The Hilltop Institute
UMBC

Risk Score Specifications and Codebook for The Hilltop Institute's Pre- Models

March 9, 2026

Version 4

Maryland
DEPARTMENT OF HEALTH

Documentation Edit History

Version	Date	Description of Primary Change(s)
MDPCP 1	October 3, 2019	Initial Release
MDPCP 2	January 11, 2020	▪ Added clarification of time lag of estimates; consistency of risk scores over time; reasons for risk; and model performance in production ▪ Updated model coefficients and appendix table ▪ Added List of Tables and Figures
MDPCP 3	June 29, 2020	▪ Added section on nonlinear modeling tests ▪ Updated weighting methodology for environmental risk factors ▪ Added section on new risk factors as of June 2020 ▪ Updated Appendix 1 to reflect additional risk factors
Pre- Models 1	November 7, 2022	▪ Substantially restructured to accommodate new predictive models ▪ Added details about census tract-level environmental risk factors ▪ Updated Pre-AH outcome definition to reflect latest AHRQ PQI specifications
Pre- Models 1.1	April 27, 2023	▪ Updated Pre-HE Model risk score name.
Pre- Models 2	December 19, 2023	▪ Updated Pre-AH outcome definition to reflect 2022 AHRQ PQI specifications ▪ Updated CCW risk factors to reflect the CCW 30 Version (2022) ▪ Updated Appendix 1 to reflect additional risk factors
Pre- Models 3	January 2, 2025	▪ Substantially restructured to accommodate new predictive model populations and inactive models ▪ Updated variable specifications and performance metrics for existing models where necessary
Pre- Models 4	March 9, 2026	▪ Updated primary care program language from TCoC to AHEAD ▪ Updated variable specifications and performance metrics for existing models where necessary

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for The Hilltop Institute's Pre- Models (Version 4)

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Section 1. Introduction

In 2014, the state of Maryland partnered with the Centers for Medicare and Medicaid Services (CMS) to modernize its unique all-payer rate-setting system for hospital services to improve the overall health of Maryland residents by increasing health care quality and reducing the cost of care. In service of providing better care at lower cost, The Hilltop Institute at UMBC, in partnership with the Maryland Department of Health (the Department), has developed predictive risk stratification models to identify patients at high risk for potentially preventable health care utilization that can be used to help target care resources to the patients who need them most.

This document explains the intended use, technical implementation, and model performance of the Hilltop Pre- Models as of January 2026. The Pre- Models are a suite of prediction tools spanning the Pre-AH Model, Pre-DC Model, and Pre-HE Model, currently deployed in several populations. This document will be updated as the models are updated or when new models become operational, and significant changes will be noted in the documentation edit history table. This first section of the codebook provides a short introduction; the second section provides a general overview of data sources, training methodology, and scoring methodology; the third section provides specific details on each model within the Hilltop Pre- Models suite; and the fourth section includes an overview of Pre- Models that are active at the time of writing.

As of January 2026, the Pre- Models are operational in four distinct populations:

- Medicare beneficiaries who are attributed to practices participating in the Maryland Primary Care Program (MDPCP). MDPCP was originally developed as a key element of the Total Cost of Care (TCOC) All Payer model, an agreement between the CMS and the state of Maryland. In January of 2026, the State of Maryland transitioned to the Achieving Healthcare Efficiency through Accountable Design (AHEAD) Model, where MDPCP continues as a primary element. MDPCP is a voluntary program that provides funding and support for the delivery of advanced primary care throughout the state. It allows primary care providers to play an increased role in the prevention and management of chronic disease, as well as in the prevention of unnecessary hospital utilization. As an important part of supporting providers in their care management efforts, the MDPCP provides event risk scores to participating practices of their attributed beneficiaries according to each patient's risk of incurring a model-specific outcome. Patient-level risk scores and reasons for risk are generated for the Pre-AH, Pre-DC, and Pre-HE models for the MDPCP population. As of January 2026, this population spans approximately 350,000 beneficiaries.
- Medicaid recipients enrolled in the Maryland HealthChoice program. HealthChoice is the Medicaid managed care delivery system in Maryland, and patient-level risk scores and

reasons for risk are generated for the Pre-AH and Pre-DC models for this population. As of January 2026, this population spans approximately 1.4 million individuals.

- Medicare fee-for-service (FFS) beneficiaries who live in Maryland and are not attributed to an MDPCP-participating provider. Patient-level risk scores and reasons for risk are generated for the Pre-AH and Pre-DC models for this population. As of January 2026, this population spans approximately 350,000 individuals.
- Full-benefit, non-dual Maryland Medicaid FFS beneficiaries who are not enrolled in the HealthChoice program. Patient-level risk scores and reasons for risk are generated for the Pre-AH and Pre-DC models for this population. As of January 2026, this population spans approximately 40,000 individuals.

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Section 2. Pre- Model Overview, Data, and Methodology

Intended Use

The Hilltop Pre- Model risk scores are intended to facilitate improved efficiency in the allocation of scarce care coordination resources and each model is calibrated to predict a patient's risk of a specific health event. Theoretically, if such resources are limited and the patients in a given practice panel differ in the benefit they would obtain through care coordination, then patient outcomes are optimized by focusing those care coordination resources on the patients for whom these resources will generate the most benefit.[1] Hilltop's models are intended to be used to *rank* beneficiaries in each practice's or MCO's panel based on their risk of experiencing a health event – as opposed to classifying individuals as "high" or "low" risk - in order to assist in the identification and care coordination efforts for high-risk individuals.

Hilltop conceptualizes benefit, in this context, as the avoidance of a patient-specific adverse event. Many distinct adverse events are possible (ranging from disease onset to institutionalization to death), but for each model (i.e., the Pre-AH Model, Pre-DC Model, and Pre-HE Model), Hilltop treats these events as homogeneous and therefore focuses on patients' *probabilities* of incurring the specified outcome. This forms the theoretical foundation for the Hilltop Pre- Model framework: those individuals with the highest *probability* of incurring a given health event are likely to benefit the most from advanced primary care services with respect to that outcome. Through the dissemination of risk scores and reasons for risk, Hilltop aims to facilitate the identification of these individuals within each practice or MCO so that providers and end-users can allocate their care management resources accordingly.

It is crucial that the risk scores are as accurate as possible: ideally, the riskiest individuals as identified by the model have the highest *actual* likelihood of incurring a given health event, and the individuals identified by the model as lowest risk have the lowest actual likelihood. Due to the nature of the modeling problem—estimating the *distribution* of risk, rather than binary classification—it is not appropriate to use the traditional Receiver Operator Characteristic curve as a measure of model fit. Instead, the utility of the model is assessed using *concentration curves,* which estimate the share of all health events occurring within the riskiest patients. Concentration curves can indicate, for example, that 50% of all patients who experience an avoidable hospital event are in the top 10% riskiest patients as estimated by the Hilltop Pre-AH Model. Concentration curves are presented for all models and populations in Section 4, below.

Clinical Vignette

In order to illustrate the intended use of the Hilltop Pre- Models, we have created a hypothetical clinical vignette using the Hilltop Pre-AH Model risk scores for an MDPCP practice. For the sake

[1] There is some evidence to suggest that different patients receive different benefits from care coordination services. Researchers have found that proactive care coordination interventions for patients with a high risk of hospitalization have so far led to reductions in avoidable hospitalizations, ED utilization, and readmissions for the Medicaid population but not the Medicare population (Berkowitz et al., 2018).

of exposition, the patient panel consists of thirteen patients, each of which represents ten similar patients. Table 1 displays the patient panel, along with each patient's (hypothetical) Hilltop Pre-AH Model risk score.

Table 1. Hypothetical Patient Panel

Patient Name	Pre-AH Risk Score (%)
Patient 1	75%
Patient 2	15%
Patient 3	5%
Patient 4	4%
Patient 5	2%
Patient 6	1%
Patient 7	Less than 1%
Patient 8	Less than 1%
Patient 9	Less than 1%
Patient 10	Less than 1%
Patient 11	Less than 1%
Patient 12	Less than 1%
Patient 13	Less than 1%

Patients in this practice are listed in descending order of risk. Based on the most recently available month of risk factors spanning diagnoses, procedures, medications, utilization, demographics, and geographic information, in conjunction with risk coefficients derived from the most recent quarterly model retraining, Patient 1 (or, equivalently, the ten patients represented by Patient 1) has a 75% chance of incurring an avoidable hospital event in the near future.[2] Patient 2 is the next riskiest and has a 15% chance of incurring an avoidable hospital event. Patient 3 is the next riskiest, with a 5% chance. The distribution of risk is highly skewed: the majority of the practice's or MCO's panel has less than 1% chance of incurring an avoidable hospital event, and all but two of the patients have under a 6% event risk.

Distributing available care coordination resources equally to all 130 underlying patients would result in each patient receiving a relatively small portion of available resources. This distribution of resources may not have a significant impact on patient outcomes: the low-risk individuals would likely be low-risk even without the advanced primary care intervention, and the high-risk individuals may require more resource-intensive interventions to experience improvement in outcomes.[3] The Pre-AH Model risk scores, used in conjunction with provider clinical guidance,

[2] See below for a more detailed discussion of the Pre-AH Model training and scoring process.

[3] Liaw et al. (2015) conclude that, based on a review of four CMS-funded demonstrations involving care management fees, "to generate savings, resource allocation cannot be homogeneous. Instead, practices must focus more intensely on those at highest risk of utilization" (p. 557). Indeed, this may (partly) explain the varying effectiveness of care management, care coordination, and intensive primary care interventions as documented in the academic literature; many patients have low underlying risk of adverse outcomes, thus obviating the need for intervention, and the few high-risk patients may require significant intervention resources. For summaries of the literature on this subject, see Edwards et al. (2017) and Baker et al. (2018).

can assist practices and MCO's with a more efficient and impactful allocation of their care management efforts.

Care Interventions

While care managers and other users of the Hilltop Pre- Model risk scores can prioritize care intervention efforts towards individuals with the highest risk of incurring a given health event in the near future, risk scores are not meant to override the clinical and subject matter expertise of the practice, their care transformation organization (CTO) partners, or the MCOs. The risk scores should be used in conjunction with the practice's current care coordination protocols and any acute community health needs.

Hilltop remains agnostic as to the types of interventions that are best suited for the high-risk patients. Many interventions are possible, ranging from medication reconciliation to patient education to scheduling assistance, and patients are likely to respond best to different interventions based on their clinical and social needs. Interested readers should see published best practices in care coordination and care management.[4]

Risk Factor Overview

The risk factors in each of the Hilltop Pre- Models are derived from comprehensive literature reviews designed to identify risk factors that have been shown, in previously published research, to be statistically associated with the outcome of interest. Initially, Hilltop identified over 190 risk factors for the Pre-AH Model risk factor pool based on a literature review conducted in early 2019 (Pelser et al., 2019). Hilltop subsequently expanded the pool of Pre-AH Model risk factors in 2020. All Hilltop Pre- Models use the risk factor pool developed for the Pre-AH Model, as well as additional event-specific risk factors identified through targeted literature reviews.

Data Sources

Medicare Populations (MDPCP and Medicare FFS)

The administrative data used in the Pre- Models developed for the MDPCP and Medicare FFS populations are derived from the Claim and Claim Line Feed (CCLF) Medicare Parts A, B, and D claims files. Each month, Hilltop receives Part A claims, Part A revenue centers, Part A procedure codes, Part A diagnosis codes, Part B claim lines, Part B durable medical equipment claims (DME), Part D claims, patient demographic information (which also includes eligibility information) from CMS, and enhanced demographic information from CRISP. Additionally, Hilltop receives beneficiary attribution files and practice rosters each quarter.

Upon receipt of the monthly claims files, Hilltop first performs automated data validity checks in order to assess the integrity of the CCLF data files and verify beneficiary identification numbers - followed by a data reduction step that subsets the claims files against the beneficiary attribution

[4] See examples at Hong et al. (2014); McCarthy et al. (2015); and Anderson et al. (2015).

file. The resulting files retain the raw claims data that are inputs to the risk factor feature engineering process.

In addition to risk factors based on administrative claims, the models also include risk factors based on publicly available, environmental risk factors. Appendix 2 details the data sources for these risk factors.

Medicaid Populations (HealthChoice and Medicaid FFS)

The administrative data used in the Pre- Models developed for the HealthChoice and Medicaid FFS populations are derived from the Medicaid Management Information System (MMIS2) eligibility, recipient information, enhanced demographic information, inpatient, outpatient, physician, and pharmacy claim files for the Medicaid beneficiaries. Each month, Hilltop receives new claim files from the Maryland Department of Health.

Upon receipt of the monthly claims files, Hilltop first performs automated data validity checks in order to assess the integrity of the MMIS2 data files, followed by a data reduction step that subsets the claims files against the MCO eligibility files. The resulting files retain the raw claims data that are inputs to the risk factor feature engineering process.

In addition to risk factors based on administrative claims, the models also include risk factors based on publicly available environmental risk factors. Appendix 2 details the data sources for these risk factors.

Condition-Based Risk Factors

A significant portion of Hilltop's risk factor pool is composed of condition-based risk factors: that is, 0/1 variables that indicate—based on an individual's claims history—whether they have been recorded as having diagnoses consistent with a given condition. These condition flags largely rely on diagnostic information from hospital, nursing home, physician, and lab claims in conjunction with Chronic Conditions Data Warehouse (CCW) coding specifications in order to generate beneficiary-level risk factors that represent underlying disease states.[5]

At the time of writing, the models use the August 2025 CCW definitions.

Utilization-Based Risk Factors

Risk factors from this category cover utilization of certain services (such as vaccinations, lab tests, or provider-administered drugs), place of service (for example, urgent care or rural health clinic), and provider specialty (for example, endocrinology or oncology). These risk factors also

[5] Additional detail on the CCW condition flag specifications can be found here: https://www2.ccwdata.org/documents/10280/19139421/chr-chronic-condition-algorithms.pdf , https://www.ccwdata.org/documents/10280/19139421/ccw-chronic-condition-algorithms-reference-list.pdf

capture information on inpatient and outpatient hospital admissions, ED visits, and nursing home admissions over the past 12 months.

Prescription Drug-Related Risk Factors

Risk factors from this category index utilization of prescription drugs. The coding logic relies on first mapping drug names to National Drug Codes (NDCs) and then identifying those NDCs in pharmacy claims files. In order to capture compound drugs, which are drugs that contain multiple active ingredients, Hilltop relies largely on text-based, "contains"-type searches of the FDA's National Drug Code Directory to map drug names to NDCs.[6] We regularly update the list of NDCs to account for the addition of new NDCs.

At the time of writing, the models use the FDA NDC database from February 2025.

Demographic Risk Factors

Risk factors from this category index cover beneficiary demographic characteristics such as age, race, and Medicare or Medicaid eligibility information. The respective beneficiary eligibility files are used to create these risk factors for all populations for which risk scores are deployed. Starting in 2025, to address fluctuating availability and data quality in beneficiary race information, Hilltop integrated enhanced race and ethnicity information from CRISP and the Maryland Health Benefit Exchange (MHBE). When converting enhanced race and ethnicity data to the existing Pre- Models race variables Hilltop followed guidance from the Office of Management and Budget for Federal data on race and ethnicity.[7]

Social and Environmental Risk Factors

Social and environmental variables play an important role in health; however, many individual-level demographic and socioeconomic factors are unavailable in administrative claims data (for example, marital status). Consequently, Hilltop developed an extensive database of area risk factors from publicly available data sources (i.e., the percentage of the population aged 15+ that is currently married) that can be linked to an individual's administrative claims using their recorded address to proxy for the unobserved individual-level variables. Other environmental risk factors (e.g., area poverty rate) are intended to capture social determinants of health—the neighborhood conditions in which people live and age that may affect health outcomes. Hilltop created two versions of these variables: one that maps to an individual's ZIP code (ZCTA), and, in

[6] For example, "Simcor" contains two active substances: Simvastatin and Niacin. This is flagged as a statin because one of its active ingredients is a statin. Source for the FDA NDC directory: https://www.fda.gov/drugs/drug-approvals-and-databases/national-drug-code-directory

[7] See the "Provisional Guidance on the Implementation of the 1997 Standards for Federal Data on Race and Ethnicity" (dated Dec 15, 2000) https://ofm.wa.gov/wp-content/uploads/sites/default/files/public/dataresearch/pop/asr/re_guidance2000update.pdf

October 2021, more granular versions of the variables at the census tract level[8]. See Appendix 2 for more details on the risk factors and how they are linked to claims data.

General Methodology

Training

Each of the Hilltop Pre- Models is operationalized as a discrete-time survival model that uses the *current* month of risk factors in order to predict the specified event outcome in the *following* month. The model uses month as a time unit—instead of, for example, weeks or years—to balance the increased model accuracy obtained by a more granular time unit with the increased prediction error due to rare events.

The raw claims data span three years, or 36 person-months for individuals with full coverage. Since the model estimates the risk of incurring an outcome in the *next* month; however, it is not possible to use the most recently available month of risk data in the training model (since the next month's outcomes have not been realized at this point). Therefore, the training data are based on underlying data covering 35 person-months per attributed patient with full coverage. While, in general, a reduction in sample size can adversely impact the statistical precision of the risk factor estimates, lagged predictors are used for three reasons. First, several of the risk factors—such as the count of hospitalizations in the previous 12 months, or the condition flag for diabetes—overlap with the definition of the outcome variables. Consequently, including these risk factors as *contemporaneous* predictors could artificially increase the predictive power of the model. Second, Hilltop believes that using lagged predictors aids in the interpretability of the model. The goal of the Hilltop Pre- Models is to predict future events and using contemporaneous predictors to generate future risk scores requires the assumption that individuals' risk factors do not change in the future. Finally, the use of lagged predictors implies a natural "person-now" data set: the most *recent* month of risk factors, which is not included in the training data set.

The statistical model is trained on an 80% sample of our analytical person-month data set. The functional form of the statistical model is:

$$\log \frac{p_i(t)}{1-p_i(t)} = \varphi(t) + \beta X_i(t-1) + \Omega V_i$$

- $\varphi(t)$ is a function of time at risk
- t is duration of time at risk in months

[8] Goetschius et al., (2023) found that ZCTA and census tract level granularity social and environmental risk factors resulted in similar predictive performance. However, the more granular census tract risk factors resulted in improved model interpretation.

  - counting start from the first month of available data if the patient is in coverage longer than three years, or
  - counting from the coverage start month if the patient's coverage start is within three years
- β and Ω are the vectors of model parameters to be determined by training data
- $X_i(t-1)$ is a vector of patient $i's$ time-dependent features in the previous month
- V_i is a vector of patient *i*'s time-independent features
- $p_i(t)$ is the probability of a given outcome of patient i at time t (i.e., the month following the realization of the risk factors)

The statistical model uses five types of risk factors: condition, pharmacy, utilization-based, geographic, and demographic. It is important to note that not all risk factors are available for every person-month. Hilltop uses a twelve-month lookback period for most of the time-varying risk factors, implying that an individual with, for example, five months of claims history will have incomplete information in their risk factors: if this individual truly has glaucoma, then it is possible that they will not amass the claims history by month five that meets the qualifications required for a glaucoma flag in our model. Furthermore, while most individuals in the data have addresses that link to the environmental risk factor data set, there are a small proportion of individuals for whom a valid census tract cannot be identified or who have ZIP codes for which there is no equivalent ZCTA, and therefore receive no environmental risk factors.[9] Table 2 presents the risk factor availability, depending on claims history and availability of area-level (ZCTA or census tract) data.

Table 2. Risk Factors by Data Availability

	12+ Months of Claims History	<12 Months of Claims History
Available Geographic Risk Factors	Claims-based/Geo/Demo	Geo/Demo
Unavailable Geographic Risk Factors	Claims-based/Demo	Demo

Risk factor availability is an issue for the "scoring" step, in which risk scores are assigned to every individual based on the parameter estimates derived in the training step. For example, suppose that the vector of estimated coefficients from the logistic regression is as follows in Table 3.

[9] These individuals appear to use P.O. boxes as their mailing address, which, being point representations, do not have ZCTA areal equivalents.

Table 3. Risk Factor Availability Example 1

Risk Factor	Value for individual i
Asthma Flag	.1
…	
ZIP Code Income	-.00001
…	
Age	.02

These hypothetical risk factor coefficients indicate that, as expected, if an individual meets the clinical criteria for asthma, the risk of the outcome is higher; if they live in a ZIP code with higher income, the risk is lower; and if they are older, the risk is higher. The scoring step will apply this vector of coefficients to the "person-now;" that is, the current month for each individual. Individual *i*'s predicted probability of incurring an outcome in the next month, then, will be scored as follows:

$$Risk_i = \frac{e^{.1*Asthma_i + \cdots - .00001*ZIP\ Code\ Income_i + \cdots + .02*Age_i}}{1 + e^{.1*Asthma_i + \cdots - .00001*ZIP\ Code\ Income_i + \cdots + .02*Age_i}}$$

Suppose that these variables (Asthma Flag, ZIP Code Income, and Age) are the only three risk factors in the model. Furthermore, suppose that individual *i* has the following characteristics:

Table 4. Risk Factor Availability Example 2

Risk Factor	Value for individual i
Asthma Flag	1
ZIP Code Income	$55,000
Age	66

This hypothetical individual has asthma, lives in a ZIP code in which the median income is $55,000 and is 66years old. Then, that individual's risk of an outcome event in the following month is:

$$Risk_i = \frac{e^{(.1*1 - .00001*55{,}000 + .02*66)}}{1 + e^{(.1*1 - .00001*55{,}000 + .02*66)}} = 70.47\%$$

Suppose, however, that this individual is newly eligible for Medicare and does not have sufficient claims history to meet the criteria for an asthma flag (anything under 12 months). In this instance, the individual might truly have asthma as an underlying disease state, but this is not observable. The individual's risk factors, then, are:

Table 5. Risk Factor Availability Example 3

Risk Factor	Value for individual i
Asthma Flag	NOT OBSERVED
ZIP Code Income	$55,000
Age	66

If the model's coefficients are applied only to the risk factors that are *observed*, then this individual's estimated risk is 68.35%. By failing to account for the risk factors that are not present in the model, the risk of incurring the outcome is underestimated for individual *i*.

Hilltop's solution to this issue is to estimate four different regression models for a given outcome based on the risk factors that are available for each group. This allows the risk factors that are present to "compensate," to a certain extent, for the risk factors that are missing due to data availability. For example, suppose that an individual lacks sufficient claims history to generate condition risk factors but does have the following demographic risk factors: age, sex, and race. If sex is correlated with the unobserved condition factors (if, for example, female beneficiaries are more likely to experience chronic conditions than male beneficiaries), then the coefficient for the "sex" risk factor will capture this correlation—and thus represent the marginal impact of being female *and* the portion of unobserved diagnostic risk factors that is correlated with sex. Consequently, if female beneficiaries are more likely to experience chronic conditions than male beneficiaries, then the risk factor coefficient for "sex" will be larger in the models without condition risk factors than in the models with diagnostic risk factors. By allowing observed risk factors to capture some of the predictive power of unobserved risk factors, the loss in predictive power due to missing data is minimized.

The four sub-models are trained on the subset of person-months for which all risk factors are complete (that is, person-months with at least 12 months of claims history and a valid geographic linkage), and include the following sets of risk factors (analogous to the four partitions of the person-month sample):

- Sub-Model 1: use Claims-based/Geo/Demo risk factors
- Sub-Model 2: use Geo/Demo risk factors
- Sub-Model 3: use Claims-based/Demo risk factors
- Sub-Model 4: use Demo risk factors

Variable selection can improve the performance of predictive models by reducing prediction variance and increasing generalizability (Bagherzadeh-Khiabani et al., 2016; Walter & Tiemeier, 2009). Hilltop performed this in two steps: first, the team selected initial risk factors for the Pre-AH Model based on an extensive literature review, which screened over 3,300 articles and ultimately selected 211 published, peer-reviewed papers from which to extract risk factors. This generated a baseline pool of 204 risk factors; each of the additional Pre- Models is based on its own literature which adds risk factors to this baseline pool. Additionally, in model training,

Hilltop uses stepwise selection in the multivariable logistic model to remove insignificant predictors from the model before adding significant predictors.

In the current version of the Hilltop Pre- Models, the risk factors typically enter the model additively: that is, if an individual has both diabetes and heart failure diagnostic flags, then their risk score will reflect the risk coefficient for the diabetes flag, plus that of the heart failure flag. It is possible, however, that there is additional risk due to the fact of the beneficiary having *both* conditions, over and above the sum of the risks of having each condition. We have included such "interaction terms" where indicated by the literature reviews. For example, in the Pre-HE Model, we include a measure of frailty, a 0/1 variable indicating a history of Alzheimer's disease or related dementia, and the interaction of the two.

Hilltop trains each of the Pre- Models on a quarterly basis unless otherwise specified. We will, however, monitor the predictive accuracy of the model and adjust the training schedule as needed.

Scoring

The four risk models above are *trained* each quarter on the subset of data with at least twelve months of claims history and full environmental data (ZIP code or census tract) data to estimate the vectors of coefficients for the risk factors in each model. Then, using the most recently available month of risk factors (that is, the "person-now" data set), individuals are scored using the model coefficients that correspond to the risk factors available in the person-now data set.

The Hilltop Pre- Models generate risk scores for the entire population cohorts, but individual practices or MCOs only receive risk scores for their specific beneficiaries. This has the consequence that, if a practice or MCO contains disproportionately high-risk patients, and another contains disproportionately low-risk patients, then the riskiest patients within each will differ in their *absolute* risk.

Hilltop scores the Pre- Models monthly. During this process, we create risk factors from raw claims data for the most recent one month of claims history and apply the most recent model coefficients to create risk scores.

Predictive Performance Metrics

Predicted Probabilities

The output for all the Pre- Models is a set of probabilities that estimate the patient-specific risk of incurring the model-specific outcome. In general, these events are rare and, consequently, the predicted probabilities are low. Hilltop does not interpret this as a limitation of the risk scores; rather, this reflects the relative rarity of the outcome events. Moreover, the *relative* risk is the key metric that should be used to allocate care resources: no matter the absolute risk of the patient panel, the efficient allocation of care resources requires the identification (and treatment) of the riskiest patients the medical practice treats.

Patient-level risk tends to persist across time: that is, higher-risk patients tend to remain at a high-risk from one month to the next, while lower-risk patients tend to remain at a lower-risk. This is likely due to two factors. First, to prevent coding idiosyncrasies from introducing noise into the predictions, the majority of risk factors are coded with at least one year of lookback. This has the consequence of making the Pre- Model risk factors relatively stable over time, thus smoothing out variation in the risk scores. Second, it is likely that true, underlying patient risk is also persistent: if some patients tend to have high (or low) risk for structural reasons, then the risk scores should also be relatively stable across time.

However, large month-to-month changes in risk scores can occur for three reasons. First, using a given set of risk factors coefficients, any changes in underlying risk factors will lead to changes in patients' predicted risk. For example, if an attributed beneficiary meets the conditions for heart failure beginning in July 2025, then their risk score will likely increase significantly because of that underlying change.

Second, Hilltop estimates new risk factor coefficients every quarter in model retraining. As a result, the *relationship* between a given risk factor and the model-specific outcome events can also change upon retraining. To continue the previous example, if the risk factor coefficient for heart failure rises after the model is retrained, the individual's risk score would rise not only because they have a new heart failure risk factor, but also because the heart failure risk factor has risen in predictive importance based on the new coefficients.

Finally, changes in a patient's sub-model group from month to month can impact predicted risk. For example, if in June 2025 a patient with geographic and demographic data availability, only had 11 months of claims history, their risk score would be calculated using coefficients from sub-model 2, which only contains demographic and geographic risk factors. In July 2025, that same patient would have 12 months of claims history, and their risk score would be calculated using coefficients from sub-model 1 which include claims based, demographic, and geographic risk factors. Notably, this change in predicted risk would not necessarily indicate a change in the patient's true underlying risk. Instead, their predicted risk changed as more information about the individual became available.

We present the predicted probabilities separately for each model and population (if applicable).

Predictive Power

It is imperative that the accuracy of predictive models be assessed during both model development using holdout data, and in a production environment once the scores have been deployed. "Holdout data" are data that are available at the time of model training *but not used to train the models*; the Pre- Models reserve 20% of all data to use as holdout data for purposes of model assessment. Testing model performance on holdout data constitutes assessing the predictive performance on the model on data that is new to the model (although which is technically available at the time of model training). Assessing model performance in a production environment, however, means that we check the accuracy of scores that were released to the relevant healthcare providers against events that *actually occurred* in the following month. Since

this requires knowledge of the "true" events in the month after a given score release, this is only possible several months following the release of a given month of risk scores.

Typically, the discriminatory power of predictive models is summarized using the c-statistic, which is a measure of the area under the Receiver Operating Characteristic (ROC) curve (Steyerberg et al., 2010). The ROC curve plots the true positive rate against the false positive rate for binary classifiers using successive cutoff thresholds and "measures the probability that a randomly selected diseased subject has a higher predicted risk than a randomly selected non-diseased subject" (Mauguen & Begg, 2016). However, this measure is uninformative regarding model calibration, which is the degree to which estimated risk scores match underlying true risk: it is possible to have a model with strong discrimination and poor calibration (Alba et al., 2017). Moreover, the objective of the Hilltop Pre- Models is not binary classification, but instead the estimation of individual-level risks of incurring the model specific outcome event so that care managers can, by focusing on the riskiest individuals, potentially intervene. To that end, the performance of the Hilltop Pre- Models is assessed using the *concentration curve*.[10]

This measure of model accuracy estimates the cumulative share of all model-specific outcome events incurred by the riskiest patients, where the reader can determine the share of all outcome events occurring for individuals above different risk thresholds. To estimate the concentration curve, the patient cohort panel is ordered from most to least risky (in terms of predicted risk) on the X axis, and the fraction of total outcome events captured by the riskiest patients on the Y axis. We estimate the percent of outcome events incurred by the top 1% and 10% riskiest patients based on their absolute risk.

Concentration curves can be summarized by a Gini coefficient, a measure of 0 to 1, that can be interpreted as a measure of risk concentration in the population: the greater the Gini index, the more concentrated is the risk of the model-specific outcome event in a small proportion of persons (Llorca & Delgado-Rodríguez, 2002). A higher Gini coefficient indicates better model fit. To assess whether model performance is improving or declining over time, we estimate monthly concentration curves for the 20% holdout sample of the training data set.

We assess predictive power on both holdout and production samples. We present the predictive performance metrics separately for each model and population. Beginning in 2024, we enhanced the methodology used for production predictive performance evaluations to improve accuracy and expanded these evaluations to examine whether predictive performance differs across select demographic groups.

Reason for Risk

As of January 11, 2020, the Hilltop Pre- Models have—in addition to generating individual-level risk scores—also displayed the top actionable risk factors underlying each patient's risk of

[10] This is very similar to the Lorenz curve, which "is especially useful in the context of disease prevention because it maps out what public health policy investigators need to know. That is, it tells us how much disease burden will occur in any given proportion of the population with risks above a chosen threshold" (Mauguen & Begg, 2016).

incurring a future model-specific outcome. The intention of this update was to further facilitate patient-specific advanced primary care by providing practices insight into why a patient received their risk score. For example, in addition to a risk score of 3.2% for a particular patient, care managers will also be able to see that the patient (for example) meets the clinical criteria for diabetes and heart failure and incurred a claim for insulin within the past year (in descending order of contribution to risk). This is particularly important as patients may have the same risk score but have different contributing risk factors.

While that patient may also have had other salient risk factors, Hilltop only displays the most predictive and intervene-able risk factors in order to allow care mangers to focus their attention on the most pressing patient needs.[11] These constitute the "reasons for risk". Based on the feedback from stakeholders, Hilltop excludes risk factors that are not potentially modifiable; that is, for which the effects cannot be meaningfully modified by clinical intervention (e.g., area income). Additionally, risk factors that are not positive and statistically significant are also excluded from the reason for risk pool.

These reasons for risk are based on the underlying risk factor coefficients, which are derived from the training phase of the model. It is important to note that these coefficients do not necessarily have a *causal* interpretation: they only capture the strength of *association* between a given risk factor and the risk of incurring a future outcome. For example, if the risk factor coefficient for diabetes is positive in a particular model, then that could mean that having diabetes *causes* an increased risk of that model's outcome; however, it could also mean that having diabetes is only *correlated* with some unobserved factor that causes an increased risk of that model's outcome. While these risk factors do not have a strictly causal interpretation, they are intended to provide care managers with a useful starting point from which to address specific patient needs.

In order to operationalize the identification of reasons for risk, the Hilltop team first re-coded select risk factors so that a higher level of a given risk factor is theoretically associated with greater risk of incurring the outcome event for each model. Consider the example of flu vaccinations: there is evidence that receiving annual influenza and/or pneumococcal vaccinations reduce the risk of hospitalization for various prevention quality indicators (PQIs) in various populations (Furumoto et al., 2008; Hedlund et al., 2003; Nichol et al., 2003). This implies that receipt of a flu vaccination should be *negatively* associated with the risk of incurring an avoidable hospital event. This risk factor, then, was re-coded to be 1 if the individual has *not* received a flu vaccination, and 0 if the individual *has* received a flu vaccination.

Consider the following illustrative example. Suppose that the Pre-AH Model contains only three risk factors: a flag for diabetes, the number of recent avoidable hospitalizations, and a flag for heart failure. In this example, the coefficients for these three risk factors are 0.1, 0.08, and 0.07, respectively. The coefficient for diabetes represents the increase in risk of avoidable

[11] Hilltop collected stakeholder feedback from clinical partners in order to ensure that we only displayed those risk factors over which patients, providers, and care managers can exert some control. We did not, for example, include most environmental risk factors, since providers cannot directly assist patients with the management of this factor.

hospitalizations associated with having diabetes (relative to not having diabetes), holding all other factors constant.[12] The coefficient for the number of avoidable hospitalizations reflects the added risk associated with one additional previous avoidable hospitalization, and the coefficient for heart failure reflects the added risk associated with having heart failure (relative to not having heart failure), again holding all other factors constant.

It is important to note that these risk coefficients are marginal effects; that is, the *additional* risk due to, for example, a patient having one additional previous avoidable hospitalization. In order to translate these marginal effects to reason for risk contributions, Hilltop multiplies each marginal estimate by the *level* of that risk factor for each individual. Thus, if an individual has four previous avoidable hospitalizations (over the last 35 person-months), then the risk contribution of avoidable hospitalizations is 4*0.08 = 0.32.[13] Crucially, this risk contribution is still interpreted relative to a reference category: in this case, individuals with no history of avoidable hospitalizations. More broadly, the risk contribution should be interpreted relative to individuals *without* that particular risk factor.[14]

Suppose that, in this example, there are four patients in a given practice panel. Patient 1 has diabetes, no history of avoidable hospitalization, and heart failure. Patient 2 does not have diabetes, has no history of avoidable hospitalization, and has heart failure. Patient 3 has diabetes, four prior avoidable hospitalizations, and does not have heart failure. Finally, Patient 4 does not have diabetes, has one previous avoidable hospitalization, and has heart failure. This information is presented in Table 6, below.

Table 6. Hypothetical Reason for Risk Example

Patient ID	Diabetes	Diabetes * Coefficient	# AH	# AH * Coefficient	Heart Failure	Heart Failure * Coefficient
1	1	0.1	0	0.0	1	0.07
2	0	0.0	0	0.0	1	0.07
3	1	0.1	4	0.32	0	0.0
4	0	0.0	1	0.08	1	0.07

In this example, the top reason for risk for Patient 1 is diabetes: this risk factor yields the largest positive contribution (risk factor level * coefficient) among all the risk factors for that individual. For Patient 2, the top reason for risk is heart failure; for Patient 3, the top reason for risk is the history of avoidable hospitalizations; and for Patient 4, the top reason for risk is the history of avoidable hospitalizations. The second reason for risk is calculated analogously: it is the second

[12] Since our baseline model is a multivariate logistic regression, the coefficient is technically the marginal impact on log odds of incurring an avoidable hospital event. For the sake of exposition, we label this as "risk."

[13] This assumes that marginal effect is constant across units: that is, that the effect neither grows, nor shrinks, as the level of the risk factor rises. Since the vast majority of the reason for risk factors are binary variables, for which this assumption does not bind, we believe that this is a reasonable simplification.

[14] This motivates the exclusion of continuous (that is, non-binary and non-count) risk factors from the reason for risk pool: there is no natural reference group for these risk factors. For example, there is no meaningful group of people that do not have the "age" risk factor.

highest contribution of (risk factor level * coefficient) for each individual. All other reasons for risk are estimated in a similar fashion.

Users can also see the contribution of each risk factor category (Condition, Demographic, Pharmacy, Utilization, and Environmental) in percentage terms for the risk models. These are intended to provide a high-level description of the contribution of various types of risk factors that are positive and significant for an individual. The contribution for a given category is calculated as the sum of (risk factor level * coefficient) for all reasons for risk in that category, divided by the sum of (risk factor level * coefficient) for all positive, statistically significant reasons for risk. It is important to note that an individual's *overall* risk is a function of *all* risk factors, including those that are not included as potential reasons for risk (e.g., median area income). The category contributions, however, are only interpretable relative to the reason for risk pool, which is restricted to the operationalizable, modifiable risk factors.[15]

Limitations

There are three main limitations of the Hilltop Pre- Models that are important to consider when implementing the models for guiding care coordination services: the timing lag, the lack of clinical risk factors, and the granularity of the environmental risk factors. These are discussed in detail below.

Timing Lag

Hilltop receives the Medicare CCLF claims with a lag of over one month. CCLF claims that arrive in late October 2024, for example, cover utilization through mid-September 2024. Hilltop uses these data to calculate risk factors based on utilization in September 2024 and then applies the risk model coefficients to estimate the risk of incurring an avoidable hospitalization in October 2024. These scores are then deployed in mid-November 2024 for use by providers and care managers. This raises thee distinct, but related, issues:

- By providing the one-month predictions (in this example, predicting October 2024 events) to care managers over a two-month time horizon (here, in November 2024), the risk predictions may be "outdated" when they are used by care managers and providers.
- The risk predictions do not incorporate the most recent patient experience, which may degrade the quality of the risk scores.
- Information on beneficiary deaths is also lagged, which means each month a small proportion of beneficiaries who have died receive risk scores. Internal tests show that individuals who receive risk scores but died before the risk scores are released have disproportionately higher risk scores.

[15] If an individual has 3.2% overall risk and the Condition category contribution is 50%, then it is not appropriate to conclude that 50% of that individual's risk is due to Condition risk factors. Instead, it is appropriate to conclude that, of the positive, statistically significant, operationalizable, modifiable risk factors for that individual, conditions represent 50% of the total (risk factor level * coefficient).

Hilltop does not believe that these time lag issues substantively impact the utility of our risk scores, for several reasons. First, the time-variant risk factors in the predictive models are all estimated with a look-back period of at least one year. This has the consequence that risk factors tend to change slowly, meaning that the risk scores also change slowly. As a result, there is high consistency of risk scores across months: patients that have high risk scores in October 2024 will also have high risk scores in November 2024.

Second, internal testing has verified that applying one-month predictions on a two-month time horizon is substantively equivalent to directly estimating two-month predictions. This, to the extent that structural factors determine the risk of incurring a given outcome, it is likely that high-risk *behavior* persists across time; that is, most individuals will not suddenly "become" high-risk in the interval between the most recent claims data and receipt of the risk scores by care managers and providers.

Third care managers and providers have access to beneficiary death information from additional data sources. Therefore, it is unlikely that any care management resources are allocated towards beneficiaries who are deceased. Finally, when evaluating the predictive performance of risk scores in production, individuals who died before risk scores were released are removed from the evaluation. Fundamentally, since these individuals have disproportionately higher risk scores but cannot have a model specific outcome event, assessing predictive performance without removing them could lead to under-measuring predictive performance.

Clinical Data

Administrative claims data do not include information on vital statistics—for example, blood pressure or lab results—meaning that Hilltop is unable to incorporate those clinical risk factors into our predictive models. It is likely that development of clinical risk factors would improve the predictive power of the models, although researchers have documented only relatively modest improvements in model performance for claims-and-clinical models relative to claims-only prediction models for heart failure patients (Hammill et al., 2011). Hilltop hopes to include this information in future versions of the model once the level of information exchange between electronic health records allows.

Environmental Risk Factors

To control for environmental factors in the Hilltop Pre- Models, we have developed a rich set of ZIP code-level and census tract-level covariates derived from publicly available sources. These data have two main limitations:

- The data are static: the environmental risk factors for a given attributed beneficiary do not change over time. This is largely due to data availability, as the publicly available data sources are only refreshed periodically. Hilltop plans, in the future, to use the address-level information available in the CCLF claims to disaggregate (and refresh) the area-level risk factors as much and as frequently as possible. Additionally, if available in the future,

individual-level social welfare screening data will be added to provide a more robust individual-level risk prediction.

- ZCTA-level risk factors are relatively coarse: Maryland has 468 ZCTAs, each containing, on average, roughly 13,000 Maryland residents. To the extent that risky individuals tend to live in the same ZIP codes, ZIP code-level risk factors offer little predictive power. The census tract-level of the covariates are more granular; however, they are currently only available for MDPCP beneficiaries. Hilltop plans to assess the feasibility of extending the geocoding procedure to link individual claims and census tract-level environmental risk factors to the Medicaid population in the near future.

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Section 3. Pre- Model Specifications

Pre-AH

The Hilltop Pre-AH Model is a risk prediction model that uses a variety of risk factors derived from administrative claims and publicly available social and environmental data to estimate the probability that a given patient incurs an avoidable hospital event in the following month. It was initially developed by The Hilltop Institute, in conjunction with the Maryland Department of Health (the Department), to support the care management efforts of primary care providers enrolled in MDPCP. Given the MDPCP's emphasis on the reduction of unneeded utilization, the Hilltop Pre-AH Model focuses on *potentially avoidable* hospitalization or ED visits.[16] These events, by definition, are more likely to be prevented with targeted, outpatient care efforts than all-cause, general hospitalizations and ED visits.

The Hilltop Pre-AH Model risk scores were first deployed for the MDPCP population in October 2019. Patient-level risk scores and reasons for risk are provided to participating practices monthly for their attributed beneficiaries via the MDPCP Prediction Tools area on CRISP. These risk scores were originally referred to as the "Likelihood of Avoidable Hospital Event" (LAH) scores; at the time of this writing, they are known as the "Avoidable Hospital Events (Pre-AH)" scores. In addition to being available in the MDPCP Prediction Tools area, the Pre-AH Model risk scores are also available in the CRISP multi-payer reporting suite.

Beginning in May 2021, a second version of the Hilltop Pre-AH Model was deployed for the MCOs that are part of the Maryland Medicaid HealthChoice program. This version of the model uses the same risk factors but is trained and scored for Medicaid recipients enrolled in the HealthChoice program. These patient-level risk scores are provided to MCOs monthly for their enrollees via secure file transfer and are also available in the CRISP multi-payer reporting suite.

Beginning in January 2025, a third version of the Hilltop Pre-AH Model was deployed for two new populations: Medicare FFS beneficiaries not attributed to an MDPCP participating practice and Medicaid FFS beneficiaries. Patient-level risk scores and reasons for risk are made available via the CRISP Multi-Payer reporting suite.

Outcome: Avoidable Hospitalizations and ED Visits

The outcome measure in the Hilltop Pre-AH Model is a 0/1 indicator variable denoting whether an individual incurred an avoidable hospitalization or ED visit in a given month. To construct this measure, Hilltop relies on technical definitions provided by the Agency for Healthcare Research

[16] Potentially avoidable hospitalizations/ED visits are those incurred for medical conditions or diagnoses "for which timely and effective outpatient care can help to reduce the risks of hospitalization by either preventing the onset of an illness or condition, controlling an acute episodic illness or condition, or managing a chronic disease or condition" (Billings et al., 1993). This measure is discussed in greater detail in Section 3.2.1.

and Quality (AHRQ) as part of its PQI measures.[17] Diagnosis codes from administrative claims are used to flag the following conditions, which are the basis for the composite outcome variable:[18]

- PQI #1: Diabetes Short-Term Complications
- PQI #3: Diabetes Long-Term Complications
- PQI #5: COPD or Asthma in Older Adults
- PQI #7: Hypertension
- PQI #8: Heart Failure
- PQI #11: Community Acquired Pneumonia
- PQI #12: Urinary Tract Infection
- PQI #14: Uncontrolled diabetes
- PQI #15: Asthma in Younger Adults
- PQI #16: Lower-Extremity Amputation among Patients with Diabetes

This is implemented in the model as an indicator variable at the person-month level. If an individual incurs at least one avoidable hospitalization or ED visit in a given month, then that person receives a value of 1 for this variable—and 0 otherwise. At the time of writing, the model uses the 2025 PQI definitions.

In order to make the AH outcome for the Medicaid populations, Hilltop adjusted the age restrictions in the PQI specifications. Table 7 summarizes the indicator-specific age restrictions in the PQI specifications and in the Pre-AH outcome for the Medicare and Medicaid populations.

Table 7. Summary of Age Restrictions by PQI Indicator and Population

PQI	PQI Specification	Medicare AH	Medicaid AH
Diabetes Short-Term Complications	Ages 18+ years	Ages 18+ years	No age restriction
Diabetes Long-Term Complications	Ages 18+ years	Ages 18+ years	No age restriction
COPD or Asthma in Older Adults	Ages 40+ years	Ages 40+ years	Ages 40+ years
Hypertension	Ages 18+ years	Ages 18+ years	No age restriction
Heart Failure	Ages 18+ years	Ages 18+ years	No age restriction
Community Acquired Pneumonia	Ages 18+ years	Ages 18+ years	No age restriction
Urinary Tract Infection	Ages 18+ years	Ages 18+ years	No age restriction
Uncontrolled Diabetes	Ages 18+ years	Ages 18+ years	No age restriction
Asthma in Younger Adults	Ages 18-39 years	Ages 18-39 years	Ages <40 years

[17] For more information, see https://www.qualityindicators.ahrq.gov/modules/pqi_resources.aspx.
[18] Specifically, Hilltop defines these claims as those with a claim type of either 60 or 61 (indicating an inpatient claim) or a claim type of 40 (indicating an outpatient claim) and revenue center codes of 0450-0459 and 0981. Source: https://www.resdac.org/articles/how-identify-hospital-claims-emergency-room-visits-medicare-claims-data.

PQI	PQI Specification	Medicare AH	Medicaid AH
Lower-Extremity Amputation Among Patients with Diabetes	Ages 18+ years	Ages 18+ years	No age restriction

Risk Factor Updates

As part of the ongoing development process, Hilltop makes improvements or additions to the pool of risk factors.

- June 2020: Hilltop added eight new risk factors to the model: an indicator for frailty; an indicator for original Medicare eligibility due to a non-age-related reason; an indicator for DME use within the past year; the number of ED visits in the past six months; an indicator for sickle cell anemia; area-level pollution level; area-level walkability; and area-level pharmacy density.
- October 2021: Hilltop developed an automated geocoding pipeline to identify each beneficiary's census block of residence where possible. This allowed us to use more granular versions of the environmental risk factors (census tract-level) that are posited to more accurately describe an individual's' proximal environment. The census tract versions of the variables are currently only used for the MDPCP population (see Appendix 2 for more detail).

Pre-DC

The Hilltop Institute's Pre-DC Model is designed to facilitate the active management of type 2 diabetes by estimating individuals' risk of incurring inpatient admissions or ED visits for severe diabetes complications. For each population in which the Pre-DC model is deployed, Hilltop estimates risk scores and reasons for risk for all patients in the population every month to help care teams proactively identify high-risk individuals and thus target care management resources accordingly.

It is important to note that we do not require patients to have an active type 2 diabetes diagnosis to receive a Pre-DC score. This is intentional. Requiring an active diabetes diagnosis would exclude individuals who may have undiagnosed diabetes, or who have diagnosed diabetes, but who have not received care within the data window. Additionally, the model estimates risk for conditions that are considered severe complications for type 2 diabetes based on the Diabetes Complications Severity Index. Certain of the conditions, like "type 2 diabetes with ketoacidosis with coma," are specific to type 2 diabetes, but others, like "gas gangrene," are more general. Therefore, it is possible for a patient without type 2 diabetes to be at high risk for one (or more) of the more general complications.

This model was initially developed by The Hilltop Institute, in conjunction with the Maryland Department of Health, to support the care management efforts of primary care providers enrolled in MDPCP in alignment with the State's Statewide Integrated Health Improvement Strategy (SIHIS) goal of reducing the public health costs of diabetes.

The Hilltop Pre-DC Model risk scores were first deployed for the MDPCP population in October 2022. Patient-level risk scores are provided to participating practices monthly for their attributed beneficiaries via CRISP and are known as the "Severe Diabetes Complications (Pre-DC)" scores. In January 2025, the Pre-DC Model was deployed in three additional populations - the Maryland HealthChoice population, the Medicare FFS population and the Medicare FFS population – and are made available to end-users through the CRISP Multi-Payer Reporting Suite.

Finally, is it important to note that while the Pre-AH Model and the Pre-DC Model both include diabetes complications in the outcome that is predicted, the predicted outcome differs significantly across the two models, and the resulting risk scores are statistically distinct.[19]

Outcome: Severe Type 2 Diabetes Complication

Severe complication of type 2 diabetes (1/0) is defined as an inpatient hospitalization or ED visit in a person-month with one or more of the following ICD-10 diagnosis codes (in any position on the claim) associated with severe complications of diabetes as defined by the Diabetes Complication Severity Index (DCSI):[20]

Retinopathy
Retinal detachments and breaks: H33.x
Type 2 diabetes mellitus with severe non-proliferative diabetic retinopathy: E11.34xx
Type 2 diabetes mellitus with proliferative diabetic retinopathy: E11.35xx
Blindness and low vision: H54.x
Vitreous hemorrhage: H43.1x

Nephropathy
Type 2 diabetes mellitus with chronic kidney disease (stage 4 or 5): E11.22, N18.4, N18.5
Type 2 diabetes mellitus with end stage renal disease: E11.22, N18.6
Unspecified kidney failure: N19

Cerebrovascular Complications
Nontraumatic intracerebral hemorrhage: I61.x
Cerebral infarction: I63.x
Occlusion and stenosis of precerebral arteries, not resulting in cerebral infarction: I65.x
Occlusion and stenosis of precerebral arteries, not resulting in cerebral infarction: I66.x
Acute cerebrovascular insufficiency: I67.81

Cardiovascular Complications
Acute myocardial infarction (STEMI, NSTEMI): I21.x
Subsequent acute myocardial infarction (STEMI, NSTEMI): I22.x
Complications from acute myocardial infarction (STEMI, NSTEMI): I23.x
Old myocardial infarction: I25.2
Atrial fibrillation and flutter: I48.x

[19] For additional information see https://health.maryland.gov/mdpcp/Documents/PreDC_PreAH_Outcome_Distinction_Final.pdf
[20] Centers for Disease Control and Prevention, 2020; Chang et al., 2012; Glasheen et al., 2017

Cardiac arrest: I46.x
Paroxysmal tachycardia: I47.x
Other cardiac arrythmia: I49.x
Heart failures: I50x
Atherosclerosis of native arteries of the extremities with ulceration/gangrene: I70.25x, I70.26x
Aortic aneurysm/dissection: I71.x

Peripheral Vascular Disease
Gas gangrene: A48.0
Embolism and thrombosis of arteries of the lower extremities: I74.3
Non-pressure chronic ulcer of limb, not elsewhere classified: L97.x
Type 2 diabetes with diabetic peripheral angiopathy, with gangrene: E11.52
Gangrene, not elsewhere classified: I.96

Metabolic Complications
Type 2 diabetes mellitus with hyperosmolarity, with coma: E1101
Type 2 diabetes mellitus with ketoacidosis, with coma: E1111
Type 2 diabetes mellitus with hypoglycemia, with coma: E11641

The DSCI scores complications from 0 (no abnormality) to 2 (severe abnormality). Only complications with a score of 2 are included in the event definition for "severe complications of type 2 diabetes" (Young et al., 2008).

Risk Factors

The Pre-DC Model is built on the Hilltop Pre-AH Model and thus uses all the risk factors from the Pre-AH Model. There are 18 additional risk factors created from facility-related claims, provider-related claims, and prescription drug-related claims. See the Literature Review section below for details on the identification of these additional risk factors. While some of these risk factors are eliminated in the variable selection step, this process is data-driven, and all risk factors are included in the pool of *potential* risk factors to be used in the model. A high-level description of risk factors, as well as the process for identifying them, is provided in the sections below. For a description of each risk factor, along with data source and sample statistics, see Appendix 1.

Focused Literature Review

As part of the development process for its type 2 diabetes complications predictive model, Hilltop conducted a literature review to identify potential risk factors for inclusion in the model. This is a crucial element of model development: including high-quality risk factors as predictors can improve model performance, transparency, and interpretability. The review was intended to survey the existing literature and locate risk factors for which there is statistical evidence of association with type 2 diabetes complications. In early 2022, the research team searched PubMed to identify published literature that identifies risk factors for hospitalization for type 2

diabetes complications.[21] This review proceeded in three phases: a title screen, an abstract screen, and a full-text review. All records were reviewed by two independent reviewers on the research team. Any disagreements were reconciled through additional reviewer discussion.

We identified 107 articles that met the search criteria and conducted title and abstract screens on this pool of results. This process yielded 35 papers for full-text review. In the risk factor extraction process, we excluded as candidate risk factors those that were similar in substance to those already in the Pre-AH risk factor library. We then grouped similar remaining risk factors. The risk factor extraction yielded 18 unduplicated risk factors that have been shown to be highly predictive of type 2 diabetes complications.

Pre-HE

The Hilltop Institute's Pre-HE Model is designed to support proactive advanced care planning discussions by estimating a patient's risk of death within the next six months. Every month, Hilltop estimates risk scores and reasons for risk for all attributed patients of MDPCP-participating practices with the goal of identifying patients who are potentially suitable for hospice care and providing care teams with information that can guide the sensitive and difficult conversations about end-of-life care with patients and their families. It was initially developed by The Hilltop Institute, in conjunction with the Maryland Department of Health, to support the care management efforts of primary care providers enrolled in MDPCP.

The Hilltop Pre-HE Model risk scores were first deployed for the MDPCP population in October 2022. Patient-level risk scores are provided to participating practices monthly for their attributed beneficiaries via CRISP and are known as the "Hospice Eligibility and Advanced Care Planning (Pre-HE)" scores. These scores are only available for patients attributed to MDPCP-participating providers.

Outcome: Death within Six Months

Death within six months (1/0) is defined at the person-month level as the presence of a date of death for a beneficiary in the Beneficiary Demographics file that is within six months of the last day of each person-month. This means that for each beneficiary who has died, the flag for this event will be a 1 for the month of their death and for the five months prior to their death.

Table 8. Example Scenario for Modeling Death within 6 Months

	Jun 2024	Jul 2024	Aug 2024	Sep 2024	Oct 2024	Nov 2024	Dec 2024
Presence of a Date of Death	-	-	-	-	-	-	X
Death within 6 Months Flag	0	1	1	1	1	1	1

[21] We used the following search strings: "(Diabetes Mellitus, Type 2/complications*) AND (Machine Learning)"; "(Diabetes Mellitus, Type 2/complications*) AND (Predict*) AND (Administrative data)"

Risk Factors

Because the Pre-HE Model is built on the Hilltop Pre-AH Model, it uses all the risk factors from the Pre-AH Model, in addition to 18 other risk factors created from facility-related claims, provider-related claims, and prescription drug-related claims. While some of these risk factors are eliminated in the variable selection step, this process is data-driven, and all risk factors are included in the pool of *potential* risk factors to be used in the model. A high-level description of risk factors, as well as the process for identifying them, is provided in the sections below. For a description of each risk factor, along with data source and sample statistics, see Appendix 1.

Literature Review

As part of the development process for this model, Hilltop conducted a literature review in order to identify potential risk factors for inclusion in the model. This is a crucial element of model development: including high-quality risk factors as predictors can improve model performance, transparency, and interpretability. The review was intended to survey the existing literature and locate risk factors for which there is statistical evidence of association with mortality within a short or moderate time horizon. In early 2022, the research team searched PubMed to identify published literature that identifies risk factors for mortality.[22] This review proceeded in three phases: a title screen, an abstract screen, and a full-text review. All records were reviewed by two independent reviewers on the research team, and any disagreements were reconciled through additional reviewer discussion.

We identified 80 articles that met the search criteria and conducted title and abstract screens on this pool of results. This process yielded 22 papers for full-text review. In the risk factor extraction process, we excluded as candidate risk factors those that were similar in substance to those already in the Pre-AH risk factor library and then grouped similar remaining risk factors. The risk factor extraction yielded 18 unduplicated risk factors that have been shown to be highly predictive of mortality within a short or moderate time horizon.

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[22] We used the following search strings: "(mortality/frailty) AND (predict*) AND Medicare*"; "(mortality) AND (machine learning) AND Medicare*"

Section 4: Pre- Model Operations & Performance

This section provides an overview of how each Pre- Model operates and performs in each population. We present three sets of information for all nine model-population combinations – Pre-AH, Pre-DC, Pre-HE Models for the MDPCP population and Pre-AH and Pre-DC Models for the Medicare FFS, Medicaid HealthChoice, and Medicaid FFS populations:

- Risk factor coefficients: Coefficient estimates for all risk factors retained in Model 1, which includes all six categories of risk factors: diagnostic, pharmacy, procedural, utilization-based, geographic, and demographic. The risk factor coefficients in each table are presented as odds ratios[23]. Note that risk factor coefficient estimates will change as the model is re-trained. Updated risk factor coefficients are available upon request.

- Predicted probability: A summary of the set of predicted probabilities that estimate the patient-specific risk of incurring the model-specific outcome for each population. In general, these events are rare and, consequently, the predicted probabilities are low. Hilltop does not interpret this as a limitation of the risk scores; rather, this reflects the relative rarity of the outcome events. Moreover, the relative risk is the key metric that should be used to allocate care resources: no matter the absolute risk of the patient panel, the efficient allocation of care resources requires the identification (and treatment) of the riskiest patients.

- Predictive performance: A summary of how well the Pre- Model risk scores predict the specified outcome in holdout data (20%), which occurs during the model training process, and how they predict the model-specific outcome events in temporally distinct production data. See Section 2 for more detailed information on the predictive performance metrics.

Pre-AH

MC-PCP

Table 9 presents the risk factor coefficient estimates for Model 1 for the Pre-AH Model trained in the MDPCP-attributed Medicare FFS (MC-PCP) population in January 2026.

Table 9. Pre-AH MC-PCP Risk Model Odds Ratios for Model 1

Risk Factor	Odds Ratio
Prior hospitalization discharge status - other	1.81
CCW indicator for heart failure and non-ischemic heart disease	1.504
Number of avoidable hospitalizations	1.465
Discontinuity of primary care - Index	1.447

[23] Odds ratios can be interpreted in terms of a multiplicative impact. For example, an odds ratio of 1.05 indicates that if that risk factor were to increase by one unit, then the risk of incurring an avoidable hospitalization would increase by 5%.

Risk Factor	Odds Ratio
CCW indicator for chronic obstructive pulmonary disease (COPD) and bronchiectasis	1.445
CCW indicator for hypertension	1.414
Indicator for retinopathy	1.384
CCW indicator for intellectual disabilities and related conditions	1.371
Indicator for original Medicare eligibility for a non-age related cause	1.355
Indicator for urinary tract infection	1.345
Beneficiary race - Black	1.318
CCW indicator for cerebral palsy	1.315
Prior hospitalization admission type - emergency	1.28
Prior hospitalization discharge status - home	1.275
Indicator for previous conservative diabetic wound procedure	1.272
CCW indicator for tobacco use	1.272
Beneficiary race - Hispanic	1.262
Indicator for problems with care provider dependency	1.258
Indicator for hospice enrollment	1.243
Indicator for insulin use	1.229
Indicator for durable medical equipment (DME) use	1.202
Indicator for arrhythmia	1.199
Located in partial county primary care shortage area	1.198
Indicator for diabetes with complications	1.182
CCW indicator for Parkinson's Disease or Secondary Parkinsonism	1.155
Indicator for fluid and electrolyte imbalance	1.154
Indicator for oral corticosteroid use	1.153
CCW indicator for lung cancer	1.143
CCW indicator for chronic kidney disease	1.142
CCW indicator for diabetes	1.142
Indicator for dual eligibility with Medicaid	1.132
Indicator for frailty	1.13
CCW indicator for asthma	1.111
CCW indicator for pneumonia, all-cause	1.109
CCW indicator for ischemic heart disease	1.107
CCW indicator for pressure and chronic ulcers	1.104
Indicator for oral antibiotic use	1.1
Located in whole county mental health care shortage area	1.094
Indicator for pulmonary circulatory disorder	1.093
CCW indicator for anxiety disorders	1.092
Indicator for albuminuria	1.092
CCW indicator for peripheral vascular disease	1.089
CCW indicator for atrial fibrillation and flutter	1.088
Number of emergency department visits within the past 6 months	1.084
CCW indicator for anemia	1.083
Indicator for cerebrovascular disease	1.079
Indicator for provider administered drug	1.076
Number of urgent care visits	1.068
Indicator for respiratory infection	1.061

Risk Factor	Odds Ratio
Beneficiary sex - female	1.06
Indicator for no vaccination (flu or pneumonia)	1.055
Indicator for neuropathy	1.054
Indicator for beta blocker use	1.047
Age	1.022
National ranking of deprivation	1.003
Number of outpatient visits	1.003
Population density	1
Continuity of primary care - Duration	.999
Number of primary care visits	.997
Number of HbA1c tests	.981
Number of prior admissions	.972
Number of lab tests	.968
CCW indicator for glaucoma	.953
Indicator for anti-diabetes medication use	.945
Indicator for sepsis	.932
CCW indicator for rheumatoid arthritis/osteoarthritis	.924
Indicator for prior surgery	.916
CCW indicator for hyperlipidemia	.913
Indicator for protein-calorie malnutrition	.896
CCW indicator for cataracts	.889
Indicator for statin use	.843
Discontinuity of primary care - Proportion	.736
Beneficiary race - Unknown	.575

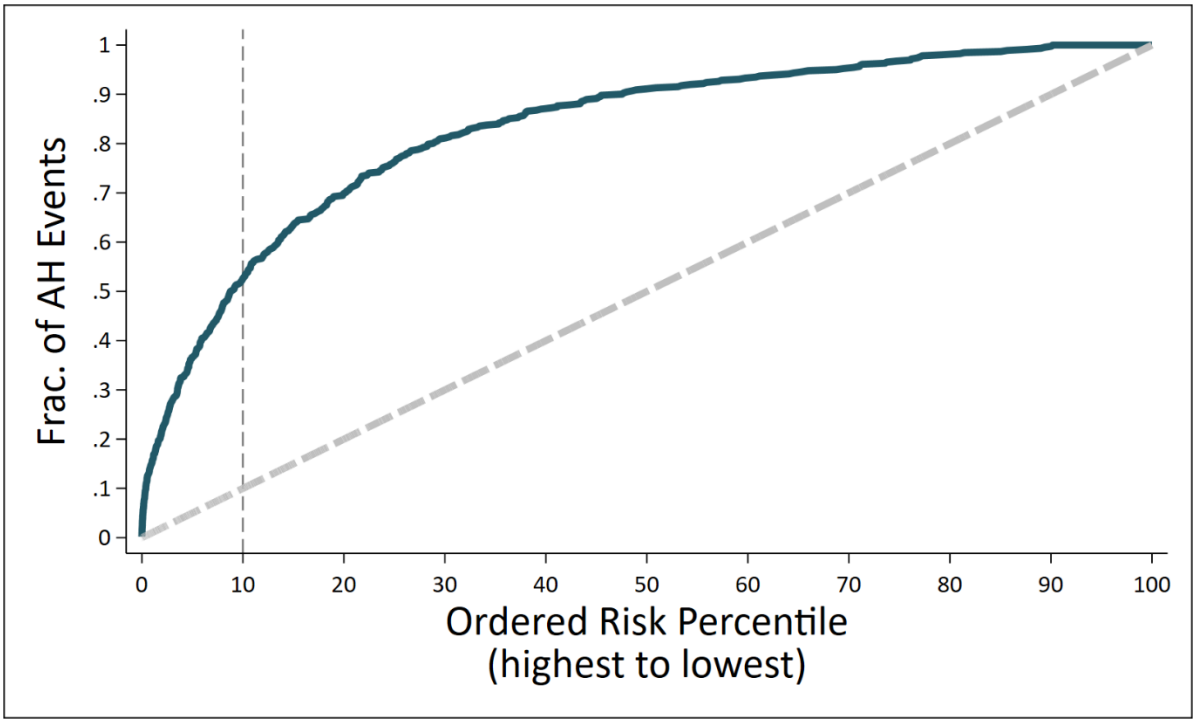
Table 10 presents summary statistics from a recent month of Pre-AH Model risk scores in the MC-PCP patient population.

Table 10. Summary Statistics for Pre-AH Scores in the MC-PCP Population

Scoring Cohort	Cohort Size	Average Score	N > 1% Risk	Monthly Correlation
Dec 2025	340,465	.0045	26,444	.9708

Figure 1 shows the concentration curve for the Pre-AH scores in one month of the holdout data. This curve shows how well the risks cores predict AH events in the following month. We find that the top 10% riskiest patients account for approximately 52.6% of all avoidable hospital events in the following month.

Figure 1. Pre-AH Concentration Curve as of October 2025 in the MC-PCP Population



Post-deployment model evaluation is a crucial component of the predictive model lifecycle. The first Pre-AH risk scores were released for the MC-PCP population in November 2019 and have since been regularly updated. Hilltop monitors the accuracy of the Pre-AH Model predictions in a production environment by comparing the risk scores released in a given month with the true outcomes that occur in the following month. Table 11 shows the percentage of all AH events incurred by patients with the top 1% and top 10% of Pre-AH scores in the month following the score release for six sets of risk scores.

Table 11. Production Predictive Performance of the MC-PCP Pre-AH Scores by Month

Model Version	Score Release Date	Top 1% of Patients	Top 10% of Patients
y7q1m03	05/10/2025	14.20%	48.13%
y7q1m03	06/06/2025	12.68%	48.78%
y7q1m03	07/11/2025	13.89%	44.75%
y7q2m06	08/08/2025	15.42%	49.62%
y7q2m06	09/12/2025	13.55%	47.18%
y7q2m06	10/10/2025	13.47%	45.33%

Note: The evaluation period is for 1 month following the score release date.

MC-FFS

Table 12 presents the risk factor coefficient estimates for Model 1 for the Pre-AH Model trained in the remaining, non-MDPCP-attributed Medicare FFS (MC-FFS) population in January 2026.

Table 12. Pre-AH MC-FFS Risk Model Odds Ratios for Model 1

Risk Factor	Odds Ratio
Prior hospitalization discharge status - other	2.207
CCW indicator for hypertension	1.547
Number of avoidable hospitalizations	1.46
Indicator for retinopathy	1.447
Discontinuity of primary care - Index	1.43
CCW indicator for chronic obstructive pulmonary disease (COPD) and bronchiectasis	1.425
CCW indicator for heart failure and non-ischemic heart disease	1.396
Indicator for original Medicare eligibility for a non-age related cause	1.371
Beneficiary race - Black	1.367
Indicator for urinary tract infection	1.36
Indicator for problems with care provider dependency	1.326
Indicator for previous conservative diabetic wound procedure	1.317
Beneficiary race - Hispanic	1.305
Prior hospitalization admission type - emergency	1.302
Indicator for insulin use	1.246
CCW indicator for tobacco use	1.234
Prior hospitalization discharge status - home	1.232
CCW indicator for intellectual disabilities and related conditions	1.225
Indicator for durable medical equipment (DME) use	1.209
Indicator for diabetes with complications	1.191
Indicator for arrhythmia	1.188
CCW indicator for chronic kidney disease	1.179
Indicator for oral antibiotic use	1.173
Indicator for fluid and electrolyte imbalance	1.166
Located in partial county primary care shortage area	1.164
Indicator for albuminuria	1.16
CCW indicator for acute myocardial infarction	1.141
CCW indicator for ischemic heart disease	1.124
Beneficiary sex - female	1.122
Indicator for oral corticosteroid use	1.12
Indicator for frailty	1.11
CCW indicator for diabetes	1.105
CCW indicator for peripheral vascular disease	1.103
CCW indicator for asthma	1.101
Indicator for neuropathy	1.1
CCW indicator for anxiety disorders	1.097
Indicator for provider administered drug	1.091
Indicator for dual eligibility with Medicaid	1.087
Indicator for pulmonary circulatory disorder	1.081
Indicator for respiratory infection	1.08
CCW indicator for pressure and chronic ulcers	1.077
CCW indicator for stroke/ischemic transient attack	1.076
Number of urgent care visits	1.073
Indicator for no vaccination (flu or pneumonia)	1.07

Risk Factor	Odds Ratio
Indicator for beta blocker use	1.068
CCW indicator for atrial fibrillation and flutter	1.064
Number of emergency department visits within the past 6 months	1.049
Age	1.013
Number of outpatient visits	1.002
Median household income	1
Number of primary care visits	.995
Number of HbA1c tests	.97
Percent foreign born	.966
CCW indicator for obesity	.953
CCW indicator for rheumatoid arthritis/osteoarthritis	.946
CCW indicator for hyperlipidemia	.941
Indicator for prior surgery	.917
Indicator for protein-calorie malnutrition	.9
Indicator for statin use	.873
CCW indicator for cataracts	.86
Discontinuity of primary care - Proportion	.797
Beneficiary race - Unknown	.57

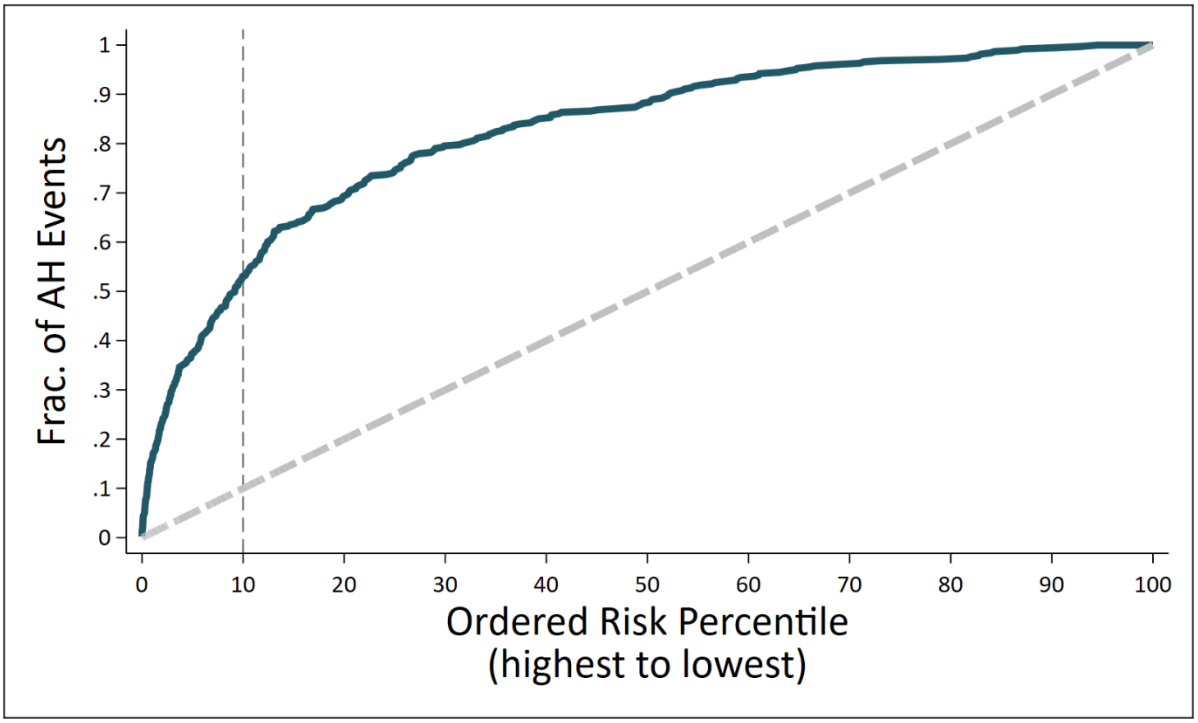
Table 13 presents summary statistics from a recent month of Pre-AH Model risk scores in the MC-FFS patient population.

Table 13. Summary Statistics for Pre-AH Scores in the MC-FFS Population

Scoring Cohort	Cohort Size	Average Score	N > 1% Risk	Monthly Correlation
Dec 2025	377,825	.0051	36,441	.9718

Figure 2 shows the concentration curve for the Pre-AH scores in one month of the holdout data. This curve shows how well the risk scores predict AH events in the following month. We find that the top 10% riskiest patients account for approximately 53.0% of all avoidable hospital events in the following month.

Figure 2. Pre-AH Concentration Curve as of October 2025 in the MC-FFS Population



The first Pre-AH risk scores were released for the MC-FFS population in January 2025 and have since been regularly updated. Hilltop monitors the accuracy of the Pre-AH Model predictions in a production environment by comparing the risk scores released in a given month with the true outcomes that occur in the following month. Table 14 shows the percentage of all AH events incurred by patients with the top 1% and top 10% of Pre-AH scores in the month following the score release for six sets of risk scores.

Table 14. Production Predictive Performance of the MC-FFS Pre-AH Scores by Month

Model Version	Score Release Date	Top 1% of Patients	Top 10% of Patients
y7q1m03	05/10/2025	14.36%	50.19%
y7q1m03	06/06/2025	13.61%	45.27%
y7q1m03	07/11/2025	15.39%	51.82%
y7q2m06	08/08/2025	14.96%	50.42%
y7q2m06	09/12/2025	14.97%	50.00%
y7q2m06	10/10/2025	16.40%	49.34%

Note: The evaluation period is for 1 month following the score release date.

MA_MCO

Table 15 presents the risk factor coefficient estimates for Model 1 for the Pre-AH Model trained in the Medicaid HealthChoice (MA-MCO) population in December 2025.

Table 15. Pre-AH MA-MCO Risk Model Odds Ratios for Model 1

Risk Factor	Odds Ratio
CCW indicator for asthma	2.679
Indicator for insulin use	1.77
CCW indicator for diabetes	1.605
Indicator for urinary tract infection	1.542
Number of avoidable hospitalizations	1.535
Indicator for dual eligibility with Medicaid	1.486
Indicator for oral corticosteroid use	1.46
CCW indicator for pressure and chronic ulcers	1.427
Indicator for diabetes with complications	1.414
CCW indicator for heart failure and non-ischemic heart disease	1.393
CCW indicator for tobacco use	1.37
Beneficiary race - Black	1.361
CCW indicator for hypertension	1.354
Discontinuity of primary care - Index	1.348
Indicator for fluid and electrolyte imbalance	1.309
Indicator for arrhythmia	1.284
CCW indicator for learning disabilities	1.259
Prior hospitalization discharge status - other	1.249
CCW indicator for spinal cord injury	1.247
Indicator for previous conservative diabetic wound procedure	1.238
Indicator for respiratory infection	1.227
CCW indicator for drug use disorders	1.213
CCW indicator for mobility impairments	1.212
Indicator for provider administered drug	1.183
CCW indicator for pneumonia, all-cause	1.179
Indicator for oral antibiotic use	1.171
CCW indicator for chronic obstructive pulmonary disease (COPD) and bronchiectasis	1.168
Indicator for leukotriene receptor modifier use	1.157
Indicator for problems with housing and economic conditions	1.123
Beneficiary sex - female	1.122
Indicator for gastroparesis	1.113
Beneficiary race - Hispanic	1.108
CCW indicator for chronic kidney disease	1.105
Indicator for beta blocker use	1.087
CCW indicator for depression, bipolar, and other depressive mood disorders	1.058
Indicator for no vaccination (flu or pneumonia)	1.058
Number of heart-related procedures	1.056
Number of hospitals	1.054
Indicator for presence of a for-profit hospital	1.05
Number of emergency department visits within the past 6 months	1.044
Percent live alone, ages 65+	1.006
Percent in poverty age 65+	1.006
Percent with less than high school education, ages 65+	1.004

Risk Factor	Odds Ratio
Number of medications	1.004
Age	1.004
National ranking of deprivation	1.003
Number of outpatient visits	1
Continuity of primary care - Duration	.999
Number of primary care visits	.996
General internists per 1000 residents	.983
Percent foreign born	.974
Number of home health visits	.963
Indicator for gastroesophageal reflux disease	.946
CCW indicator for anxiety disorders	.945
CCW indicator for liver disease, cirrhosis and other liver conditions (except viral hepatitis)	.933
Number of HbA1c tests	.93
CCW indicator for anemia	.93
CCW indicator for schizophrenia and other psychotic disorders	.93
CCW indicator for obesity	.925
Discontinuity of primary care - Proportion	.911
Number of prior admissions	.908
CCW indicator for migraine and chronic headache	.902
CCW indicator for fibromyalgia, chronic pain and fatigue	.9
CCW indicator for cataracts	.897
Indicator for lifestyle problems	.893
Indicator for protein-calorie malnutrition	.88
CCW indicator for glaucoma	.869
CCW indicator for hyperlipidemia	.855
Indicator for problems with care provider dependency	.847
CCW indicator for rheumatoid arthritis/osteoarthritis	.829
Indicator for anti-diabetes medication use	.827
Number of lab tests	.817
Prior hospitalization admission type - urgent	.813
CCW indicator for breast cancer	.812
Indicator for problems with employment and unemployment	.79
Indicator for difficulty with life management	.703
Prior hospitalization admission type - elective	.684
Prior hospitalization admission type - none	.646
Indicator for sickle cell anemia	.57
Beneficiary race - Unknown	.406

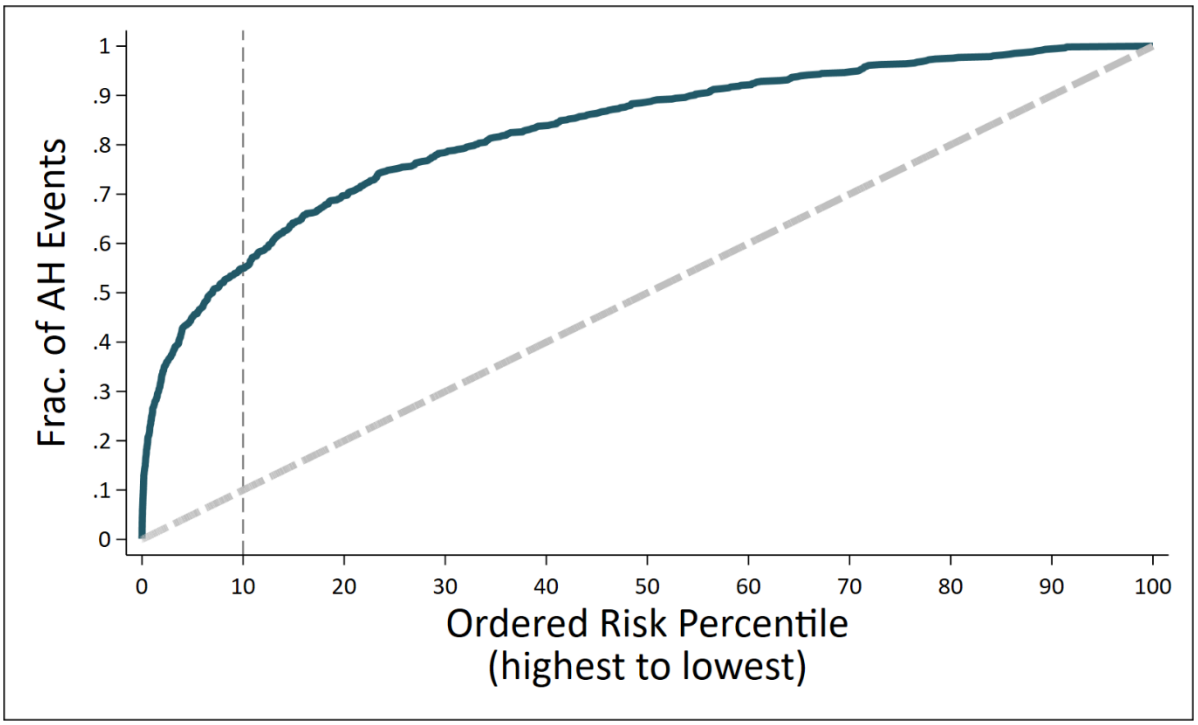
Table 16 presents summary statistics from a recent month of Pre-AH Model risk scores in the MA-MCO patient population.

Table 16. Summary Statistics for Pre-AH Scores in the MA-MCO Population

Scoring Cohort	Cohort Size	Average Score	N > 1% Risk	Monthly Correlation
Dec 2025	1,275,845	.0025	29,982	.9674

Figure 3 shows the concentration curve for the Pre-AH scores in one month of the holdout data. This curve shows how well the risk scores predict AH events in the following month. We find that the top 10% riskiest patients account for approximately 54.9% of all avoidable hospital events in the following month.

Figure 3. Pre-AH Concentration Curve as of October 2025 in the MA-MCO Population



The first Pre-AH risk scores were released for the MA-MCO population in May 2021 and have since been regularly updated. Hilltop monitors the accuracy of the Pre-AH Model predictions in a production environment by comparing the risk scores released in a given month with the true outcomes that occur in the following month. Table 17 shows the percentage of all AH events incurred by patients with the top 1% and top 10% of Pre-AH scores in the month following the score release for six sets of risk scores.

Table 17. Production Predictive Performance of the MA-MCO Pre-AH Scores by Month

Model Version	Score Release Date	Top 1% of Patients	Top 10% of Patients
y24m11	2/19/2025	23.41%	54.72%
y24m11	3/13/2025	22.53%	57.29%
y25m02	4/11/2025	22.15%	53.53%
y25m02	5/09/2025	23.26%	56.36%
y25m02	6/06/2025	24.35%	56.11%
y25m02	7/11/2025	25.56%	55.63%

Note: The evaluation period is for 1 month following the score release date.

MA-FFS

Table 18 presents the risk factor coefficient estimates for Model 1 for the Pre-AH Model trained in the Medicaid FFS (MA-FFS) population in December 2025.

Table 18. Pre-AH MA-FFS Risk Model Odds Ratios for Model 1

Risk Factor	Odds Ratio
Indicator for cilostazol use	2.17
Indicator for diabetes with complications	1.614
CCW indicator for hypertension	1.576
CCW indicator for asthma	1.567
Discontinuity of primary care - Index	1.508
Indicator for insulin use	1.493
Indicator for oral corticosteroid use	1.482
CCW indicator for heart failure and non-ischemic heart disease	1.478
Indicator for fluid and electrolyte imbalance	1.359
Number of avoidable hospitalizations	1.356
Indicator for urinary tract infection	1.322
CCW indicator for tobacco use	1.288
CCW indicator for chronic obstructive pulmonary disease (COPD) and bronchiectasis	1.284
CCW indicator for drug use disorders	1.274
Indicator for provider administered drug	1.244
Indicator for oral antibiotic use	1.238
Beneficiary race - Black	1.223
Indicator for arrhythmia	1.205
CCW indicator for pressure and chronic ulcers	1.195
Indicator for mental health use	1.19
Indicator for durable medical equipment (DME) use	1.178
Number of emergency department visits within the past 6 months	1.022
Percent aged 65 and over	1.016
Percent live alone, ages 65+	1.01
Age	1.009
Social workers per 1000 residents	1.004
Number of prior admissions	.964
Indicator for protein-calorie malnutrition	.841

Risk Factor	Odds Ratio
CCW indicator for ADHD, conduct disorders, and hyperkinetic syndrome	.802
CCW indicator for cataracts	.782
Prior hospitalization admission type - elective	.692
Discontinuity of primary care - Proportion	.618
Prior hospitalization admission type - none	.558
Indicator for prior nursing home stay	.549

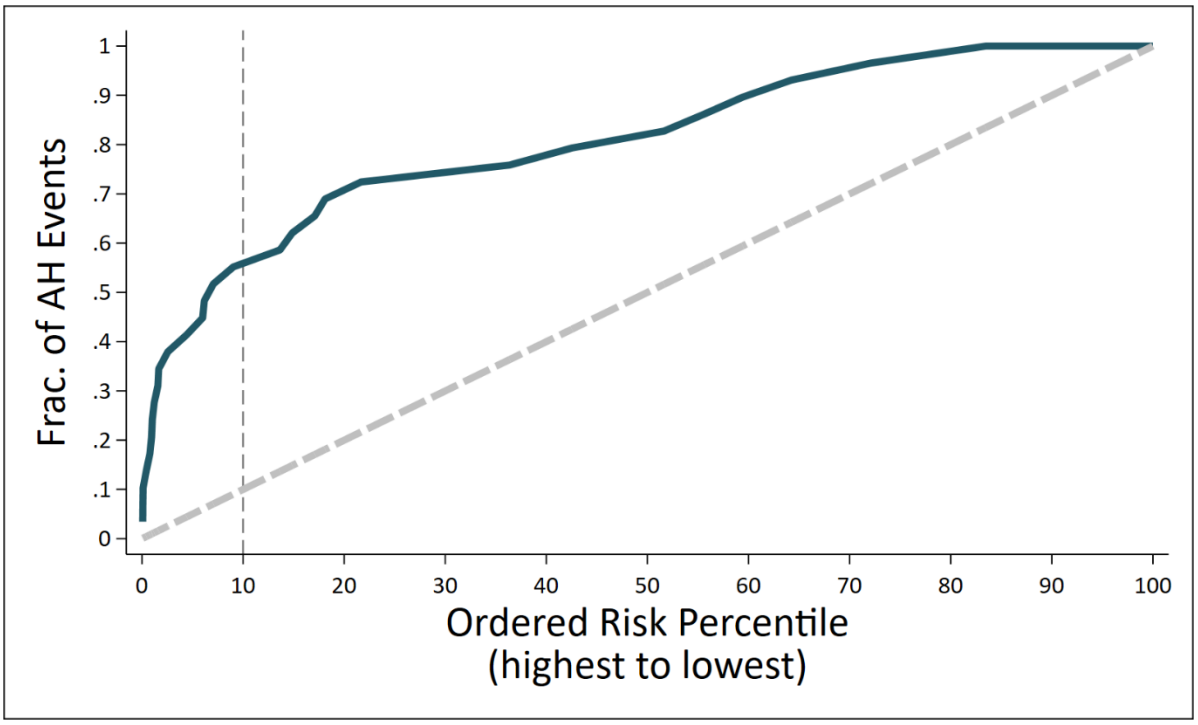
Table 19 presents summary statistics from a recent month of Pre-AH Model risk scores in the MA-FFS patient population.

Table 19. Summary Statistics for Pre-AH Scores in the MA-FFS Population

Scoring Cohort	Cohort Size	Average Score	N > 1% Risk	Monthly Correlation
Dec 2025	39,576	.0057	3,914	.9630

Figure 4 shows the concentration curve for the Pre-AH scores in one month of the holdout data. This curve shows how well the risk scores predict AH events in the following month. We find that the top 10% riskiest patients account for approximately 55.2% of all avoidable hospital events in the following month.

Figure 4. Pre-AH Concentration Curve as of October 2025 in the MA-FFS Population



The first Pre-AH risk scores were released for the MA-FFS population in January 2025 and have since been regularly updated. Hilltop monitors the accuracy of the Pre-AH Model predictions in a production environment by comparing the risk scores released in a given month with the true

outcomes that occur in the following month. Table 20 shows the percentage of all AH events incurred by patients with the top 1% and top 10% of Pre-AH scores in the month following the score release for six sets of risk scores.

Table 20. Production Predictive Performance of the MA-FFS Pre-AH Scores by Month

Model Version	Score Release Date	Top 1% of Patients	Top 10% of Patients
y24m11	2/19/2025	17.27%	55.31%
y24m11	3/13/2025	20.00%	50.64%
y25m02	4/11/2025	18.69%	47.66%
y25m02	5/09/2025	17.01%	48.55%
y25m02	6/06/2025	24.20%	59.36%
y25m02	7/11/2025	27.09%	58.13%

Note: The evaluation period is for 1 month following the score release date.

Pre-DC

MC-PCP

Table 21 presents the risk factor coefficient estimates for Model 1 for the Pre-DC Model trained in the MDPCP-attributed Medicare FFS (MC-PCP) population in January 2026.

Table 21. Pre-DC MC-PCP Risk Model Odds Ratios for Model 1

Risk Factor	Odds Ratio
Prior hospitalization discharge status - other	5.204
Prior hospitalization discharge status - transferred to inpatient care	2.715
Indicator for hospice enrollment	2.217
Indicator for sickle cell anemia	1.978
DCSI Score – Cardiovascular	1.771
CCW indicator for atrial fibrillation and flutter	1.667
CCW indicator for heart failure and non-ischemic heart disease	1.476
CCW indicator for hypertension	1.389
Prior hospitalization discharge status - transferred to post-acute care	1.388
Chronic Renal Insufficiency/ESRD	1.366
CCW indicator for sensory (blindness and visual) impairment	1.313
CCW indicator for cerebral palsy	1.294
Indicator for original Medicare eligibility for a non-age related cause	1.275
Discontinuity of primary care - Index	1.226
Indicator for metastatic cancer	1.221
CCW indicator for intellectual disabilities and related conditions	1.217
Number of Previous Severe Type 2 Diabetes Complications	1.202
Prior hospitalization discharge status - home	1.177
Beneficiary race - Black	1.169
CCW indicator for chronic obstructive pulmonary disease (COPD) and bronchiectasis	1.15
Indicator for arrhythmia	1.147
CCW indicator for anemia	1.137

Risk Factor	Odds Ratio
Prior hospitalization admission type - emergency	1.133
Indicator for gastroparesis	1.13
Indicator for fluid and electrolyte imbalance	1.128
CCW indicator for lung cancer	1.126
DCSI Score – Nephropathy	1.125
CCW indicator for tobacco use	1.124
Indicator for beta blocker use	1.122
Indicator for frailty	1.121
Beneficiary race - Hispanic	1.118
CCW indicator for Parkinson's Disease or Secondary Parkinsonism	1.114
Indicator for previous conservative diabetic wound procedure	1.111
Indicator for use of Anticoagulants	1.103
Indicator for problems with care provider dependency	1.098
Beneficiary race - White	1.097
DCSI Score - Peripheral Vascular Disease	1.093
Indicator for insulin use	1.092
CCW indicator for leukemias and lymphomas	1.091
Indicator for albuminuria	1.088
Indicator for problems with housing and economic conditions	1.085
Indicator for cerebrovascular disease	1.084
Number of emergency department visits within the past 6 months	1.08
Indicator for oral corticosteroid use	1.079
CCW indicator for epilepsy	1.07
Indicator for diabetes with complications	1.066
Indicator for oncologist visit	1.063
Indicator for warfarin use	1.059
CCW indicator for depression, bipolar, and other depressive mood disorders	1.057
Indicator for provider administered drug	1.057
CCW indicator for pressure and chronic ulcers	1.056
CCW indicator for chronic kidney disease	1.055
Located in partial county primary care shortage area	1.054
Indicator for durable medical equipment (DME) use	1.054
Indicator for no vaccination (flu or pneumonia)	1.052
Number of avoidable hospitalizations	1.049
Indicator for rheumatoid arthritis/collagen vascular disease	1.048
Indicator for pulmonary circulatory disorder	1.047
DCSI Score – Retinopathy	1.046
CCW indicator for ischemic heart disease	1.042
Indicator for urinary tract infection	1.036
Number of urgent care visits	1.034
DCSI Score – Neuropathy	1.032
Indicator for dual eligibility with Medicaid	1.032
DCSI Score – Cerebrovascular	1.029
CCW indicator for obesity	1.029
Number of home health visits	1.025

Risk Factor	Odds Ratio
Age	1.023
Prior admission length of stay	1.004
Number of outpatient visits	1.003
National ranking of deprivation	1.003
Diabetes Duration	1.001
Physician diversity	1
Total health spending	1
Part D OOP spending	1
Continuity of primary care - Duration	.999
Number of primary care visits	.998
Number of HbA1c tests	.972
CCW indicator for rheumatoid arthritis/osteoarthritis	.968
Indicator for losartan use	.963
CCW indicator for sensory (deafness and hearing) impairment	.954
Number of heart-related procedures	.947
CCW indicator for benign prostatic hyperplasia	.946
Number of prior admissions	.946
CCW indicator for glaucoma	.946
Indicator for anti-diabetes medication use	.944
CCW indicator for hip/pelvic fracture	.926
CCW indicator for cataracts	.92
CCW indicator for hyperlipidemia	.919
Beneficiary sex - female	.914
Prior hospitalization admission type - elective	.9
Indicator for statin use	.877
Discontinuity of primary care - Proportion	.86
Indicator for prior nursing home stay	.829
Beneficiary race - Unknown	.602

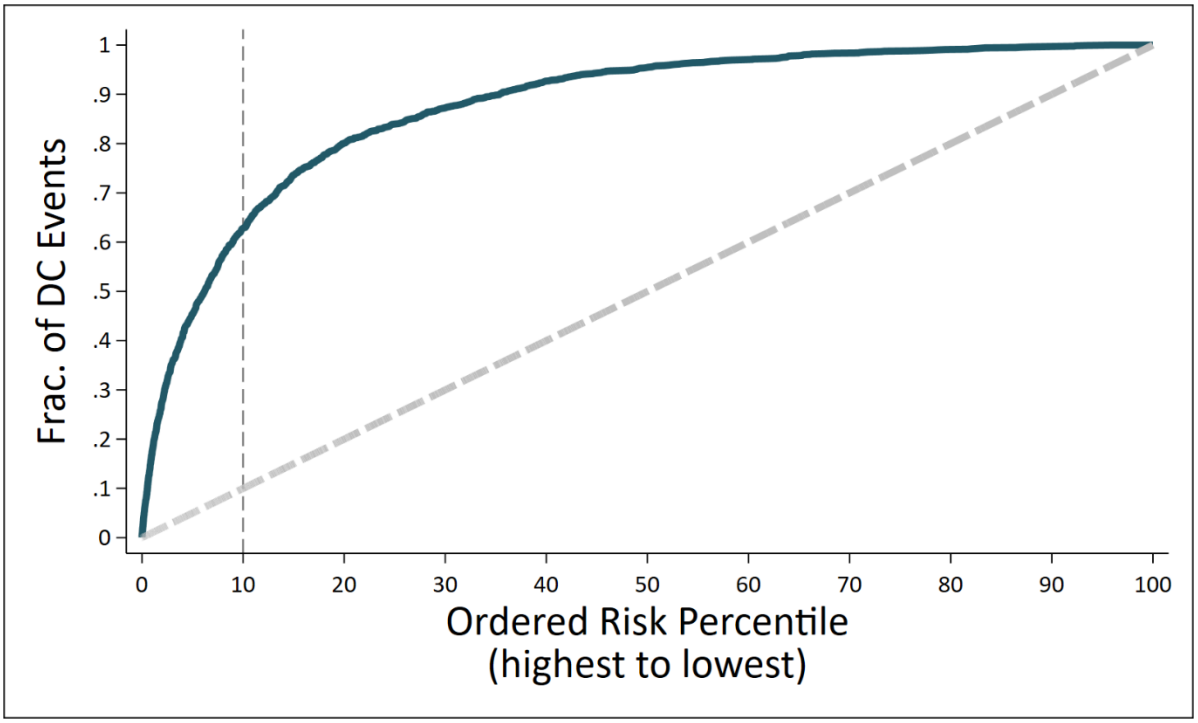
Table 22 presents summary statistics from a recent month of Pre-DC Model risk scores in the MC-PCP patient population.

Table 22. Summary Statistics for Pre-DC Scores in the MC-PCP Population

Scoring Cohort	Cohort Size	Average Score	N > 1% Risk	Monthly Correlation
Dec 2025	340,465	.0132	87,266	.9680

Figure 5 shows the concentration curve for the Pre-DC scores in one month of the holdout data. This curve shows how well the risk scores predict DC events in the following month. We find that the top 10% riskiest patients account for approximately 62.8% of all severe type 2 diabetes complication events in the following month.

Figure 5. Pre-DC Concentration Curve as of October 2025 in the MC-PCP Population



The first Pre-DC risk scores were released for the MC-PCP population in October 2022 and have since been regularly updated. Hilltop monitors the accuracy of the Pre-DC Model predictions in a production environment by comparing the risk scores released in a given month with the true outcomes that occur in the following month. Table 23 shows the percentage of all DC events incurred by patients with the top 1% and top 10% of Pre-DC scores in the month following the score release for six sets of risk scores.

Table 23. Production Predictive Performance of the MC-PCP Pre-DC Scores by Month

Model Version	Score Release Date	Top 1% of Patients	Top 10% of Patients
y7q1m03	05/10/2025	13.45%	56.88%
y7q1m03	06/06/2025	13.70%	54.89%
y7q1m03	07/11/2025	13.79%	56.43%
y7q2m06	08/08/2025	13.80%	56.39%
y7q2m06	09/12/2025	12.62%	55.64%
y7q2m06	10/10/2025	13.18%	56.12%

Note: The evaluation period is for 1 month following the score release date.

MC-FFS

Table 24 presents the risk factor coefficient estimates for Model 1 for the Pre-DC Model trained in the remaining, non-MDPCP-attributed Medicare FFS (MC-FFS) population in January 2026.

Table 24. Pre-DC MC-FFS Risk Model Odds Ratios for Model 1

Risk Factor	Odds Ratio
Prior hospitalization discharge status - other	8.416
Prior hospitalization discharge status - transferred to inpatient care	2.253
Indicator for sickle cell anemia	1.941
DCSI Score – Cardiovascular	1.709
CCW indicator for atrial fibrillation and flutter	1.591
CCW indicator for hypertension	1.586
Chronic Renal Insufficiency/ESRD	1.493
Discontinuity of primary care - Index	1.446
CCW indicator for heart failure and non-ischemic heart disease	1.367
Indicator for original Medicare eligibility for a non-age related cause	1.338
Prior hospitalization discharge status - transferred to post-acute care	1.246
Number of Previous Severe Type 2 Diabetes Complications	1.228
Beneficiary race - Black	1.215
CCW indicator for sensory (blindness and visual) impairment	1.198
DCSI Score – Nephropathy	1.194
Prior hospitalization admission type - emergency	1.185
Beneficiary race - Hispanic	1.18
Indicator for metastatic cancer	1.153
Indicator for use of Anticoagulants	1.152
Indicator for fluid and electrolyte imbalance	1.152
Indicator for arrhythmia	1.146
Indicator for beta blocker use	1.146
CCW indicator for chronic obstructive pulmonary disease (COPD) and bronchiectasis	1.139
Indicator for problems with care provider dependency	1.135
CCW indicator for anemia	1.128
Beneficiary race - White	1.125
Indicator for other problems with primary support group	1.123
Prior hospitalization discharge status - home	1.109
Indicator for insulin use	1.107
Indicator for rivaroxaban use	1.092
Indicator for previous conservative diabetic wound procedure	1.091
DCSI Score - Peripheral Vascular Disease	1.089
Indicator for cerebrovascular disease	1.086
Indicator for frailty	1.079
CCW indicator for chronic kidney disease	1.079
CCW indicator for tobacco use	1.077
CCW indicator for epilepsy	1.076
Indicator for oral corticosteroid use	1.076
Indicator for oncologist visit	1.073
Indicator for no vaccination (flu or pneumonia)	1.068
Indicator for albuminuria	1.068
Indicator for provider administered drug	1.062
Indicator for diabetes with complications	1.057

Risk Factor	Odds Ratio
CCW indicator for depression, bipolar, and other depressive mood disorders	1.055
CCW indicator for pressure and chronic ulcers	1.052
Indicator for urinary tract infection	1.051
DCSI Score – Retinopathy	1.049
DCSI Score – Neuropathy	1.048
Number of avoidable hospitalizations	1.048
Indicator for durable medical equipment (DME) use	1.043
CCW indicator for fibromyalgia, chronic pain and fatigue	1.043
CCW indicator for ischemic heart disease	1.042
Number of urgent care visits	1.041
Number of emergency department visits within the past 6 months	1.041
Indicator for oral antibiotic use	1.035
CCW indicator for obesity	1.032
Number of home health visits	1.031
DCSI Score – Cerebrovascular	1.023
Age	1.012
Percent with less than high school education, ages 65+	1.003
Number of outpatient visits	1.002
Continuity of primary care - Duration	1.001
National ranking of deprivation	1.001
Diabetes Duration	1.001
Population density	1
Total health spending	1
Number of primary care visits	.998
Percent Hispanic, ages 65+	.995
Number of HbA1c tests	.958
Number of heart-related procedures	.946
CCW indicator for glaucoma	.943
Number of prior admissions	.94
Indicator for prior readmission	.927
CCW indicator for hyperlipidemia	.925
CCW indicator for schizophrenia and other psychotic disorders	.924
Discontinuity of primary care - Proportion	.905
CCW indicator for cataracts	.899
Indicator for statin use	.895
Indicator for prior nursing home stay	.854
Beneficiary race - Unknown	.645

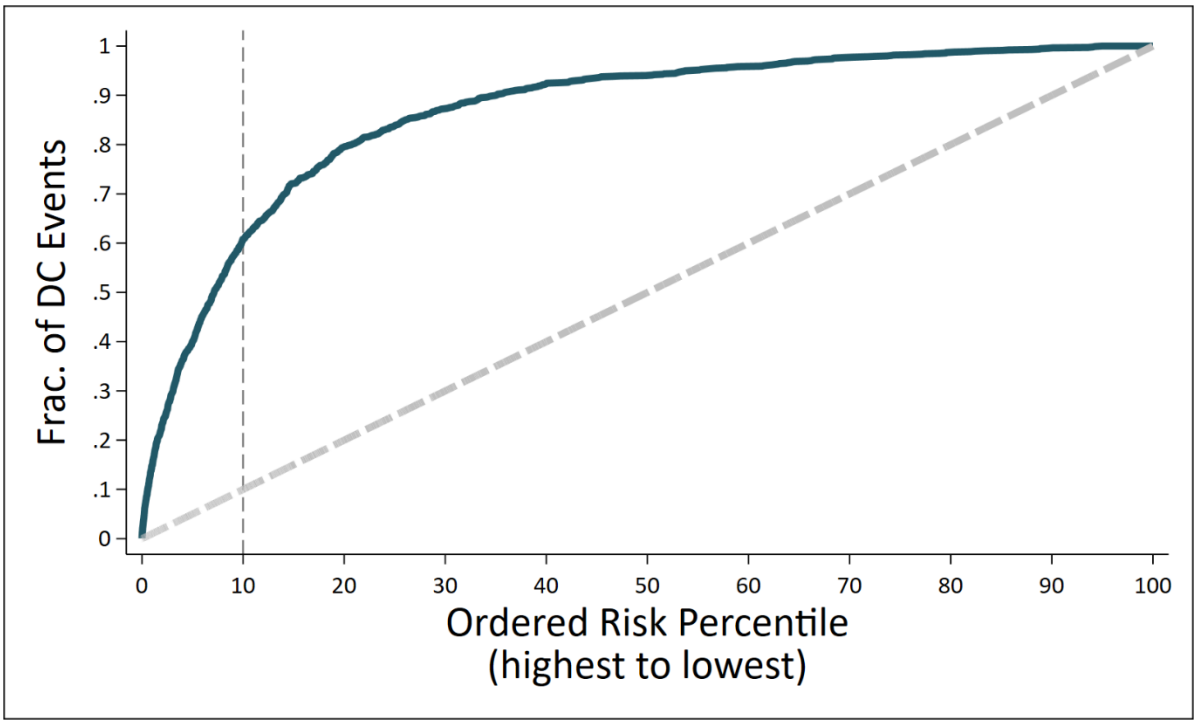
Table 25 presents summary statistics from a recent month of Pre-DC Model risk scores in the MC-FFS patient population.

Table 25. Summary Statistics for Pre-DC Scores in the MC-FFS Population

Scoring Cohort	Cohort Size	Average Score	N > 1% Risk	Monthly Correlation
Dec 2025	377,825	.0156	96,787	.9694

Figure 6 shows the concentration curve for the Pre-DC scores in one month of the holdout data. This curve shows how well the risk scores predict DC events in the following month. We find that the top 10% riskiest patients account for approximately 60.8% of all severe type 2 diabetes complication events in the following month.

Figure 6. Pre-DC Concentration Curve as of October 2025 in the MC-FFS Population



The first Pre-DC risk scores were released for the MC-FFS population in January 2025 and have since been regularly updated. Hilltop monitors the accuracy of the Pre-DC Model predictions in a production environment by comparing the risk scores released in a given month with the true outcomes that occur in the following month. Table 26 shows the percentage of all AH events incurred by patients with the top 1% and top 10% of Pre-AH scores in the month following the score release for six sets of risk scores.

Table 26. Production Predictive Performance of the MC-FFS Pre-DC Scores by Month

Model Version	Score Release Date	Top 1% of Patients	Top 10% of Patients
y7q1m03	05/10/2025	15.30%	61.22%
y7q1m03	06/06/2025	16.69%	61.68%
y7q1m03	07/11/2025	15.89%	60.57%
y7q2m06	08/08/2025	16.12%	59.88%
y7q2m06	09/12/2025	15.53%	59.31%
y7q2m06	10/10/2025	15.62%	60.18%

Note: The evaluation period is for 1 month following the score release date.

MA-MCO

Table 27 presents the risk factor coefficient estimates for Model 1 for the Pre-DC Model trained in the Medicaid HealthChoice (MA-MCO) population in December 2025.

Table 27. Pre-DC MA-MCO Risk Model Odds Ratios for Model 1

Risk Factor	Odds Ratio
CCW indicator for heart failure and non-ischemic heart disease	2.299
Indicator for sickle cell anemia	2.283
CCW indicator for sensory (blindness and visual) impairment	2.174
Prior hospitalization discharge status - transferred to inpatient care	2.026
Chronic Renal Insufficiency/ESRD	1.822
Prior hospitalization discharge status - other	1.811
CCW indicator for spina bifida and other congenital anomalies of the nervous system	1.81
DCSI Score – Cardiovascular	1.799
Beneficiary race - Native American	1.703
CCW indicator for hypertension	1.618
Beneficiary race - Black	1.607
CCW indicator for atrial fibrillation and flutter	1.596
Beneficiary race - White	1.554
CCW indicator for cerebral palsy	1.433
Beneficiary race - Other	1.415
CCW indicator for pressure and chronic ulcers	1.415
CCW indicator for tobacco use	1.365
Indicator for arrhythmia	1.352
CCW indicator for other developmental delays	1.347
Indicator for use of Anti-Hypertensive Treatment	1.334
DCSI Score – Nephropathy	1.289
CCW indicator for drug use disorders	1.287
Indicator for beta blocker use	1.278
Indicator for insulin use	1.276
DCSI Score - Peripheral Vascular Disease	1.272
CCW indicator for intellectual disabilities and related conditions	1.253
Indicator for fluid and electrolyte imbalance	1.252
Discontinuity of primary care - Index	1.228
Located in whole county primary care shortage area	1.228
Number of Previous Severe Type 2 Diabetes Complications	1.228
DCSI Score – Retinopathy	1.224
Indicator for warfarin use	1.2
CCW indicator for epilepsy	1.185
CCW indicator for diabetes	1.185
CCW indicator for asthma	1.179
Beneficiary race - Hispanic	1.177
Indicator for no vaccination (flu or pneumonia)	1.171
CCW indicator for anemia	1.17
CCW indicator for stroke/ischemic transient attack	1.167

Risk Factor	Odds Ratio
Indicator for albuminuria	1.165
Indicator for oral antibiotic use	1.158
Indicator for diabetic ulcer	1.156
Indicator for rheumatoid arthritis/collagen vascular disease	1.155
Indicator for gastroparesis	1.154
Indicator for oral corticosteroid use	1.149
CCW indicator for migraine and chronic headache	1.143
CCW indicator for depression, bipolar, and other depressive mood disorders	1.139
CCW indicator for obesity	1.127
Indicator for pulmonary circulatory disorder	1.107
CCW indicator for viral hepatitis	1.1
CCW indicator for post-traumatic stress disorder	1.09
CCW indicator for anxiety disorders	1.081
CCW indicator for bipolar disorder	1.066
Age	1.038
Number of emergency department visits within the past 6 months	1.03
Number of urgent care visits	1.028
Percent with less than high school education, ages 65+	1.004
Percent Native American	1.003
Physician diversity	1
Air pollution level	.999
Number of primary care visits	.997
Number of medications	.995
Percent married	.994
Number of heart-related procedures	.969
Indicator for lifestyle problems	.935
CCW indicator for ischemic heart disease	.91
DCSI Score - Metabolic	.894
CCW indicator for rheumatoid arthritis/osteoarthritis	.88
CCW indicator for benign prostatic hyperplasia	.869
Beneficiary sex - female	.857
CCW indicator for hyperlipidemia	.854
CCW indicator for cataracts	.83
CCW indicator for non-Alzheimer's dementia	.82
Indicator for peripheral and visceral atherosclerosis	.805
Prior hospitalization admission type - urgent	.798
CCW indicator for acute myocardial infarction	.78
Prior hospitalization admission type - none	.761
Indicator for prior nursing home stay	.713
Prior hospitalization admission type - elective	.703

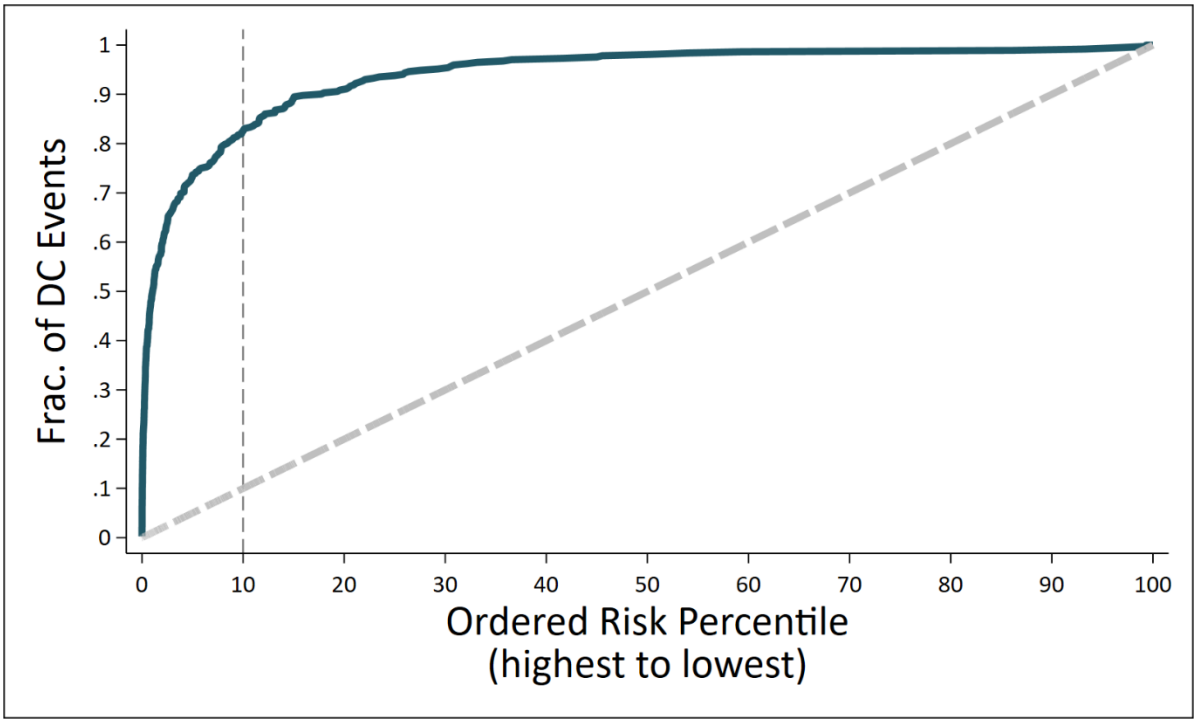
Table 28 presents summary statistics from a recent month of Pre-DC Model risk scores in the MA-MCO patient population.

Table 28. Summary Statistics for Pre-DC Scores in the MA-MCO Population

Scoring Cohort	Cohort Size	Average Score	N > 1% Risk	Monthly Correlation
Dec 2025	1,275,845	.0015	22,681	.9746

Figure 7 shows the concentration curve for the Pre-DC scores in one month of the holdout data. This curve shows how well the risk scores predict DC events in the following month. We find that the top 10% riskiest patients account for approximately 82.5% of all severe type 2 diabetes complication events in the following month.

Figure 7. Pre-DC Concentration Curve as of October 2025 in the MA-MCO Population



The first Pre-DC risk scores were released for the MA-MCO population in January 2025 and have since been regularly updated. Hilltop monitors the accuracy of the Pre-DC Model predictions in a production environment by comparing the risk scores released in a given month with the true outcomes that occur in the following month. Table 29 shows the percentage of all AH events incurred by patients with the top 1% and top 10% of Pre-AH scores in the month following the score release for six sets of risk scores.

Table 29. Production Predictive Performance of the MA-MCO Pre-DC Scores by Month

Model Version	Score Release Date	Top 1% of Patients	Top 10% of Patients
y24m11	2/19/2025	51.42%	82.31%
y24m11	3/13/2025	50.23%	82.18%
y25m02	4/11/2025	50.29%	82.78%
y25m02	5/09/2025	48.86%	81.55%
y25m02	6/06/2025	52.20%	82.84%
y25m02	7/11/2025	51.62%	83.41%

Note: The evaluation period is for 1 month following the score release date.

MA-FFS

Table 30 presents the risk factor coefficient estimates for Model 1 for the Pre-DC Model trained in the Medicaid FFS (MA-FFS) population in December 2025.

Table 30. Pre-DC MA-FFS Risk Model Odds Ratios for Model 1

Risk Factor	Odds Ratio
Prior hospitalization discharge status - other	8.416
Prior hospitalization discharge status - transferred to inpatient care	2.253
Indicator for sickle cell anemia	1.941
DCSI Score – Cardiovascular	1.709
CCW indicator for atrial fibrillation and flutter	1.591
CCW indicator for hypertension	1.586
Chronic Renal Insufficiency/ESRD	1.493
Discontinuity of primary care - Index	1.446
CCW indicator for heart failure and non-ischemic heart disease	1.367
Indicator for original Medicare eligibility for a non-age related cause	1.338
Prior hospitalization discharge status - transferred to post-acute care	1.246
Number of Previous Severe Type 2 Diabetes Complications	1.228
Beneficiary race - Black	1.215
CCW indicator for sensory (blindness and visual) impairment	1.198
DCSI Score – Nephropathy	1.194
Prior hospitalization admission type - emergency	1.185
Beneficiary race - Hispanic	1.18
Indicator for metastatic cancer	1.153
Indicator for use of Anticoagulants	1.152
Indicator for fluid and electrolyte imbalance	1.152
Indicator for arrhythmia	1.146
Indicator for beta blocker use	1.146
CCW indicator for chronic obstructive pulmonary disease (COPD) and bronchiectasis	1.139
Indicator for problems with care provider dependency	1.135
CCW indicator for anemia	1.128
Beneficiary race - White	1.125
Indicator for other problems with primary support group	1.123
Prior hospitalization discharge status - home	1.109

Risk Factor	Odds Ratio
Indicator for insulin use	1.107
Indicator for rivaroxaban use	1.092
Indicator for previous conservative diabetic wound procedure	1.091
DCSI Score - Peripheral Vascular Disease	1.089
Indicator for cerebrovascular disease	1.086
Indicator for frailty	1.079
CCW indicator for chronic kidney disease	1.079
CCW indicator for tobacco use	1.077
CCW indicator for epilepsy	1.076
Indicator for oral corticosteroid use	1.076
Indicator for oncologist visit	1.073
Indicator for no vaccination (flu or pneumonia)	1.068
Indicator for albuminuria	1.068
Indicator for provider administered drug	1.062
Indicator for diabetes with complications	1.057
CCW indicator for depression, bipolar, and other depressive mood disorders	1.055
CCW indicator for pressure and chronic ulcers	1.052
Indicator for urinary tract infection	1.051
DCSI Score – Retinopathy	1.049
DCSI Score – Neuropathy	1.048
Number of avoidable hospitalizations	1.048
Indicator for durable medical equipment (DME) use	1.043
CCW indicator for fibromyalgia, chronic pain and fatigue	1.043
CCW indicator for ischemic heart disease	1.042
Number of urgent care visits	1.041
Number of emergency department visits within the past 6 months	1.041
Indicator for oral antibiotic use	1.035
CCW indicator for obesity	1.032
Number of home health visits	1.031
DCSI Score – Cerebrovascular	1.023
Age	1.012
Percent with less than high school education, ages 65+	1.003
Number of outpatient visits	1.002
Continuity of primary care - Duration	1.001
National ranking of deprivation	1.001
Diabetes Duration	1.001
Population density	1
Total health spending	1
Number of primary care visits	.998
Percent Hispanic, ages 65+	.995
Number of HbA1c tests	.958
Number of heart-related procedures	.946
CCW indicator for glaucoma	.943
Number of prior admissions	.94
Indicator for prior readmission	.927

Risk Factor	Odds Ratio
CCW indicator for hyperlipidemia	.925
CCW indicator for schizophrenia and other psychotic disorders	.924
Discontinuity of primary care - Proportion	.905
CCW indicator for cataracts	.899
Indicator for statin use	.895
Indicator for prior nursing home stay	.854
Beneficiary race - Unknown	.645

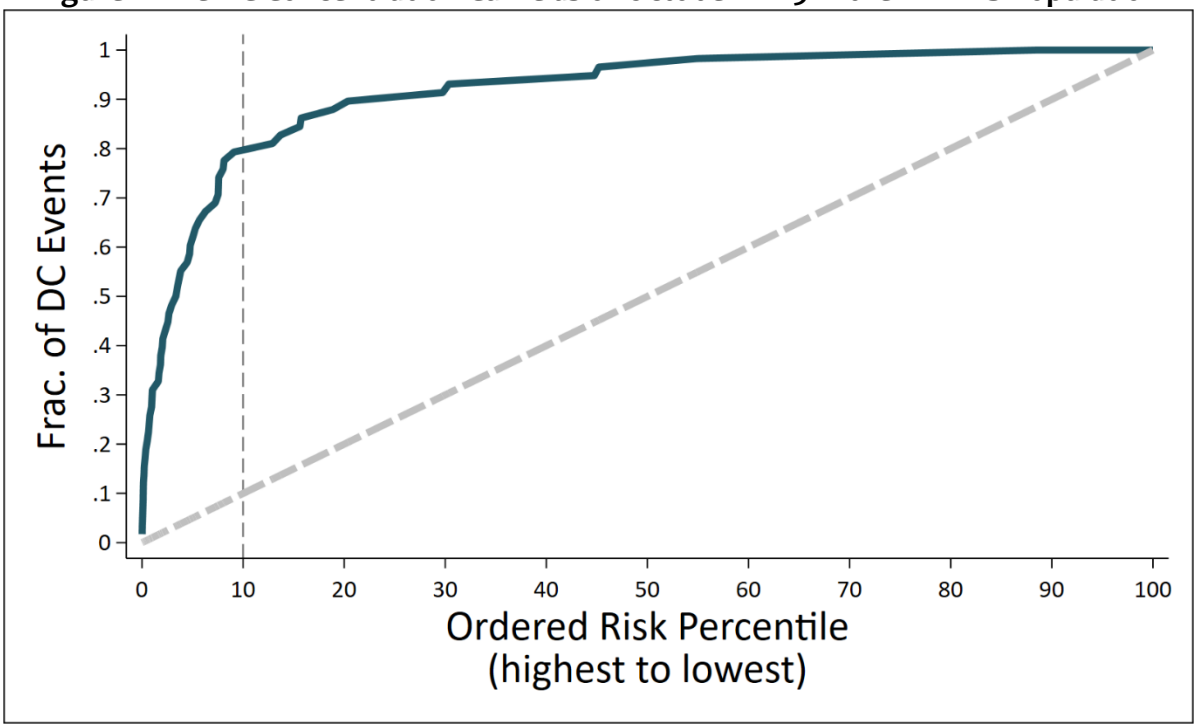
Table 31 presents summary statistics from a recent month of Pre-DC Model risk scores in the MA-FFS patient population.

Table 31. Summary Statistics for Pre-DC Scores in the MA-FFS Population

Scoring Cohort	Cohort Size	Average Score	N > 1% Risk	Monthly Correlation
Dec 2025	39,576	.0097	7,204	.9651

Figure 8 shows the concentration curve for the Pre-DC scores in one month of the holdout data. This curve shows how well the risk scores predict DC events in the following month. We find that the top 10% riskiest patients account for approximately 79.3% of all severe type 2 diabetes complication events in the following month.

Figure 8. Pre-DC Concentration Curve as of October 2025 in the MA-FFS Population



The first Pre-DC risk scores were released for the MA-FFS population in January 2025 and have since been regularly updated. Hilltop monitors the accuracy of the Pre-DC Model predictions in a

production environment by comparing the risk scores released in a given month with the true outcomes that occur in the following month. Table 32 shows the percentage of all AH events incurred by patients with the top 1% and top 10% of Pre-AH scores in the month following the score release for six sets of risk scores.

Table 32. Production Predictive Performance of the MA-FFS Pre-DC Scores by Month

Model Version	Score Release Date	Top 1% of Patients	Top 10% of Patients
y24m11	2/19/2025	28.14%	71.26%
y24m11	3/13/2025	26.67%	71.30%
y25m02	4/11/2025	25.95%	68.99%
y25m02	5/09/2025	28.95%	69.01%
y25m02	6/06/2025	32.48%	68.81%
y25m02	7/11/2025	32.75%	71.35%

Note: The evaluation period is for 1 month following the score release date.

Pre-HE

MC-PCP

Table 33 presents the risk factor coefficient estimates for Model 1 for the Pre-HE Model trained in the MDPCP-attributed Medicare FFS (MC-PCP) population in January 2026.

Table 33. Pre-HE MC-PCP Risk Model Odds Ratios for Model 1

Risk Factor	Odds Ratio
Severity of Frailty	110.477
Indicator for hospice enrollment	58.282
Prior hospitalization discharge status - other	6.039
CCW indicator for non-Alzheimer's dementia	4.879
Indicator for Cancer of Pancreas	2.751
Indicator for metastatic cancer	2.737
Indicator for Cancer of Brain and Nervous System	2.617
Indicator for Cancer of Liver and Intrahepatic Bile Duct	2.315
Indicator for having Received Chemotherapy	1.917
CCW indicator for muscular dystrophy	1.914
CCW indicator for alcohol use disorders	1.745
Indicator for Cancer of Esophagus	1.743
Indicator for sickle cell anemia	1.676
Indicator for Cancer of Bone and Connective Tissue	1.625
Indicator for original Medicare eligibility for a non-age related cause	1.517
Prior hospitalization discharge status - transferred to inpatient care	1.506
Indicator for Cancer of Ovary	1.467
CCW indicator for Parkinson's Disease or Secondary Parkinsonism	1.438
Indicator for Cancer of Bronchus; Lung	1.434
Chronic Renal Insufficiency/ESRD	1.425
CCW indicator for heart failure and non-ischemic heart disease	1.402

Risk Factor	Odds Ratio
CCW indicator for pressure and chronic ulcers	1.395
CCW indicator for intellectual disabilities and related conditions	1.375
CCW indicator for Alzheimer's disease	1.365
Beneficiary race - White	1.365
CCW indicator for leukemias and lymphomas	1.36
Indicator for frailty	1.348
Indicator for having Received Dialysis	1.292
Indicator for protein-calorie malnutrition	1.288
Indicator for oncologist visit	1.287
CCW indicator for anemia	1.264
Prior hospitalization discharge status - transferred to post-acute care	1.259
CCW indicator for chronic obstructive pulmonary disease (COPD) and bronchiectasis	1.255
Indicator for Cancer of Stomach	1.252
Indicator for solid tumor without metastasis	1.247
Recent Increase in Frailty severity	1.246
Indicator for problems with care provider dependency	1.217
CCW indicator for tobacco use	1.216
Indicator for insulin use	1.213
CCW indicator for drug use disorders	1.193
CCW indicator for liver disease, cirrhosis and other liver conditions (except viral hepatitis)	1.191
Indicator for warfarin use	1.171
Indicator for pulmonary circulatory disorder	1.169
Indicator for no vaccination (flu or pneumonia)	1.164
Indicator for fluid and electrolyte imbalance	1.163
CCW indicator for atrial fibrillation and flutter	1.158
Beneficiary race - Black	1.154
CCW indicator for peripheral vascular disease	1.151
Indicator for Oxygen Usage in DME	1.135
Indicator for Paraplegia or Hemiplegia	1.134
Indicator for other problems with primary support group	1.132
CCW indicator for acute myocardial infarction	1.123
Prior hospitalization admission type - emergency	1.122
CCW indicator for chronic kidney disease	1.104
CCW indicator for diabetes	1.104
Located in whole county mental health care shortage area	1.103
Indicator for dual eligibility with Medicaid	1.101
Indicator for previous conservative diabetic wound procedure	1.093
Discontinuity of primary care - Proportion	1.088
Indicator for albuminuria	1.085
Indicator for beta blocker use	1.079
Age	1.073
Indicator for oral corticosteroid use	1.07
Indicator for Morphine Use	1.063
Number of home health visits	1.062

Risk Factor	Odds Ratio
Number of emergency department visits within the past 6 months	1.053
Indicator for diabetes with complications	1.05
Indicator for urinary tract infection	1.04
CCW indicator for depression, bipolar, and other depressive mood disorders	1.039
Number of prior admissions	1.038
Number of avoidable hospitalizations	1.024
Number of medications	1.016
Prior admission length of stay	1.011
Percent in poverty age 65+	1.002
Percent with less than high school education, ages 65+	1.002
National ranking of deprivation	1.002
Number of primary care visits	1.002
Percent aged 65 and over	1.002
Percent non-English speakers	1.001
Continuity of primary care - Duration	1.001
Physician diversity	1
Population	1
Total health spending	1
Population density	1
Percent with less than high school education	.999
Percent Hispanic, ages 65+	.997
Number of specialist visits	.997
Number of outpatient visits	.995
Indicator for oral antibiotic use	.971
Number of lab tests	.968
Number of heart-related procedures	.965
Indicator for mental health use	.955
CCW indicator for anxiety disorders	.951
Number of urgent care visits	.949
CCW indicator for hypothyroidism	.948
Indicator for sepsis	.943
CCW indicator for osteoporosis with or without pathological fracture	.941
Indicator for prior surgery	.94
Indicator for anti-diabetes medication use	.94
Indicator for leukotriene receptor modifier use	.933
Indicator for neuropathy	.929
Number of HbA1c tests	.928
CCW indicator for breast cancer	.922
Indicator for provider administered drug	.92
CCW indicator for fibromyalgia, chronic pain and fatigue	.92
CCW indicator for sensory (deafness and hearing) impairment	.918
CCW indicator for glaucoma	.915
Indicator for gastroesophageal reflux disease	.902
Indicator for sleep apnea	.901
Indicator for presence of a for-profit hospital	.898

Risk Factor	Odds Ratio
CCW indicator for benign prostatic hyperplasia	.897
CCW indicator for bipolar disorder	.897
Beneficiary race - Unknown	.896
Indicator for problems with housing and economic conditions	.894
Indicator for problems with social environment	.879
Indicator for losartan use	.873
CCW indicator for hip/pelvic fracture	.865
CCW indicator for personality disorders	.856
Indicator for difficulty with life management	.849
CCW indicator for migraine and chronic headache	.848
CCW indicator for asthma	.843
Indicator for Hospital Bed Usage in DME	.843
CCW indicator for rheumatoid arthritis/osteoarthritis	.838
Indicator for statin use	.833
CCW indicator for obesity	.816
CCW indicator for cataracts	.789
CCW indicator for hyperlipidemia	.783
Indicator for prior nursing home stay	.78
Indicator for respiratory infection	.776
Indicator for diabetic foot procedure	.763
Prior hospitalization admission type - elective	.758
CCW indicator for prostate cancer	.726
Beneficiary sex - female	.671
Discontinuity of primary care - Index	.566
Interaction of ADRD and Frailty Index	.015

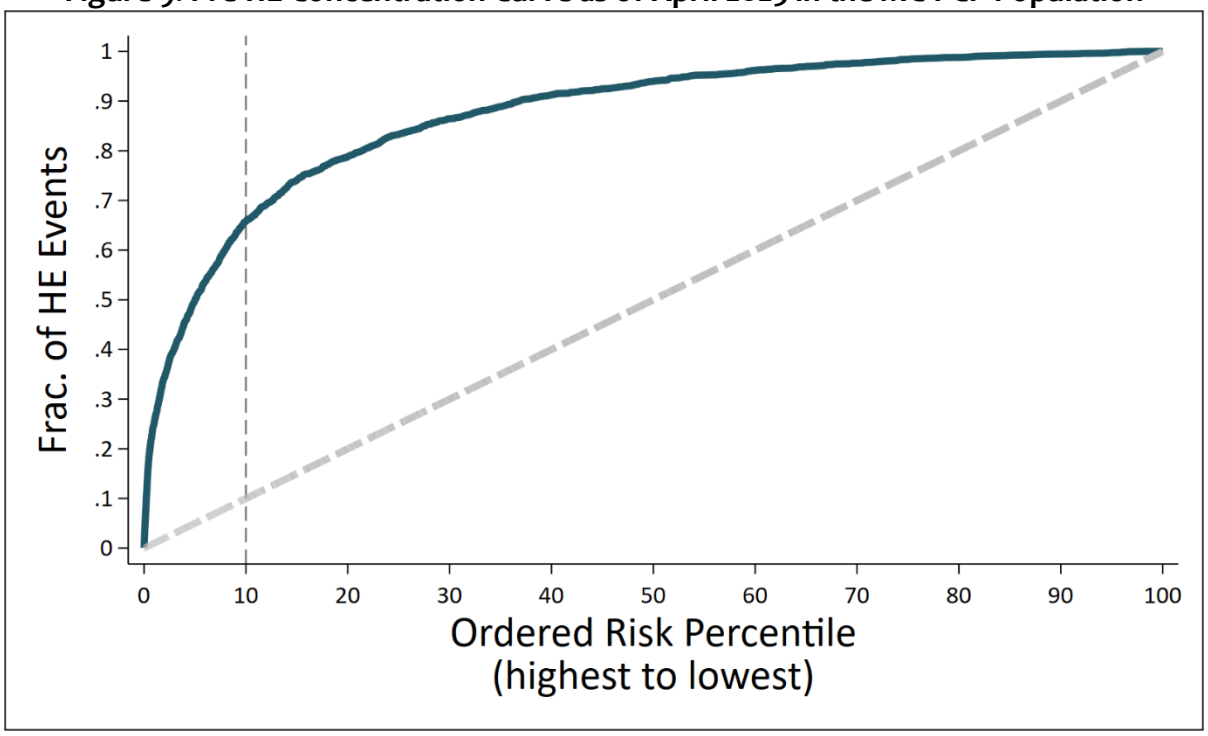
Table 34 presents summary statistics from a recent month of Pre-HE Model risk scores in the MC-PCP patient population.

Table 34. Summary Statistics for Pre-HE Scores in the MC-PCP Population

Scoring Cohort	Cohort Size	Average Score	N > 1% Risk	Monthly Correlation
Dec 2025	340,465	.0162	90,672	.9265

Figure 9 shows the concentration curve for the Pre-HE scores in one month of the holdout data. This curve shows how well the risk scores predict DC events within six months. We find that the top 10% riskiest patients account for approximately 65.8% of mortality events within six months.

Figure 9. Pre-HE Concentration Curve as of April 2025 in the MC-PCP Population



The first Pre-HE risk scores were released for the MC-PCP population in October 2022 and have since been regularly updated. Hilltop monitors the accuracy of the Pre-HE Model predictions in a production environment by comparing the risk scores released in a given month with the true outcomes that occur within the next six months. Table 35 shows the percentage of all HE events incurred by patients with the top 1% and top 10% of Pre-DC scores within six months following the score release for six sets of risk scores.

Table 35. Production Predictive Performance of the MC-PCP Pre-HE Scores by Month

Model Version	Score Release Date	Top 1% of Patients	Top 10% of Patients
y6q2m06	10/11/2024	15.88%	61.05%
y6q3m09	11/08/2024	15.83%	60.85%
y6q3m09	12/06/2024	15.51%	61.92%
y6q3m09	01/10/2025	16.14%	62.09%
y6q4m12	02/07/2025	16.71%	62.63%
y6q4m12	03/07/2025	16.95%	62.23%

Note: The evaluation period is for 6 months following the score release date.

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Section 5: FAQs

Differentiation from CMS HCC Risk Scores

It is important to note that the Hilltop Preventive Predictive Model risk scores are conceptually distinct from the CMS Hierarchical Condition Category (HCC) risk scores that are currently presented in CRISP. The Hilltop risk scores use risk factors based on diagnoses, procedures, medications, utilization, demographics, and geographic factors in order to produce a practice-specific ranking of patient risk in the near future. The CMS HCC risk scores are based on a model that uses diagnosis codes and a limited set of demographic information from a base year in order to predict *expenditures* over the following year. There is likely to be some overlap among individuals who incur potentially preventable utilization and individuals who experience high medical spending, but the overlap is unlikely to be complete.[24] High medical expenditure can reflect multiple factors ranging from moderate utilization of high-cost procedures, high utilization of moderate-cost procedures, underlying morbidity, or geographic differences in treatment or referral practices.

Moreover, the theoretical interpretation of each risk score differs substantially. The CMS HCC risk score was developed as a capitated payment risk adjustment methodology for Medicare Advantage participants in order to "address [the] issue of risk selection and to compensate Medicare Advantage health plans for accepting the risk of enrolling beneficiaries of varying health statuses" (Centers for Medicare and Medicaid Services, 2018, pp. 9–10). Additionally, "the underlying risk assessment is designed to accurately explain the variation at the group level, not at the individual level, because risk adjustment is applied to large groups" (Centers for Medicare and Medicaid Services, 2018, pp. 9–10). Note that "risk" for the CMS HCC risk model refers to *actuarial* risk: this model seeks to predict average expenditures over large groups of individuals. In contrast, the Hilltop risk scores are designed to estimate, as closely as possible, event risk: for example, an *individual's* risk of an avoidable hospital event in the following month.

There are also differences in the time horizons of each risk score. CMS HCC "final risk scores are generally available 16-18 months after the close of the base year. For example, 2017 risk scores (based on 2016 diagnoses) will be available in the spring of 2018"(Center for Medicare and Medicaid Innovation, 2017, p. 26). The Hilltop risk scores, however, are updated monthly and use patient-level risk factor information current to the most recently available month of claims in order to generate risk scores. This is a strength of the Hilltop models because these risk scores reflect the underlying patient condition with a lag of only, at most, three months.[25] Finally, by definition, avoidable hospital events are preventable through timely primary care and so, in principle, the identification and management of individuals at high risk of incurring potentially

[24] Internal testing shows a limited degree of substitutability between the two sets of risk scores. Specifically, we find that the Hilltop Pre-AH Model™ outperforms the CMS HCC risk score in predicting avoidable hospitalization in the following month. Both concentration curves are presented below.

[25] This lag is related to the unavoidable delay in obtaining and processing administrative claims data. For example, claims data delivered to Hilltop in late October 2021 reflect utilization through mid-September 2021. We discuss this point further in the "Limitations" section below.

preventable health care utilization may result in the avoidance of that particular utilization event. High medical expenditures, however, may reflect underlying morbidities that would necessitate utilization *regardless* of primary care intervention.

What Makes the Pre-DC Outcome Different from the Pre-AH Outcome?

Both the Pre-AH Model and the Pre-DC Model outcomes include diabetes complications; however, they are conceptually and statistically distinct. The Pre-AH outcome is a composite of 10 conditions that are determined to be potentially preventable with high-quality outpatient care by the AHRQ.[26] These PQIs are intended to serve as a high-level check of primary/outpatient care access in a community and to help organizations identify potentially unmet needs in their communities. The Pre-AH outcome indexes, among other non-diabetes-related conditions, uncontrolled diabetes complications as well as complications from type 1 diabetes, type 2 diabetes, and other forms of diabetes (e.g., gestational diabetes). In comparison, the Pre-DC outcome is based on the DCSI, which is designed to quantify the severity of diabetes complications based on risk for adverse medical outcomes including future medical needs, high treatment costs, hospitalizations, and mortality (described in more detail above). Although the DCSI can measure non-severe and severe complications from all forms of diabetes, we focused on severe complications related to type 2 diabetes only.

In order to confirm that the Pre-DC outcome was statistically distinct from the Pre-AH outcome, we quantified the overlap in the ICD-10 diagnosis codes included in both outcomes and calculated the correlation between the Pre-AH and Pre-DC outcome frequency and risk scores in the MDPCP scoring data. See Table 36.

Table 36. Coding Differences in Pre-AH and Pre-DC Model Outcomes

Status of ICD-10 Diagnosis Codes	N
Overlapping	36
Unique to Pre-AH Outcome	491
Unique to Pre-DC Outcome	244

Hilltop also determined that, as of July 2022, only 12.46% of the avoidable hospital events in the MDPCP scoring data were related to PQIs indexing diabetes or its complications (i.e., PQI#1, PQI#3, PQI#14, PQI#16). The most prevalent PQIs in the MDPCP population were PQI#14: Urinary Tract Infections (25.43%) and PQI#5: COPD or Asthma in Older Adults (18.47%).

For additional detail on the differences in these outcomes, please see the standalone document entitled "What's the Difference between the Pre-DC and Pre-AH Models?".

[26] For more information, see https://www.qualityindicators.ahrq.gov/modules/pqi_resources.aspx

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Appendix 1. Risk Factor Codebook

Age: For each person-month, this variable records person age as of the end of the month.

Source: Beneficiary demographics

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	74.249	20	110
Medicare FFS	73.215	3	152
Medicaid HealthChoice	23.023	0	65
Medicaid FFS	43.821	0	106

Air pollution level: For each person, this variable records the average daily fine particulate matter (PM 2.5) concentration from the EPA's Downscaler Model for 2011-2015 in the person's Census Tract or ZCTA of residence.

Source: Environmental Protection Agency (2023)

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	9.872	0	249
Medicare FFS	53.827	0	276
Medicaid HealthChoice	61.771	0	300
Medicaid FFS	66.004	0	245

Number of hospital beds per 1000 residents: For each person, this variable records the number of active (short term or critical access or transplant) hospital beds per 1000 residents in the person's Census Tract or ZCTA of residence.

Source: CMS Provider of Service Files (December 2023) American Community Survey (2022, 5-year estimates)

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	2.011	0	744
Medicare FFS	2.381	0	4589
Medicaid HealthChoice	2.456	0	2012
Medicaid FFS	3.398	0	119

National ranking of deprivation: For each person, this variable records the national ranking of deprivation for the person's Census Tract or ZCTA of residence. This index 'includes factors for the theoretical domains of income, education, employment, and housing quality.' See https://www.neighborhoodatlas.medicine.wisc.edu/ for additional detail. Higher values indicate a greater degree of deprivation.

Source: Neighborhood Atlas

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	32.612	1	100
Medicare FFS	33.746	1	97
Medicaid HealthChoice	41.615	2	98
Medicaid FFS	44.265	2	97

General internists per 1000 residents: For each person, this variable records the number of general internists per 1000 residents in the Census Tract or ZCTA of residence.

Source: National Provider Identifier Database, American Community Survey (2022, 5-year estimates)

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.945	0	180
Medicare FFS	.881	0	1139
Medicaid HealthChoice	.866	0	115
Medicaid FFS	1.12	0	115

Indicator for presence of a for-profit hospital: For each person, this variable records whether the person's Census Tract or ZCTA of residence contains at least one active (short term or critical access or transplant) for-profit hospital.

Source: CMS Provider of Service Files (December 2023)

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.024	0	1
Medicare FFS	.086	0	1
Medicaid HealthChoice	.092	0	1
Medicaid FFS	.112	0	1

Indicator for no federally qualified health center: For each person, this variable records whether the person's Census Tract or ZCTA of residence does not contain at least one active federally qualified health center.

Source: CMS Provider of Service Files (December 2023)

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.928	0	1
Medicare FFS	.736	0	1
Medicaid HealthChoice	.643	0	1
Medicaid FFS	.589	0	1

Indicator for no mental health center: For each person, this variable records whether the person's Census Tract or ZCTA of residence does not contain at least one active community mental health center.

Source: CMS Provider of Service Files (December 2023)

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.999	0	1
Medicare FFS	.983	0	1
Medicaid HealthChoice	.966	0	1
Medicaid FFS	.956	0	1

Indicator for no rural health clinic: For each person, this variable records whether the person's Census Tract or ZCTA of residence does not contain at least one active rural health clinic.

Source: CMS Provider of Service Files (December 2023)

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.999	0	1
Medicare FFS	.998	0	1
Medicaid HealthChoice	.999	0	1
Medicaid FFS	.999	0	1

Indicator for no VA clinic or VA medical center: For each person, this variable records whether the person's Census Tract or ZCTA of residence does not contain at least one VA clinic or medical center.

Source: Veterans Affairs Facility Listing

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.979	0	1
Medicare FFS	.884	0	1
Medicaid HealthChoice	.861	0	1
Medicaid FFS	.867	0	1

Median household income: For each person, this variable records the median household income in the person's Census Tract or ZCTA of residence (pooled from 2015-2019).

Source: American Community Survey (2022, 5-year estimates)

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	112789.6	0	250000
Medicare FFS	108160.5	0	250000
Medicaid HealthChoice	90763.56	0	250000
Medicaid FFS	87290.19	0	250000

Located in partial county mental health care shortage area: For each person, this variable takes the value of 1 if the person's Census Tract or ZCTA of residence is located in a county that is designated by HRSA in 2018 to be a partial-county mental health care shortage area. The variable takes the value of 0, otherwise. If the census tract lies in two counties, the value is estimated as a weighted average of the county-level attributes.

Source: Area Health Resources File

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.763	0	1
Medicare FFS	.828	0	1
Medicaid HealthChoice	.867	0	1
Medicaid FFS	.888	0	1

Located in whole county mental health care shortage area: For each person, this variable takes the value of 1 if the person's Census Tract or ZCTA of residence is located in a county that is designated by HRSA in 2018 to be a whole-county mental health care shortage area. The variable takes the value of 0, otherwise. If the census tract lies in two or more counties, the value is estimated as a weighted average of the county-level attributes.

Source: Area Health Resources File

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.182	0	1
Medicare FFS	.16	0	1
Medicaid HealthChoice	.123	0	1
Medicaid FFS	.096	0	1

Number of hospitals: For each person, this variable records the number of active (short term or critical access or transplant) hospitals in the person's Census Tract or ZCTA of residence.

Source: CMS Provider of Service Files (December 2023)

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.062	0	6
Medicare FFS	.368	0	7
Medicaid HealthChoice	.381	0	7
Medicaid FFS	.475	0	7

Number of hospitals per 1000 residents: For each person, this variable records the number of active (short term or critical access or transplant) hospitals per 1000 residents in the person's Census Tract or ZCTA of residence.

Source: CMS Provider of Service Files (December 2023) American Community Survey (2022, 5-year estimates)

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.01	0	3
Medicare FFS	.011	0	6
Medicaid HealthChoice	.012	0	4
Medicaid FFS	.015	0	0

Located in partial county primary care shortage area: For each person, this variable takes the value of 1 if the person's Census Tract or ZCTA of residence is located in a county that is designated by HRSA in 2018 to be a partial-county primary care shortage area. The variable takes the value of 0, otherwise. If the census tract lies in two or more counties, the value is estimated as a weighted average of the county-level attributes.

Source: Area Health Resources File

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.927	0	1
Medicare FFS	.949	0	1
Medicaid HealthChoice	.962	0	1
Medicaid FFS	.959	0	1

Located in whole county primary care shortage area: For each person, this variable takes the value of 1 if the person's Census Tract or ZCTA of residence is located in a county that is designated by HRSA in 2018 to be a whole-county primary care shortage area. The variable takes the value of 0, otherwise. If the census tract lies in two or more counties, the value is estimated as a weighted average of the county-level attributes.

Source: Area Health Resources File

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.006	0	1
Medicare FFS	.007	0	1
Medicaid HealthChoice	.009	0	1
Medicaid FFS	.01	0	1

Number of primary care physicians per 1000 residents: For each person, this variable records the number of primary care physicians per 1000 residents in the person's Census Tract or ZCTA of residence.

Source: National Provider Identifier Database, American Community Survey (2022, 5-year estimates)

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	2.021	0	385
Medicare FFS	1.895	0	3241
Medicaid HealthChoice	1.801	0	385
Medicaid FFS	2.225	0	385

Percent aged 65 and over: For each person, this variable records the percentage of individuals in the person's Census Tract or ZCTA of residence aged 65 and over (pooled from 2013-2017).

Source: American Community Survey (2022, 5-year estimates)

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	18.723	0	100
Medicare FFS	17.284	0	100
Medicaid HealthChoice	15.655	0	100
Medicaid FFS	15.706	0	73

Percent with less than high school education, ages 65+: For each person, this variable records the percent of the population aged 65 and above in the person's Census Tract or ZCTA of residence that has less than a high school diploma.

Source: American Community Survey (2022, 5-year estimates)

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	10.878	0	100
Medicare FFS	11.202	0	85
Medicaid HealthChoice	14.365	0	85
Medicaid FFS	15.104	0	85

Percent live alone, ages 65+: For each person, this variable records the percentage of the population aged 65 and above in the person's Census Tract or ZCTA of residence that lives alone.

Source: American Community Survey (2022, 5-year estimates)

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	25.473	0	77
Medicare FFS	27.176	0	100
Medicaid HealthChoice	29.275	0	100
Medicaid FFS	31.164	0	74

Percent speak Spanish, aged 65+: For each person, this variable records the percent of the population aged 65 and above in the person's Census Tract or ZCTA of residence that speaks Spanish.

Source: American Community Survey (2022, 5-year estimates)

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	2.647	0	96
Medicare FFS	3.291	0	64
Medicaid HealthChoice	3.732	0	89
Medicaid FFS	3.343	0	91

Percent in poverty age 65+: For each person, this variable records the percentage of people age 65+ whose income in the past 12 months is below the poverty level in the person's Census Tract or ZCTA of residence (pooled from 2015-2019).

Source: American Community Survey (2022, 5-year estimates)

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	4.087	0	85
Medicare FFS	4.4	0	100
Medicaid HealthChoice	5.623	0	100
Medicaid FFS	6.317	0	59

Percent foreign born: For each person, this variable records the percentage of individuals who are foreign-born in the person's Census Tract or ZCTA of residence.

Source: American Community Survey (2022, 5-year estimates)

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	1.562	0	14
Medicare FFS	1.628	0	60
Medicaid HealthChoice	1.605	0	60
Medicaid FFS	1.568	0	26

Percent Hispanic, ages 65+: For each person, this variable records the percent of the population aged 65 and above in the person's Census Tract or ZCTA of residence that is Hispanic.

Source: American Community Survey (2022, 5-year estimates)

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	2.935	0	99
Medicare FFS	3.578	0	73
Medicaid HealthChoice	4.134	0	94
Medicaid FFS	3.644	0	98

Percent with less than high school education: For each person, this variable records the percentage of individuals aged 18 and older with less than a high school diploma in the person's Census Tract or ZCTA of residence.

Source: American Community Survey (2022, 5-year estimates)

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	19.177	0	147
Medicare FFS	8.645	0	67
Medicaid HealthChoice	11.098	0	67
Medicaid FFS	11.321	0	42

Percent married: For each person, this variable records the percentage of the population aged 15+ in the person's Census Tract or ZCTA of residence that is currently married (pooled from 2013-2017).

Source: American Community Survey (2022, 5-year estimates)

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	51.208	0	100
Medicare FFS	48.663	0	100
Medicaid HealthChoice	43.324	0	100
Medicaid FFS	40.946	0	100

Percent Native American: For each person, this variable records the percent of the population in the person's Census Tract or ZCTA of residence that is Native American.

Source: American Community Survey (2022, 5-year estimates)

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	68.935	0	100
Medicare FFS	59.972	0	100
Medicaid HealthChoice	49.849	0	100
Medicaid FFS	46.766	0	100

Percent non-English speakers: For each person, this variable records the percent of individuals who speak Spanish or other languages and who speak English less than 'very well' in the person's Census Tract or ZCTA of residence.

Source: American Community Survey (2022, 5-year estimates)

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	30.256	0	100
Medicare FFS	32.273	0	100
Medicaid HealthChoice	35.562	0	100
Medicaid FFS	34.808	0	100

Percent non-white, ages 65+: For each person, this variable records the percent of the population aged 65 and above in the person's Census Tract or ZCTA of residence that is non-white.

Source: American Community Survey (2022, 5-year estimates)

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	27.006	0	100
Medicare FFS	34.609	0	100
Medicaid HealthChoice	43.77	0	100
Medicaid FFS	47.642	0	100

Physician diversity: For each person, this variable records the percentage of medical doctors who are minorities (African Americans, Hispanics, and others, but excluding Asian Americans). If the zip code tabulation area lies in two or more counties, the value is estimated as a weighted average of the county-level attributes, with weights being the fraction of the ZCTA population residing within each county.

Source: American Community Survey (2022, individual)

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	36.038	0	2657
Medicare FFS	259.105	0	2924
Medicaid HealthChoice	280.629	0	2089
Medicaid FFS	262.153	0	2089

Percent in poverty: For each person, this variable records the percentage of families whose income in the past 12 months is below the poverty level in the person's Census Tract or ZCTA of residence (pooled from 2015-2019) .

Source: American Community Survey (2022, 5-year estimates)

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	5.552	0	58
Medicare FFS	6.039	0	100
Medicaid HealthChoice	8.352	0	67
Medicaid FFS	9.468	0	38

Percent single mothers: For each person, this variable records the percent of women aged 15-50 giving birth within the past 12 months who are not married in the person's Census Tract or ZCTA of residence.

Source: American Community Survey (2022, 5-year estimates)

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	22.2	0	100
Medicare FFS	27.931	0	100
Medicaid HealthChoice	36.397	0	100
Medicaid FFS	38.107	0	100

Percent aged 0-4: For each person, this variable records the percentage of individuals in the person's Census Tract or ZCTA of residence aged 0-4 (pooled from 2013-2017) .

Source: American Community Survey (2022, 5-year estimates)

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	5.411	0	31
Medicare FFS	5.599	0	31
Medicaid HealthChoice	6.037	0	31
Medicaid FFS	5.952	0	31

Population: For each person, this variable records the population of the person's Census Tract or ZCTA of residence.

Source: American Community Survey (2022, 5-year estimates)

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	6451.085	0	107887
Medicare FFS	31900.15	0	105521
Medicaid HealthChoice	34806.72	0	108180
Medicaid FFS	35171.12	0	108180

Population growth: For each person, this variable records the percent population growth recorded in the person's Census Tract or ZCTA of residence from 2013 - 2019.

Source: American Community Survey (2020 and 2022, 5-year estimates)

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	2.368	-82	354
Medicare FFS	2.516	-100	3900
Medicaid HealthChoice	2.123	-100	3900
Medicaid FFS	1.366	-100	170

Population density: For each person, this variable records the population per square mile in the person's Census Tract or ZCTA of residence.

Source: American Community Survey (2022, 5-year estimates), Census Gazetteer File (2020)

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	3130.127	0	144674
Medicare FFS	2828.878	0	144674
Medicaid HealthChoice	3750.003	0	109098
Medicaid FFS	4536.017	0	112881

Social workers per 1000 residents: For each person, this variable records the number of social workers per 1000 residents in the Census Tract or ZCTA of residence.

Source: National Provider Identifier Database, American Community Survey (2022, 5-year estimates)

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	2.306	0	885
Medicare FFS	2.204	0	885
Medicaid HealthChoice	2.124	0	885
Medicaid FFS	2.599	0	885

Number of specialty care physicians per 1000 residents: For each person, this variable records the number of specialty care physicians per 1000 residents in the person's Census Tract or ZCTA of residence.

Source: National Provider Identifier Database, American Community Survey (2022, 5-year estimates)

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	2.094	0	536
Medicare FFS	1.956	0	2696
Medicaid HealthChoice	1.872	0	154
Medicaid FFS	2.398	0	154

Taxable interest per capita: For each person, this variable records taxable interest (tax year 2018) per person in the person's Census Tract or ZCTA of residence.

Source: IRS Statistics of Income and American Community Survey (2022, 5-year estimates)

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	1926.705	0	271166
Medicare FFS	10555.06	4	396881
Medicaid HealthChoice	5916.479	4	117671
Medicaid FFS	6285.135	4	128373

Number of avoidable hospitalizations: For each person-month, this variable counts the number of avoidable hospitalizations incurred within the prior 12 months (not including the month in which the avoidable hospitalization occurred).

Source: Institutional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.051	0	39
Medicare FFS	.061	0	25
Medicaid HealthChoice	.031	0	42
Medicaid FFS	.081	0	30

Indicator for anti-diabetes medication use: For each person-month, this variable takes the value of 1 if a person incurred a claim for anti-diabetes medication within the past 12 months, and 0 otherwise.

Source: Pharmacy claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.159	0	1
Medicare FFS	.134	0	1
Medicaid HealthChoice	.038	0	1
Medicaid FFS	.105	0	1

Indicator for beta blocker use: For each person-month, this variable takes the value of 1 if a person incurred a claim for beta blockers within the past 12 months, and 0 otherwise.

Source: Pharmacy claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.29	0	1
Medicare FFS	.249	0	1
Medicaid HealthChoice	.039	0	1
Medicaid FFS	.136	0	1

CCW indicator for acute myocardial infarction: For each person-month, this variable records whether the person meets the CCW clinical criteria for acute myocardial infarction. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.007	0	1
Medicare FFS	.009	0	1
Medicaid HealthChoice	.001	0	1
Medicaid FFS	.005	0	1

CCW indicator for ADHD, conduct disorders, and hyperkinetic syndrome: For each person-month, this variable records whether the person meets the CCW clinical criteria for ADHD, conduct disorders, and hyperkinetic syndrome. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.013	0	1
Medicare FFS	.015	0	1
Medicaid HealthChoice	.086	0	1
Medicaid FFS	.076	0	1

Indicator for albuminuria: For each person-month, this variable records whether the person has incurred at least one inpatient or two non-inpatient claims with any diagnosis for albuminuria within the past two years. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.03	0	1
Medicare FFS	.032	0	1
Medicaid HealthChoice	.004	0	1
Medicaid FFS	.011	0	1

CCW indicator for alcohol use disorders: For each person-month, this variable records whether the person meets the CCW clinical criteria for alcohol use disorders. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.004	0	1
Medicare FFS	.004	0	1
Medicaid HealthChoice	.028	0	1
Medicaid FFS	.071	0	1

CCW indicator for Alzheimer's disease: For each person-month, this variable records whether the person meets the CCW clinical criteria for Alzheimer's Disease. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.017	0	1
Medicare FFS	.022	0	1
Medicaid HealthChoice	0	0	1
Medicaid FFS	.004	0	1

CCW indicator for anemia: For each person-month, this variable records whether the person meets the CCW clinical criteria for anemia. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.219	0	1
Medicare FFS	.25	0	1
Medicaid HealthChoice	.06	0	1
Medicaid FFS	.154	0	1

CCW indicator for anxiety disorders: For each person-month, this variable records whether the person meets the CCW clinical criteria for anxiety disorders. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.195	0	1
Medicare FFS	.175	0	1
Medicaid HealthChoice	.159	0	1
Medicaid FFS	.208	0	1

Indicator for arrhythmia: For each person-month, this variable records whether the person has incurred at least one inpatient or two non-inpatient claims with any diagnosis for arrhythmia within the past two years. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.248	0	1
Medicare FFS	.228	0	1
Medicaid HealthChoice	.035	0	1
Medicaid FFS	.136	0	1

CCW indicator for asthma: For each person-month, this variable records whether the person meets the CCW clinical criteria for asthma. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.086	0	1
Medicare FFS	.074	0	1
Medicaid HealthChoice	.09	0	1
Medicaid FFS	.095	0	1

CCW indicator for atrial fibrillation and flutter: For each person-month, this variable records whether the person meets the CCW clinical criteria for atrial fibrillation and flutter. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.129	0	1
Medicare FFS	.122	0	1
Medicaid HealthChoice	.004	0	1
Medicaid FFS	.032	0	1

CCW indicator for autism spectrum disorders: For each person-month, this variable records whether the person meets the CCW clinical criteria for autism spectrum disorders. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.004	0	1
Medicare FFS	.004	0	1
Medicaid HealthChoice	.022	0	1
Medicaid FFS	.027	0	1

CCW indicator for benign prostatic hyperplasia: For each person-month, this variable records whether the person meets the CCW clinical criteria for benign prostatic hyperplasia. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.144	0	1
Medicare FFS	.13	0	1
Medicaid HealthChoice	.004	0	1
Medicaid FFS	.029	0	1

CCW indicator for bipolar disorder: For each person-month, this variable records whether the person meets the CCW clinical criteria for bipolar disorder. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.029	0	1
Medicare FFS	.038	0	1
Medicaid HealthChoice	.055	0	1
Medicaid FFS	.119	0	1

CCW indicator for breast cancer: For each person-month, this variable records whether the person meets the CCW clinical criteria for breast cancer. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.058	0	1
Medicare FFS	.045	0	1
Medicaid HealthChoice	.003	0	1
Medicaid FFS	.007	0	1

CCW indicator for cataracts: For each person-month, this variable records whether the person meets the CCW clinical criteria for cataracts. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.332	0	1
Medicare FFS	.25	0	1
Medicaid HealthChoice	.011	0	1
Medicaid FFS	.043	0	1

CCW indicator for cerebral palsy: For each person-month, this variable records whether the person meets the CCW clinical criteria for cerebral palsy. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.003	0	1
Medicare FFS	.003	0	1
Medicaid HealthChoice	.001	0	1
Medicaid FFS	.06	0	1

Indicator for cerebrovascular disease: For each person-month, this variable records whether the person has incurred at least one inpatient or two non-inpatient claims with any diagnosis for cerebrovascular disease within the past two years. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.134	0	1
Medicare FFS	.133	0	1
Medicaid HealthChoice	.009	0	1
Medicaid FFS	.083	0	1

CCW indicator for chronic kidney disease: For each person-month, this variable records whether the person meets the CCW clinical criteria for chronic kidney disease. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.196	0	1
Medicare FFS	.193	0	1
Medicaid HealthChoice	.013	0	1
Medicaid FFS	.098	0	1

CCW indicator for chronic obstructive pulmonary disease (COPD) and bronchiectasis: For each person-month, this variable records whether the person meets the CCW clinical criteria for chronic obstructive pulmonary disease (COPD) and bronchiectasis. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.112	0	1
Medicare FFS	.102	0	1
Medicaid HealthChoice	.015	0	1
Medicaid FFS	.07	0	1

CCW indicator for colorectal cancer: For each person-month, this variable records whether the person meets the CCW clinical criteria for colorectal cancer. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.014	0	1
Medicare FFS	.013	0	1
Medicaid HealthChoice	.001	0	1
Medicaid FFS	.004	0	1

CCW indicator for cystic fibrosis and other metabolic developmental disorders: For each person-month, this variable records whether the person meets the CCW clinical criteria for cystic fibrosis and other metabolic developmental disorders. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.007	0	1
Medicare FFS	.008	0	1
Medicaid HealthChoice	.002	0	1
Medicaid FFS	.017	0	1

CCW indicator for depression, bipolar, and other depressive mood disorders: For each person-month, this variable records whether the person meets the CCW clinical criteria for depression, bipolar, or other depressive mood disorders. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.191	0	1
Medicare FFS	.19	0	1
Medicaid HealthChoice	.16	0	1
Medicaid FFS	.263	0	1

CCW indicator for diabetes: For each person-month, this variable records whether the person meets the CCW clinical criteria for diabetes. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.294	0	1
Medicare FFS	.282	0	1
Medicaid HealthChoice	.048	0	1
Medicaid FFS	.156	0	1

Indicator for diabetes with complications: For each person-month, this variable records whether the person has incurred at least one inpatient or two non-inpatient claims with any diagnosis for diabetes with complications within the past two years. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.21	0	1
Medicare FFS	.192	0	1
Medicaid HealthChoice	.03	0	1
Medicaid FFS	.107	0	1

Indicator for diabetic ulcer: For each person-month, this variable records whether the person has incurred at least one inpatient or two non-inpatient claims with any diagnosis for diabetic ulcer within the past two years. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.049	0	1
Medicare FFS	.047	0	1
Medicaid HealthChoice	.002	0	1
Medicaid FFS	.01	0	1

CCW indicator for drug use disorders: For each person-month, this variable records whether the person meets the CCW clinical criteria for drug use disorders. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.006	0	1
Medicare FFS	.006	0	1
Medicaid HealthChoice	.072	0	1
Medicaid FFS	.176	0	1

CCW indicator for endometrial cancer: For each person-month, this variable records whether the person meets the CCW clinical criteria for endometrial cancer. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.007	0	1
Medicare FFS	.006	0	1
Medicaid HealthChoice	0	0	1
Medicaid FFS	.001	0	1

CCW indicator for epilepsy: For each person-month, this variable records whether the person meets the CCW clinical criteria for epilepsy. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.023	0	1
Medicare FFS	.027	0	1
Medicaid HealthChoice	.013	0	1
Medicaid FFS	.094	0	1

CCW indicator for fibromyalgia, chronic pain and fatigue: For each person-month, this variable records whether the person meets the CCW clinical criteria for fibromyalgia, chronic pain and fatigue. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.243	0	1
Medicare FFS	.214	0	1
Medicaid HealthChoice	.053	0	1
Medicaid FFS	.12	0	1

Indicator for fluid and electrolyte imbalance: For each person-month, this variable records whether the person has incurred at least one inpatient or two non-inpatient claims with any diagnosis for fluid and electrolyte imbalance within the past two years. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.143	0	1
Medicare FFS	.161	0	1
Medicaid HealthChoice	.032	0	1
Medicaid FFS	.155	0	1

Indicator for gastroesophageal reflux disease: For each person-month, this variable records whether the person has incurred at least one inpatient or two non-inpatient claims with any diagnosis for gastroesophageal reflux disease within the past two years. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.245	0	1
Medicare FFS	.201	0	1
Medicaid HealthChoice	.043	0	1
Medicaid FFS	.126	0	1

Indicator for gastroparesis: For each person-month, this variable records whether the person has incurred at least one inpatient or two non-inpatient claims with any diagnosis for gastroparesis within the past two years. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.004	0	1
Medicare FFS	.004	0	1
Medicaid HealthChoice	.001	0	1
Medicaid FFS	.004	0	1

CCW indicator for glaucoma: For each person-month, this variable records whether the person meets the CCW clinical criteria for glaucoma. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.22	0	1
Medicare FFS	.184	0	1
Medicaid HealthChoice	.016	0	1
Medicaid FFS	.044	0	1

CCW indicator for heart failure and non-ischemic heart disease: For each person-month, this variable records whether the person meets the CCW clinical criteria for heart failure and non-ischemic heart disease. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.092	0	1
Medicare FFS	.11	0	1
Medicaid HealthChoice	.009	0	1
Medicaid FFS	.07	0	1

CCW indicator for hip/pelvic fracture: For each person-month, this variable records whether the person meets the CCW clinical criteria for hip/pelvic fracture. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.009	0	1
Medicare FFS	.01	0	1
Medicaid HealthChoice	.001	0	1
Medicaid FFS	.006	0	1

CCW indicator for HIV/AIDS: For each person-month, this variable records whether the person meets the CCW clinical criteria for HIV/AIDS. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.005	0	1
Medicare FFS	.006	0	1
Medicaid HealthChoice	.005	0	1
Medicaid FFS	.02	0	1

CCW indicator for hyperlipidemia: For each person-month, this variable records whether the person meets the CCW clinical criteria for hyperlipidemia. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.82	0	1
Medicare FFS	.63	0	1
Medicaid HealthChoice	.092	0	1
Medicaid FFS	.235	0	1

CCW indicator for hypertension: For each person-month, this variable records whether the person meets the CCW clinical criteria for hypertension. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.746	0	1
Medicare FFS	.626	0	1
Medicaid HealthChoice	.099	0	1
Medicaid FFS	.326	0	1

CCW indicator for hypothyroidism: For each person-month, this variable records whether the person meets the CCW clinical criteria for hypothyroidism. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.218	0	1
Medicare FFS	.182	0	1
Medicaid HealthChoice	.018	0	1
Medicaid FFS	.05	0	1

CCW indicator for intellectual disabilities and related conditions: For each person-month, this variable records whether the person meets the CCW clinical criteria for intellectual disabilities and related conditions. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.01	0	1
Medicare FFS	.009	0	1
Medicaid HealthChoice	.006	0	1
Medicaid FFS	.055	0	1

CCW indicator for ischemic heart disease: For each person-month, this variable records whether the person meets the CCW clinical criteria for ischemic heart disease. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.225	0	1
Medicare FFS	.2	0	1
Medicaid HealthChoice	.01	0	1
Medicaid FFS	.063	0	1

CCW indicator for learning disabilities: For each person-month, this variable records whether the person meets the CCW clinical criteria for learning disabilities. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.002	0	1
Medicare FFS	.002	0	1
Medicaid HealthChoice	.03	0	1
Medicaid FFS	.088	0	1

CCW indicator for leukemias and lymphomas: For each person-month, this variable records whether the person meets the CCW clinical criteria for leukemias and lymphomas. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.019	0	1
Medicare FFS	.017	0	1
Medicaid HealthChoice	.001	0	1
Medicaid FFS	.004	0	1

CCW indicator for liver disease, cirrhosis and other liver conditions (except viral hepatitis): For each person-month, this variable records whether the person meets the CCW clinical criteria for liver disease, cirrhosis and other liver conditions (except viral hepatitis). If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.064	0	1
Medicare FFS	.055	0	1
Medicaid HealthChoice	.018	0	1
Medicaid FFS	.044	0	1

CCW indicator for lung cancer: For each person-month, this variable records whether the person meets the CCW clinical criteria for lung cancer. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.013	0	1
Medicare FFS	.011	0	1
Medicaid HealthChoice	.001	0	1
Medicaid FFS	.004	0	1

Indicator for metastatic cancer: For each person-month, this variable records whether the person has incurred at least one inpatient or two non-inpatient claims with any diagnosis for metastatic cancer within the past two years. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.018	0	1
Medicare FFS	.019	0	1
Medicaid HealthChoice	.002	0	1
Medicaid FFS	.009	0	1

CCW indicator for migraine and chronic headache: For each person-month, this variable records whether the person meets the CCW clinical criteria for migraine and chronic headache. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.042	0	1
Medicare FFS	.034	0	1
Medicaid HealthChoice	.025	0	1
Medicaid FFS	.018	0	1

CCW indicator for mobility impairments: For each person-month, this variable records whether the person meets the CCW clinical criteria for mobility impairments. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.021	0	1
Medicare FFS	.029	0	1
Medicaid HealthChoice	.003	0	1
Medicaid FFS	.077	0	1

CCW indicator for multiple sclerosis and transverse myelitis: For each person-month, this variable records whether the person meets the CCW clinical criteria for multiple sclerosis and transverse myelitis. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.006	0	1
Medicare FFS	.006	0	1
Medicaid HealthChoice	.001	0	1
Medicaid FFS	.004	0	1

CCW indicator for muscular dystrophy: For each person-month, this variable records whether the person meets the CCW clinical criteria for muscular dystrophy. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	0	0	1
Medicare FFS	0	0	1
Medicaid HealthChoice	0	0	1
Medicaid FFS	.006	0	1

Indicator for neuropathy: For each person-month, this variable records whether the person has incurred at least one inpatient or two non-inpatient claims with any diagnosis for neuropathy within the past two years. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.063	0	1
Medicare FFS	.06	0	1
Medicaid HealthChoice	.006	0	1
Medicaid FFS	.028	0	1

CCW indicator for non-Alzheimer's dementia: For each person-month, this variable records whether the person meets the CCW clinical criteria for non-Alzheimer's dementia. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.051	0	1
Medicare FFS	.078	0	1
Medicaid HealthChoice	.001	0	1
Medicaid FFS	.041	0	1

CCW indicator for obesity: For each person-month, this variable records whether the person meets the CCW clinical criteria for obesity. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.263	0	1
Medicare FFS	.185	0	1
Medicaid HealthChoice	.104	0	1
Medicaid FFS	.107	0	1

Indicator for occupational exposure to risk factors: For each person-month, this variable records whether the person has incurred at least one inpatient or two non-inpatient claims with any diagnosis for occupational exposure to risk factors within the past two years. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	0	0	1
Medicare FFS	0	0	1
Medicaid HealthChoice	0	0	1
Medicaid FFS	0	0	0

CCW indicator for osteoporosis with or without pathological fracture: For each person-month, this variable records whether the person meets the CCW clinical criteria for osteoporosis with or without pathological fracture. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.147	0	1
Medicare FFS	.109	0	1
Medicaid HealthChoice	.002	0	1
Medicaid FFS	.026	0	1

CCW indicator for other developmental delays: For each person-month, this variable records whether the person meets the CCW clinical criteria for other developmental delays. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.001	0	1
Medicare FFS	.001	0	1
Medicaid HealthChoice	.015	0	1
Medicaid FFS	.086	0	1

Indicator for other problems with primary support group: For each person-month, this variable records whether the person has incurred at least one inpatient or two non-inpatient claims with any diagnosis for other problems with primary support group within the past two years. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.007	0	1
Medicare FFS	.008	0	1
Medicaid HealthChoice	.006	0	1
Medicaid FFS	.009	0	1

Indicator for pancreatitis: For each person-month, this variable records whether the person has incurred at least one inpatient or two non-inpatient claims with any diagnosis for pancreatitis within the past two years. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.02	0	1
Medicare FFS	.019	0	1
Medicaid HealthChoice	.004	0	1
Medicaid FFS	.014	0	1

CCW indicator for Parkinson's Disease or Secondary Parkinsonism: For each person-month, this variable records whether the person meets the CCW clinical criteria for Parkinson's Disease or Secondary Parkinsonism. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.016	0	1
Medicare FFS	.018	0	1
Medicaid HealthChoice	0	0	1
Medicaid FFS	.006	0	1

Indicator for peptic ulcer disease: For each person-month, this variable records whether the person has incurred at least one inpatient or two non-inpatient claims with any diagnosis for peptic ulcer disease within the past two years. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.009	0	1
Medicare FFS	.01	0	1
Medicaid HealthChoice	.002	0	1
Medicaid FFS	.007	0	1

Indicator for peripheral and visceral atherosclerosis: For each person-month, this variable records whether the person has incurred at least one inpatient or two non-inpatient claims with any diagnosis for peripheral and visceral atherosclerosis within the past two years. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.118	0	1
Medicare FFS	.129	0	1
Medicaid HealthChoice	.005	0	1
Medicaid FFS	.047	0	1

CCW indicator for peripheral vascular disease: For each person-month, this variable records whether the person meets the CCW clinical criteria for peripheral vascular disease. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.132	0	1
Medicare FFS	.141	0	1
Medicaid HealthChoice	.005	0	1
Medicaid FFS	.048	0	1

CCW indicator for personality disorders: For each person-month, this variable records whether the person meets the CCW clinical criteria for personality disorders. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.009	0	1
Medicare FFS	.009	0	1
Medicaid HealthChoice	.008	0	1
Medicaid FFS	.013	0	1

CCW indicator for pneumonia, all-cause: For each person-month, this variable records whether the person meets the CCW clinical criteria for pneumonia, all-cause. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.034	0	1
Medicare FFS	.044	0	1
Medicaid HealthChoice	.009	0	1
Medicaid FFS	.058	0	1

CCW indicator for post-traumatic stress disorder: For each person-month, this variable records whether the person meets the CCW clinical criteria for post-traumatic stress disorder. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.012	0	1
Medicare FFS	.014	0	1
Medicaid HealthChoice	.038	0	1
Medicaid FFS	.054	0	1

CCW indicator for pressure and chronic ulcers: For each person-month, this variable records whether the person meets the CCW clinical criteria for pressure and chronic ulcers. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.03	0	1
Medicare FFS	.045	0	1
Medicaid HealthChoice	.004	0	1
Medicaid FFS	.054	0	1

Indicator for problems with education and literacy: For each person-month, this variable records whether the person has incurred at least one inpatient or two non-inpatient claims with any diagnosis for problems with education and literacy within the past two years. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.014	0	1
Medicare FFS	.018	0	1
Medicaid HealthChoice	.005	0	1
Medicaid FFS	.016	0	1

Indicator for problems with employment and unemployment: For each person-month, this variable records whether the person has incurred at least one inpatient or two non-inpatient claims with any diagnosis for problems with employment and unemployment within the past two years. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.001	0	1
Medicare FFS	.002	0	1
Medicaid HealthChoice	.004	0	1
Medicaid FFS	.011	0	1

Indicator for problems with housing and economic conditions: For each person-month, this variable records whether the person has incurred at least one inpatient or two non-inpatient claims with any diagnosis for problems with housing and economic conditions within the past two years. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.01	0	1
Medicare FFS	.013	0	1
Medicaid HealthChoice	.022	0	1
Medicaid FFS	.179	0	1

Indicator for difficulty with life management: For each person-month, this variable records whether the person has incurred at least one inpatient or two non-inpatient claims with any diagnosis for difficulty with life management within the past two years. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.004	0	1
Medicare FFS	.005	0	1
Medicaid HealthChoice	.001	0	1
Medicaid FFS	.008	0	1

Indicator for lifestyle problems: For each person-month, this variable records whether the person has incurred at least one inpatient or two non-inpatient claims with any diagnosis for lifestyle problems within the past two years. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.022	0	1
Medicare FFS	.019	0	1
Medicaid HealthChoice	.015	0	1
Medicaid FFS	.029	0	1

Indicator for psychosocial problems: For each person-month, this variable records whether the person has incurred at least one inpatient or two non-inpatient claims with any diagnosis for psychosocial problems within the past two years. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.001	0	1
Medicare FFS	.001	0	1
Medicaid HealthChoice	.003	0	1
Medicaid FFS	.012	0	1

Indicator for problems with social environment: For each person-month, this variable records whether the person has incurred at least one inpatient or two non-inpatient claims with any diagnosis for problems with social environment within the past two years. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.009	0	1
Medicare FFS	.011	0	1
Medicaid HealthChoice	.003	0	1
Medicaid FFS	.009	0	1

Indicator for problems with upbringing: For each person-month, this variable records whether the person has incurred at least one inpatient or two non-inpatient claims with any diagnosis for problems with upbringing within the past two years. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.001	0	1
Medicare FFS	.001	0	1
Medicaid HealthChoice	.003	0	1
Medicaid FFS	.006	0	1

Indicator for problems with care provider dependency: For each person-month, this variable records whether the person has incurred at least one inpatient or two non-inpatient claims with any diagnosis for problems with care provider dependency within the past two years. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.088	0	1
Medicare FFS	.111	0	1
Medicaid HealthChoice	.003	0	1
Medicaid FFS	.076	0	1

CCW indicator for prostate cancer: For each person-month, this variable records whether the person meets the CCW clinical criteria for prostate cancer. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.053	0	1
Medicare FFS	.049	0	1
Medicaid HealthChoice	.001	0	1
Medicaid FFS	.006	0	1

Indicator for protein-calorie malnutrition: For each person-month, this variable records whether the person has incurred at least one inpatient or two non-inpatient claims with any diagnosis for protein-calorie malnutrition within the past two years. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.021	0	1
Medicare FFS	.036	0	1
Medicaid HealthChoice	.004	0	1
Medicaid FFS	.054	0	1

Indicator for pulmonary circulatory disorder: For each person-month, this variable records whether the person has incurred at least one inpatient or two non-inpatient claims with any diagnosis for pulmonary circulatory disorder within the past two years. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.045	0	1
Medicare FFS	.047	0	1
Medicaid HealthChoice	.005	0	1
Medicaid FFS	.032	0	1

CCW indicator for rheumatoid arthritis/osteoarthritis: For each person-month, this variable records whether the person meets the CCW clinical criteria for rheumatoid arthritis/osteoarthritis. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.404	0	1
Medicare FFS	.343	0	1
Medicaid HealthChoice	.039	0	1
Medicaid FFS	.108	0	1

Indicator for respiratory infection: For each person-month, this variable records whether the person has incurred at least one inpatient or two non-inpatient claims with any diagnosis for respiratory infection within the past two years. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.161	0	1
Medicare FFS	.129	0	1
Medicaid HealthChoice	.233	0	1
Medicaid FFS	.132	0	1

Indicator for retinopathy: For each person-month, this variable records whether the person has incurred at least one inpatient or two non-inpatient claims with any diagnosis for retinopathy within the past two years. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.002	0	1
Medicare FFS	.002	0	1
Medicaid HealthChoice	0	0	1
Medicaid FFS	.001	0	1

Indicator for rheumatoid arthritis/collagen vascular disease: For each person-month, this variable records whether the person has incurred at least one inpatient or two non-inpatient claims with any diagnosis for rheumatoid arthritis/collagen vascular disease within the past two years. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.068	0	1
Medicare FFS	.057	0	1
Medicaid HealthChoice	.009	0	1
Medicaid FFS	.013	0	1

CCW indicator for schizophrenia and other psychotic disorders: For each person-month, this variable records whether the person meets the CCW clinical criteria for schizophrenia and other psychotic disorders. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.016	0	1
Medicare FFS	.027	0	1
Medicaid HealthChoice	.023	0	1
Medicaid FFS	.1	0	1

CCW indicator for sensory (blindness and visual) impairment: For each person-month, this variable records whether the person meets the CCW clinical criteria for sensory (blindness and visual) impairment. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.004	0	1
Medicare FFS	.004	0	1
Medicaid HealthChoice	0	0	1
Medicaid FFS	.005	0	1

CCW indicator for sensory (deafness and hearing) impairment: For each person-month, this variable records whether the person meets the CCW clinical criteria for sensory (deafness and hearing) impairment. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.105	0	1
Medicare FFS	.079	0	1
Medicaid HealthChoice	.007	0	1
Medicaid FFS	.021	0	1

Indicator for sepsis: For each person-month, this variable records whether the person has incurred at least one inpatient or two non-inpatient claims with any diagnosis for sepsis within the past two years. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.032	0	1
Medicare FFS	.045	0	1
Medicaid HealthChoice	.009	0	1
Medicaid FFS	.074	0	1

Indicator for sleep apnea: For each person-month, this variable records whether the person has incurred at least one inpatient or two non-inpatient claims with any diagnosis for sleep apnea within the past two years. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.189	0	1
Medicare FFS	.172	0	1
Medicaid HealthChoice	.047	0	1
Medicaid FFS	.107	0	1

Indicator for solid tumor without metastasis: For each person-month, this variable records whether the person has incurred at least one inpatient or two non-inpatient claims with any diagnosis for solid tumor without metastasis within the past two years. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.138	0	1
Medicare FFS	.119	0	1
Medicaid HealthChoice	.007	0	1
Medicaid FFS	.027	0	1

CCW indicator for spina bifida and other congenital anomalies of the nervous system: For each person-month, this variable records whether the person meets the CCW clinical criteria for spina bifida and other congenital anomalies of the nervous system. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.002	0	1
Medicare FFS	.002	0	1
Medicaid HealthChoice	.002	0	1
Medicaid FFS	.047	0	1

CCW indicator for spinal cord injury: For each person-month, this variable records whether the person meets the CCW clinical criteria for spinal cord injury. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.006	0	1
Medicare FFS	.006	0	1
Medicaid HealthChoice	.001	0	1
Medicaid FFS	.007	0	1

CCW indicator for stroke/ischemic transient attack: For each person-month, this variable records whether the person meets the CCW clinical criteria for stroke/ischemic transient attack. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.066	0	1
Medicare FFS	.071	0	1
Medicaid HealthChoice	.006	0	1
Medicaid FFS	.055	0	1

CCW indicator for tobacco use: For each person-month, this variable records whether the person meets the CCW clinical criteria for tobacco use. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.07	0	1
Medicare FFS	.061	0	1
Medicaid HealthChoice	.061	0	1
Medicaid FFS	.139	0	1

CCW indicator for traumatic brain injury and nonpsychotic mental disorders due to brain damage: For each person-month, this variable records whether the person meets the CCW clinical criteria for traumatic brain injury and nonpsychotic mental disorders due to brain damage. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.003	0	1
Medicare FFS	.003	0	1
Medicaid HealthChoice	.001	0	1
Medicaid FFS	.007	0	1

Indicator for urinary tract infection: For each person-month, this variable records whether the person has incurred at least one inpatient or two non-inpatient claims with any diagnosis for urinary tract infection within the past two years. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.115	0	1
Medicare FFS	.132	0	1
Medicaid HealthChoice	.028	0	1
Medicaid FFS	.08	0	1

CCW indicator for urologic cancer: For each person-month, this variable records whether the person meets the CCW clinical criteria for urologic cancer. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.008	0	1
Medicare FFS	.008	0	1
Medicaid HealthChoice	0	0	1
Medicaid FFS	.002	0	1

CCW indicator for viral hepatitis: For each person-month, this variable records whether the person meets the CCW clinical criteria for viral hepatitis. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.007	0	1
Medicare FFS	.011	0	1
Medicaid HealthChoice	.006	0	1
Medicaid FFS	.029	0	1

Indicator for cilostazol use: For each person-month, this variable takes the value of 1 if a person incurred a claim for cilostazol within the past 12 months, and 0 otherwise.

Source: Pharmacy claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.002	0	1
Medicare FFS	.002	0	1
Medicaid HealthChoice	0	0	1
Medicaid FFS	.001	0	1

DCSI Score – Cardiovascular: For each person-month, this variable records the person's cardiovascular DCSI score over the past 12 months: 0 = had no complications; 1 = had at least 1 non-severe complication; 2 = had at least 1 severe complication.

Source: Institutional and professional claims

Models: Pre-DC

Population	Mean	Min	Max
Medicare MDPCP	.642	0	2
Medicare FFS	.602	0	2
Medicaid HealthChoice	.062	0	2
Medicaid FFS	.297	0	2

DCSI Score – Cerebrovascular: For each person-month, this variable records the person's cerebrovascular DCSI score over the past 12 months: 0 = had no complications; 1 = had at least 1 non-severe complication; 2 = had at least 1 severe complication.

Source: Institutional and professional claims

Models: Pre-DC

Population	Mean	Min	Max
Medicare MDPCP	.229	0	2
Medicare FFS	.216	0	2
Medicaid HealthChoice	.015	0	2
Medicaid FFS	.123	0	2

DCSI Score - Metabolic: For each person-month, this variable records the person's metabolic DCSI score over the past 12 months: 0 = had no complications; 1 = had at least 1 non-severe complication; 2 = had at least 1 severe complication.

Source: Institutional and professional claims

Models: Pre-DC

Population	Mean	Min	Max
Medicare MDPCP	.01	0	2
Medicare FFS	.013	0	2
Medicaid HealthChoice	.003	0	2
Medicaid FFS	.014	0	2

DCSI Score – Nephropathy: For each person-month, this variable records the person's nephropathy DCSI score over the past 12 months: 0 = had no complications; 1 = had at least 1 non-severe complication; 2 = had at least 1 severe complication.

Source: Institutional and professional claims

Models: Pre-DC

Population	Mean	Min	Max
Medicare MDPCP	.152	0	2
Medicare FFS	.199	0	2
Medicaid HealthChoice	.014	0	2
Medicaid FFS	.113	0	2

DCSI Score – Neuropathy: For each person-month, this variable records the person's neuropathy DCSI score over the past 12 months: 0 = had no complications; 1 = had at least 1 non-severe complication.

Source: Institutional and professional claims

Models: Pre-DC

Population	Mean	Min	Max
Medicare MDPCP	.132	0	1
Medicare FFS	.126	0	1
Medicaid HealthChoice	.021	0	1
Medicaid FFS	.078	0	1

DCSI Score - Peripheral Vascular Disease: For each person-month, this variable records the person's PVD DCSI score over the past 12 months: 0 = had no complications; 1 = had at least 1 non-severe complication; 2 = had at least 1 severe complication.

Source: Institutional and professional claims

Models: Pre-DC

Population	Mean	Min	Max
Medicare MDPCP	.157	0	2
Medicare FFS	.164	0	2
Medicaid HealthChoice	.012	0	2
Medicaid FFS	.108	0	2

DCSI Score – Retinopathy: For each person-month, this variable records the person's retinopathy DCSI score over the past 12 months: 0 = had no complications; 1 = had at least 1 non-severe complication; 2 = had at least 1 severe complication.

Source: Institutional and professional claims

Models: Pre-DC

Population	Mean	Min	Max
Medicare MDPCP	.135	0	2
Medicare FFS	.126	0	2
Medicaid HealthChoice	.021	0	2
Medicaid FFS	.065	0	2

Chronic Renal Insufficiency/ESRD: For each person-month, this variable records whether the person has incurred at least one inpatient or two non-inpatient claims with any diagnosis for chronic renal insufficiency or ESRD within the past two years. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-DC

Population	Mean	Min	Max
Medicare MDPCP	.005	0	1
Medicare FFS	.025	0	1
Medicaid HealthChoice	.001	0	1
Medicaid FFS	.017	0	1

Diabetes Duration: For each person-month, this variable records the time since the person's first recorded diagnosis of diabetes.

Source: Beneficiary demographics

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	24.205	0	119
Medicare FFS	24.243	0	119
Medicaid HealthChoice	NA	NA	NA
Medicaid FFS	NA	NA	NA

Number of Previous Severe Type 2 Diabetes Complications: For each person-month, this variable records the number of severe type-2 diabetes complications in the previous 12 months.

Source: Institutional and professional claims

Models: Pre-DC

Population	Mean	Min	Max
Medicare MDPCP	.147	0	42
Medicare FFS	.198	0	143
Medicaid HealthChoice	.021	0	115
Medicaid FFS	.172	0	150

Indicator for Use of Insulin AND Another Glucose-Lowering Medication: For each person-month, this variable records whether the person has been prescribed both insulin AND another glucose-lowering drug within the same month in the past 12 months. If so, this variable takes the value 1; if not, then 0.

Source: Pharmacy claims

Models: Pre-DC

Population	Mean	Min	Max
Medicare MDPCP	.028	0	1
Medicare FFS	.027	0	1
Medicaid HealthChoice	.008	0	1
Medicaid FFS	.028	0	1

Part D OOP spending: For each person-month, this variable records the total amount of out-of-pocket spending for prescriptions in the previous 12 months.

Source: Pharmacy claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	314.31	0	3573
Medicare FFS	258.978	0	3686
Medicaid HealthChoice	NA	NA	NA
Medicaid FFS	NA	NA	NA

Indicator for use of Anticoagulants: For each person-month, this variable records whether the person has been prescribed an anticoagulant in the past 12 months. If so, this variable takes the value 1; if not, then 0.

Source: Pharmacy claims

Models: Pre-DC

Population	Mean	Min	Max
Medicare MDPCP	.103	0	1
Medicare FFS	.095	0	1
Medicaid HealthChoice	.008	0	1
Medicaid FFS	.052	0	1

Indicator for use of Anti-Hypertensive Treatment: For each person-month, this variable records whether the person has been prescribed an anti-hypertensive in the past 12 months. If so, this variable takes the value 1; if not, then 0.

Source: Pharmacy claims

Models: Pre-DC

Population	Mean	Min	Max
Medicare MDPCP	.545	0	1
Medicare FFS	.449	0	1
Medicaid HealthChoice	.099	0	1
Medicaid FFS	.275	0	1

Indicator for Use of Fibrates: For each person-month, this variable records whether the person has been prescribed a fibrate in the past 12 months. If so, this variable takes the value 1; if not, then 0.

Source: Pharmacy claims

Models: Pre-DC

Population	Mean	Min	Max
Medicare MDPCP	.018	0	1
Medicare FFS	.013	0	1
Medicaid HealthChoice	.003	0	1
Medicaid FFS	.007	0	1

Indicator for use of Sulfonylureas: For each person-month, this variable records whether the person has been prescribed a sulfonylurea in the past 12 months. If so, this variable takes the value 1; if not, then 0.

Source: Pharmacy claims

Models: Pre-DC

Population	Mean	Min	Max
Medicare MDPCP	.039	0	1
Medicare FFS	.031	0	1
Medicaid HealthChoice	.008	0	1
Medicaid FFS	.024	0	1

Indicator for use of Thiazolidinediones: For each person-month, this variable records whether the person has been prescribed a thiazolidinedione or glitazone in the past 12 months. If so, this variable takes the value 1; if not, then 0.

Source: Pharmacy claims

Models: Pre-DC

Population	Mean	Min	Max
Medicare MDPCP	.008	0	1
Medicare FFS	.007	0	1
Medicaid HealthChoice	.001	0	1
Medicaid FFS	.003	0	1

Cumulative Number of Days for Inpatient Stays: For each person-month, this variable records the number of days for inpatient hospital stays in the previous 12 months.

Source: Institutional claims

Models: Pre-DC

Population	Mean	Min	Max
Medicare MDPCP	.852	0	212
Medicare FFS	1.232	0	334
Medicaid HealthChoice	.309	0	1268
Medicaid FFS	3.986	0	465

Indicator for frailty: For each person-month, this variable takes the value of 1 if a person meets the definition for frailty within the past twelve months, and 0 otherwise. The clinical definition for frailty is derived from Kim and Schneeweiss 2014.

Source: Institutional, professional, and DME claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.37	0	1
Medicare FFS	.347	0	1
Medicaid HealthChoice	.08	0	1
Medicaid FFS	.232	0	1

Indicator for sickle cell anemia: For each person-month, this variable records whether the person has incurred at least one inpatient or two non-inpatient claims with any diagnosis for sickle cell anemia within the past two years. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	0	0	1
Medicare FFS	.001	0	1
Medicaid HealthChoice	.001	0	1
Medicaid FFS	.001	0	1

Indicator for durable medical equipment (DME) use: For each person-month, this variable takes the value of 1 if a person used any durable medical equipment in the previous 12 months, and 0 otherwise.

Source: DME claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.302	0	1
Medicare FFS	.262	0	1
Medicaid HealthChoice	.064	0	1
Medicaid FFS	.134	0	1

Indicator for dual eligibility with Medicaid: For each person-month, this variable takes the value of 1 if a person was dually eligible for both Medicaid and Medicare within the past 12 months, and 0 otherwise.

Source: Beneficiary demographics

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.106	0	1
Medicare FFS	.158	0	1
Medicaid HealthChoice	0	0	1
Medicaid FFS	0	0	1

Number of emergency department visits within the past 6 months: For each person-month, this variable counts the number of emergency department visits incurred within the prior 6 months.

Source: Institutional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.163	0	73
Medicare FFS	.175	0	128
Medicaid HealthChoice	.193	0	107
Medicaid FFS	.367	0	103

Indicator for endocrinologist visit: For each person-month, this variable takes the value of 1 if a person visited an endocrinologist within the past 12 months, and 0 otherwise.

Source: Professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.09	0	1
Medicare FFS	.077	0	1
Medicaid HealthChoice	.005	0	1
Medicaid FFS	.013	0	1

Indicator for diabetic foot procedure: For each person-month, this variable takes the value of 1 if a person incurred an inpatient diabetic foot procedure over the last 12 months and 0 otherwise.

Source: Institutional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.001	0	1
Medicare FFS	.001	0	1
Medicaid HealthChoice	0	0	1
Medicaid FFS	.001	0	1

Indicator for having Received Chemotherapy: For each person-month, this variable records whether the person has received chemotherapy in the past 12 months. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.012	0	1
Medicare FFS	NA	NA	NA
Medicaid HealthChoice	NA	NA	NA
Medicaid FFS	NA	NA	NA

Chronic Renal Insufficiency/ESRD: For each person-month, this variable records whether the person has incurred at least one inpatient or two non-inpatient claims with any diagnosis for chronic renal insufficiency or ESRD within the past two years. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.005	0	1
Medicare FFS	NA	NA	NA
Medicaid HealthChoice	NA	NA	NA
Medicaid FFS	NA	NA	NA

Indicator for having Received Dialysis: For each person-month, this variable records whether the person has been on dialysis in the past 12 months. If so, this variable takes the value 1; if not, then 0.

Source: Professional claims

Models: Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.001	0	1
Medicare FFS	NA	NA	NA
Medicaid HealthChoice	NA	NA	NA
Medicaid FFS	NA	NA	NA

Indicator for Cancer of Bone and Connective Tissue: For each person-month, this variable records whether the person has had a diagnosis for cancer of the bone or connective tissue in the past 12 months. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.001	0	1
Medicare FFS	NA	NA	NA
Medicaid HealthChoice	NA	NA	NA
Medicaid FFS	NA	NA	NA

Indicator for Cancer of Brain and Nervous System: For each person-month, this variable records whether the person has had a diagnosis for cancer of the brain or nervous system in the past 12 months. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.001	0	1
Medicare FFS	NA	NA	NA
Medicaid HealthChoice	NA	NA	NA
Medicaid FFS	NA	NA	NA

Indicator for Cancer of Esophagus: For each person-month, this variable records whether the person has had a diagnosis for cancer of the esophagus in the past 12 months. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.001	0	1
Medicare FFS	NA	NA	NA
Medicaid HealthChoice	NA	NA	NA
Medicaid FFS	NA	NA	NA

Indicator for Cancer of Liver and Intrahepatic Bile Duct: For each person-month, this variable records whether the person has had a diagnosis for cancer of the liver or intrahepatic bile duct in the past 12 months. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.002	0	1
Medicare FFS	NA	NA	NA
Medicaid HealthChoice	NA	NA	NA
Medicaid FFS	NA	NA	NA

Indicator for Cancer of Bronchus; Lung: For each person-month, this variable records whether the person has had a diagnosis for cancer of the bronchus/lung in the past 12 months. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.012	0	1
Medicare FFS	NA	NA	NA
Medicaid HealthChoice	NA	NA	NA
Medicaid FFS	NA	NA	NA

Indicator for Cancer of Ovary: For each person-month, this variable records whether the person has had a diagnosis for cancer of the ovary in the past 12 months. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.002	0	1
Medicare FFS	NA	NA	NA
Medicaid HealthChoice	NA	NA	NA
Medicaid FFS	NA	NA	NA

Indicator for Cancer of Pancreas: For each person-month, this variable records whether the person has had a diagnosis for cancer of the pancreas in the past 12 months. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.002	0	1
Medicare FFS	NA	NA	NA
Medicaid HealthChoice	NA	NA	NA
Medicaid FFS	NA	NA	NA

Indicator for Cancer of Stomach: For each person-month, this variable records whether the person has had a diagnosis for cancer of the stomach in the past 12 months. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.001	0	1
Medicare FFS	NA	NA	NA
Medicaid HealthChoice	NA	NA	NA
Medicaid FFS	NA	NA	NA

Indicator for Paraplegia or Hemiplegia: For each person-month, this variable records whether the person has had a diagnosis for paraplegia or hemiplegia in the past 12 months. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.012	0	1
Medicare FFS	NA	NA	NA
Medicaid HealthChoice	NA	NA	NA
Medicaid FFS	NA	NA	NA

Indicator for Hospital Bed Usage in DME: For each person-month, this variable records whether the person has a DME claim for a home hospital bed in the previous 12 months. If so, this variable takes the value 1; if not, then 0.

Source: Professional claims

Models: Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.007	0	1
Medicare FFS	NA	NA	NA
Medicaid HealthChoice	NA	NA	NA
Medicaid FFS	NA	NA	NA

Interaction of ADRD and Frailty Index: For each person-month, this variable records the interaction between whether a person has a dementia diagnosis AND their frailty index score.

Source: Institutional and professional claims

Models: Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.014	0	1
Medicare FFS	NA	NA	NA
Medicaid HealthChoice	NA	NA	NA
Medicaid FFS	NA	NA	NA

Indicator for Morphine Use: For each person-month, this variable records whether the person has received or been prescribed morphine in the past 12 months. If so, this variable takes the value 1; if not, then 0.

Source: Institutional, professional, and pharmacy claims

Models: Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.018	0	1
Medicare FFS	NA	NA	NA
Medicaid HealthChoice	NA	NA	NA
Medicaid FFS	NA	NA	NA

Indicator for Oxygen Usage in DME: For each person-month, this variable records whether the person has a DME claim for home oxygen therapy in the previous 12 months. If so, this variable takes the value 1; if not, then 0.

Source: Professional claims

Models: Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.088	0	1
Medicare FFS	NA	NA	NA
Medicaid HealthChoice	NA	NA	NA
Medicaid FFS	NA	NA	NA

Severity of Frailty: For each person-month, this variable records each patient's claims-based frailty index (CFI) score using claims from the previous 12 months. CFI calculated using methods detailed in Gautam et al., 2020, Journals of Gerontology: Medical Sciences.

Source: Institutional and professional claims

Models: Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.161	0	1
Medicare FFS	NA	NA	NA
Medicaid HealthChoice	NA	NA	NA
Medicaid FFS	NA	NA	NA

Recent Increase in Frailty severity: For each person-month, this variable records whether the person's claims-based frailty index score has increased compared to the previous month. If so, this variable takes the value 1; if not, then 0.

Source: Institutional and professional claims

Models: Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.276	0	1
Medicare FFS	NA	NA	NA
Medicaid HealthChoice	NA	NA	NA
Medicaid FFS	NA	NA	NA

Number of HbA1c tests: For each person-month, this variable counts the number of visits within the past 12 months in which a person received a Hemoglobin A1C (HbA1c) test. We define visits as unique combinations of person-provider-day.

Source: Professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.858	0	10
Medicare FFS	.727	0	14
Medicaid HealthChoice	.047	0	11
Medicaid FFS	.022	0	6

Number of heart-related procedures: For each person-month, this variable counts the number of heart-related procedures incurred over the past year.

Source: Institutional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.022	0	15
Medicare FFS	.026	0	14
Medicaid HealthChoice	.004	0	14
Medicaid FFS	.02	0	9

Number of home health visits: For each person-month, this variable counts the number of home health visits incurred within the past 12 months. We apply a logarithmic transformation to non-zero values. We define visits as unique combinations of person-provider-day.

Source: Professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.05	0	5
Medicare FFS	.09	0	5
Medicaid HealthChoice	.08	0	7
Medicaid FFS	.77	0	7

Indicator for hospice enrollment: For each person-month, this variable takes the value of 1 if a person enrolled in hospice within the past 12 months, and 0 otherwise.

Source: Beneficiary demographics

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.002	0	1
Medicare FFS	.009	0	1
Medicaid HealthChoice	NA	NA	NA
Medicaid FFS	NA	NA	NA

Indicator for insulin use: For each person-month, this variable takes the value of 1 if a person incurred a claim for insulin within the past 12 months, and 0 otherwise.

Source: Pharmacy claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.04	0	1
Medicare FFS	.043	0	1
Medicaid HealthChoice	.015	0	1
Medicaid FFS	.046	0	1

Indicator for leukotriene receptor modifier use: For each person-month, this variable takes the value of 1 if a person incurred a claim for leukotriene receptor modifiers within the past 12 months, and 0 otherwise.

Source: Pharmacy claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.039	0	1
Medicare FFS	.033	0	1
Medicaid HealthChoice	.021	0	1
Medicaid FFS	.022	0	1

Indicator for losartan use: For each person-month, this variable takes the value of 1 if a person incurred a claim for losartan within the past 12 months, and 0 otherwise.

Source: Pharmacy claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.16	0	1
Medicare FFS	.125	0	1
Medicaid HealthChoice	.025	0	1
Medicaid FFS	.076	0	1

Indicator for original Medicare eligibility for a non-age related cause: Beneficiary was originally eligible for Medicare for a reason other than age.

Source: Beneficiary demographics

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.132	0	1
Medicare FFS	.184	0	1
Medicaid HealthChoice	NA	NA	NA
Medicaid FFS	NA	NA	NA

Total health spending: For each person-month, this variable measures the total health spending incurred within the past 12 months. We define this as the sum of claim total charge amount (Part A), claim payment amount (Part B claim lines, aggregated to the claim level), and claim line beneficiary payment amount (part D).

Source: Institutional, professional, and pharmacy claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	16995.04	0	5323044
Medicare FFS	36067.11	0	9714033
Medicaid HealthChoice	NA	NA	NA
Medicaid FFS	NA	NA	NA

Indicator for mental health use: For each person-month, this variable takes the value of 1 if a person incurred a visit with a mental health professional over the past 12 months, and 0 otherwise.

Source: Professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.046	0	1
Medicare FFS	.061	0	1
Medicaid HealthChoice	.131	0	1
Medicaid FFS	.167	0	1

Number of medications: For each person-month, this variable counts the number of distinct medications (as measured by NDC codes) for which there are Pharmacy claims within the past 12 months.

Source: Pharmacy claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	9.248	0	103
Medicare FFS	8.248	0	120
Medicaid HealthChoice	5.313	0	221
Medicaid FFS	9.049	0	131

Indicator for oncologist visit: For each person-month, this variable takes the value of 1 if a person visited an oncologist within the past 12 months, and 0 otherwise.

Source: Professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.129	0	1
Medicare FFS	.111	0	1
Medicaid HealthChoice	.01	0	1
Medicaid FFS	.019	0	1

Indicator for oral antibiotic use: For each person-month, this variable takes the value of 1 if a person incurred a claim for oral antibiotics within the past 12 months, and 0 otherwise.

Source: Pharmacy claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.413	0	1
Medicare FFS	.349	0	1
Medicaid HealthChoice	.346	0	1
Medicaid FFS	.301	0	1

Indicator for oral corticosteroid use: For each person-month, this variable takes the value of 1 if a person incurred a claim for oral corticosteroids within the past 12 months, and 0 otherwise.

Source: Pharmacy claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.179	0	1
Medicare FFS	.143	0	1
Medicaid HealthChoice	.083	0	1
Medicaid FFS	.082	0	1

Number of outpatient visits: For each person-month, this variable counts the number of visits in an outpatient setting incurred within the past 12 months. We define visits as unique combinations of person-provider-day.

Source: Professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	18.354	0	297
Medicare FFS	15.379	0	354
Medicaid HealthChoice	9.966	0	814
Medicaid FFS	15.006	0	594

Continuity of primary care - Duration: For each person-month, this variable calculates the average time interval between primary care visits over the past 12 months. Visits that occur within 14 days are aggregated. Individuals with no primary care visits over the past 12 months are assigned a value of 365. We define visits as unique combinations of person-provider-day.

Source: Professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	85.652	16	365
Medicare FFS	131.583	15	365
Medicaid HealthChoice	198.961	16	365
Medicaid FFS	192.742	15	365

Discontinuity of primary care - Index: For each person-month, this variable calculates (1 - the continuity of care index), from Boxerman and Bice, 1977. This score ranges from 0 to 1 and is intended to measure dispersion in person-provider contact. If the person sees the same provider for all visits, indicating highly continuous care, the index score is 0; if the person sees a different physician for every visit, indicating fragmented care, the index score is 1. If a person has no primary care visits within the past year, they are assigned a value of 0. We define visits as unique combinations of person-provider-day.

Source: Professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.751	0	1
Medicare FFS	.609	0	1
Medicaid HealthChoice	.348	0	1
Medicaid FFS	.415	0	1

Discontinuity of primary care - Proportion: For each person-month, this variable estimates (1 - the fraction of primary care visits within the past 12 months provided by the same provider). For example, if a person had 10 primary care visits over the past 12 months, and four visits were with the same provider, then this measure would take a value of (1 - .4) = .6. We define visits as unique combinations of person-provider-day.

Source: Professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.577	0	1
Medicare FFS	.602	0	1
Medicaid HealthChoice	.414	0	1
Medicaid FFS	.6	0	1

Number of primary care visits: For each person-month, this variable counts the number of primary care visits within the past 12 months. We define visits as unique combinations of person-provider-day.

Source: Professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	11.458	0	304
Medicare FFS	11.728	0	518
Medicaid HealthChoice	5.132	0	419
Medicaid FFS	11.914	0	501

Indicator for previous conservative diabetic wound procedure: For each person-month, this variable takes the value of 1 if a person underwent at least one conservative diabetic procedure within the past 12 months, and 0 otherwise.

Source: Professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.01	0	1
Medicare FFS	.013	0	1
Medicaid HealthChoice	.001	0	1
Medicaid FFS	.008	0	1

Number of prior admissions: For each person-month, this variable counts the number of all inpatient hospital admissions incurred within the past twelve months.

Source: Institutional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.163	0	20
Medicare FFS	.204	0	45
Medicaid HealthChoice	.07	0	30
Medicaid FFS	.371	0	48

Prior admission length of stay: For each person-month, this variable calculates the length of the most recently incurred hospital inpatient stay over the past 12 months. For individuals without a previous inpatient stay, this value is set to zero.

Source: Institutional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.513	0	133
Medicare FFS	.659	0	118
Medicaid HealthChoice	.168	0	500
Medicaid FFS	.988	0	133

Prior hospitalization admission source - none: For each person-month, this variable indicates the individual did not incur an inpatient hospital stay within the past 12 month.

Source: Institutional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.894	0	1
Medicare FFS	.88	0	1
Medicaid HealthChoice	.953	0	1
Medicaid FFS	.857	0	1

Prior hospitalization admission source - other: For each person-month, this variable indicates that for the individual's most recently incurred inpatient hospital stay within the past 12 months, the individual's admission source was: other.

Source: Institutional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.001	0	1
Medicare FFS	.001	0	1
Medicaid HealthChoice	.018	0	1
Medicaid FFS	.127	0	1

Prior hospitalization admission source - physician referral: For each person-month, this variable indicates that for the individual's most recently incurred inpatient hospital stay within the past 12 months, the individual's admission source was: physician referral.

Source: Institutional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.09	0	1
Medicare FFS	.097	0	1
Medicaid HealthChoice	.025	0	1
Medicaid FFS	.012	0	1

Prior hospitalization admission source - transferred from facility: For each person-month, this variable indicates that for the individual's most recently incurred inpatient hospital stay within the past 12 months, the individual's admission source was: transferred from facility.

Source: Institutional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.015	0	1
Medicare FFS	.022	0	1
Medicaid HealthChoice	.004	0	1
Medicaid FFS	.004	0	1

Prior hospitalization admission type - elective: For each person-month, this variable indicates that for the individual's most recently incurred inpatient hospital stay within the past 12 months, the individual's admission type was: elective.

Source: Institutional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.026	0	1
Medicare FFS	.024	0	1
Medicaid HealthChoice	.009	0	1
Medicaid FFS	.025	0	1

Prior hospitalization admission type - emergency: For each person-month, this variable indicates that for the individual's most recently incurred inpatient hospital stay within the past 12 months, the individual's admission type was: emergency.

Source: Institutional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.075	0	1
Medicare FFS	.09	0	1
Medicaid HealthChoice	.021	0	1
Medicaid FFS	.1	0	1

Prior hospitalization admission type - none: For each person-month, this variable indicates the individual did not incur an inpatient hospital stay within the past 12 month.

Source: Institutional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.894	0	1
Medicare FFS	.88	0	1
Medicaid HealthChoice	.953	0	1
Medicaid FFS	.857	0	1

Prior hospitalization admission type - other: For each person-month, this variable indicates that for the individual's most recently incurred inpatient hospital stay within the past 12 months, the individual's admission type was: other.

Source: Institutional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	0	0	1
Medicare FFS	0	0	1
Medicaid HealthChoice	.012	0	1
Medicaid FFS	.005	0	1

Prior hospitalization admission type - trauma center: For each person-month, this variable indicates that for the individual's most recently incurred inpatient hospital stay within the past 12 months, the individual's admission type was: trauma center.

Source: Institutional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.001	0	1
Medicare FFS	.001	0	1
Medicaid HealthChoice	0	0	1
Medicaid FFS	.002	0	1

Prior hospitalization admission type - urgent: For each person-month, this variable indicates that for the individual's most recently incurred inpatient hospital stay within the past 12 months, the individual's admission type was: urgent.

Source: Institutional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.004	0	1
Medicare FFS	.005	0	1
Medicaid HealthChoice	.005	0	1
Medicaid FFS	.01	0	1

Prior hospitalization discharge status - home: For each person-month, this variable indicates that for the individual's most recently incurred inpatient hospital stay within the past 12 months, the individual's discharge status was: home.

Source: Institutional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.086	0	1
Medicare FFS	.088	0	1
Medicaid HealthChoice	.046	0	1
Medicaid FFS	.095	0	1

Prior hospitalization discharge status - none: For each person-month, this variable indicates the individual did not incur an inpatient hospital stay within the past 12 month.

Source: Institutional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.894	0	1
Medicare FFS	.88	0	1
Medicaid HealthChoice	.953	0	1
Medicaid FFS	.857	0	1

Prior hospitalization discharge status - other: For each person-month, this variable indicates that for the individual's most recently incurred inpatient hospital stay within the past 12 months, the individual's discharge status was: other.

Source: Institutional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.001	0	1
Medicare FFS	.001	0	1
Medicaid HealthChoice	.001	0	1
Medicaid FFS	.021	0	1

Prior hospitalization discharge status - transferred to inpatient care: For each person-month, this variable indicates that for the individual's most recently incurred inpatient hospital stay within the past 12 months, the individual's discharge status was: transferred to inpatient care.

Source: Institutional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.001	0	1
Medicare FFS	.001	0	1
Medicaid HealthChoice	0	0	1
Medicaid FFS	.002	0	1

Prior hospitalization discharge status - transferred to post-acute care: For each person-month, this variable indicates that for the individual's most recently incurred inpatient hospital stay within the past 12 months, the individual's discharge status was: transferred to post-acute care.

Source: Institutional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.019	0	1
Medicare FFS	.03	0	1
Medicaid HealthChoice	.001	0	1
Medicaid FFS	.025	0	1

Indicator for prior nursing home stay: For each person-month, this variable takes the value of 1 if a person incurred a nursing home stay within the last 12 months, and 0 otherwise.

Source: Institutional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.022	0	1
Medicare FFS	.037	0	1
Medicaid HealthChoice	.001	0	1
Medicaid FFS	.086	0	1

Indicator for prior readmission: For each person-month, this variable takes the value of 1 if a person incurred an all-cause 30-day hospital readmission within the last 12 months, and 0 otherwise. We define readmission as two inpatient stays occurring fewer than 30 days apart.

Source: Institutional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.021	0	1
Medicare FFS	.027	0	1
Medicaid HealthChoice	.007	0	1
Medicaid FFS	.037	0	1

Indicator for prior surgery: For each person-month, this variable takes the value of 1 if a person underwent a surgery within the past 12 months, and 0 otherwise.

Source: Professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.666	0	1
Medicare FFS	.556	0	1
Medicaid HealthChoice	NA	NA	NA
Medicaid FFS	NA	NA	NA

Indicator for provider administered drug: For each person-month, this variable takes the value of 1 if a person received a provider-administered drug as defined by a 'J code' in the past 12 months, and 0 otherwise.

Source: Professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.275	0	1
Medicare FFS	.224	0	1
Medicaid HealthChoice	.06	0	1
Medicaid FFS	.06	0	1

Beneficiary race - Asian: Beneficiary's Research Triangle Institute (RTI) race code is Asian.

Source: Beneficiary demographics

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.027	0	1
Medicare FFS	.037	0	1
Medicaid HealthChoice	.055	0	1
Medicaid FFS	.051	0	1

Beneficiary race - Black: Beneficiary's Research Triangle Institute (RTI) race code is Black.

Source: Beneficiary demographics

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.173	0	1
Medicare FFS	.242	0	1
Medicaid HealthChoice	.455	0	1
Medicaid FFS	.539	0	1

Beneficiary race - Hispanic: Beneficiary's Research Triangle Institute (RTI) race code is Hispanic.

Source: Beneficiary demographics

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.021	0	1
Medicare FFS	.026	0	1
Medicaid HealthChoice	.206	0	1
Medicaid FFS	.114	0	1

Beneficiary race - Native American: Beneficiary's Research Triangle Institute (RTI) race code is Native American.

Source: Beneficiary demographics

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.002	0	1
Medicare FFS	.003	0	1
Medicaid HealthChoice	.01	0	1
Medicaid FFS	.007	0	1

Beneficiary race - Other: Beneficiary's Research Triangle Institute (RTI) race code is Other.

Source: Beneficiary demographics

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.021	0	1
Medicare FFS	.025	0	1
Medicaid HealthChoice	.034	0	1
Medicaid FFS	.042	0	1

Beneficiary race - Unknown: Beneficiary's Research Triangle Institute (RTI) race code is Unknown.

Source: Beneficiary demographics

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.014	0	1
Medicare FFS	.069	0	1
Medicaid HealthChoice	.005	0	1
Medicaid FFS	.011	0	1

Beneficiary race - White: Beneficiary's Research Triangle Institute (RTI) race code is White.

Source: Beneficiary demographics

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.742	0	1
Medicare FFS	.599	0	1
Medicaid HealthChoice	.235	0	1
Medicaid FFS	.235	0	1

Indicator for rivaroxaban use: For each person-month, this variable takes the value of 1 if a person incurred a claim for rivaroxaban within the past 12 months, and 0 otherwise.

Source: Pharmacy claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.021	0	1
Medicare FFS	.018	0	1
Medicaid HealthChoice	.001	0	1
Medicaid FFS	.007	0	1

Number of rural clinic visits: For each person-month, this variable counts the number of rural clinic visits incurred within the past 12 months. We define visits as unique combinations of person-provider-day.

Source: Professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	0	0	1
Medicare FFS	0	0	4
Medicaid HealthChoice	.001	0	20
Medicaid FFS	.001	0	10

Beneficiary sex - female: Beneficiary sex is female.

Source: Beneficiary demographics

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.596	0	1
Medicare FFS	.547	0	1
Medicaid HealthChoice	.542	0	1
Medicaid FFS	.427	0	1

Beneficiary sex - male: Beneficiary sex is male.

Source: Beneficiary demographics

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.404	0	1
Medicare FFS	.453	0	1
Medicaid HealthChoice	.458	0	1
Medicaid FFS	.573	0	1

Number of specialist visits: For each person-month, this variable counts the number of specialist visits incurred within the past 12 months. We define visits as unique combinations of person-provider-day.

Source: Professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	5.533	0	397
Medicare FFS	5.503	0	375
Medicaid HealthChoice	.571	0	311
Medicaid FFS	1.707	0	206

Indicator for statin use: For each person-month, this variable takes the value of 1 if a person incurred a claim for statins within the past 12 months, and 0 otherwise.

Source: Pharmacy claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.536	0	1
Medicare FFS	.418	0	1
Medicaid HealthChoice	.078	0	1
Medicaid FFS	.244	0	1

Number of lab tests: For each person-month, this variable counts the number of visits within the past 12 months in which a person received any laboratory test. We define visits as unique combinations of person-provider-day.

Source: Professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.174	0	27
Medicare FFS	.186	0	38
Medicaid HealthChoice	.025	0	15
Medicaid FFS	.008	0	5

Number of urgent care visits: For each person-month, this variable counts the number of urgent care visits incurred within the past 12 months. We define visits as unique combinations of person-provider-day.

Source: Professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.245	0	35
Medicare FFS	.181	0	32
Medicaid HealthChoice	.551	0	58
Medicaid FFS	.202	0	31

Indicator for no vaccination (flu or pneumonia): For each person-month, this variable takes the value of 1 if a person did not receive a vaccination (flu or pneumonia) within the past 12 months, 0 otherwise.

Source: Professional claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.499	0	1
Medicare FFS	.649	0	1
Medicaid HealthChoice	.91	0	1
Medicaid FFS	.939	0	1

Indicator for warfarin use: For each person-month, this variable takes the value of 1 if a person incurred a claim for warfarin within the past 12 months, and 0 otherwise.

Source: Pharmacy claims

Models: Pre-AH, Pre-DC, Pre-HE

Population	Mean	Min	Max
Medicare MDPCP	.013	0	1
Medicare FFS	.01	0	1
Medicaid HealthChoice	.001	0	1
Medicaid FFS	.003	0	1

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Appendix 2. Social Determinants of Health Data Set

Geocoding Procedure

Hilltop enhanced the granularity of the SDOH risk factors from ZCTA to census tract as part of regular improvements to the MDPCP production model in October 2021. We increased the granularity of the SDOH covariates because research shows there can be substantial variability of SDOH within ZCTAs. Because census tract measures represent smaller areas, they may provide a more accurate representation of an individual's proximal environment (Moss et al., 2021), but it requires the additional (and potentially non-trivial) development step of geocoding patient addresses.

We used an automated two-step geocoding procedure to identify an individual's unique census tract. First, we used Microsoft® Azure Maps' "Get Search Address" feature to transform their home address from the CCLF data into geographical coordinates (i.e., latitude, longitude). Then, we mapped the coordinates to a census tract using the GeoPandas (v0.8.1) python package. Once a unique census tract was identified for an individual, we linked the environmental risk factors from both their census tract and their 5-digit ZCTA of residence to their individual utilization risk factors in SAS (v.9.4).

As of the time of writing, this geocoding is only performed for the Pre-AH Model, Pre-DC Model, and Pre-HE Model risk scores for the MDPCP population. All other models use ZCTA as the basis for geographic linkage to social determinants of health risk factors.

Description of Variables

Social and environmental variables play an important role in health; however, many individual-level demographic and socioeconomic factors are unavailable in administrative claims data. Consequently, Hilltop developed a database of area-level risk factors from publicly available data sources that can be linked to an individual's administrative claims using their recorded address to proxy for the unobserved individual-level variables. Other environmental risk factors are intended to capture social determinants of health—the neighborhood conditions in which people live and age that may affect health outcomes. Table 37 includes a list of the areal-level risk factors along with the data used to create them.

Table 37. Environmental Risk Factor Sources

Risk Factor	Source	Year	Original Granularity for Census Tract	Original Granularity for ZCTA
Population	ACS; Table B01003	2022	Census Tract	ZCTA
Population Growth[1]	ACS; Table B01003	2022	Census Tract	ZCTA
Population Density[2]	ACS; Table B01003	2022	Census Tract	ZCTA
Percent Age 0-4	ACS; Table S0101	2022	Census Tract	ZCTA
Percent Married	ACS; Table S1201	2022	Census Tract	ZCTA
Percent Single Mothers	ACS; Table S1301	2022	Census Tract	ZCTA
Median Household Income	ACS; Table S1901	2022	Census Tract	ZCTA
Percent in Poverty	ACS; Table S1702	2022	Census Tract	ZCTA
Percent Less than High School Diploma	ACS; Table S1501	2022	Census Tract	ZCTA
Percent Native American	ACS; Table DP05	2022	Census Tract	ZCTA
Percent Non-English Speakers	ACS; Table S1601	2022	Census Tract	ZCTA
Percent Foreign Born	ACS; Table DP02	2022	Census Tract	ZCTA
Percent Age 65+	ACS; Table S0101	2022	Census Tract	ZCTA
Percent Age 65+ Live Alone	ACS; Table S1101	2022	Census Tract	ZCTA
Percent Age 65+ Non-White	ACS; Table B01001A	2022	Census Tract	ZCTA
Percent Age 65+ Latinx	ACS; Table B01001L	2022	Census Tract	ZCTA
Percent Age 65+ in Poverty	ACS; Table S1702	2022	Census Tract	ZCTA
Percent Age 65+ Less than High School Diploma	ACS; Table S1501	2022	Census Tract	ZCTA
Area Deprivation Index	WISC	2021	Census Block[3]	ZCTA
Taxable Interest	IRS	2020	ZCTA[3]	ZCTA
Has a Mental Health Center	CMS	2023	Census Tract	ZCTA
Has a Federally Qualified Health Center	CMS	2023	Census Tract	ZCTA
Has a Rural Health Clinic	CMS	2023	Census Tract	ZCTA
Has a For Profit Hospital	CMS	2023	Census Tract	ZCTA
Number of Hospitals	CMS	2023	Census Tract	ZCTA
Hospitals/1000 Residents[4]	CMS	2023	Census Tract	ZCTA
Hospital Beds/1000 Residents[4]	CMS	2023	Census Tract	ZCTA
Has a VA Clinic or Center	VA	2024	Census Tract	ZCTA
Primary Care Providers/1000 Residents[4]	NPI	2024	Census Tract	ZCTA
Internists/1000 Residents[4]	NPI	2024	Census Tract	ZCTA
Specialists/1000 Residents[4]	NPI	2024	Census Tract	ZCTA
Social Workers/1000 Residents[4]	NPI	2024	Census Tract	ZCTA
Partial Primary Care Shortage Area	AHRF	2023	County[5]	County[3]

Risk Factor	Source	Year	Original Granularity for Census Tract	Original Granularity for ZCTA
Whole Primary Care Shortage Area	AHRF	2023	County[5]	County[3]
Partial Mental Health Care Shortage Area	AHRF	2023	County[5]	County[3]
Whole Mental Health Shortage Area	AHRF	2023	County[5]	County[3]
Percent Physician Diversity (racial or ethnic minority, excluding Asian Americans)	ACS Individual-Level Data	2022	County[5]	County[3]
Air Pollution (average daily PM2.5 concentration)	EPA	2023	Census Tract	Census Tract[3]

ACS = American Community Survey, 5-year estimates, data table number in ( ), AHRF = Area Health Resources File, CMS = Centers for Medicare and Medicaid Services, EPA = Environmental Protection Agency, IRS = Internal Revenue Service, NPI = National Provider Identified Database, USDA = United States Department of Agriculture, VA = Veteran's Affairs, WISC = Wisconsin School of Medicine and Public Health

[1]Population growth for census tracts is from 2013-2019 and from 2011-2019 for ZCTAs.

[2]Density calculated using land area (square miles) according to the 2019 Census Gazetteer records.

[3]Transformed to final geographic unit using **HUDuser.gov ratios**[27] **and the methods from Din & Wilson (2020).**

[4]Calcuated using the 2022 population estimates from ACS.

[5]FIPS county code was matched with the county code for each FIPS census tract.

[6]Tract estimate calculated from the average value across all blocks within a tract.

Update November 2024: In order to ensure that the SDOH risk factors accurately reflect individuals' neighborhood environment, we updated the data underlying the SDOH/environmental risk factors as part of regular model maintenance.

Additionally, two of the environmental risk factors, rural-urban index and walkability index, were removed because their underlying data had not been updated to use the current 2020 Census boundaries. We were unable to use the previous versions of these risk factors because there was a change in the number and boundaries of census tracts between the 2010 vs. 2020 Census, which means that the 2010 census tracts do not directly map to the 2020 versions.

Lastly, we retired the ZCTA-level risk factors engineered in the Pre-CH Model because production of that model was paused in March 2024. Those risk factors include:

- Percent 60+ minute commute
- Percent Workers who travel to work by car
- Percent Workers who travel to work by public transit
- Percent Black
- Percent Male
- Percent Population living in college group quarters
- Percent Population living in nursing home group quarters

[27] https://www.huduser.gov/portal/datasets/usps_crosswalk.html

- Percent of units with 0 or 1 bedrooms
- Population per household

Transformation Details

For risk factors that were only available at the ZCTA-level (*N*=1) or at the census tract level (or other census polygon, including county - *N*=7), we used the Department of Housing and Urban Development (HUD) USPS ZIP Code Crosswalk files to transform the variables to the appropriate geographic unit (Din & Wilson, 2020; Office of Policy Development and Research, 2021).

Imputation of Missing Values

To facilitate training the Pre- Models, a version of the data set was also created where all missing variables were imputed using the overall mean of the variable.

Census Tract-Level

Physician Diversity: Imputation of missing variables was done for the county_pct_physician_diversity variable because, in the ACS public-use microdata (from IPUMS), counties were not identified from 1950 onwards. Therefore, IPUMS assigns county based on other low-level geographic identifiers which is not possible for all counties. To avoid large amounts of missing data, county_pct_physician_diversity was imputed from a weighted average of physician diversity from the counties in that state.

ZCTA-Level

Physician Diversity: In the ACS public-use microdata (from IPUMS), counties were not identified from 1950 onwards. Therefore, IPUMS assigns county based on other low-level geographic identifiers which is not possible for all counties. To avoid large amounts of missing data, county_pct_physician_diversity was imputed from a weighted average of physician diversity from the counties in that state.

Taxable Interest Per Capita: Data for missing ZCTAs were imputed when possible based on a weighted average of taxable interest per capita from the other ZCTAs within the same ZIP code sorting area (first three digits of ZCTA).

Area Deprivation Index: Data for missing ZCTAs were imputed when possible based on a weighted average of the area deprivation index from the other ZCTAs within the same ZIP code sorting area (first three digits of ZCTA).

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Appendix 3. Inactive Models

Pre-CH

This predictive model was an extension of the Hilltop Pre-AH Model and was designed to estimate individual-level risk of hospitalization due to COVID-19 for Medicaid enrollees across the state of Maryland. This predictive model was intended to help health care providers prospectively identify individuals at risk of hospitalization for *current and future pandemics*. With the tool, it may be possible for them to have designed suitable proactive interventions to try to reduce these individuals' risk of hospitalization because health care providers could identify these individuals before they reach the hospital. Moreover, such an evidence-based forward-triage mechanism—particularly if implemented via telehealth—could help control the spread of COVID-19 through reduced hospital-based exposure and alleviate excess demand on critical acute care infrastructure.

This project was originally funded by the University of Maryland, Baltimore, Institute for Clinical and Translational Research (ICTR) through the Accelerated Translational Incubator Pilot (ATIP) Grant Program in October 2019 (awarded to Dr. Fei Han). Risk scores were deployed for the HealthChoice population starting in May 2021 and were last deployed in February 2024. These risk scores were not deployed for any other populations.

Outcome: COVID-19 Hospitalizations

The outcome measure in the Hilltop Pre-CH Model™ is a 0/1 indicator variable denoting whether an individual incurred a COVID-19-related hospitalization in a given month. To construct this measure, Hilltop uses ICD-10 diagnosis codes from inpatient claims to flag the following conditions, which are the basis for the composite COVID-19 hospitalization flag:[28]

- COVID-19 (U07.1)
- Other coronavirus as the cause of diseases classified elsewhere (B97.29)

This is implemented in the model as an indicator variable at the person-month level. If an individual incurs at least one COVID-19 inpatient hospital visit in a given month, then that person receives a value of 1 for this variable—and 0 otherwise.

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[28] Specifically, Hilltop defines these claims as those with a claim type of either 60 or 61 (indicating an inpatient claim) or a claim type of 40 (indicating an outpatient claim) and revenue center codes of 0450-0459 and 0981. Source: https://www.resdac.org/articles/how-identify-hospital-claims-emergency-room-visits-medicare-claims-data. To the extent that claims for observation stays are coded in this manner in the CCLF Medicare claims, observation stays are included in this outcome.

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