**Table A. Full Results: Coefficients and $R^2$s for Models Predicting 2013 Costs (Fee-for-Service Members, N=357660)**

| Models | RRS | | SDH | | SDH Final |
|---|---|---|---|---|---|
| | %* | Coeff | Coeff | t-stat | Coeff |
| Intercept | 100 | | 1105 | 19.7 | 0 |
| **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** |
| NSS* | -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); in the **SDH Final** model, it was then rescaled (from a mean of $5,590 to $6,000) for ease of exposition. RRS is Verscend's DxCG v4.2 (model 312) concurrent risk score; Neigborhood 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 "%" column displays mean x 100; although mean RRS=1 and mean NSS=0 across all of MassHealth, means in the FFS population alone are 1.164 and -0.044, respectively.

** 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.

**Supplement B.** The UMass research team that authored this paper also produced a FAQ for users entitled "MassHealth Risk Adjustment Methodology" 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. **T**he 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 ½ of a person-year of experience, at an annual spending rate of $6,000/(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.

**<u>About the Neighborhood Stress Score</u>**

- 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 ($v_1$, $v_2$, …, $v_7$) 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 $z_1 = (v_1 – \text{mean}(v_1))/SD(v_1)$, etc. We then added them to get $S = z_1 + z_2 + … + z_7$, and defined NSS = (S – mean(S))/SD(S). Finally, for the ~5 percent of members whose addresses could not be assigned to a census block group, we set 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

**References**


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
2. UMASS Modeling SDH Summary Report
   http://www.mass.gov/eohhs/docs/eohhs/healthcare-reform/masshealth-innovations/1610-umass-modeling-sdh-summary-report.pdf
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.


**For more information feel free to contact Arlene Ash at arlene.ash@umassmed.edu.**