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Hierarchical Condition Categories for Pulmonary Diseases

Population Health Management and Policy Opportunities

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Hierarchical condition categories (HCCs) are groups of diagnostic codes that are used to adjust federal payments to insurers and health systems based on differences in expected spending. Risk models built on HCCs improve on previous adjustment strategies that used demographic characteristics but did not include clinical diagnoses. Thus, accurate coding by clinicians of inpatient and outpatient encounters ensures capitated payments and reimbursements that are commensurate with predicted expenditures. Pulmonary diseases and various forms of critical illness play a significant role in this risk adjustment process both through their associated HCC codes and through interactions with other risk categories representing cardiac and psychiatric diseases. Ongoing uncertainty in federal health policy ensures a changing role for HCCs and risk-adjusted reimbursements across a variety of payment models and federal programs.

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Hierarchical condition categories (HCC) are groups of diagnostic codes that are used to adjust federal payments to insurers and health systems based on differences in expected spending. Federal reimbursements to insurers offering Medicare Advantage plans, individual and small group plans on insurance exchanges under the Affordable Care Act (ACA), and health systems participating in accountable care organization (ACO) payment models are sensitive to accurate documentation of diagnostic codes from inpatient and outpatient encounter visits. Pulmonary diseases, in particular, play a central role in HCC-based risk adjustment models through their primary risk categories and through interactions with cardiac and psychiatric disease risk categories. The present article reviews the history of risk-adjusted payments for federal programs, the mechanics of HCC-based risk adjustment and its specific application to pulmonary diseases, and current policy considerations and population health opportunities.

History of Risk Adjustments

People aged > 65 years, those with certain disabilities, and those with end-stage renal disease are eligible for federally supported

ABBREVIATIONS: ACA = Affordable Care Act; ACO = accountable care organization; CMS = Centers for Medicare & Medicaid Services; FFS = fee-for-service; ICD-10-CM = *International Classification of Diseases, Tenth Revision, Clinical Modification*; RF = relative factor

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health insurance through the Medicare program. Traditional fee-for-service (FFS) Medicare, implemented in 1966, is a federal government program that makes payments to hospitals and physicians directly for providing clinical services to beneficiaries. In 1985, the Health Care Financing Administration began encouraging private insurers to offer plans to Medicare-eligible people through a program that is today called Medicare Advantage.[1,2] The intent of this plan was to reduce spending while simultaneously expanding choices for beneficiaries.

Payments from the Centers for Medicare & Medicaid Services (CMS) to insurers offering such private plans (which at the time were offered through health maintenance organizations) were initially set to 95% of the expected spending based on demographic characteristics, welfare status, and observed health-care spending among FFS beneficiaries located in the corresponding county.[3] This estimate was known as the adjusted average per capita cost. Due to selection of healthier people into these privately managed plans, they did not end up saving money for the federal government. The adjusted average per capita cost risk adjustment method, to the contrary, led to private health maintenance organization plans costing the federal government 5.7% more than if the same people had been enrolled in a traditional FFS plan.[1]

After a few years of experimenting with different risk adjustment approaches, 2004 marked the beginning of capitated payments to insurers offering Medicare Advantage plans that are adjusted for expected spending based not just on demographic information but also on clinical diagnoses.[4] This approach relies on diagnostic codes grouped into HCCs. The risk adjustment model used by CMS for Medicare Advantage payments is known as the CMS-HCC model, distinguishing it from HCC-based models used in other federal programs.

The original CMS-HCC model included age, sex, and Medicaid and disability status, in addition to $>$ 3,000 *International Classification of Diseases, Ninth Revision, Clinical Modification* codes that were grouped into 70 categories and interactions between those categories.[4] Separate models were developed for community-dwelling and nursing home populations, and for new enrollees (those with $<$ 12 months of historical data). Each model is built by using historical CMS claims data with fitted coefficients from a linear regression. For each individual, input variables from the previous calendar year's billing data are used to predict costs for the upcoming year. HCCs continue to be the foundation of risk adjustment for Medicare Advantage plans and for other federal programs.

Risk Adjustment Under the ACA

Using diagnostic categories in addition to demographic information proved more accurate for purposes of risk adjustment. Hence, under the ACA, HCCs were also used for risk-adjusting payments to insurers offering plans in the individual and small group ACA Marketplaces beginning in 2014.[5] This model, developed by the Department of Health and Human Services specifically for risk adjustment in ACA Marketplaces, is known as the HHS-HCC model. It differs from the CMS-HCC model in several important ways. First, the HHS-HCC approach includes 15 separate models that account for all combinations of age group (infant, child, and adult) and plan level (catastrophic, bronze, silver, gold, and platinum). The HHS-HCC model does not stratify populations according to their dwelling location or new enrollment status. Second, the categories of the HCCs themselves were revised because the demographic and clinical characteristics of those enrolling in Marketplace plans are expected to be very different from those enrolling in Medicare plans.[6,7] Third, the HHS-HCC model is a concurrent rather than prospective model (Table 1)[5,8]; that is, it uses information from the current year to predict reimbursements in the same year. This approach is in contrast to the CMS-HCC model, which uses information from the previous year to predict the current year's reimbursement. Under the CMS-HCC model, sudden increases in costs for a patient in the current year will not generate reimbursement until the following year, and only then if the underlying diagnoses are documented and associated with reimbursable HCCs.

Other Risk Adjustments

The CMS-HCC model also serves as the basis for risk adjustment under CMS alternative payment models such as those used for the Medicare Shared Savings Program ACOs and Comprehensive Primary Care Plus.[9,10] In contrast, state Medicaid programs use a wide variety of risk adjustment models that vary by state and do not rely primarily on HCCs.[11]

Model Performance

How well do the CMS-HCC and other HCC-based models perform? Periodic evaluation of risk adjustment models is mandated under the ACA.[8] The CMS-HCC

TABLE 1] Notable Characteristics of the CMS-HCC and HHS-HCC Risk Adjustment Models

Variable	CMS-HCC	HHS-HCC
Intended population	Medicare Advantage Plans	ACA Marketplace Plans
No. of HCCs	83 (Version 23)	127
Training data source	CMS FFS claims	Truven MarketScan Commercial Claims and Encounter database (private insurers in the large-employer based insurance market)
Temporal orientation	Prospective	Concurrent
Drug spending	Uses a separate model to account for drug spending	Accounts for both medical and drug spending
R^2	12.5%[8]	28.8%-36.0%[5]

ACA = Affordable Care Act; CMS = Centers for Medicare & Medicaid Services; FFS = fee-for-service; HCC = hierarchical condition category; HHS = Department of Health and Human Services.

model is well calibrated with the stated goal of producing good estimates on average (in contrast to producing accurate predictions for individuals).[6] The primary performance measure used to judge calibration of HCC-based models is the predictive ratio by decile of risk. Although this approach provides a measure of performance on average, formal evaluations of the predictive ratios of the CMS-HCC models have not been reported with CIs.[5,8] Reporting the precision of such risk estimates may improve financial and clinical planning operations by health systems and insurers and simultaneously increase confidence in their use.

Secondary performance measures used to guide model development have been the R^2 value and mean absolute error, among others.[12] The R^2 measure ranges from 0% to 100% and describes the degree of variation in the outcome (expected health-care spending in this case) explained by the model.[13] All of these performance metrics attribute equal weight to overestimates and underestimates.

Version 21 (revised in 2009) of the CMS-HCC model has a reported R^2 of 12.5%, an improvement over 10.9% from Version 12 (2005). The HHS-HCC model has comparable performance to other claims-based spending prediction models.[14]

CMS-HCC Scoring

The current iteration of the CMS-HCC model for use in 2019 was updated for use with *International Classification of Diseases, Tenth Revision, Clinical Modification* (ICD-10-CM) diagnosis codes and is available online from the CMS website.[15] The downloadable files provide software written in SAS (SAS Institute, Inc) to calculate the predicted costs for individuals based on demographic information and updated diagnostic codes. Software for separate HCC-based models that predict costs for prescription drug use and for beneficiaries eligible because of end-stage renal disease are also available for download.

The proposed 2019 model (Version 23) accounts for > 9,000 unique ICD-10-CM codes mapped to 83 HCCs. Not all ICD-10-CM codes map to an HCC. The categories that account for pulmonary and critical care-related diagnoses are given in Table 2.[6,15] Diagnostic codes for pulmonary hypertension (I27.0, I27.1, I27.2, and I27.29) all map to HCC 85 (Heart Failure).

In addition to the predicted costs associated with each of these HCC groups individually, many HCCs are also included in disease-specific interaction terms that additionally increase expected spending.[6,15] For example, among community-dwelling patients with both COPD (HCC 111) and Heart Failure (HCC 85), the relative factor (RF) is increased by 0.191 beyond the individual RF for each of those categories alone. Pulmonary and critical care HCCs interact with numerous other disease categories.

HCCs are both hierarchical and additive. They are hierarchical in that some disease states, such as kidney disease, have multiple HCCs that differ only by severity of disease. In such cases in which a patient has ICD-10-CM codes that map to both Chronic Kidney Disease Moderate (HCC 138) and Severe (HCC 137), only the latter code will be included. For example, if both COPD (HCC 111) and Fibrosis of Lung and Other Chronic Lung Disorders (HCC 112) are present, then only the former is counted (Table 3).[6]

TABLE 2] HCCs Describing Patients With Pulmonary Diseases and Critical Illness

HCC	Category Description	Relative Factor
2	Septicemia, Sepsis, Systemic Inflammatory Response Syndrome/Shock	0.428
9	Lung and Other Severe Cancers	1.027
82	Respiratory Dependence/Tracheostomy Status	1.051
83	Respiratory Arrest	0.404
84	Cardio-Respiratory Failure and Shock	0.314
110	Cystic Fibrosis	0.509
111	COPD	0.335
112	Fibrosis Of Lung and Other Chronic Lung Disorders	0.216
114	Aspiration and Specified Bacterial Pneumonias	0.612
115	Pneumococcal Pneumonia, Empyema, Lung Abscess	0.164
186	Major Organ Transplant or Replacement Status	0.855

Relative factors are for the 2019 model for community-dwelling, non-dual-eligible, continuously enrolled beneficiaries. See Table 1 legend for expansion of abbreviation.

HCCs are additive because each individual category and interaction term increases the expected spending by some RF. These RFs are then added together and multiplied by a denominator determined by CMS for a given year and population to calculate the final total expended spending in a given year. The CMS-HCC denominator for continuing enrollees in 2019 is $9,367.34 and is based on the observed spending in a cohort of FFS beneficiaries in 2015.[12] There are no penalties or cost reductions for recording additional diagnostic codes.[8]

Example of a CMS-HCC Calculation

Let us consider the example of a 68-year-old, nondisabled, community-dwelling woman who is not enrolled in Medicaid and who has been enrolled in a Medicare Advantage plan for 3 years. Her previous diagnoses, culled from outpatient encounter claims forms in the previous calendar year, include COPD (J44.9), Unspecified Diastolic Heart Failure (I50.30), and Essential Hypertension (I10). These ICD-10-CM codes map to HCCs 111, 85, and none, respectively. Thus her additive RFs include 0.316 (the baseline adjustment for her age, sex, community-dwelling, Medicaid, and disability status), 0.335 (COPD), 0.310 (Heart Failure), and 0.191 (interaction between COPD and Heart Failure). The sum of the RFs (1.152) multiplied by the denominator ($9,367.34) predicts $10,791.18 in spending for the current year.

Evolving Risk Adjustment

All types of HCC-based risk adjustment models are updated periodically. The HHS-CMS model coefficients are updated every year based on the Truven MarketScan database. The CMS-HCC model coefficients and diagnostic codes are updated regularly by using claims data from the FFS population.

The CMS-HCC model will soon reflect the total number of diagnoses to account for beneficiaries with a high comorbidity burden. With a proposed start in 2019, a phase-in period would begin that will use a Payment Condition Count Model modification to the CMS-HCC

TABLE 3] Examples of Some Disease Hierarchies of HCCs Related to Pulmonary Diseases

Primary HCC	Primary Category Description	Secondary HCC	Secondary Category Description
9	Lung and Other Severe Cancers	10	Lymphoma and Other Cancers
		11	Colorectal, Bladder, and Other Cancers
		12	Breast, Prostate, and Other Cancers and Tumors
110	Cystic Fibrosis	111	COPD
		112	Fibrosis of Lung and Other Chronic Lung Disorders
111	COPD	112	Fibrosis of Lung and Other Chronic Lung Disorders

The primary HCC (left-most two columns) takes precedence over all secondary codes (right-most two columns); that is, if a primary HCC category is present, then the secondary categories are ignored. See Table 1 legend for expansion of abbreviation.

model, with all payments adjusted by using this modified approach beginning in 2022.[12] However, in response to public comments about the complexity of implementing this model, the addition of HCC counts has been postponed.[6] This proposed change is the result of the 21st Century Cures Act, which specifically requires re-evaluation of the role of total counts of diagnoses for each enrollee.[12] Specifically, an additional coefficient will be added to the spending prediction model that represents a numeric count of the total number of HCCs associated with a patient's diagnosis to reflect the additional expected spending associated with a high morbidity burden. This change represents an incremental addition to the existing risk adjustment approach while other features of the model are maintained as described.

Of all the HCCs reflecting pulmonary and critical care diagnoses (Table 2), all will count toward this additional adjustment with the exception of HCC 186 (Major Organ Transplant). At the time of this writing, a possible cap on the total number of conditions at 10 or 15 was still being debated.

One policy that will likely remain the same in the coming years is that each comorbidity must be documented each year for it to count toward the following year's risk prediction and payment. Thus, if COPD(HCC 111) is documented in a clinical note and abstracted into the claims forms in 2017, it will count toward the 2018 risk estimate and payment. But if COPD is not documented again in 2018, it will not be included in the 2019 risk estimate and payment.

Population Health Opportunities

A notable limitation of the CMS-HCC model is that it only explains a small amount of the variation in spending ($R^2 = 12.5\%$). This finding suggests the presence of other important sources of variation that are not captured in the HCC modeling approach. Such sources may include neighborhood-level deprivation,[16] rural location, and socioeconomic vulnerability limiting access to timely and coordinated care.[17] On the one hand, overlooking these other contributors to variation in spending may disincentivize providing coverage or caring for more vulnerable populations. On the other hand, increased attention to these other factors may provide actionable targets for insurers and health systems to promote high-value care. For example, among Medicare FFS beneficiaries, implementation of an ACO contract was associated with an overall decrease in spending, with the greatest reductions among those with at least three HCCs.[18] These reductions were primarily driven by decreased hospital and skilled-nursing spending, and they may reflect the benefit of increased attention to care coordination and proactive outpatient care management programs.

In addition to care coordination and management, nonmedical services may benefit vulnerable populations. The recent passage of the Creating High-Quality Results and Outcomes Necessary to Improve Chronic (CHRONIC) Care Act allows Medicare Advantage plans to offer nonmedical services and to tailor benefits packages to high-risk populations with particular needs, such as those with chronic lung diseases.[19] Such policy changes create an opportunity for health systems and insurers to improve care for high-risk populations while reducing spending.

Local Data for Local Interventions

Rich information about mechanisms of vulnerability and potentially actionable risk mechanisms, however, may not always be found in CMS claims forms. Therefore, realization of high-value care opportunities will require more local, data analytic solutions. The inclusion of relevant data around frailty and functional limitations, for example, would likely improve the performance of risk models, but such data are more likely to be available in health-system electronic health records than in administrative claims.[20,21]

There is probably an upper limit on the amount of predictive information that can be extracted from administrative claims. Even propensity score matching to better identify Medicare Advantage-like patients in FFS training datasets and advanced machine learning methods for model development using observable information do not improve risk prediction.[22]

HCC-based risk adjustment approaches share a common feature across populations and payment models: they predict expected spending. They do not predict responsiveness to a particular intervention, such as the probability of benefiting from a community health worker, visiting nurse, or care transition management progam.[17] Diagnosis- or severity-based identification of patients with COPD, for example, without accounting for complex psychosocial and socioeconomic factors—data more likely to be available to local health systems—may be insufficient to identify patients in need of or likely to respond to community-based interventions.[23–25]

Health systems that take the lead on targeted care management programs will be the first to realize the returns. As long as, on average, most health systems are not engaging in such proactive population health management, there is a relative opportunity for those health systems and insurers with sufficiently advanced analytics to identify at-risk patients likely to benefit from such interventions.

Conclusions

HCCs play a central role in determining reimbursements for patients enrolled in health plans through Medicare Advantage, ACA Marketplaces, and those cared for in ACO programs. Accurate documentation of relevant diagnostic codes by clinicians is necessary to predict future spending and justify reimbursements to insurers and health systems. HCC-based models continue to evolve in response to market changes, public concerns, and a dynamic health policy landscape. Pulmonary diseases and critical illness are recognized among the most common contributors to health spending, and they figure prominently in HCC-based spending prediction models.

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