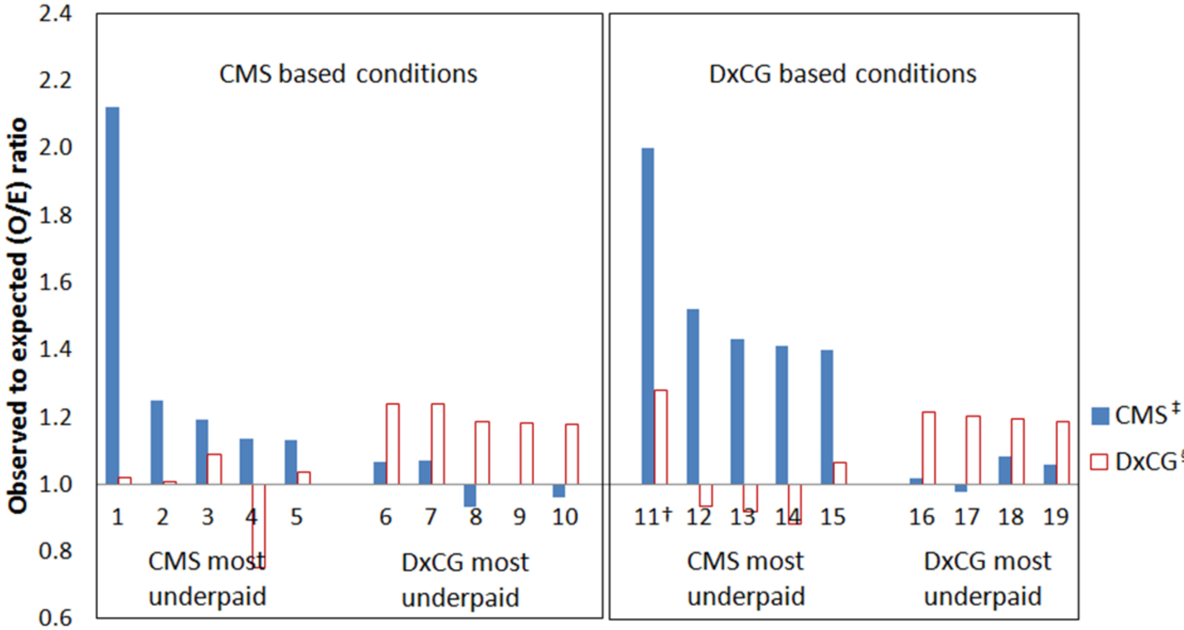
2. 2014 CMS Implemented model.

3. Both DxCG models were calibrated on the 2005 – 2006 Medicare Fee-For-Service (FFS) 5-percent sample.

4. DxCG Model 121: Predictors are: patient age, sex, and diagnoses from inpatient, outpatient and carrier-file claims.

5. DxCG Model 125: Adds Year-1 utilization variables to the Model 121 predictors.

Exhibit 5: Most underpaid conditions: CMS & DxCG classifications and Models*



SOURCE: Medicare Fee-For-Service (FFS) 5-percent sample, present in both 2010 and 2011, excluding those with 2010 ESRD. Both models use 2010 information to predict 2011 Medicare cost. N = 1,487,628.

Note: * CMS- and DxCG-based conditions with the 5 highest O/E ratios under each of the CMS and DxCG models.

Label	Condition Name	Frequency	Mean Medicare Cost
CMS-based conditions			
CMS most underpaid			
1	Dialysis Status	7,411	$91,586
2	Other Significant Endocrine and Metabolic Disorders	53,973	$30,999
3	Proliferative Diabetic Retinopathy and Vitreous Hemorrhage	11,566	$27,165
4	Chronic Kidney Disease, Stage 5	8,962	$25,587
5	Complications of Specified Implanted Device or Graft	25,877	$40,516
DxCG most underpaid			
6	Muscular Dystrophy	1,096	$26,678
7	Amyotrophic Lateral Sclerosis and Other Motor Neuron Disease	992	$35,901
8	Pressure Ulcer of Skin with Necrosis Through to Muscle, Tendon, or	2,249	$68,847
9	Exudative Macular Degeneration	24,927	$18,921
10	Hemiplegia/Hemiparesis	23,328	$31,735
DxCG-based conditions			
CMS most underpaid			
11	Hemophilia	502	$63,841
12	Homelessness	918	$32,412
13	Kidney Transplant Status	1,853	$29,644
14	Kidney Transplant Complications	965	$44,498
15	Chemotherapy / Immunotherapy	13,484	$49,151
DxCG most underpaid			
16	Bone Marrow Transplant Status	552	$44,087
17	Spinal Cord Disorders/Injuries Without Fracture	7,652	$25,154

18	Lipidoses, Including Gaucher's Disease	1,438	$18,889
19	Muscular Dystrophy	828	$26,229

† Hemophilia is also one of the five most underpaid conditions under the DxCG model.

‡ 2014 CMS Implemented model.

§ DxCG Dx only Medicare model. The risk score from this model is a function of patient age, sex, and diagnoses from inpatient, outpatient and carrier-file claims.

Exhibit 6: Observed to expected (O/E) ratios of Medicare cost for CMS[1] and DxCG[2] models, by kinds of medical conditions presence (N=1,487,628)

Presence of any conditions in 2010						O/E ratio	
CMS	Next 100 DxCGs[3]	Other DxCGs[4]	N	Percent	Mean 2011cost per member	CMS	DxCG
Yes	-	-	1,014,037	68	$15,440	1.00	1.01
No	Yes	-	187,281	13	$6,238	1.36	0.94
No	No	Yes	185,067	12	$3,755	0.87	0.97
No	No	No	101,243	7	$3,232	0.71	0.95
ALL			1,487,628	100	$11,943		

SOURCE: Medicare Fee-For-Service (FFS) 5-percent sample, present in both 2010 and 2011, excluding those with 2010 ESRD. Both models use 2010 information to predict 2011 Medicare cost.

Note: 1. 2014 CMS Implemented model.

2. DxCG Dx only model (Model 121): Medicare All Medical Predicting Prospective Medical Risk. This model was calibrated on 2005 – 2006 Medicare Fee-For-Service (FFS) 5-percent sample.

3. The conditions with the highest 100 coefficients from DxCG Dx only model after excluding conditions also classified in CMS-HCC.

4. The conditions with coefficients other than the top 100 ones from DxCG Dx only model after excluding conditions also classified in CMS-HCC.

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