

UMass Risk Adjustment Project for MassHealth Payment and Care Delivery Reform:

Describing the 2017 Payment Model

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# Social Determinants of Health Modeling

**Report of September 2016**

The Social Determinants of Health Model was developed by UMass for MassHealth to improve its approach to risk adjustment and to incorporate, to the extent feasible, key Social Determinants of Health (SDH). The final model predicts a concurrent cost outcome that applies only to services that MassHealth expects its 2017 managed care payments and alternative payment models to cover. The model refines and enhances the State’s previous DxCG medical-risk-based predictions, adding predictors for unstable housing, disability, agency relationships, serious mental illness and substance use disorders, plus a summary measure of “neighborhood stress” based upon residence in a census block group.

Risk adjustment models are designed to determine the *relative* resource needs of individual members, so that plans that enroll sicker members receive more money than plans that avoid them. It is not designed to determine the total amount of money allocated across all plans.

Methods:

We used concurrent models to predict costs only for those enrolled for at least one-half year in the CY2013 PCC plan (costs are annualized by the fraction of the year present and then top-coded at $125K). This reference sample was used to identify inherent differences in the need for services (and, therefore, expected cost) of individuals who enroll in the managed care (MCO) sector. This strategy enables us to rely on uniformly determined (administrative) rates that are not affected by differences in contracting costs, and is the same as CMS’s approach to risk adjustment in their Medicare Advantage program. Our final model predicts the bundle of expenses that MassHealth currently intends its bundled payments to cover, extremely well. The model relies on the following predictors: DxCG v4.2 concurrent Medicaid RRS, selected medical conditions, social determinants of health (disability indicators, housing indicators, and medical/behavioral indicators), and neighborhood-based predictors of health.

Concurrent modeling allows for capturing the costs of several consequential subgroups of people that would be missed by a prospective model, including newborns and those with high end-of-life costs. A concurrent model is appropriate for making a payment in the future to an insured *group* of patients, so long as the underlying patient mix remains fairly stable.

The final risk-adjustment modeling proceeded as follows:

1. Only those medical expenditures from the CY2013 data that will be included in the State’s 2017 MCO contract (see attachment) were used in constructing COST. This outcome captures 91% and 88% of oldCOST (mean reductions of $452 and $733) in the MCO and PCC plans, respectively.

While COST was identical to oldCOST for 38% of MCO and 42% of PCC enrollees, more than 10% of members in each plan lost at least $700 in moving to the new outcome. For some people, reductions were sizeable; 1% of MCO members had drops of at least $4,700 and 1% of PCC members, over $20,500. See Appendix A for a list of inclusions and exclusions leading to COST.

1. Prior models (Basic and Full) were re-fit to the new outcome. The goal was to re-assess performance and recommendations from model building previously conducted to predict total medical expenditures.

Note that top-coding at $125,000 eliminated $33.9 million (1.9%) of oldCOST dollars, incurred by members contributing 0.151% of all person-years, from the PCC plan and $91.9 million (3.8%), incurred by members contributing 0.177% of all person-years, from the MCO.

1. Model building steps
* We defined COST2 by annualizing and top-coding COST at $125,000.
* We used weighted least squares regression to predict COST2 in 2013 from 2013 patient characteristics for MassHealth members in the PCC plan.
* We simplified the “neighborhood stress score” (NSS7) by basing it on the sum of each of the 7 previously-identified, standardized census block group variables (rather than a weighted sum from a principal components analysis). Each individual variable is first standardized by subtracting its mean and dividing by its standard deviation. Their sum is again standardized, so that the coefficient of NSS7 is the increment to expected cost associated with a 1 SD increase in NSS7. The minimum, median and maximum values of NSS7 are -1.75, -0.06 and +3.28.
* We considered, but ultimately did not include “% living alone” as a neighborhood-level predictor. While “living alone” is likely an important predictor of an individual’s cost, the “contextual” variable (percent living alone) would often reward providers for enrolling people in higher SES neighborhoods, such as Beacon Hill and Back Bay.
* We also considered but did not include profound/severe DD (for which the COST2 coefficient would have been *negative* $1,800). Dropping this variable left the model R2 unchanged to four digits of accuracy.
* In a final round of edits, we also did not include any “stand-alone” disease indicators (such as, asthma/COPD, separately for kids and adults; diabetes; polyneuropathy; schizophrenia; and PTSD) that we had been considering because: 1) each is already recognized in the DxCG relative risk score which provides most of the final model’s explanatory power, 2) these particular conditions had not emerged from a systematic search of all condition categories that might merit additional consideration, and 3) not explicitly including them as predictors only minimally reduced the model’s predictive power (R2 dropped by about 1/3 of 1 percentage point or less).
1. Although weighted least squares regression was our core modeling tool, we “groomed” the regression outputs as follows:
* The fitted model included variables for “homeless, by ICD code” and for “3 or more distinct addresses in a year.” Our pooled category of “Unstable Housing” marks people with either condition, using the coefficient for “3+ addresses” for the pooled group. In doing this, we over-rode the unacceptably high coefficient for “coded homelessness,” because – in the 2013 data – homelessness was almost never coded, and when it was, it was largely found on hospital bills (presumably to help explain a long stay due to not having a safe discharge location).
* We expect that paying for homelessness will encourage providers to code it more often among people who are not hospitalized.

Note that creating a pooled variable (rather than setting both coefficients to have the same value) avoids paying double for the rare person who is both coded as homeless AND has 3 or more addresses during the year.

* We set the coefficient for the indicator for “failure to GeoCode” (which applies to about 6% of members, and had been negative) to 0.
* We set the minimum prediction to ~$15 to pay for the cost of keeping track of (a minimal requirement for managing the care of) a member and set the maximum to ~$125,000. These numbers are approximate, since when models setting payments they will be normalized – that is, multiplied by a constant such as an inflation factor of 1.03 – to ensure that total predicted dollars are set to the total amount of money available for payments for the entire population. Such “trimming” has been imposed by other payers.

Setting the minimum to $15 adds $8.50 to the PCC average prediction and $7 to the MCO average; the amount of this due to setting the minimum at $15 rather than 0 is around 50 cents or less in each program.

* Note that the outcome predicted, COST2 was top-coded (after annualizing) at $125,000, which means that it is not designed to pay out all the money actually used in caring for MassHealth members. Specifically, top-coding COST2 dropped 3.0% of all dollars spent: $104 per person-year (1.8%) from the PCC plan and $191 per person-year (3.9%) in the MCO plan. The state will need to decide how to address “covered” costs that were excluded from this model.
* Top coding *our predictions of COST2* at $125,000, on the other hand, is not very consequential. In our data, it affects just 54 and 78 people (in the PCC and MCO plans, respectively), and eliminates about $21,500 and $27,500 per person affected, but only $3 and $4 on average in each population.
* Our near-final prediction, for a patient with characteristics **X** is now

 PRED(**X**) = max {15, min (f(**X**), 125000)}, where f(**X**) is a sum of amounts associated with each patient characteristic, as described in more detail below.

* In testing the resulting model for its fit to the PCC and MCO 2013 populations we multiply by constants, k, (called “inflators”):

PREDpcc = kpcc \* PRED, and

PREDmco = kmco \* PRED,

where each inflator is chosen to make mean predicted cost equal mean actual COST2 in that population. In these data, kpcc = 1.0058 and kmco = 1.0827.

* Finally, since top-coding COST2 at $125,000 removed 1.8% and 3.9% of dollars from the PCC and MCO plans, respectively, some mechanism (such as using a larger inflator) will be needed to account for these dollars that were “top-coded out.”
* In practice, predictions from the final model will be used only for MCO contracting, and the State and its actuarial consultants will determine appropriate multipliers to reflect inflation, regional differences in labor costs and other inputs, while ensuring that the total number of dollars predicted matches the total dollars allocated for the entire MCO population.

The final product of this work is a **newRRS**, created by normalizing the final (2013 PCC) model to have mean its mean equal 1 in the full 2013 modeling population (PCC and MCO members). This score can be used in the same way that MassHealth has previously used DxCG RRS to make payments to plans intended to cover the first $125,000 of (included) dollars spent on members present for at least 183 days in a year.

## The Recommended model:

Our recommended model, based on predicting COST2 in 2013 data for PCC members with at least 183 days of enrollment has 28 predictors (27 degrees of freedom).

20 **age-sex category dummy variables**. These range from highs of about $1300 to $1650 for the youngest girls and boys, to some negatives for males, as low as -$400 to $650 for males aged 18 to 24, and those 55 and over.

 1DxCG **Relative Risk Score**. Each RRS unit adds about $3,600.

 3 markers for **DMH clients**, (non-DMH) **DDS clients** and any other person entitled due to **Disability**. These factors add about $15,000, $2,800 and $1,500, respectively.

 1 **Unstable housing**. Having 3 or more addresses and/or an ICD-code for homelessness adds about $600.

 2 markers for **mental illness (SMI)** and **substance use (SUD)**, contributing $2500 and $2200, respectively.

 1 standardized neighborhood stress score, NSS7. Each 1 SD increment of NSS7 adds about $50. Note that when addresses cannot be geocoded, we set NSS7 to 0.

The final prediction for the MCO population, PRED, is achieved by first bottom-coding at $15 and top-coding at $125,000 the outputs of the above formula, and then rescaling them (that is, multiplying them by the constant needed) to make their sum equal the sum of COST2 in the 2013 MCO population.

To make it easy to see how this model assesses *relative risk across MassHealth*, we use use **newRRS**, in which PRED is rescaled to have mean 1 in the 2013 PCC and MCO population.

## Model Performance:

PRED has an R2 of 57.2% for predicting COST2 in the 2013 PCC population, and 62.4% in the 2013 MCO. When used to predict *next* year’s costs from this year’s data, the model’s explanatory power is estimated to be 38%, which is at the high end of best-performing prospective models in Medicaid populations.

# Appendix Materials

## Defining COST2

EXCLUDED are ALL costs in**:**

* Disbursement codes other than 0. This eliminated codes 1 (pass-through for other state agencies (DMH, DDS, DCF, DYS)), 2 (school-based Medicaid), and 6 (HSN); also, small dollars with Disbursement codes 3 and 4 (which, ideally should not be eliminated).
* Non-Emergency Transport (see code list in Section A2)
* Crossover (only 34 people, $8000 in MCO; 43 people, $7000 in PCC)
* Rest Homes
* ICFMR

## Partly EXCLUDED are costs in:

* Dental claims (EXCLUSIONS are 89% of costs in MCO; 87% in PCC)
* NH/Chronic Inpatient (EXCLUSIONS are 8% in MCO; no such bills in PCC)
* Hospice (EXCLUSIONS are 4% in MCO; no exclusions in PCC)
* Early intervention (EXCLUSIONS are 5% in MCO; 9% in PCC)
* Chapter 766 (in MCO, 160K people, mean = $23; w 3% of costs EXCLUDED; in PCC, total cost is $171 for 5 people)
* Home Health Agency  (only $2,000 of over $100 million in HHA costs are excluded)

## INCLUDED are ALL costs in:

* Inpatient
* Outpatient
* Chiropractor
* Lab
* Abortion
* Pharmacy
* Any other cost that is not explicitly EXCLUDED

## Excluded non-Emergency transport:

A0080 - NON-EMERGENCY TRANSPORTATION: PER MILE

A0090 - NON-EMERGENCY TRANSPORTATION: PER MILE

A0100 - NON-EMERGENCY TRANSPORTATION - TAXI, IN

A0110 - NONEMERG TRANSPRT & BUS, INTRA/INTER-ST

A0120 - NON EMERGENCY TRANSPORTATION - MINBUS/O

A0130 - NONEMERGENCY TRANSPORT (WHEELCHAIR VAN)

A0140 - NON-EMERGENCY TRANSPORT, AIR TRAVEL IN/

A0150 - NON-EMERGENCY AMBULANCE ONE WAY

A0160 - NON-EMERGENCY TRANSPORTATION: PER MILE

A0170 - NON-EMERGENCY TRANSPORTATION: ANCILLARY

A0180 - NON-EMERGENCY TRANSPORTATION: ANCILLARY

A0190 - NON-EMERGENCY TRANSPORTATION: ANCILLARY

A0200 - NON-EMERGENCY TRANSPORTATION: ANCILLARY

A0210 - NON-EMERGENCY TRANSPORTATION: ANCILLARY

A0215 - ALPHA-NUMERIC RESP. RELATED EQUIP & SUP

A0222 - AMBULANCE SERVICE, RETURN TRIP, TRANSPO

A0300 - AMB SERV., BASIC LIFE SUPPORT, NON EMER

A0304 - AMB SERV., NO ADV LIFE SUPPORT, NON-EME

A0306 - AMB SERV., ADV LIFE SUPPORT, NON-EMERGE

A0320 - AMB SERV., BLS, MILES SEPARATE, NON-EME

A0360 - AMBULANCE (BLS) NON-EMERGENCY ONE WAY

A0382 - BLS ROUTINE DISPOSABLE SUPPLIES

A0384 - BLS SPECIALIZED SERV DISPOS SUPPLIES DE

A0426 - AMBULANCE SRVC ADVANCED LIFE SUPPORT NO

A0428 - AMBULANCE SRVC BASIC LIFE SUPPORT NON-E

Q3020 - ALS VEHICLE USED, NON-EMERGENCY TRANSPO

S0215 - NONEMERG TRANSPORTATION, MILEAGE (WHEEL

S9960 - AIR AMBULANC NONEMERG FIXED

S9961 - AIR AMBULAN NONEMERG ROTARY

T2001 - NON-EMERGENCY TRANSPORTATION; PATIENT A

T2002 - NON-EMERGENCY TRANSPORTATION; PER DIEM

T2003 - NON-EMERGENCY TRANSPORT, ENCOUNTER/TRIP

T2004 - NON-EMERGENCY TRANSPORT; COMMERCIAL CAR

T2005 - NON-EMERGENCY TRANSPORTATION; NON-AMBUL

T2006 - AMBULANCE RESPONSE AND TREATMENT, NO TR

T2007 - TRANSPORTATION WAITING TIME, AIR AMBULA

T2049 - NON-EMERGENCY TRANSPORTATION; STRETCHER

# Answers to expected “Frequently Asked Questions” (FAQs)

How does the model recognize differences in the costs of infants vs. kids vs. adults?

* Use of coefficients within 10 age categories (0-1, 2-5, 6-12, 13-17, 18-24, 25-34, 35-44, 45-54, 55-59, 60+), separately for male and female
* Use of the DxCG model that both
* Recognizes the costs of diseases, including empirically-identified differences in costs for diseases when they are differentially costly for kids (<18 years)
* Uses second-stage “tuning” to ensure that average costs are right within age-sex categories that (among other things) distinguish infants (aged 0 or 1) from other young people and older adults

What fraction of people have (annualized) COST2 > $125,000? How many dollars are spent on people above that threshold?

* Among PCC members, 556 members (representing (0.151% of PCC person-years) had annualized COST2 greater than $125,000. In the MCO program, 991 such people contributed 0.177% of person-years. Thus, in the combined population, there were 1,547 people representing 0.166% of all person-years.
* Thus, truncation removes $33.90 million and $91.85 million dollars from the two plans, respectively.
* The removed dollars reduce the two population means by $104 and $191, representing 1.8% and 3.9% of original COST2 dollars in the two plans, respectively, and 3.0% overall.

How is the “neighborhood stress score” (NSS7) calculated?

* We first standardize (on the combined PCC and MCO population) each of the following 7 census block group (CBG) variables: % of families with incomes < 100% of the federal poverty level (FPL), % < 200% of FPL, % of adults who are unemployed, % of households receiving public assistance, % of households with no car, % of households with children and a single parent, and % of people age 25 or older who have no HS degree.
* We then add these variables and standardize their sum, so that the coefficient of NSS7 is the increment to expected cost associated with a 1 SD increase in NSS7.

What does the distribution of NSS7 look like?

* By design, the mean of NSS7 in the 2013 Medicaid modeling population is 0 and its SD is 1; its minimum, median and maximum values are -1.75, -0.06 and +3.28.
* Its means in the PCC and MCO populations are -.044 and +0.030.

Are risk scores ever negative?

* + No. We “bottom code” all predictions at a value that translates into at least $15.
	+ Bottom coding is needed because some age-sex category coefficients (only among males, aged 18 and above) are negative; the most negative is about -$580 - it is for males between the ages of 18 and 24. Thus, without bottom coding, enrolling a 20-year-old man with no additional risk factors would lead to a loss of over $500!
	+ The only other predictor in the model that could subtract dollars is NSS7. Its coefficient is less than $50 and its lowest value, larger than -2, so it would never subtract as much as $100 – and, if this ever contributed to a prediction being smaller than $15, bottom-coding would be used to raise it.

What codes are included in “serious mental illness” (SMI)?

HCC Chronic Description

160       - PSY.15 Acute Paranoid Reaction and Confusion

161       C PSY.20 Schizophrenia

162       C PSY.30 Other Nonorganic Psychosis

163       C PSY.40 Delusional Disorder and Paranoid States

166       C ANG.20 Bipolar Disorder

168       C ANG.40 Major Depression

What codes are included in “substance use disorders”?

HCC Chronic Description

148 - SAD.15 Drug Induced Hallucinations, Delusions, and Delirium

149   C SAD.20 Withdrawal and Other Specified Drug-Induced Mental Disorders

150       C SAD.30 Drug Dependence

151  C SAD.40 Drug Abuse without Dependence, Except Alcohol and Tobacco

152       C SAA.20 Alcohol Psychosis

153       C SAA.30 Alcohol Dependence

154       C     SAA.40 Alcohol Abuse, Without Dependence

#  Table 1 Population Characteristics, COSTS, COST2, and Risk Scores for MCO and PCC Members in CY2013

**Table 2 Coefficients and R2 for Models Predicting Top-Coded CY2013 COST2 Separately for PCC & MCO Members**



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