Risk Adjustment in the Expanded HHVBP Model

The Centers for Medicare & Medicaid Services (CMS) expanded Home Health Value-Based Purchasing (HHVBP) Model uses **risk adjustment** to allow for meaningful comparisons of quality measure performance between home health agencies (HHAs) with different case mix profiles. The purpose of this document is to review the application of risk adjustment in the expanded HHVBP Model.

Key terms:

- **Risk adjustment**: a statistical process that considers individual patient's health circumstances when predicting health care use and health outcomes.
- **Risk factors**: a representation of a patient's underlying health conditions, functional status, and other characteristics.
- **Case mix**: reflects the patient population served by the HHA, including patient's severity of illness and level of care needed.

Risk adjustment levels the playing field by allowing for a meaningful comparison of HHA performance.

Quality Measure Outcomes

For each HHA, an observed value is created for every eligible quality episode of care for each quality measure. The episode's observed value identifies the patient's reported status at end of care (EOC) compared to start of care or resumption of care (SOC/ROC).

For three (3) of the OASIS-based measures (Discharged to Community, Improvement in Management of Oral Medications, and Improvement in Dyspnea) and for the two (2) claims-based measures (Acute Care Hospitalization and Emergency Department Use Without Hospitalization) each eligible episode is either identified as a "yes" (*i.e.*, the conditions defined by the measure were met) or a "no" (*i.e.*, the conditions defined by the measure were not met). These are ***binary measure outcomes***. For measures with binary outcomes, the home health agency (HHA) observed value is the number of "yes" episodes divided by the total number of eligible episodes.

For the remaining two (2) OASIS-based composite measures (TNC Self-Care and TNC Mobility), CMS assesses the total amount of change during each home health quality episode. These are ***continuous measure outcomes***. For measures with continuous outcomes, the HHA observed value is the average change observed across all eligible episodes.

Prediction Models

Prediction models are commonly referred to as risk adjustment models because of their use to risk adjust a given measure. Prediction models are developed using sample data to measure the statistical associations between risk factors and quality measure outcomes. When applying the prediction model for risk adjustment, risk factors are translated into one or more **covariates** and their associated statistical associations are expressed as **coefficients**. Each quality measure has its own prediction model.

Predicted values are calculated at the episode-level by multiplying each risk factor coefficient with a given risk factor (0 or 1) and adding up the resulting products, as defined in the equations below.

There are two (2) types of prediction models used for expanded HHVBP Model quality measures:

The prediction model for binary measure outcomes uses the form:

The predicted probability of a "yes" outcome* for a quality episode = $1/[1+e^{-X}]$

Where e is the base of natural logarithms and **X** is a linear combination of the constant and the logistic regression coefficients times the covariate scores using this formula:

X (quality measure triggered [yes=1, no=0]) =

$$\mathbf{B_0 + B_1*COV_1 + B_2*COV_2 + B_3*COV_3 + \ldots B_N*COV_N}$$

Where B_0 is the logistic regression constant, B_1 is the logistic regression coefficient for the first covariate, COV_1 is the episode-level value for the first covariate, B_2 is the logistic regression coefficient for the second covariate, and COV_2 is the episode-level value for the second covariate, etc.

* For example, the predicted probability that a patient with this risk profile will be discharged to the community.

The prediction model for continuous measure outcomes uses the form:

The predicted measure value** for a quality episode = **X**

Where X is a linear combination of the constant and the OLS regression coefficients times the covariate scores using this formula:

$$\mathbf{X = B_0 + B_1*COV_1 + B_2*COV_2 + B_3*COV_3 + \ldots B_N*COV_N}$$

Where B_0 is the OLS regression constant, B_1 is the OLS regression coefficient for the first covariate, COV_1 is the episode-level value for the first covariate, B_2 is the OLS regression coefficient for the second covariate, and COV_2 is the episode-level value for the second covariate, etc.

** For example, the predicted TNC Mobility measure value for a patient with this risk profile.

Risk Adjustment Algorithm

CMS follows these steps* to determine an HHA's risk-adjusted quality measure value for OASIS-based and claims-based measures:

1. Calculate the *observed value* for each eligible quality episode for the HHA.
2. Calculate the average of the *observed values* for the HHA; this result is labeled: $\mathbf{HHA_{Observed.}}$
3. Apply the quality measure prediction or risk adjustment model to calculate the *predicted value* for each eligible quality episode for the HHA.
4. Calculate the average of the *predicted values* for the HHA; this result is labeled: $\mathbf{HHA_{Predicted.}}$
5. Calculate the average of the *predicted values* from all eligible episodes of care nationally; this result is labeled $\mathbf{National_{Predicted.}}$
6. Calculate the HHA's risk-adjusted measure value ($\mathbf{HHA_{Risk\text{-}Adjusted}}$) using this formula:

$$\boldsymbol{(HHA_{Observed} - HHA_{Predicted}) + National_{Predicted} = HHA_{Risk\text{-}Adjusted}}$$

** For HHCAHPS Survey-based measures, HHA-level (rather than episode-level) values are predicted. The algorithm used to produce HHA risk-adjusted measure values for these measures can be found on the Home Health Care CAHPS Survey website.*

Risk Adjustment Algorithm Example (simulated data)

Exhibit 1. shows the calculation steps CMS would follow to calculate the risk adjusted TNC Mobility measure value for a fictional HHA:

1. Calculate the *observed value* for each eligible quality episode for the HHA: **column B.**
2. Calculate the average of the *observed values* for the HHA: **column C, $HHA_{Observed.}$**
3. Apply the quality measure prediction or risk adjustment model to calculate the *predicted value* for each eligible quality episode for the HHA: **column D.**
4. Calculate the average of the *predicted values* for the HHA: **column E, $HHA_{Predicted.}$**
5. Calculate the average of the *predicted values* from all eligible episodes of care nationally: **column F, $National_{Predicted.}$**
6. Calculate the HHA's risk adjusted measure value (**column G, $HHA_{Risk\text{-}Adjusted}$**) using this formula:

$$(HHA_{Observed} - HHA_{Predicted}) + National_{Predicted} = HHA_{Risk\text{-}Adjusted}$$

(**0.94**[column C] – **0.76**[column E]) + **0.77**[column F] **= 0.96**[column G]

Exhibit 1. TNC Mobility Risk-Adjusted Measure Value Calculation

A	B	C	D	E	F	G
TNC Mobility Quality Episode	**Step 1: Observed TNC Mobility by Episode**	**Step 2: Observed HHA average TNC Mobility ($HHA_{Observed}$)**	**Step 3: Episode Predicted TNC Mobility Score[3]**	**Step 4: Predicted HHA TNC Mobility ($HHA_{Predicted}$)[4]**	**Step 5: Predicted National TNC Mobility ($National_{Predicted}$)**	**Step 6: Risk-Adjusted HHA TNC Mobility ($HHA_{Risk\text{-}Adjusted}$)**
1	2.22	**0.94**	0.41	**0.76**	**0.77**	**0.96**
2	1.27		1.32			
3	0.90		0.32			
4	1.05		0.46			
5	-0.35		-0.26			
6	1.18		0.92			
7	-1.03		1.22			
8	2.75		1.16			
9	-0.95		0.52			
10	1.23		1.23			
11	1.38		1.86			
12	-0.52		0.48			
13	0.82		0.34			
14	2.17		1.09			
15	1.42		0.74			
16	2.70		0.55			
17	1.43		1.35			
18	-0.22		-0.11			
19	0.77		0.22			
20	0.60		1.30			

[3] Predicted values reflect the risk factors present for each episode.

[4] HHA predicted value reflects case mix.

How Can Risk-Adjusted HHVBP Measures be Interpreted?

Risk adjustment of the expanded HHVBP Model quality measures allows for direct comparison of the quality performance of HHAs that may serve different patient populations. Quality performance is defined as the difference between expected and observed outcomes, with expected outcomes derived from prediction models that consider individual patient characteristics. **Exhibit 2** illustrates three (3) examples of how the risk adjustment calculation for an OASIS-based measure, Improvement in Dyspnea, considers differences in agency performance and the patient population the agency serves based on the following formula:

$$(HHA_{Observed} - HHA_{Predicted}) + National_{Predicted} = HHA_{Risk\text{-}Adjusted}$$

Exhibit 2. Improvement in Dyspnea Risk Adjustment Examples (simulated data)

Improvement in Dyspnea Quality Outcome	HHA #1 Average Case Mix Risk	HHA #2 Higher Case Mix Risk	HHA #3 Lower Case Mix Risk
$HHA_{Observed}$	68.5	65.3	70.4
$HHA_{Predicted}$	69.1	63.5	71.5
$(HHA_{Observed} - HHA_{Predicted})$	(-0.6)	(1.8)	(-1.1)
$National_{Predicted}$	70.2	70.2	70.2
$HHA_{Risk\text{-}Adjusted}$	69.6	72.0	69.1

1. **HHA #1 ("Average Case Mix Risk")**. This HHA has a predicted value of 69.1, which is close to, but somewhat lower than the national predicted value of 70.2. This indicates that the HHA patient population case mix for this measure is similar to the national average. The observed value for this agency, 68.5, is lower than its predicted value of 69.1 resulting in a difference of -0.6. The risk adjustment equation gives this agency a small boost to its observed value of 68.5, resulting in a risk-adjusted value of 69.6.
2. **HHA #2 ("Higher Case Mix Risk").** This HHA has a predicted value of 63.5, which is much lower than the national predicted value of 70.2, indicating that its patient population case mix risk for this measure is higher than the national average. The agency's observed value, 65.3, is higher than its predicted value of 63.5, resulting in a difference of 1.8. Hence, their risk-adjusted value of 72.0 is considerably higher than their observed value and is the highest among these three (3) HHAs, even though their observed value was the lowest among the three (3). This example illustrates how risk adjustment levels the playing field for agencies who serve patients with higher case mix risk.
3. **HHA #3 ("Lower Case Mix Risk").** This HHA has a predicted value of 71.5 that is higher than the national predicted value of 70.2. This indicates that its patient population has a lower-case mix risk for this measure than the national average. The agency's observed value, 70.4, is lower than its predicted value of 71.5, resulting in a difference of -1.1. When the risk adjustment formula is applied, HHA #3's risk-adjusted value of 69.1 is the lowest of the three (3) agencies. This example illustrates that risk adjustment can eliminate any advantage an agency could have from serving patients with lower case mix risk.

Resources

Technical documentation for quality measurement definitions and risk adjustment can be found here:

- ***OASIS-based Measures***: CMS Home Health Quality Measures website – technical documentation is available in the Downloads section. Technical documentation for the TNC Change measures is available on the Expanded HHVBP Model webpage.
- ***Claims-based Measures***: CMS Home Health Quality Measures website – technical documentation is available in the Downloads section.
- ***HHCAHPS Survey-based Measures***: Technical documentation is located on the Home Health Care CAHPS Survey website.

For questions regarding the expanded HHVBP Model, please contact the HHVBP Help Desk, HHVBPquestions@lewin.com.