Predictive Modeling Industry Commentary

The evolution of DxCG, the gold standard in risk adjustment and predictive modeling

Contributed by Verscend Technologies

To achieve value-based healthcare, organizations assess population risk and align clinical resources based on that assessment to ensure that healthcare dollars are spent efficiently and effectively. Sophisticated data analytics can improve risk assessment within and between populations, and can help predict future medical escalations for targeted clinical support.

The foundational role of accurate risk assessment has been recognized for decades, with risk adjustment and predictive modeling serving as cornerstones of modern value-based healthcare. Healthcare payers use risk adjusters and predictive models to better align healthcare budgeting and payment. Propelled by organizations such as the Centers for Medicare & Medicaid Services, risk adjusters and predictive models are cemented in the actuarial efforts of payer organizations across the country.

In 2016, DxCG celebrates its 20th anniversary, an occasion to examine its fascinating history and to understand its importance in advancing the science of risk adjustment and predictive modeling. DxCG grew out of the federally funded academic research conducted by its founders, who developed the hierarchical condition categories that CMS uses for reimbursement today. Over the past two decades, providers, health plans, governments and researchers have adopted DxCG for use across all facets of healthcare delivery.

The need for risk adjustment and predictive models

The roots of modern risk adjustment and predictive modeling can be traced to the creation of Medicare in 1965, a transformational moment in the history of US healthcare. For the first time, Americans 65 and older were guaranteed healthcare through government-provided health insurance; Medicare has been heralded as one of President Lyndon B. Johnson's greatest accomplishments.

Three decades ago, healthcare cost much less than it does today; per capita medical spending in the early 1980s was $1,580 ($3,657 in 2016 dollars) versus nearly $10,000 today. However, costs were escalating rapidly. One promising solution to these spiraling costs was the 1982 passage of the Tax Equity and Fiscal Responsibility Act, legislation that allowed the government to enter into risk-based contracts with HMOs to finance care for Medicare beneficiaries.

HCFA, the agency that oversaw Medicare and that has since been renamed CMS, hoped to save money because the HMOs were expected to better manage Medicare beneficiaries' needs. But those savings never materialized. Research revealed that Medicare HMO enrollees tended to be healthier on average, while the sickest beneficiaries were enrolled in Medicare's traditional fee-for-service program. The HMOs, it turned out, were enrolling beneficiaries who would, quite predictably, not end up costing as much as the Medicare program was paying for them.

A better predictor of risk and future cost

Why didn't Medicare payments to HMOs more closely match patients' anticipated costs? Throughout the 1980s and 1990s, healthcare payments were set by actuaries who used, by today's standards, relatively rudimentary methods to determine how much should be paid for medical care. Those methods, which were regionally adjusted, considered age, gender and Medicaid eligibility -- a proxy for poverty -- when determining anticipated costs. "HCFA knew that if it didn't find a better way to calculate payments to HMOs, it would get killed on the risk contracts," said Arlene Ash PhD, the mathematician who was part of the trio that would go on to found DxCG. "HCFA needed to figure out how to tell if someone was sicker or healthier than the average patient and how much sicker or healthier, then use that information in its contracts."

HCFA began reaching out to some of the best analytical minds in the country to devise a better way to assess medical risk so it could then adjust payments to reflect the relative chance of future illness. For many years, a research consortium based at universities in the Boston area -- Brandeis and Boston University -- received a good deal of the funding HCFA disbursed to help the agency solve the conundrum of equitable healthcare financing.

The triumvirate: Ash, Ellis, and Pope

In 1984, Ash had recently arrived at the Boston University School of Medicine, where she was asked to take over one of these HCFA-funded research projects. At the time, Ash was a mathematician with expertise in pure mathematics. "If 10 or 20 people in the world read one of my papers," she quipped, "that was a big deal." She vividly remembers the 30 or so huge computer tapes of patient data -- a goldmine of enrollment and hospital claims information -- that arrived in her office from Medicare at the beginning of her tenure at the medical school. The tapes had to be lugged to the bowels of a BU building in another part of the city so they could be mounted on a mainframe computer for processing.

At the time, there were about 32 million people enrolled in Medicare, and Ash's first research project examined a 5% research sample -- data from 1979 to 1980 for about 1.6 million patients. "You can't imagine how much data there was," recalled Ash. "I had never been handed anything like this -- a project this complex. I was trained as a mathematician and had only analyzed small data sets."

The BU-Brandeis research consortium connected her with BU health economist Randall Ellis PhD, whose experience coordinating and completing large research projects complemented Ash's analytical skills. A third collaborator was also brought on: Gregory Pope, a consultant for the Massachusetts-based company Health Economics Research, subsequently acquired by RTI International.

Although Ash, Ellis, and Pope were the principals in the eventual development of DxCG, they worked with other collaborators over the years, including Harvard Medical School physicians, who provided critical clinical input into model development.

The smart idea

By the mid-1980s, researchers had begun to explore predictors of future costs beyond age and gender, including chronic disease. As Ash explained, "the original idea was to look at the reasons that people have been hospitalized -- their diagnoses -- and classify them into those likely to have high future costs, middling costs and lower costs."

Considering only hospital information might seem like a narrow view of patients' costs today, but in the early 1980s, physician documentation of office visits varied widely. Therefore, Medicare did not trust the accuracy and completeness of that information. Although physicians were required to write down at least one medical problem to justify payment for a relevant medical service, they had no additional incentive to list all of the diagnoses that might complicate that patient's care. Even where physicians took the time to code more thoroughly, the information technology systems might truncate the information -- for example, retaining only the first diagnosis listed.

The DxCG team's earliest research used only diagnoses listed during hospitalizations, in conjunction with age and sex. Although far more accurate than models based on demographics alone, the newer hospital-based models still had a few inherent problems. First, because they view patients who are not hospitalized as healthy, their use discourages providers from spending money to avoid hospitalizations. Second, if the models paid more when there were more hospitalizations, they could actually stimulate hospital use.

The race for the HCFA win

By the mid-1990s, the DxCG team was competing against four other research entities -- including groups from Johns Hopkins and the research arm of the multinational corporation 3M -- to have their risk adjustment methodology adopted as the basis for future payments to Medicare HMOs. Ash and her collaborators' model, which came to be known as the principal inpatient diagnostic cost group model, or PIP-DCG, was chosen. This was remarkable -- a small group of researchers besting a Goliath like 3M to receive Medicare's imprimatur.

CMS cited several reasons for selecting the PIP-DCG model, including:

- Accuracy
- Transparency, especially to clinicians
- Ease of understanding and modification

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HCFA announced it would begin using PIP-DCG risk adjustment for 10% of Medicare HMO payments starting in 2000, with the percentage increasing in subsequent years. Simultaneously, HCFA stated its intention to phase in, starting in 2004, a far more sophisticated version of the model that the team had already developed, using additional patient data from ambulatory settings.

The models evolve

The PIP-DCG model was intended as a transitional model -- a way to begin risk adjusting Medicare payments using the most accessible and reliable data at the time. The DxCG team's development of hierarchical condition categories represented another huge methodological advance. HCCs recognize the fact that patients often have multiple things wrong with them. HCCs also enable payers to see -- and factor into budgeting -- the patients' complete array of diseases and conditions, using clinically informed hierarchies.

For example, consider two patients treated for a cough. For one, the cough is a symptom of an upper respiratory infection. For the other, a workup reveals chronic obstructive pulmonary disease, a far more serious and costly illness. Hierarchies "suppress" -- that is, ignore -- the knowledge that the patient with COPD was treated for a cough. Thus, the model understands that in the absence of more serious respiratory problems, a cough has no bearing on future cost. Without the hierarchy, the future costs of people with and without COPD would be mixed together.

The other leap forward in the team's risk adjustment models was the ability to include diagnostic codes from ambulatory encounters. In the early 1980s, physician encounter coding was incomplete and often inaccurate. Physician coding began to improve as HMOs started using provider coding data to set panel size, create quality reports and perform other activities, giving providers incentives to code more accurately. "Once people understood that they would be judged and monitored based on the data," Ash said, "the data got better." At the same time, IT systems also evolved, becoming capable of capturing the more complete coding. The enhanced risk adjustment model was called DCG-HCC. In 2004, Medicare called a simplified version of this model CMS-HCC and started using it to risk-adjust its HMO payments.

The business grows

Even before HCFA announced that it would use the DxCG team's model to risk adjust its Medicare HMO payments, it became clear to them that they had a commercially viable tool on their hands. "People kept contacting Randy and me, asking us how they could get ahold of these models that they'd been reading about," recalled Ash. "We realized that only a company could supply the 'industrial strength' support that commercial and Medicaid programs needed."

In late 1996, they founded their company. Borrowing from the DCG term and adding the medical abbreviation for diagnosis, Dx, the company was named DxCG. Like many startups, it began as a shoestring operation, first housed in a room at Waltham, MA-based RTI, where Pope worked. "We were small and underfunded," recalled Ash, who, like the other co-founders, still kept her "day job" as a BU mathematician. "We had $50,000 in capitalization, and our first year's income, in 1996, was $14,000. We were mostly working from home, after hours, and it took a while to build up and have real income," she said.

However, their models were being used by Medicare -- and that recognition was priceless. It helped establish DxCG as the go-to company for risk adjustment and predictive modeling. DxCG's earliest commercial clients included large regional health plans, such as Kaiser Permanente and Blue Cross Blue Shield of Massachusetts, as well as government entities such as the Group Insurance Commission, the Massachusetts state agency that manages health and other benefits for public employees, their families and retirees. The founders also consulted with healthcare organizations around the world, and the DxCG model became the basis of healthcare payment systems in Germany and the Netherlands.

DxCG models have also been used in academic research in other countries, including Canada, Australia and Chile. The company's expanding roster of health plan clients and growing workforce, coupled with the proven reputation of its risk adjustment and predictive models, attracted the attention of larger companies, including national health plans, large healthcare consulting houses and emerging provider organizations. DxCG was acquired by Verisk Analytics (then called ISO) in 2004, an acquisition that jump-started the development of Verisk Analytics' healthcare business arm, Verisk Health (now known as Verscend Technologies). Ash and Ellis continued to be instrumental to the models' success at the new company, working to advance the science of risk adjustment and predictive modeling, as well as to integrate the models into the company's broader set of healthcare analytics solutions.

From start-up to gold standard

Since 2004, advancing the DxCG risk adjustment and predictive models has continued to be a focal point. In addition to refining and recalibrating its models for Medicare, Medicaid and commercial populations, the DxCG team has created new models to predict specific medical events. These models include:

- Likelihood of Hospitalization (2006)
- Primary Care Activity Level to enable appropriate payments to primary care teams in support of coordinated patient care (2009)
- Likelihood of Emergency Department Visit (2011)

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Today, hundreds of health insurers, business application integrators, commercial and Medicare ACOs and reinsurance companies use DxCG. Data on more than 100 million individuals are run through the models each year. DxCG is used to support fair healthcare payments, to assess provider efficiency and effectiveness, to inform academic research, to close care gaps and shine a spotlight on patients in need of focused care management programs and for many other purposes.

The original DCG-HCC methodology has also continued to prosper. CMS has built upon the Ash/Ellis/Pope model that it adopted for Medicare Advantage risk adjustment. HCCs are used in the Medicare End-Stage Renal Disease program to risk-adjust Part D drug program premiums and were adapted to calculate risk sharing in the state insurance Marketplaces that operate under the Affordable Care Act. And the eighth version of HCCs is on the horizon. DxCG risk-based predictive modeling has transformed the way healthcare is evaluated, delivered and paid for, leading the way for value-based care initiatives across the country.

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