

Supplementary Online Content

Ash AS, Mick EO, Ellis RP, Kiefe C, Allison JJ, Clark MA. Including social determinants of health in payment formulas: a step toward health equity. *JAMA*. Published online August 7, 2017. doi:10.1001/jamainternmed.2017.3317

eTable. Full Results: Coefficients and R2s for Models Predicting 2013 Costs (Fee-for-Service Members, N=357660)

eAppendix

eReferences

This supplementary material has been provided by the authors to give readers additional information about their work.

eTable. Full Results: Coefficients and R²s for Models Predicting 2013 Costs (Fee-for-Service Members, N=357660)

	PCC alone (N = 357,660)					
Models		RRS	SDH		SDH Final	
	%*	Coeff	Coeff	t-stat	Coeff	
Intercept	100		1105	19.7		
Age-sex categories					**	
0-1 Female	1.8		104	1.0	1297	
2-5 Female (Referent)	5.2				1186	
6-12 Female	7.9		-276	-3.8	890	
13-17 Female	5.7		-178	-2.3	994	
18-24 Female	5.2		-393	-4.9	764	
25-34 Female	7.3		-346	-4.7	814	
35-44 Female	6.3		-826	-10.8	299	
45-54 Female	6.0		-728	-9.2	405	
55-59 Female	2.6		-611	-6.1	530	
≥ 60 Female	2.4		-624	-6.1	516	
0-1 Male	1.9		182	1.7	1381	
2-5 Male	5.4		431	5.5	1648	
6-12 Male	8.6		157	2.2	1354	
13-17 Male	6.3		-386	-5.1	771	
18-24 Male	4.8		-1683	-20.7	-621	
25-34 Male	6.0		-1148	-14.8	-46	
35-44 Male	5.5		-1098	-13.9	7	
45-54 Male	6.4		-1277	-16.5	-185	
55-59 Male	2.6		-1555	-15.7	-484	
≥ 60 Male	2.0		-1457	-13.4	-378	
RRS (normalized)	116.4	5157	3337	514.7	3582	
DMH client	1.5		13804	124.0	14817	
Not DMH but DDS client	2.5		2569	30.4	2757	
All other disabled	18.0		1428	35.6	1533	
Homeless, by ICD-9 coding	0.7		7089	44.1	596	***
3+ addresses in a year	11.5		555	13.6	596	***
Serious mental illness (SMI)	14.4		2295	54.2	2463	
Substance use disorder (SUD)	9.6		2014	40.6	2162	
NSS7	-4.4		43	3.4	46	
Not able to geocode (flag)	6.0		-126	-2.3	-	
Model degrees of freedom		1	29		27	
Model R-squared (x 100)		53.48	57.29		57.22	
R-squared after top- and bottom-coding predictions					57.244	

Source: MassHealth Medicaid Management Information System (MMIS)

Notes: Analyses are weighted (WGT = fraction of the year during which the member was eligible) and include only those enrolled for at least 183 days; Cost was first top-coded at an annualized rate of \$125,000, that is, Cost = minimum (dollars spent/WGT, 125000); it was then rescaled (from a mean of \$5,590 to \$6,000) for ease of interpretability. RRS is Verscend's DxCG v4.2 (model 312) concurrent risk score; Neighborhood stress score is a standardized measure (mean = 0, SD = 1) summarizing 7 census-block-level variables.

The Mean-only model uses the rescaled average for each person. The RRS Model predicts using \$5,157 times each person's risk score (based on their diagnoses, age, and sex as captured in the DxCG RRS). The Social Determinants of Health (SDH) model additionally includes the 7 sociodemographic variables shown and 20 age-sex dummies to ensure that average payments are correct within each age-sex group. All predictions are bottom- and top-coded at approximately \$15 and \$125,000.

* For continuous variables RRS and NSS, the Percent column displays mean x 100; while mean RRS=1 and mean NSS=0 across all of MassHealth, their means in the FFS population alone are 1.164 and -0.044, respectively.

** The SDH Model also assigns "intercept" dollars to 20 age-sex categories

*** Unstable housing is a pooled category containing people with either an ICD diagnosis code for homelessness or ≥ 3 addresses during the year. Because ICD coding for homelessness currently flags a small, non-representative subset of those who are homeless, we used the model-derived \$596 coefficient for those with multiple addresses for the pooled category.

eAppendix. The UMass research team that authored this paper also produced a FAQ for users entitled “[MassHealth Risk Adjustment Methodology](http://www.mass.gov/hhs/masshealth-innovations)” posted at www.mass.gov/hhs/masshealth-innovations and reproduced (with slight edits) here.

FAQs for MassHealth’s 2017 Payment Model

About the change from a prospective to a concurrent model

- **What is the difference between a prospective and concurrent model?**
A prospective model predicts *next year’s costs* for a person based on their non-cost data (e.g., age, sex, medical problems and SDH) *this year*, while a concurrent model predicts costs from these same kinds of factors *measured in the same year* that the costs are incurred.
- **Why did MassHealth change from using a prospective to a concurrent model?**
Concurrent models are built on a single year of data. Thus, they can capture costs for people who enter or leave the program within a single year. Prospective models do not, for example, describe the costs of newborns in their first year, nor the relationships between people’s characteristics and costs in the year that they die. The ACA MarketPlace also uses a concurrent model.
- **Does the use of a concurrent model mean that we will have to wait until after a year is over to know what we will be paid?**
No. MassHealth will apply the new model in the same time frame as it did the old one. For the October 1, 2016 – December 30, 2016 risk adjusted rates sent to each MCO on September 23, 2016, the SDH model was *applied* prospectively, based on the enrollment snapshot taken on September 1, 2016. Member level risk adjustment scores were developed using a base year of January 1, 2015 – December 31, 2015 claims and encounters, paid through June 30, 2016.
- **Is it legitimate to use a concurrent model to predict costs in a future year?**
Yes. So long as the same kinds of people enroll in a program from year to year, both prospective and concurrent models make payments that are “right on average” for groups of people. Indeed, in preliminary tests, our concurrent model predicts next year’s costs about as well as the best prospective models do (with an estimated individual-level R^2 of 38%).

About racial equity

- **Has anything been done to examine racial equity in the model?**
Yes. Although race and ethnicity was only coded for a bit more than 60% of members in either program, we checked models to ensure that predicted and actual costs were close within each racial subgroup. In our development data, differences between predicted and actual costs were less than 2% for all racial/ethnic subgroups examined; in out-of-sample applications of the model, such differences were a bit larger, but always less than 5%.
- **Do any of the variables in the model measure race?**
No.

About top-coded, annualized costs

- **What does it mean to say that costs are “annualized”?**

A person's annualized cost equals "cost divided by the fraction of the year that the person is enrolled." If a member is present for, say only half the year and spends, say \$6,000, then his data contributes $\frac{1}{2}$ of a person-year of experience, at an annual spending rate of $\$6,000 / (\frac{1}{2}) = \$12,000$.

- **Why are costs top-coded?**

Models that try to predict **all** costs (including "million-dollar babies" and catastrophic accidents) end up predicting poorly for the vast majority of people whose costs are more normal. In health care, costs above some high threshold are usually covered through some form of risk-sharing, such as "reinsurance."

- **How was the top-coding threshold selected?**

In examining data on all MassHealth members from 2011, 2012, and 2013, only about 1% of members had costs above \$125,000. In the final modeling to predict annualized cost for members present for at least 6 months in 2013, the number was a bit higher, but still less than 2%.

- **How often do people have (annualized) costs greater than \$125,000?**

Among PCC members, 556 members (representing 0.151% of PCC person-years) had annualized cost 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.

- **How many dollars were spent on people above \$125,000?**

Top-coding removed \$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 the original costs in the two plans, respectively, and 3.0% overall.

About the Neighborhood Stress Score

- The **Neighborhood Stress Score (NSS)** is a composite measure of economic stress which summarizes 7 census variables that were identified in a principal components analysis of 2013 Massachusetts Medicaid data. The NSS is derived from addresses geocoded at the census block group level; it was developed by Arlene Ash and others at the University of Massachusetts Medical School as part of a project to incorporate social determinants of health (SDH) variables into risk adjustment for MassHealth's global payment models.

Census variables in the NSS:

- % 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
- % of people age 25 or older who have no high school degree

- **How did we calculate NSS?**

First, we geocoded each member's current address to the census block group level and included the value of each of the above census variables (v_1, v_2, \dots, v_7) to a file with one line per member. Next, we standardized each variable by subtracting its mean and dividing by its standard deviation (SD), that is, letting $z_1 = (v_1 - \text{mean}(v_1))/\text{SD}(v_1)$, etc. We then added them to get $S = z_1 + z_2 + \dots + z_7$, and defined $\text{NSS} = (S - \text{mean}(S))/\text{SD}(S)$. Finally, for the ~5 percent of members whose addresses could not be assigned to a census block group, we set $\text{NSS} = 0$. By construction, NSS has mean = 0 and SD a little less than 1 (because of the extra 0s due to non-geocodable addresses), but its distribution is not necessarily normally distributed. In our data, its values ranged from a little more than -2 to a little more than +3. The coefficient of NSS in a regression model is the increment to expected cost associated with approximately a 1 standard deviation (SD) increase in NSS. Note that in our original report we used weights from our principal components analysis, but for simplicity – and given that these weights varied little across the 7 variables – we now calculate it using the unweighted sum, as just described.

- **How can you use the NSS?**
Follow the same steps as above with your own data.

About positive and negative risk factors

- **Are risk scores ever negative?**
No. We “bottom-code” all predictions at a value that translates into at least \$15.
- **Why is bottom-coding needed?**
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. Without bottom coding, enrolling a 20-year-old man with no additional risk factors would lead to a loss of over \$500! The ACA risk adjustment formula and previous MassHealth risk adjustment formulas also use bottom coding to avoid negative predictions.
- **Do all “risk factors” add dollars?**
No. NSS will subtract dollars for individuals living in neighborhoods with less than average stress. However, its coefficient is only about \$50 and its lowest value is larger than -2, so it will never subtract as much as \$100. Finally, if NSS ever contributed to a prediction smaller than \$15, bottom-coding would be used to raise the prediction.

About costs for kids and adults

- **How does the model recognize differences in the costs of infants vs. kids vs. adults?**
 - 1) It includes 20 age-sex categories as predictors, 10 age ranges (0-1, 2-5, 6-12, 13-17, 18-24, 25-34, 35-44, 45-54, 55-59, 60+), separately for male and female
 - 2) It uses the DxCG model that recognizes the costs of diseases, including empirically-identified differences in costs for some conditions when they occur in kids (<18 years)

- 3) The DxCG model also includes 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
- **If the model includes markers for age < 17, why don’t the predictions and costs for kids match up more closely?**
The model is built to reflect the relationship between member characteristics and costs among PCC members and then applied in MCO data. To the extent that PCC kids are relatively more expensive than adults than MCO kids are (as compared to MCO adults), the model will appear to overpay kids.





About serious mental illness and substance use disorders

- **What codes are used to identify 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 used to identify 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

eReferences

1. [MassHealth Risk Adjustment Open Public Meeting](http://www.mass.gov/eohhs/docs/eohhs/healthcare-reform/masshealth-innovations/1610-risk-adjustment-open-public-meeting.pdf)  
<http://www.mass.gov/eohhs/docs/eohhs/healthcare-reform/masshealth-innovations/1610-risk-adjustment-open-public-meeting.pdf>
2. [UMASS Modeling SDH Summary Report](http://www.mass.gov/eohhs/docs/eohhs/healthcare-reform/masshealth-innovations/1610-umass-modeling-sdh-summary-report.pdf)  
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3. Ash AS, Mick E, Zhang J, Ellis RP, Steinberg J. UMass Risk Adjustment Project for MassHealth Payment and Care Delivery Reform. UMMS Center for Health Policy and Research. June 2016.

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