Home Health Claims-Based Utilization Measures: Risk Adjustment Methodology

August 2012

Acumen, LLC

500 Airport Blvd., Suite 365

Burlingame, CA 94010

[This page is intentionally left blank.]

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

1 INTRODUCTION

This report summarizes the development and specification of the risk adjustment methodology for two acute care utilization measures: Acute Care Hospitalization and Emergency Department Use without Hospitalization. The Acute Care Hospitalization (ACH) measure has National Quality Forum number 0171, and the Emergency Department Use without Hospitalization (ED use) measure has National Quality Forum number 0173. These measures are calculated for the home health population from Medicare claims data.

Because these measures evaluate two different but related outcomes, one multinomial logistic framework models the three disjoint outcomes: no acute care use (no event), ED use, and ACH. A multinomial logistic model allows for the same risk factors to affect the possible outcomes in different ways while also constraining predicted probabilities of all three events to sum to one hundred percent. Several other models were considered, but each was deemed to be inappropriate for these measures. First, individual logits modeling ACH and ED use separately were considered. However, individual logits would hinder the interpretation of the variables because the no event category for each measure would, in fact, include the alternate event; that is, the no event category for ACH would include and be affected by ED use, and vice versa. Next, an ordered logit was analyzed as a possible model but is also not appropriate because the risk factors cannot be said to affect the probably of the three events in identical proportions. Finally, because there are no alternative factors to distinguish the nests of either ACH or ED use as opposed to no event, a nested logit model generalizes to a multinomial logit.

The remainder of the report discusses aspects of the development and performance of the multinomial logit risk adjustment model. First, Section 2 details the set of potential risk factors and each variable's specifications. Next, Section 3 describes how a subset of these risk factors was selected for the final predictive model and presents coefficients and marginal effects for each variable. Finally, Section 4 evaluates the risk adjustment model's performance and appropriateness for these measures.

2 VARIABLE SPECIFICATION

To account for beneficiary characteristics that may affect the risk of ED use or ACH, the risk adjustment model uses potential risk factors that fall into five categories:

1. Prior care setting;
2. Health status;
3. Demographics;
4. Enrollment status; and
5. Interactions terms.

The following sections detail risk factors in each of these categories in turn.

2.1 Factor 1: Prior Care Setting

Because beneficiaries who enter home health care from different prior care settings may have different health statuses, this model takes into account beneficiaries' immediate prior care setting. This variable is defined by examining Medicare institutional claims for the 30 days prior to the start of the home health stay. The main categories are community (i.e., no prior care setting), outpatient emergency room, inpatient-acute (IP-acute), inpatient rehabilitation facility (IRF), psychiatric facility, long-term care facility (LTC), and skilled nursing facility (SNF). The IP-acute category is segregated into the five cohorts from the Centers for Medicare & Medicaid Services (CMS) Hospital-Wide All-Cause Unplanned Readmission Measure (HWR).[1] The five cohorts are:

1. Surgery/Gynecology: admissions likely cared for by surgical or gynecological teams;
2. Cardiorespiratory: admissions for cardiorespiratory conditions with very high readmission rates, such as pneumonia, chronic obstructive pulmonary disease, and heart failure;
3. Cardiovascular: admissions for cardiovascular conditions , such as acute myocardial infarctions;
4. Neurology: admissions for neurological conditions, such as stroke; and
5. Medicine: admissions for all other non-surgical patients.

[1] *Centers for Medicare & Medicaid Services.* "Hospital-Wide All-Cause Unplanned Readmission Measure (HWR)." National Quality Forum. Accessed 22 March 2012. http://www.qualityforum.org/WorkArea/linkit.aspx?LinkIdentifier=id&ItemID=69324.

CMS designed these cohorts to account for the differences in readmission risk for surgical and non-surgical patients. Though the cohorts are used in the HWR in separate regression models, their methodology easily extends to separating cohorts for one model. The Surgery/Gynecology cohort is defined using AHRQ procedure CCS, while the Cardiorespiratory, Cardiovascular, and Neurology cohorts are defined using AHRQ diagnosis CCS by examining each claim's primary diagnosis. Appendix A lists the definitions of the cohorts using AHRQ CCS.[2]

Finally, the IP-acute cohorts and the SNF category are further refined by length of stay. The categories of stay length are the 25th, 50th, and 75th percentile of prior care IP and SNF stay lengths from Medicare claims data. As a result, each of the five IP-acute categories are separated into stays of length 0 to 3 days, 4 to 8 days, and 9 or more days, while the SNF category is split into stays of length 0 to 13, 14 to 41, and 42 or more days.

2.2 Factor 2: Health Status

To account for beneficiary health status, the risk adjustment model relies on CMS's Condition Categories (CCs) and Hierarchical Condition Categories (HCCs) framework. HCCs were developed for the risk adjustment model used in determining capitation payments to Medicare Advantage plans and are calculated using Part A and B Medicare claims.[3] Because CMS developed the HCCs to predict beneficiary spending, the HCCs may not fully predict beneficiary hospitalization. As a result, prior to the variable selection process, the risk adjustment model includes all 2008 HCCs and all CCs that are not hierarchically ranked. Beneficiaries' claims are examined for the six month period prior to the start of their home health stay to determine the HCCs and CCs for which they are eligible. While the CMS-HHC model uses a full year of claims data to calculate HCCs, the ACH and ED use risk adjustment model employs only six months of data to limit the number of home health stays excluded due to a beneficiary's lack of continuous enrollment.

2.3 Factor 3: Demographics

The risk adjustment model also includes age and gender as covariates. Age-gender interactions allow the model to account for the differing effects of age on the outcomes for each gender. Age is subdivided into 12 bins for each gender: ages 0-34, 35-44, 45-54, five-year age bins from 55 to 95, and one bin for ages over 95.

[2] Clinical classification software of ICD-9-CM codes into AHRQ CCS can be found at the Healthcare Cost and Utilization Project website at this web address: http://www.hcup-us.ahrq.gov/toolssoftware/ccs/ccs.jsp.

[3] Details of the CMS-HCC model and the code lists for defining the HCCs can be found at this web address: https://www.cms.gov/MedicareAdvtgSpecRateStats/06_Risk_adjustment.asp.
A description of the development of the CMS-HCC model can be found at this web address: https://www.cms.gov/HealthCareFinancingReview/Downloads/04Summerpg119.pdf.

2.4 Factor 4: Enrollment Status

The model employs both end stage renal disease (ESRD) status and disability status as covariates because beneficiaries with ESRD or who are disabled constitute a fundamentally different health profile than other Medicare beneficiaries. Additionally, the model includes interactions between original disabled status and gender.

A preliminary version of the model also included Medicaid status as a risk adjustment factor. However, risk adjusting the measure for Medicaid status would not be appropriate because it would amount to holding providers accountable for different standards of care for Medicaid beneficiaries.

2.5 Factor 5: Interaction Terms

Before variable selection, the risk adjustment model included all interaction terms from the 2008 and all interactions from the 2012 HCC risk adjustment models for which the 2008 HCC model had appropriate definitions. Interaction terms account for the additional effect two risk factors may have when present simultaneously, which may be more or less than the additive effect of each factor separately. For example, a beneficiary with chronic heart failure (CHF) and chronic obstructive pulmonary disease (COPD) may be at greater risk for hospitalization than would be estimated by adding the risk of hospitalization for each condition separately.

3 VARIABLE SELECTION

While the initial risk adjustment model includes all of the covariates described in Section 2 and an intercept, the number of covariates in the final model was reduced to avoid over-fitting and to simplify the model. The final covariates were statistically significant predictors of either ED use or ACH.

To determine statistical significance, a Wald test of joint restrictions was applied to each variable in each of 700 bootstrap samples created using simple random sampling, with replacement, of 80 percent of all home health stays. The Wald test determined the likelihood that the change in either or both outcomes associated with each covariate was statistically different from zero. The final risk adjustment model includes only covariates that were significant in at least 70 percent of bootstrap samples. This restriction reduces the number of variables included in the model, thus streamlining the model and avoiding over-fitting. The resulting final model includes 205 variables and an intercept. Additionally, the impact of excluding risk factors with low magnitudes was examined. However, a team of clinicians reviewed the final set of 205 risk factors, and this set was deemed clinically plausible as even risk factors with low magnitudes had appropriate effect directions. Appendix B presents the full list of covariates with their coefficients, p-values, and marginal effects for both outcomes. The p-values indicate if the covariate is a statistically significant predictor of the outcome. A p-value of less than 0.05 indicates that the covariate is statistically significant at the 0.05 alpha level. The average marginal effect represents the simulated magnitude of the event if every beneficiary had the covariate characteristic minus the simulated magnitude of the event if every beneficiary did not have the covariate characteristic. For example, if all beneficiaries had an ED visit without hospitalization in the 30 days prior to their home health stay, the likelihood of acute care hospitalization during the first 60 days of home health stays would be 4.122 percentage points greater than if no beneficiaries had an ED visit in the 30 days prior to their home health stay.

4 MODEL PERFORMANCE

This section evaluates the risk adjustment model and illustrates its appropriateness for the ACH and ED use measures using three approaches. First, Section 4.1 examines how risk adjustment affects the distribution of ACH and ED use rates overall. Second, Section 4.2 discusses how risk adjustment affects the rating of agencies' ACH and ED use rates. Finally, Section 4.3 evaluates how well the model predicts outcomes on the data on which it was calibrated and outside the data on which it was calibrated. To evaluate the model's performance, a simple random sampling of all home health stays beginning in 2010 was split into an 80 percent development sample, comprising 2,010,764 stays, and a 20 percent validation sample, comprising 502,690 stays.

4.1 Distributions of Rates Across Specifications

For both ACH and ED use, the risk adjustment model compresses the distribution of rates. Table 4.1.1 and Table 4.1.2 present the distributions of the actual and risk adjusted rates of ACH and ED use, respectively, for all agencies and for agencies with at least 20 home health stays using the full data set. The risk adjusted values have been Winsorized by setting the minimum value at 0 percent and the maximum at 100 percent. Risk adjustment decreases the standard deviation and the difference between the rates at the 90^{th} and 10^{th} percentile for both outcomes. The mean ACH rate and the mean ED use rate both increase with risk adjustment. Because the distribution of all agencies includes providers with fewer than 20 home health stays, the minimum and maximum values are extreme; for example, a home health agency with only one stay eligible for the measure would have a rate of 0 or 100 percent, based on only one stay. The distribution of agencies with at least 20 home health stays is not affected by outliers with low numbers of stays.

Table 4.1.1: Distributions of ACH Rates across Specifications

	Specification	Mean	St. Dev.	Min	10th	25th	50th	75th	90th	Max
All agencies	Actual	15.86	8.97	0	5.17	11.11	16.22	20.19	24.09	100
	Risk Adjusted	17.02	7.80	0	9.74	13.60	17.04	19.89	23.18	100
Agencies with at least 20 home health stays	Actual	16.17	6.43	0	7.46	12.12	16.60	20.34	23.70	52.38
	Risk Adjusted	17.23	4.78	0	11.27	14.28	17.23	19.94	22.87	50.59

Table 4.1.2: Distributions of ED Use Rates across Specifications

	Specification	Mean	St. Dev.	Min	10th	25th	50th	75th	90th	Max
All agencies	Actual	9.65	6.70	0	2.86	6.35	9.18	12.22	15.66	100

	Specification	Mean	St. Dev.	Min	10th	25th	50th	75th	90th	Max
All agencies	Risk Adjusted	9.71	6.44	0	3.46	6.67	9.30	12.06	15.33	100
Agencies with at least 20 home health stays	Actual	9.53	4.29	0	4.28	6.87	9.32	12.00	14.75	35.29
	Risk Adjusted	9.64	4.01	0	4.94	7.15	9.38	11.89	14.56	33.88

4.2 Provider Rankings Across Specifications

Risk adjustment changes the relative rankings for ACH for about 10 percent of providers and changes the rankings for ED use for about 3 percent of providers. Table 4.2.1 presents the Spearman rank correlations of providers between their observed rate and their risk adjusted rate using the development sample. In this case, the rank correlation expresses the relationship between the relative ranks of providers when ordered by their actual ACH and ED use rates and when ordered by their risk adjusted ACH and ED use rates. A value of 1.0 would indicate that the ranking of providers did not change at all after risk adjustment. Risk adjustment accounts for beneficiary health characteristics, such as health status, that may affect beneficiary outcomes but are outside the provider's control. If providers' observed rates of ACH and ED use were reported, providers with beneficiaries that were sicker or otherwise more predisposed to hospitalization before entering home health care would be penalized. By risk-adjusting the agency rates and calculating how much providers move in their relative ranks, this analysis quantifies the impact of risk adjustment on provider rankings. Because providers with small numbers of home health stays will have extreme rates, as discussed above, only providers with at least 20 home health stays eligible for the measure were ranked.

Table 4.2.1: Provider Rank Correlations

	Rank Correlation Between Observed and Risk Adjusted Rate
ACH	0.899
ED Use	0.975

In addition, the movement of provider rankings around the average shows which agencies are affected by risk adjustment. Using the development sample and restricting to agencies with over 20 stays, Table 4.2.2 presents the percent of providers with below-average observed rates that moved to above-average risk adjusted rates, and vice versa. For ACH, 8.08 percent of providers had below-average observed rates that moved to above average after risk adjustment, while 5.47 percent of providers had rates that moved from above average to below. ED use shows a similar pattern, with 3.10 percent of providers having observed rates that moved from below to above average after risk adjustment and 2.66 percent having rates that moved from above to below average.

Table 4.2.2: Provider Rates Movement after Risk Adjustment

	Below to Above Avg.	Above to Below Avg.
ACH	8.08%	5.47%
ED Use	3.10%	2.66%

4.3 Predictive Power

The predictive power of the model was evaluated using two measures on both the development sample and the validation sample. Evaluating the model's predictive power on the development sample shows how well the model predicts outcomes in the data on which it was developed, while evaluating the model using the validation sample shows how well the model predicts outcomes outside the data on which it was developed. The two measures of predictive power, which were evaluated on both samples, are the c-statistic and the range of predicted probabilities. In addition, over-fitting indices were calculated to further quantify the model's ability to predict outcomes on a new data set.

A version of the area under the receiver operating curve (AUC) statistic, also known as the c-statistic, was calculated for each individual logit and for the model overall. The c-statistic measures the ability of a risk adjustment model to differentiate between outcomes without resorting to an arbitrary cutoff point. This analysis averages pair-wise comparisons to extend the standard two-class case to the multi-class form.[4] A model that perfectly discriminates between outcomes would have a c-statistic of 1, while a model that has no predictive power would have a c-statistic of 0.5. In order to calculate c-statistics for binomial outcomes (i.e., ACH vs. no event and ED use v. no event), the outlying event was omitted and a generalized logistic estimated on the remaining two outcomes using all the risk factors in the model. A generalized logistic model omitting one event leads to the same coefficients as the full multinomial model. The average of the c-statistics for all possible binomial logistic regressions produces the AUC for the full multinomial model. For ACH, the c-statistic for the development sample is 0.693, which is identical to the validation sample value of 0.693, showing that the model differentiates between outcomes as well on new data as it does on the development data. For ED use, the c-statistic for the development sample is 0.632, which is comparable to the validation sample value of 0.631. Finally, the total AUC for the model in the development sample is 0.654, which is similar to the validation sample value of 0.653.[5] These values can be found in Table 4.3.1.

[4] For more information on this extension of the c-statistic, please refer to:
David J. Hand and Robert J. Till, "A Simple Generalisation of the Area Under the ROC Curve for Multiple Class Classification Problems." Ed. David W. Aha. *Machine Learning* 45 (2001): 171-186.

[5] The total area under the curve is an assessment of the overall model fit obtained by averaging the c-statistics for the individual logits, which in this case is the two c-statistics shown as well as the c-statistic between ACH and ED use, which is not shown. For more information on this statistic, refer to the footnote above.

Table 4.3.1: AUC Statistics

	Development Sample	Validation Sample
ACH c-statistic	0.693	0.693
ED Use c-statistic	0.632	0.631
Total AUC	0.654	0.653

In addition, the range of differences between the 90th and 10th percentile of predicted probabilities were calculated to further evaluate the predictive power of the model. In this case, a larger range of predicted values indicates that the model is better at discriminating between beneficiaries at high risk for ED use or ACH than beneficiaries at low risk. In the development sample, the range of predicted probabilities for ED use was 5 percent to 14 percent. In the validation sample, the range was 6 percent to 14 percent. In the development sample, the range of predicted probabilities for ACH was 8 percent to 31 percent. In the validation sample, this range was identical at 8 percent to 31 percent. Table 4.3.2 presents these ranges.

Table 4.3.2: Range of Differences between 90th and 10th Percentile of Predicted Probabilities

	Development Sample		Validation Sample	
	Minimum	Maximum	Minimum	Maximum
ED Use	5%	14%	6%	14%
ACH	8%	31%	8%	31%

Finally, over-fitting indices were computed and showed no indication that the model was over-fit. Over-fitting occurs when a model can describe the relationship between the covariates and the outcome in the development data set but cannot successfully predict the outcome on a new data set. To compute the over-fitting indices, the coefficients of the model were first estimated using the development sample. A logistic regression was then estimated on the validation sample with an intercept and the linear predictor for the probability of an event for a given home health stay in the validation sample. Values of the intercept far from 0 and values of the coefficient far from 1 provide evidence of over-fitting. In our validation sample, the calibration statistic for ED use produced an intercept of -0.017 and a coefficient of 0.992. With t-statistics of 0.854 and 0.819, these values are not significantly different from 0 and 1, respectively, at the 95% confidence level. The calibration statistic for ACH produced an intercept of -0.005 and a coefficient of 0.996. With t-statistics of 0.598 and 0.656, these values are also not significantly different from 0 and 1 at the 95% confidence level. In other words, there is no evidence that the model is over-fitting the data for either outcome. Table 4.3.3 presents the calibration statistics.

Table 4.3.3: Over-Fitting Indices

	Intercept		Coefficient	
	Value	**Statistically different from 0 at 95% confidence?**	**Value**	**Statistically different from 1 at 95% confidence?**
ED Use	-0.017	*No*	0.992	*No*
ACH	-0.005	*No*	0.996	*No*

5 CONCLUSION

The aim of this report is to describe and analyze the risk adjustment methodology of the Acute Care Hospitalization and Emergency Department Use without Hospitalization utilization measures of the home health population. Risk adjustment uses a multinomial logistic model with three outcomes: no event, ACH, and ED use. The risk model employs the following five sets of covariates:

1. Prior care setting
2. Health status
3. Demographics
4. Enrollment status
5. Interaction terms between the above covariates.

The specific set of 205 covariates used in the model consisted of statistically significant predictors of ACH or ED use. Risk adjustment compresses the distribution of ACH and ED use rates and decreases its variability. By taking into account beneficiary characteristics outside the provider's control, the model changes some providers' relative ranks of rates of ACH and ED use. The model was found to have considerable predictive power both on the data on which it was developed and on new data and was not determined to be over-fit to the development data.

APPENDIX A:COHORT DEFINITIONS

Table A-1: Definition of Cohorts from the Hospital-Wide All-Cause Unplanned Readmission Measure

Cohort	AHRQ CCS
Surgery/Gynecology (Procedure CCS)	1, 2, 3, 9, 10, 12, 13, 14, 15, 16, 17, 20, 21, 22, 23, 24, 26, 28, 30, 33, 36, 42, 43, 44, 49, 51, 52, 53, 55, 56, 59, 60, 61, 66, 67, 72, 73, 74, 75, 78, 79, 80, 84, 85, 86, 89, 90, 94, 96, 99, 101, 103, 104, 105, 106, 112, 113, 114, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 129, 131, 132, 133, 134, 135, 136, 137, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 150, 151, 152, 153, 154, 157, 158, 160, 161, 162, 164, 166, 167, 172, 175, 176
Cardiorespiratory (Diagnosis CCS)	103, 108, 122, 125, 127, 128, 131
Cardiovascular (Diagnosis CCS)	96, 97, 100, 101, 102, 104, 105, 106, 107, 114, 115, 116, 117, 213
Neurology (Diagnosis CCS)	78, 79, 80, 81, 82, 83, 85, 95, 109, 110, 111, 112, 113, 216, 227, 233
Medicine	All claims not in the above four cohorts.

APPENDIX B: MODEL COEFFICIENTS, P-VALUES, AND MARGINAL EFFECTS

Table B-1: Prior Care Setting Variables

1: Prior Care Setting Variable	ED Use without Hospitalization			Acute Care Hospitalization		
	Coef.	P-value	Marginal Effect	Coef.	P-value	Marginal Effect
ED Use without Hospitalization	0.663	0.000	5.739	0.407	0.000	4.122
Short Term IP, 0-3 Days, Medicine Cohort	0.326	0.000	2.171	0.369	0.000	4.445
Short Term IP, 0-3 Days, Neurology Cohort	0.246	0.000	1.785	0.191	0.000	2.060
Short Term IP, 0-3 Days, CRF Cohort	0.358	0.000	2.281	0.451	0.000	5.624
Short Term IP, 0-3 Days, Surgery Cohort	0.069	0.000	0.626	-0.046	0.003	-0.660
Short Term IP, 0-3 Days, CVD Cohort	0.391	0.000	2.962	0.305	0.000	3.354
Short Term IP, 4-8 Days, Medicine Cohort	0.258	0.000	1.401	0.430	0.000	5.527
Short Term IP, 4-8 Days, Neurology Cohort	0.206	0.000	1.155	0.326	0.000	4.052
Short Term IP, 4-8 Days, CRF Cohort	0.216	0.000	0.845	0.513	0.000	6.942
Short Term IP, 4-8 Days, Surgery Cohort	0.083	0.000	0.510	0.103	0.000	1.184
Short Term IP, 4-8 Days, CVD Cohort	0.287	0.000	1.620	0.450	0.000	5.773
Short Term IP, 9+ Days, Medicine Cohort	0.234	0.000	0.859	0.572	0.000	7.881
Short Term IP, 9+ Days, Neurology Cohort	0.271	0.000	1.413	0.474	0.000	6.195
Short Term IP, 9+ Days, CRF Cohort	0.210	0.000	0.526	0.628	0.000	8.874
Short Term IP, 9+ Days, Surgery Cohort	0.182	0.000	0.789	0.404	0.000	5.287
Short Term IP, 9+ Days, CVD Cohort	0.258	0.000	1.262	0.490	0.000	6.472
Inpatient, IRF	-0.035	0.034	-0.460	0.126	0.000	1.668
Inpatient, LTCH	0.040	0.380	-0.021	0.213	0.000	2.738
Inpatient, Psych	0.418	0.000	3.263	0.293	0.000	3.116
Skilled Nursing, 0-13 days	0.089	0.000	0.406	0.194	0.000	2.381
Skilled Nursing, 14-41 days	-0.006	0.578	-0.232	0.126	0.000	1.610
Skilled Nursing, 42+ days	0.028	0.030	0.047	0.117	0.000	1.451

Table B-2: Health Status Variables

2: Health Status Variable (2008 CCs, 6 month look-back)		ED Use without Hospitalization			Acute Care Hospitalization		
		Coef.	P-value	Marginal Effect	Coef.	P-value	Marginal Effect
1	HIV/AIDS	-0.052	0.186	-0.613	0.096	0.003	1.436
2	Septicemia/Shock	-0.104	0.000	-0.839	-0.009	0.391	0.035
5	Opportunistic Infections	-0.023	0.453	-0.462	0.144	0.000	2.092
6	Other Infectious Diseases	0.001	0.909	-0.069	0.040	0.000	0.548
7	Metastatic Cancer and Acute Leukemia	0.177	0.000	0.322	0.574	0.000	8.147
8	Lung/Upper Digestive/Other Severe Cancer	0.109	0.000	0.400	0.292	0.000	3.652
9	Lymphatic/Head/Neck/Brain/Major Cancer	0.075	0.000	0.152	0.271	0.000	3.405
10	Breast/Prostate/Colorectal/ Other Cancer	-0.051	0.000	-0.465	0.039	0.000	0.292
11	Other Respiratory and Heart Neoplasms	0.074	0.003	0.667	-0.007	0.709	-0.230
13	Other Neoplasms	-0.031	0.001	-0.222	-0.023	0.002	-0.259
14	Benign Neoplasms of Skin, Breast, Eye	-0.031	0.001	-0.136	-0.070	0.000	-0.880
15	Diabetes with Renal Manifestation	0.091	0.000	0.484	0.190	0.000	2.109
16	Diabetes w/ Neurol/Periph Circ Manifest	0.115	0.000	0.704	0.189	0.000	2.045
18	Diabetes w/ Ophthalmologic Manifestation	0.041	0.040	0.162	0.131	0.000	1.373
19	Diabetes w/ No/Unspecified comp	0.057	0.000	0.330	0.119	0.000	1.168
21	Protein-Calorie Malnutrition	0.034	0.002	0.167	0.065	0.000	0.828
22	Other Significant Endocrine/Metabolic	-0.001	0.913	-0.136	0.068	0.000	0.938
23	Fluid/Electrolyte/Acid-Base Balance	0.028	0.000	0.012	0.122	0.000	1.625
24	Other Endocrine/Metabolic/Nutritional	-0.038	0.000	-0.216	-0.057	0.000	-0.716
25	End-Stage Liver Disease	0.097	0.001	-0.168	0.466	0.000	6.959
26	Cirrhosis of Liver	0.069	0.015	0.218	0.193	0.000	2.621
27	Chronic Hepatitis	0.166	0.000	1.279	0.113	0.000	1.241
29	Other Hepatitis and Liver Disease	0.015	0.251	0.008	0.062	0.000	0.832
30	Gallbladder and Biliary Tract Dis	-0.042	0.004	-0.319	-0.020	0.062	-0.193
32	Pancreatic Disease	0.052	0.003	0.392	0.078	0.000	1.346
33	Inflammatory Bowel Disease	-0.008	0.717	-0.367	0.156	0.000	2.238

2: Health Status Variable (2008 CCs, 6 month look-back)		ED Use without Hospitalization			Acute Care Hospitalization		
		Coef.	P-value	Marginal Effect	Coef.	P-value	Marginal Effect
34	Peptic Ulcer/Hemorrhage /Other Spec GI	-0.013	0.122	-0.272	0.088	0.000	1.246
35	Appendicitis	-0.085	0.065	-0.406	-0.182	0.000	-2.214
36	Other Gastrointestinal Disorders	0.113	0.000	0.881	0.047	0.000	0.434
37	Bone/Joint/Muscle Infect/Necrosis	-0.002	0.918	-0.170	0.083	0.000	1.162
38	Rheum Arthritis/Inflammation Conn Tissue	0.065	0.000	0.279	0.145	0.000	1.920
39	Disorders of Vertebrae/Spinal Discs	0.065	0.000	0.511	0.027	0.000	0.246
40	Osteoarthritis of Hip or Knee	-0.072	0.000	-0.237	-0.218	0.000	-2.727
41	Osteoporosis and Other Bone/Cartilage	-0.034	0.000	-0.259	-0.015	0.005	-0.138
43	Other Musculoskeletal/connect Tissue	0.008	0.219	0.101	-0.018	0.000	-0.263
44	Severe Hematological Disorders	0.067	0.000	0.010	0.184	0.000	2.817
45	Disorders of Immunity	-0.040	0.076	-0.401	0.034	0.025	0.547
46	Coagulation defs/Other Spec Hematologic	-0.007	0.442	-0.101	0.023	0.000	0.327
47	Iron Deficiency, Other/Unspec Anemias/Blood	-0.039	0.000	-0.430	0.061	0.000	0.774
49	Dementia/Cerebral Degeneration	0.188	0.000	1.492	0.094	0.000	0.927
50	Nonpsychotic Org Brain Syndrome/Conditions	-0.019	0.263	-0.233	0.039	0.003	0.573
51	Drug/Alcohol Psychosis	0.034	0.122	0.619	-0.084	0.000	-0.742
52	Drug/Alcohol Dependence	0.101	0.000	0.899	0.089	0.000	1.231
53	Drug/Alcohol Abuse, W/out Dependence	0.169	0.000	1.299	0.109	0.000	1.183
54	Schizophrenia	0.092	0.000	1.006	-0.066	0.001	-0.106
55	Major Depressive, Bipolar, Paranoid	0.036	0.000	0.270	0.023	0.004	0.242
56	Reactive and Unspecified Psychosis	0.065	0.000	0.459	0.058	0.000	0.669
57	Personality Disorders	0.196	0.000	1.503	0.140	0.000	1.559
58	Depression	0.123	0.000	0.877	0.106	0.000	1.232
59	Anxiety Disorders	0.142	0.000	1.082	0.094	0.000	1.027
60	Other Psychiatric Disorders	0.159	0.000	1.260	0.081	0.000	0.809
62	Developmental Disability/Severe MR	0.113	0.170	0.569	0.208	0.005	2.767
64	Develop Disability/Mild/Unspec MR	0.108	0.000	1.019	-0.026	0.334	-0.561

2: Health Status Variable (2008 CCs, 6 month look-back)		ED Use without Hospitalization			Acute Care Hospitalization		
		Coef.	P-value	Marginal Effect	Coef.	P-value	Marginal Effect
67	Quadriplegia, Other Extensive Paralysis	-0.006	0.851	-0.262	0.113	0.000	1.586
68	Paraplegia	-0.071	0.032	-0.792	0.114	0.000	1.724
69	Spinal Cord Disorders/Injuries	0.000	0.983	-0.089	0.050	0.002	0.685
71	Polyneuropathy	0.012	0.156	0.052	0.027	0.000	0.345
72	Multiple Sclerosis	0.003	0.945	-0.430	0.162	0.000	2.061
73	Parkinson's and Huntington's Disease	0.186	0.000	1.401	0.141	0.000	1.595
74	Seizure Disorders and Convulsions	0.125	0.000	0.814	0.150	0.000	1.903
75	Coma, Brain Compression/Anoxic Damage	0.025	0.367	0.112	0.054	0.009	0.705
76	Mononeuropathy/Other Neuro Cond/Injuries	0.080	0.000	0.645	0.028	0.000	0.236
77	Respiratory Depend/Tracheostomy Status	0.064	0.012	0.638	-0.113	0.000	-1.277
80	Congestive Heart Failure	0.067	0.000	0.012	0.305	0.000	3.202
81	Acute Myocardial Infarction	0.072	0.000	0.380	0.128	0.000	1.648
82	Unstable Angina/Other Acute Ischemic Heart	0.113	0.000	0.838	0.083	0.000	0.928
83	Angina Pectoris/Old Myocardial Infect	0.069	0.000	0.526	0.041	0.000	0.436
84	Coronary Athero/Other Chronic Ischemic Heart	0.036	0.000	0.130	0.096	0.000	1.246
85	Heart Infection/Inflammation Exc Rheumatic	0.007	0.727	-0.026	0.045	0.001	0.603
86	Valvular and Rheumatic Heart Disease	-0.052	0.000	-0.441	0.002	0.651	0.124
89	Hypertensive Heart/Renal/Encephalopathy	0.058	0.000	0.328	0.091	0.000	1.145
90	Hypertensive Heart Disease	-0.088	0.000	-0.621	-0.064	0.000	-0.701
91	Hypertension	0.025	0.000	0.253	-0.024	0.000	-0.376
92	Specified Heart Arrhythmias	0.057	0.000	0.214	0.146	0.000	1.910
94	Other and Unspecified Heart Disease	0.032	0.000	0.184	0.047	0.000	0.586
95	Cerebral Hemorrhage	0.069	0.001	0.490	0.083	0.000	0.769
96	Ischemic or Unspecified Stroke	0.023	0.032	0.155	0.050	0.000	0.394
97	Precerebral Art Occl/Trans Cerebral Ischem	-0.005	0.481	-0.002	-0.024	0.000	-0.309
100	Hemiplegia/Hemiparesis	0.066	0.000	0.513	0.058	0.000	0.448

2: Health Status Variable (2008 CCs, 6 month look-back)		ED Use without Hospitalization			Acute Care Hospitalization		
		Coef.	P-value	Marginal Effect	Coef.	P-value	Marginal Effect
102	Speech/Lang/Cognitive/Perceptual Deficit	0.044	0.001	0.332	0.024	0.025	0.252
103	Cerebrovascular Late Effects/Unspec	0.057	0.000	0.383	0.059	0.000	0.699
104	Peripheral Vascular Disease with Complications	0.072	0.000	0.399	0.120	0.000	1.523
105	Peripheral Vascular Disease	0.005	0.407	-0.020	0.034	0.000	0.458
106	Other Circulatory Disease	0.012	0.047	0.019	0.046	0.000	0.611
108	Chronic Obstructive Pulmonary Disease	0.043	0.000	0.027	0.207	0.000	2.438
109	Fibrosis of Lung/Other Chronic Lung	0.019	0.057	0.038	0.067	0.000	0.896
110	Asthma	0.102	0.000	0.809	0.050	0.000	0.483
112	Pneumococcal Pneumonia/Empyema/Lung Abc	-0.017	0.463	-0.033	-0.064	0.000	-0.828
113	Viral/Unspecified Pneumonia, Pleurisy	0.009	0.227	-0.071	0.080	0.000	1.088
114	Pleural Effusion/Pneumothorax	-0.026	0.003	-0.297	0.041	0.000	0.610
115	Other Lung Disorders	0.043	0.000	0.313	0.032	0.000	0.352
120	Diabetic/Other Vascular Retinopathies	0.021	0.077	0.076	0.055	0.000	0.724
121	Retinal, Exc Detach/Vasc Retinopathies	-0.036	0.000	-0.258	-0.026	0.000	-0.282
122	Glaucoma	-0.033	0.000	-0.185	-0.054	0.000	-0.670
123	Cataract	-0.012	0.121	-0.049	-0.028	0.000	-0.362
124	Other Eye Disorders	0.023	0.001	0.210	-0.007	0.172	-0.140
125	Significant Ear, Nose, and Throat	0.054	0.011	0.354	0.060	0.000	0.722
126	Hearing Loss	-0.044	0.000	-0.295	-0.042	0.000	-0.493
127	Other Ear, Nose, Throat, and Mouth	0.082	0.000	0.730	-0.009	0.062	-0.271
128	Kidney Transplant Status	-0.195	0.000	-1.695	0.092	0.000	1.635
129	End Stage Renal Disease (Medicare eligibility)	0.199	0.000	0.910	0.399	0.000	5.571
130	Dialysis Status	0.047	0.079	0.226	0.095	0.000	1.216
131	Renal Failure	0.028	0.003	-0.074	0.151	0.000	1.706
132	Nephritis	0.045	0.352	0.167	0.117	0.002	1.532
133	Urinary Obstruction and Retention	0.142	0.000	1.045	0.113	0.000	1.286
134	Incontinence	0.055	0.000	0.413	0.035	0.000	0.377
135	Urinary Tract Infection	0.110	0.000	0.757	0.108	0.000	1.279
136	Other Urinary Tract Disorders	0.035	0.000	0.172	0.070	0.000	0.896

2: Health Status Variable (2008 CCs, 6 month look-back)		ED Use without Hospitalization			Acute Care Hospitalization		
		Coef.	P-value	Marginal Effect	Coef.	P-value	Marginal Effect
139	Other Female Genital Disorders	0.053	0.000	0.470	-0.006	0.495	-0.180
140	Male Genital Disorders	0.021	0.023	0.298	-0.063	0.000	-0.882
146	Uncompleted Pregnancy with Comps	0.220	0.117	1.549	0.220	0.120	2.697
148	Decubitus Ulcer of Skin	0.020	0.184	-0.774	0.215	0.000	1.137
149	Chronic Ulcer of Skin, Exc Decubitus	-0.008	0.489	-0.320	0.133	0.000	1.875
152	Cellulitis, Local Skin Infection	0.018	0.017	-0.036	0.099	0.000	1.340
153	Other Dermatological Disorders	0.008	0.148	0.125	-0.029	0.000	-0.406
154	Severe Head Injury	-0.268	0.014	-1.711	-0.254	0.004	-2.820
155	Major Head Injury	-0.015	0.450	-0.016	-0.061	0.000	-0.795
156	Concussion or Unspecified Head Injury	0.073	0.000	0.544	0.048	0.000	0.525
157	Vertebral Fracture w/out Spinal Cord Injury	0.032	0.015	0.013	0.136	0.000	1.853
158	Hip Fracture/Dislocation	-0.160	0.000	-0.979	-0.200	0.000	-2.332
159	Major Fracture, Exc Skull/Vertebrae/Hip	-0.178	0.000	-1.319	-0.070	0.000	-0.632
160	Internal Injuries	0.018	0.436	0.302	-0.082	0.000	-1.123
162	Other Injuries	0.116	0.000	0.901	0.057	0.000	0.557
163	Poisonings and Allergic Reactions	0.044	0.000	0.260	0.065	0.000	0.810
164	Major Comp of Medical Care/Trauma	0.043	0.000	0.232	0.072	0.000	0.910
165	Other Complications of Medical Care	0.029	0.003	0.210	0.022	0.003	0.240
166	Major Symptoms, Abnormalities	0.123	0.000	0.777	0.149	0.000	1.782
167	Minor Symptoms, Signs, Findings	0.079	0.000	0.574	0.051	0.000	0.544
174	Major Organ Transplant Status	-0.075	0.086	-0.807	0.103	0.000	1.579
176	Artificial Openings for Feeding/Elimination	0.153	0.000	0.962	0.201	0.000	2.460
177	Amputation Status/Lower Limb/Amput Compl	0.062	0.018	0.336	0.107	0.000	1.378
179	Post-Surgical States/Aftercare/Elective	0.093	0.000	0.717	0.043	0.000	0.408
180	Radiation Therapy	0.114	0.000	0.626	0.189	0.000	2.468
181	Chemotherapy	0.018	0.399	-0.370	0.264	0.000	3.828
182	Rehabilitation	-0.076	0.000	-0.380	-0.150	0.000	-1.843
183	Screening/Observation/Special Exams	-0.038	0.000	-0.204	-0.068	0.000	-0.855
184	History of Disease	0.096	0.000	0.710	0.066	0.000	0.724

Table B-3: Demographic Variables

3: Demographics Variable (*omitted*: 65-69 Male)	ED Use without Hospitalization			Acute Care Hospitalization		
	Coef.	P-value	Marginal Effect	Coef.	P-value	Marginal Effect
0-34 Years, Female	0.825	0.000	8.060	0.368	0.000	3.088
0-34 Years, Male	0.544	0.000	5.175	0.099	0.017	0.176
35-44, Female	0.673	0.000	6.592	0.191	0.000	1.054
35-44, Male	0.477	0.000	4.453	0.074	0.008	0.020
45-54, Female	0.445	0.000	4.231	0.048	0.016	-0.252
45-54, Male	0.336	0.000	3.113	-0.014	0.464	-0.796
55-59, Female	0.254	0.000	2.317	0.001	0.975	-0.446
55-59, Male	0.177	0.000	1.538	-0.007	0.722	-0.400
60-64, Female	0.134	0.000	1.234	-0.021	0.271	-0.492
60-64, Male	0.081	0.001	0.798	-0.075	0.000	-1.085
65-69, Female	0.031	0.069	0.329	-0.012	0.360	-0.206
70-74, Female	-0.003	0.871	0.032	0.000	1.000	0.007
70-74, Male	0.001	0.947	-0.069	0.047	0.000	0.622
75-79, Female	0.034	0.033	0.253	0.043	0.000	0.513
75-79, Male	0.008	0.607	-0.076	0.086	0.000	1.130
80-84, Female	0.080	0.000	0.529	0.105	0.000	1.267
80-84, Male	0.052	0.001	0.138	0.165	0.000	2.157
85-89, Female	0.117	0.000	0.692	0.183	0.000	2.288
85-89, Male	0.113	0.000	0.523	0.227	0.000	2.934
90-94, Female	0.165	0.000	0.977	0.249	0.000	3.142
90-94, Male	0.182	0.000	0.952	0.308	0.000	3.991
95+, Female	0.182	0.000	1.052	0.286	0.000	3.656
95+, Male	0.274	0.000	1.583	0.396	0.000	5.151

Table B-4: Enrollment Status Variables

4: Enrollment Status Variable	ED Use without Hospitalization			Acute Care Hospitalization		
	Coef.	P-value	Marginal Effect	Coef.	P-value	Marginal Effect
Currently ESRD	0.283	0.000	2.166	0.220	0.000	2.562
Originally ESRD	-0.041	0.209	-0.481	0.073	0.002	1.096
Originally Disabled, Female	0.221	0.000	1.684	0.146	0.000	1.603
Originally Disabled, Male	0.166	0.000	1.190	0.136	0.000	1.581

Table B-5: Interaction Terms

5: Interaction Terms	ED Use without Hospitalization			Acute Care Hospitalization		
	Coef.	P-value	Marginal Effect	Coef.	P-value	Marginal Effect
Artificial Openings * Pressure Ulcer	-0.034	0.504	-0.012	-0.160	0.000	-2.029
Bacterial Pneumonia * Pressure Ulcer	-0.084	0.065	-0.447	-0.146	0.000	-1.775
Cancer * Immune Disorders	-0.004	0.757	0.058	-0.052	0.000	-0.690
CHF * COPD	0.000	0.992	0.124	-0.069	0.000	-0.924
COPD * Cardiorespiratory Failure	-0.029	0.008	-0.439	0.104	0.000	1.511
Currently Disabled * Chronic Pancreatitis	0.116	0.001	0.575	0.217	0.000	2.910
Disabled * Severe Hematological Disorders	-0.110	0.016	-1.143	0.137	0.000	2.162
Disabled * Alcohol Psychosis	0.180	0.000	1.013	0.282	0.000	3.757
Disabled * Alcohol Dependence	0.150	0.000	1.074	0.131	0.000	1.549
Disabled * Multiple Sclerosis	-0.145	0.006	-0.932	-0.153	0.000	-1.765
Disabled * CHF	-0.049	0.002	-0.475	0.036	0.003	0.590
Disabled * Pressure Ulcer	-0.082	0.012	-0.771	0.054	0.027	0.895
Diabetes * CHF	-0.003	0.847	0.148	-0.093	0.000	-1.246
Diabetes * CVD	0.004	0.755	0.123	-0.047	0.000	-0.640
Renal Failure * CHF	-0.033	0.030	-0.070	-0.116	0.000	-1.487
Renal Failure * CHF * Diabetes	-0.028	0.070	-0.049	-0.104	0.000	-1.333
Schizophrenia * CHF	0.063	0.122	0.228	0.159	0.000	2.146
Schizophrenia * Seizure	0.070	0.099	0.295	0.159	0.000	2.138
Sepsis * CRF	-0.022	0.301	0.072	-0.147	0.000	-1.895