Can Milliman Advanced Risk Adjusters® (MARA) predict high-cost health plan members?

Assessing the performance of Milliman's industry-leading commercial risk adjustment models alongside other common industry methods for predicting high-cost members in U.S. commercial health plans

C. Seth Lester, ASA, MAAA
Erica Baird, FSA, MAAA, Ph.D.

Executive Summary

As the costs of healthcare services in the United States continue to grow, healthcare payers and employer sponsors of self-funded health plans find it increasingly challenging to offer competitive health benefits to their plans' members without increasing employee contributions or cutting benefits.

One way that payers and plan sponsors are working to manage increasing health services costs is by identifying plan members who are at risk of being future high-cost claimants. This gives plan administrators the opportunity to proactively address members' unmet health needs using tailored care management programs or employee assistance programs prior to these members' medical conditions worsening or their costs increasing.

This paper identifies several approaches that health plan sponsors and payer organizations currently use to predict plan members who are at risk of being high-cost claimants. In addition to a discussion of the risks and opportunities associated with each approach, this paper also evaluates the predictive performance of each method as applied to an illustrative but representative sample of over 1 million U.S. commercial members.

Why is predicting high-cost plan members important?

High-cost claimants pose a critical issue for health plans in that just a small percentage of membership typically accounts for a significant portion of the plan's total spending. Several studies and surveys have highlighted this in recent years. For instance, a 2019 study by the Employee Benefit Research Institute (EBRI) analyzed commercial plan member claims from 2013 to 2017, and found that the top 20% of plan membership accounted for 84% of total annual plan spending, with the top 10% accounting for 70%.[1]

Moreover, the 2023 J.D. Power U.S. Commercial Health Plan study revealed that only 17% of members with the lowest self-reported health statuses (self-reported health status of "poor" or "fair") in commercial plans were assigned to a case manager.[2] This represents a missed opportunity for plan administrators to address members' unmet health needs, suggesting a widespread need for more proactive identification and management of potential high-cost claimants.

Employers are also increasingly concerned about high-cost claims. A survey by the National Alliance of Healthcare Purchaser Coalitions found that nearly eight in 10 employers view drug prices, high-cost claims, and hospital prices as significant threats to the affordability of employer-provided health coverage.[3] This study also found that employers are seeking ways to manage these high-cost claims more effectively, with strategies ranging from implementing clinical intervention and case management solutions, to addressing the cost of specialty drugs through formulary controls, to rethinking stop-loss insurance options.

---

1 Paul Fronstin and M. Christopher Roebuck (October 24, 2019). Persistency in High-Cost Health Care Claims: 'It's Where the Spending Is, Stupid.' EBRI Issue Brief, no. 493. Retrieved May 23, 2024, from https://www.ebri.org/docs/default-source/pbriefs/ebri_ib_493_highcostclaims-24oct19.pdf?sfvrsn=ced83c2f_6.

2 J.D. Power (May 31, 2023). Commercial Health Plan Member Satisfaction Declines in Key Areas, J.D. Power Finds. Retrieved May 23, 2024, from https://www.jdpower.com/business/press-releases/2023-us-commercial-member-health-plan-study.

3 National Alliance of Healthcare Purchaser Coalitions (May 10, 2023). Rethinking How Employers Address High-Cost Claims. Retrieved May 23, 2024, from https://www.nationalalliancehealth.org/resources/rethinking-how-employers-address-high-cost-claims/.

Milliman

Why is predicting high-cost plan members difficult?

Identifying health plan members who are at risk of incurring high-cost claims is difficult primarily due to the inherent variability in healthcare spending and the multitude of factors that can influence an individual's health status and subsequent healthcare needs. For example, one common driver of high-cost claims is cancer,[4] which is difficult to predict—particularly using only administrative claims data. The challenge for plan sponsors is not just identifying which members will be high-cost, but also choosing an approach that explains *why* these members will be high-cost, so that appropriate member intervention or engagement efforts can be coordinated by the plan administrator before high-cost claims are incurred.

What are some common approaches to predicting high-cost members?

To provide an illustrative evaluation of the respective predictive performance of each of the methods discussed in this paper, we compiled the administrative claims data for a sample of over
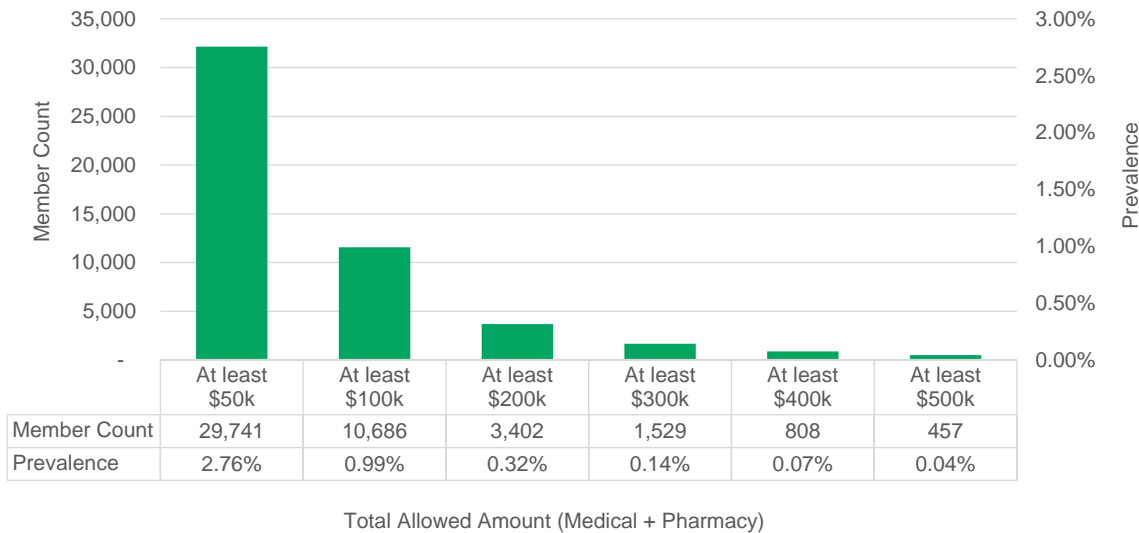
1 million U.S. commercial health plan members who had continuous medical and drug coverage for all of 2021 and 2022.

Next, we assigned high-cost members in the sample to one or more high-cost claimant cohorts by identifying those members in the sample whose per member per year (PMPY) claims in 2022 surpass commonly used annual PMPY claims cost thresholds used to classify claimants as high-cost.

Finally, we applied each method to the 2021 administrative claims data for every member in our claims sample and measured the predictive performance of the models by comparing high-cost members predicted by each model to actual 2022 high-cost members.

When it comes to measuring the performance of a predictive model, there are many relevant measures of model accuracy to consider, but we will highlight one: Positive Predictive Value (PPV). PPV measures the rate at which the model correctly identifies high-cost claimants (true positives) out of all the members predicted to be high-cost claimants (true positives and false positives).

FIGURE 1: PREVALENCE AND FREQUENCY OF MEMBERS IN HIGH-COST SPENDING TIERS, 2022

	At least $50k	At least $100k	At least $200k	At least $300k	At least $400k	At least $500k
Member Count	29,741	10,686	3,402	1,529	808	457
Prevalence	2.76%	0.99%	0.32%	0.14%	0.07%	0.04%

Total Allowed Amount (Medical + Pharmacy)

Source: Illustrative Sample of over 1 million US Commercial Plan Members
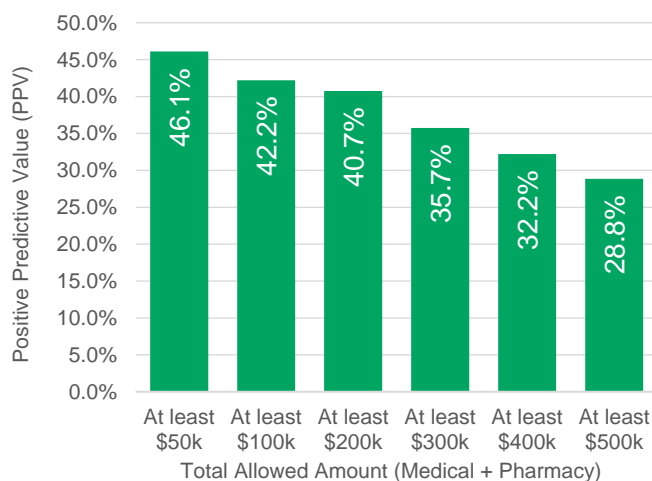
---

4 Ibid.

USING PRIOR-YEAR MEMBER-LEVEL COSTS

One simple approach to predicting high-cost members is to focus on members who were high-cost in the prior year. In this approach, members who exceeded a certain cost threshold in the prior year are assumed to be likely to incur high costs again in the current year. The primary advantage of this method is its simplicity; it does not require complex analytics or intricate models. Instead, it relies on historical annual cost data to flag members who may require intervention through care management programs provided by the plan's administrator or the employer plan sponsor.

This approach has two major limitations. First, there is a low persistency of members remaining in high-spending tiers from year to year. According to the same EBRI study cited above, out of the 27% of members whose PMPY claims exceeded the 90th percentile of PMPY claims in any year of the study period, 21% of those remained at or above the 90th percentile for only one or two years, and only 6% remained for three or more years.[5] This suggests that using prior member-level costs may predict future high-cost claimants with a low degree of accuracy compared to more complex and nuanced approaches discussed in subsequent sections.

Furthermore, this approach may inadvertently lead to inequity in clinical intervention efforts across the plan's membership, directing resources to members who are already utilizing the healthcare system and ignoring members in need of care who face barriers to getting that care.

FIGURE 2: PREDICTIVE PERFORMANCE OF PRIOR COST METHOD

Source: Illustrative Sample of over 1 million US Commercial Plan Members

Therefore, while the use of prior-year member-level costs to project current year high-cost members is straightforward and easy to implement, this approach may not be the most accurate or equitable approach for identifying plan members who are at risk of being high-cost claimants.

This simple prediction method using prior cost tiers was applied to the 2021 administrative claims data of our sample of over 1 million members to depict this method's predictive performance against actual 2022 results. For all the members in our sample whose 2022 PMPY claims totaled to $50,000 or above, this model correctly predicted high-cost members 46.1% of the time. For members whose 2022 PMPY claims totaled to $500,000 or above, the model correctly picked out high-cost members only 28.8% of the time.

USING THE HHS-HCC RISK ADJUSTER MODEL

The U.S. Department of Health and Human Services Hierarchical Condition Category (HHS-HCC) risk adjustment model[6] is another commonly used approach to projecting member-level costs for a health plan. This model, regularly updated by the Centers for Medicare and Medicaid Services (CMS), is intended for use in the risk transfer program that oversees the transfer of funds from Affordable Care Act (ACA) plans with generally lower-risk enrollees to those ACA plans with higher-risk enrollees in the current plan year.

There are several advantages to using this model in analyses of member risk. First, the HHS-HCC model's implementation in the SAS statistical programming language is freely downloadable from the CMS website. Once installed, the HHS-HCC model can process the administrative claims data for every member of a health plan in a matter of minutes, even plans with tens of thousands of members, depending on the computing resources available. Furthermore, the HHS-HCC model is widely used in healthcare analytics platforms and in population health applications because the model is regarded as highly transparent and is generally well understood by healthcare analytics professionals.

In addition to providing a numeric risk score for each member, this model also provides a list of Hierarchical Condition Categories (HCCs) and prescription drug categories (RXCs) for each member, which can be used to summarize the medical conditions that are the most impactful for each member in determining their overall projected cost to the plan. Having knowledge of each member's assigned HCCs and RXCs can help plan administrators better understand contributing factors that explain *why* plan members might be high-cost claimants.

---

5 Paul Fronstin and M. Christopher Roebuck (October 24, 2019), op cit.

6 Though it has not been updated for more recent model versions that incorporate different data sources and an expanded set of HCCs, the paper at https://www.cms.gov/mmrr/Downloads/MMRR2014_004_03_a03.pdf provides a good overview of the HHS-HCC model, its purposes, and the philosophy used when developing the model.

Finally, the HHS-HCC model does not use member costs as an input. Prior-year plan costs can vary substantially between key demographic subpopulations due, in part, to the way that different demographic groups access and interface with the healthcare delivery system in the United States. Therefore, healthcare prediction models that use prior-year plan cost as an input are at risk of producing predictions that reflect implicit biases among demographic subgroups. Compared to models that use prior-year plan costs as an input, there is generally less of a concern about the risk of implicit demographic biases in predictions made by models that do not use prior cost as an input, such as risk adjuster models like the HHS-HCC model, which use diagnosis, procedure, and drug codes associated with the member's claims information.

However, the HHS-HCC model also has significant limitations. Foremost is that this model is a *concurrent* risk adjustment model, which means that it is designed to use current-year diagnosis, procedure, and drug code inputs at the member level to *explain* (i.e., not predict) the cost incurred by that member in the same year. This design is intentional, as this model is used to retrospectively transfer risk adjustment payments among participating ACA plans after the conclusion of the current plan year. For this reason, this model is not intended for use in predicting future plan costs based on current-year administrative claims data. Despite these limitations, this model is still used in a wide variety of population health, group underwriting, and medical economics applications because it is well-known among healthcare analysts and is freely available for anyone to download and use.
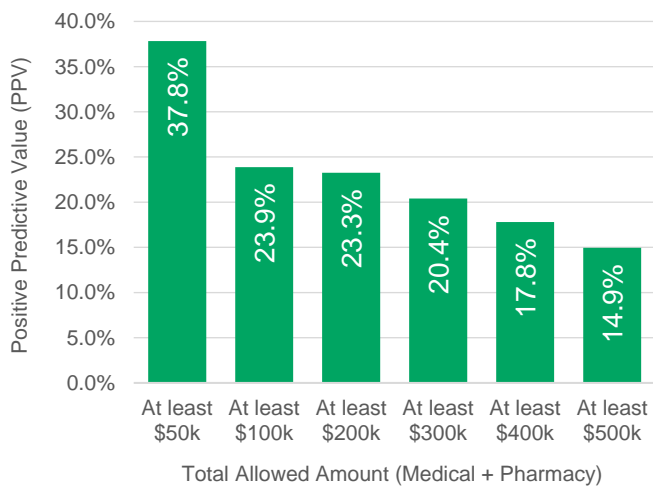
Another disadvantage to using the HHS-HCC model for predicting future member-level costs for U.S. commercial plans is that this model is not calibrated to quantify a risk score representing the total allowed amount at the member level. Rather, to produce a risk score representing the amount of *total plan liability* for ACA plan members at different metallic levels (e.g., platinum, gold, silver, bronze, and catastrophic), and the design of these plans may not necessarily match the design of a specific commercial plan.

We used the HHS-HCC risk adjuster model to process 2021 administrative claims data for our sample of over 1 million members. Preliminary member-level risk score outputs from this model, often referred to as "raw" or "unadjusted" scores, were then scaled up or down by dividing each individual member's raw risk score by the average raw risk score, so that the adjusted risk scores across the entire sample averaged to 1.00. Finally, we converted each member's adjusted risk score to a prediction of individual member-level PMPY cost by multiplying each member's adjusted risk score by the average PMPY cost over the entire sample. Then we classified each member in the applicable predicted high-cost member tiers using each member-level cost prediction. Finally, we compared the predicted cost tiers from this process to actual 2022 cost tiers to evaluate this method's predictive performance.

When applied to our sample, this method fared substantially worse than the simple prior-cost approach, which is to be expected: a concurrent risk adjustment model is designed to predict prior-year costs, therefore it is a method similar to using prior cost but with the added prediction error of using a model of prior costs instead of actual prior costs.

FIGURE 3: PREDICTIVE PERFORMANCE OF HHS-HCC RISK ADJUSTER MODEL PLATINUM SCORES

Source: Illustrative Sample of over 1 million US Commercial Plan Members

HOW TO CONVERT RISK SCORES TO COSTS

Scale the unadjusted scores up or down by dividing each member's raw risk score by the average raw risk score. This brings the adjusted risk scores across the entire sample = 1.00

Multiply each member's adjusted risk score by the average predicted PMPY cost over the entire sample to convert them to a prediction of individual member-level PMPY cost

Classify each member in the applicable predicted high-cost member tiers using the member level cost prediction

USING A COMMERCIAL RISK ADJUSTER MODEL

Commercial risk adjuster models are another tool that can be employed to predict high-cost plan members. These models are typically developed by actuaries or clinical analytics experts and often make use of proprietary methods. They may be designed to explain current-year or predict future-year member-level costs based on a variety of factors, including demographics, diagnosis codes, procedure codes, and pharmaceutical data.

In 2016, the Society of Actuaries published a comprehensive study[7] of 40 distinct claims-based risk adjuster models, both proprietary and freely available models, rating their predictive performance when applied side-by-side to the same administrative claims data set. While somewhat dated, this study is a good resource for obtaining a better understanding of the commercial risk adjuster market. Furthermore, almost all the risk adjustment models that were evaluated by this study are still actively developed, maintained, and used in population health analytics applications today.

One such suite of commercial risk adjuster models, the Milliman Advanced Risk Adjusters (MARA) models, are highly specialized and trained on the administrative claims data drawn from millions of members. MARA's suite of models includes models for commercial plan members (ages 0-64) as well as Medicare plan members (age 65+ or disabled). For each of these populations, MARA's library of models offers both concurrent and prospective models. MARA's models are used today by over 300 healthcare organizations, ranging from large national payers to regional provider systems and, in 2023, MARA's risk adjustment models were applied to more than 70 million unique individuals.

One of the key advantages of commercial risk adjuster models is the high level of granularity of clinical condition categories that can be attributed to individual members based on diagnosis and drug codes in the administrative claims input data. For example, while the payment year 2023 version of the HHS-HCC risk adjuster model uses over a hundred Hierarchical Condition Categories (HCCs) in calculation of member-level risk score outputs, the equivalent MARA concurrent risk adjuster model, CxXPLN, uses just shy of 1,200 clinical condition categories.

We evaluated the predictive performance of MARA's CxXPLN concurrent model as applied to our sample of over 1 million members similarly to how the HHS-HCC model was evaluated, by first normalizing the raw risk score outputs across the sample and then converting individual-level risk scores to predicted

costs. We then compared the MARA CxXPLN predictions for which members will be high-cost claimants in 2022 to actual high-cost claimant tiers to assess this model's effectiveness in identifying high-cost claimants.

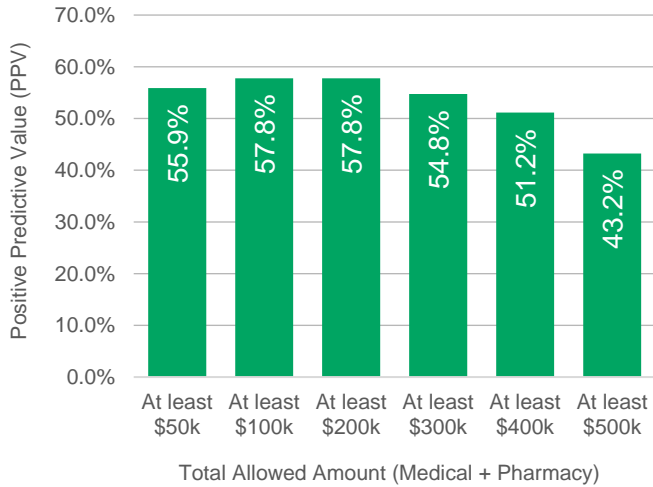**FIGURE 4: PREDICTIVE PERFORMANCE OF MARA CXXPLN CONCURRENT RISK ADJUSTER MODEL**
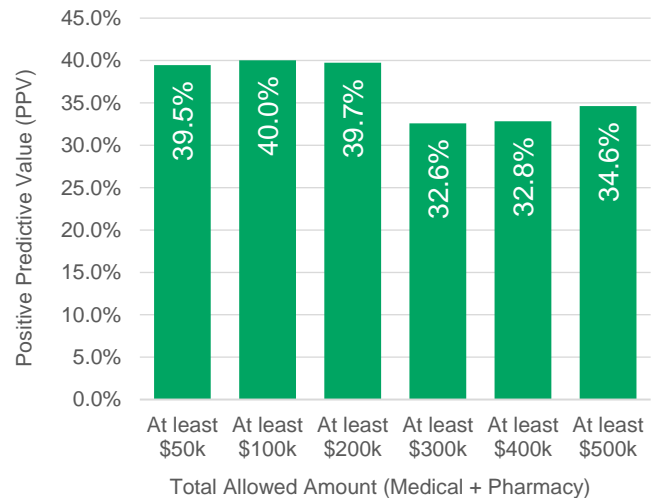
Source: Illustrative Sample of over 1 million US Commercial Plan Members

While MARA's CxXPLN concurrent risk adjuster model exhibited better predictive performance on our claims sample than the concurrent HHS-HCC risk adjuster model, it performed worse than (or at best identical to) the prior-cost method across all high-cost tiers. Despite the MARA CxXPLN model's sensitivity to a wider range of member health conditions and their influence on predicted member-level total cost of care, it should not be expected that *concurrent* risk adjustment models will ever exhibit the level of predictive performance seen in an otherwise equivalent *prospective* model designed for that specific use.

Commercial risk adjuster model vendors typically offer both concurrent models and prospective models, which are designed to predict future member-level costs based on current and historical data. Prospective models exhibit greater predictive performance in identifying future high-cost claimants compared to concurrent models like the HHS-HCC model, which are not intended to be used as a model for future costs.

---

7 Hileman, G., & Steele, S. (2016). Accuracy of Claims-Based Risk Scoring Models. Society of Actuaries. Retrieved May 23, 2024, from https://www.soa.org/4937b5/globalassets/assets/files/research/research-2016-accuracy-claims-based-risk-scoring-models.pdf.

FIGURE 5: PREDICTIVE PERFORMANCE OF MARA CXXPLN PROSPECTIVE RISK ADJUSTER MODEL

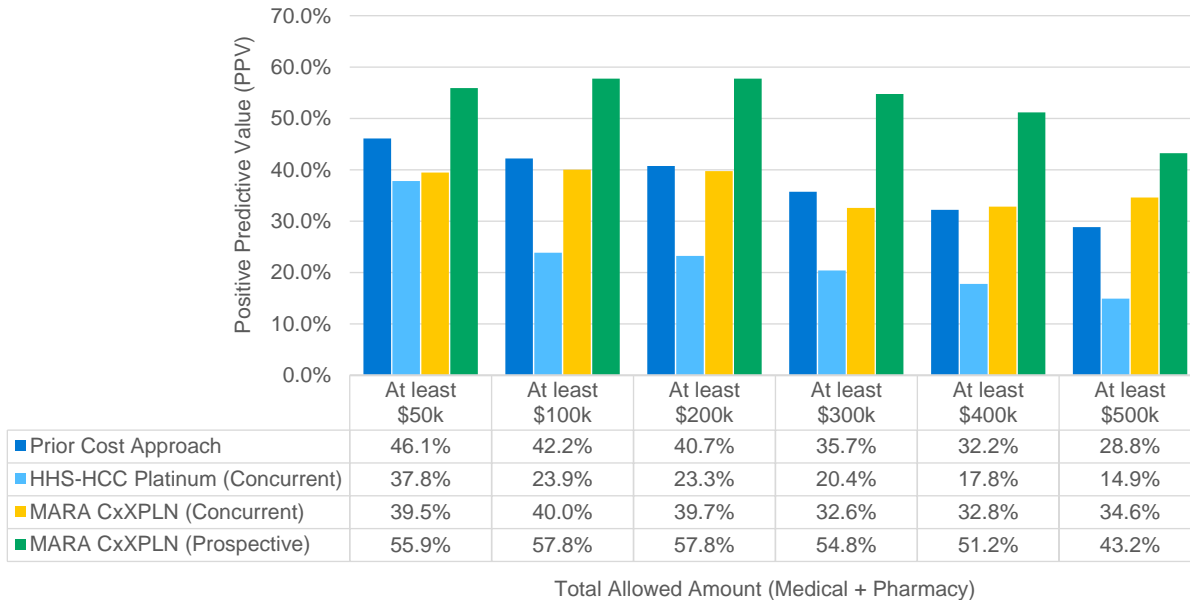Source: Illustrative Sample of over 1 million US Commercial Plan Members

When evaluated on our sample, using the same method as described previously,[8] the predictive performance of MARA's CxXPLN prospective model showed considerable improvement over the comparable concurrent models evaluated previously.

Conclusion

The analysis in this paper demonstrates that, while simple prediction methods such as using prior-year member-level costs can provide some insight into which members are at risk of incurring high-cost claims, they aren't always the most effective approaches. Furthermore, models that use prior costs may have a relatively low degree of accuracy compared to other models.

The HHS-HCC concurrent risk adjuster model, while widely used and easily accessible, is not designed to predict future costs and thus performs poorly when used for this purpose. Commercial risk adjuster models, such as the concurrent CxXPLN model from Milliman Advanced Risk Adjusters (MARA), show a slight improvement in predictive performance over the HHS-HCC model, but both of these models perform worse than the simple prior-cost approach because neither of these concurrent risk adjuster models are intended to be used for projecting future claims experience. However, when we applied MARA's prospective risk adjustment model intended for use on U.S. commercial populations to our sample, it exhibited the highest predictive performance of all models evaluated on our illustrative sample, across all high-cost member tiers.

FIGURE 6: PREDICTIVE PERFORMANCE OF METHODS FOR PREDICTING HIGH-COST MEMBERSHIP IN U.S. COMMERCIAL PLANS

	At least $50k	At least $100k	At least $200k	At least $300k	At least $400k	At least $500k
Prior Cost Approach	46.1%	42.2%	40.7%	35.7%	32.2%	28.8%
HHS-HCC Platinum (Concurrent)	37.8%	23.9%	23.3%	20.4%	17.8%	14.9%
MARA CxXPLN (Concurrent)	39.5%	40.0%	39.7%	32.6%	32.8%	34.6%
MARA CxXPLN (Prospective)	55.9%	57.8%	57.8%	54.8%	51.2%	43.2%

Total Allowed Amount (Medical + Pharmacy)

Source: Illustrative Sample of over 1 million US Commercial Plan Members

---

8 In the prospective model evaluation, we used average 2022 costs in place of average 2021 costs to calculate member-level projected costs (which avoids the impact of any trend misestimation on projections).

Ultimately, it is important to remember that no model is perfect, and there is no model that can replace the expert assessment of doctors and clinicians. It is crucial for health plan sponsors and payer organizations to make use of the appropriate clinical risk models to predict and attempt to manage the health status of their members. As technology, systems interoperability, and healthcare analytics approaches continue to evolve, it is likely that even more effective models will be developed in the future.

Predicting high-cost plan members is not only feasible, but also crucial for managing health plan costs. Just as a skilled tradesperson uses the right tool for the job, clinical analytics professionals should use an appropriate claims projection model for projecting high-cost claimants in commercial populations. The HHS-HCC model was developed to predict prior-year plan costs and facilitate retrospective risk transfer payments among ACA plans but is not intended to be used to project future claims experience. For predicting high-cost claimants, claims analytics professionals should use the right tool for the job—a prospective risk adjustment model, such as MARA's CxXPLN prospective model, that is calibrated for use on an appropriate population.

Using the right tool for the job allows claims analytics professionals to unearth actionable member-level insights that can support early intervention efforts and more tailored management of members' chronic conditions, which can ultimately aid employers and plan administrators in maintaining the health plan coverage for their members without increasing employee contributions or cutting benefits.

Milliman

Milliman is among the world's largest providers of actuarial, risk management, and technology solutions. Our consulting and advanced analytics capabilities encompass healthcare, property & casualty insurance, life insurance and financial services, and employee benefits. Founded in 1947, Milliman is an independent firm with offices in major cities around the globe.

milliman.com

CONTACT

C. Seth Lester
seth.lester@milliman.com

Erica Baird
erica.baird@milliman.com