ACUMEN

Home Health Claims-Based Rehospitalization Measures Technical Report

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1 INTRODUCTION

To inform quality and performance improvement efforts in the home health setting, the Centers for Medicare & Medicaid (CMS) Home Health Quality Reporting program continues to propose measures that rely on a mix of standards, outcomes, process of care measures, and patient experience of care measures, including measures of care transitions and changes in patient functional status, with an emphasis on measurement as close to the patient-centered outcome of interest as possible. The measure sets continue to evolve to reflect the most important areas of service and quality improvement for home health agencies (HHAs) and address a core set of measure concepts that align quality improvement objectives across all provider types and settings. Thus far, CMS has adopted 81 measures for the Home Health Quality Reporting program that fall under five (of the six) National Quality Strategy (NQS) measure priority domains: clinical care; person- and caregiver centered experience and outcomes; safety; care coordination; and community/population health.

CMS contracted with Acumen, LLC to develop two Medicare claims-based outcome measures that fall under the NQS care coordination domain. These measures, titled the "Rehospitalization During the First 30 Days of Home Health" (henceforth known as the "Rehospitalization" measure) and "Emergency Department (ED) Use without Hospital Readmission During the First 30 Days of Home Health" (henceforth known as the "ED Use without Hospital Readmission" measure), evaluate readmission to the hospital and ED use without hospital readmission, respectively, within 30 days after starting home health care for patients who have recently been discharged from an inpatient setting. The *Rehospitalization* and *ED Use without Hospital Readmission* measures are harmonized with other CMS measures, including the home health claims-based measures (i.e., *Acute Care Hospitalization [ACH]* and *ED Use without Hospitalization [ED Use]* measures), and the Hospital Wide All-Cause Unplanned Readmission (HWR) measure. In May 2014, the National Quality Forum (NQF) All-Cause Admissions and Readmissions Steering Committee recommended these measures for endorsement.

CMS has begun implementing the *Rehospitalization* and *ED Use without Hospital Readmission* measures for quality improvement and public reporting. In January 2014, CMS began reporting each HHA's performance rate on the *Rehospitalization* and *ED Use without Hospital Readmission* measures confidentially in each HHA's Certification And Survey Provider Enhanced Reports (CASPER). Additionally, using a three-year reporting period, CMS intends to start publicly reporting the performance of Medicare-certified HHAs (with at least 20 home health stays) on the *Rehospitalization* and *ED Use without Hospital Readmission* measures in 2015, using performance categories (i.e., "Better than Expected", "Same as Expected", or

"Worse than Expected").[1] Due to a large number of relatively small home health agencies treating previously hospitalized patients, the measure developer determined that reporting home health agencies' risk-adjusted rates could lead to misleading conclusions, since small home health agencies' risk-adjusted rates tend to be unstable, and small home health agencies experience large deviations between their observed and expected rates that are due to chance alone. Using the categorical reporting method would mitigate this issue, since each home health agency is classified into one of three performance categories based on its expected[2] and observed rates, rather than based on a comparison of risk-adjusted rates amongst home health agencies.

This report describes the *Rehospitalization* and *ED Use without Hospital Readmission* measures in detail. Section 2 explains the importance of these measures as part of CMS' health care improvement efforts. Section 3 provides details about the measure specifications. Section 4 evaluates the scientific acceptability of the measure properties. Section 5 explains how the *Rehospitalization* and *ED Use without Hospital Readmission* measures are harmonized with other home health measures and readmission measures for other post-acute care settings.

[1] CMS finalized the implementation plan for these measures in the Home Health Prospective Payment System final rule for CY2014.
[2] Each HHA's expected rate is the average of the predicted rates across stays within the agency.

2 MEASURE IMPORTANCE

The *Rehospitalization* and *ED Use without Hospital Readmission* measures evaluate readmission to the hospital and ED use without readmission, respectively, within 30 days after starting home health care for patients who have recently been discharged from an inpatient setting. The focus of each measure is evidence-based (i.e., there is evidence to support the relationship of the health outcome to processes or structures of care), and improvement of the measured outcomes may lead to significant gains in health care quality and to better health outcomes for a substantial number of patients. The measure developer found performance variation across HHAs and evidence that HHAs can institute interventions to improve performance on the measured outcomes. HHAs can track their own performance on both utilization measures to gain an accurate picture of how much acute care is being used by their patients.

To drive quality improvement amongst HHAs, CMS began reporting each HHA's performance rate on the *Rehospitalization* and *ED Use without Hospital Readmission* measures confidentially in each HHA's CASPER starting in January 2014. Additionally, CMS intends to publicly report the performance of Medicare-certified HHAs (with at least 20 home health stays) on these measures under three categories (i.e., "Better than Expected," "Same as Expected," and "Worse than Expected") using a three-year reporting period. Sections 2.1 and 2.2 examine the importance of the *Rehospitalization* and *ED Use without Hospital Readmission* measures, respectively, in detail.

2.1 Rehospitalization Measure

The *Rehospitalization* measure evaluates readmission to the hospital within 30 days after starting home health care for patients who have recently been discharged from an inpatient setting. Section 2.1.1 presents evidence from the scientific literature to support the relationship of the health outcome to processes or structures of care. Section 2.1.2 demonstrates the performance gap and opportunity for HHAs to improve on the *Rehospitalization* measure. Section 2.1.3 explains why the *Rehospitalization* measure is a high priority aspect of CMS' health care improvement efforts.

2.1.1 Measure Evidence

There is evidence that there are strategies that can be undertaken to reduce rehospitalization, including care coordination, physician follow up, hospital discharge planning and a variety of home health care-specific evidence-based strategies from the quality improvement organizations (QIOs). These strategies include medication management, care provision (e.g., frontloading visits), patient education, falls prevention and other domains.

The measure developer identified several studies that are specific to home health care that offer evidence for the impact of care coordination interventions for reducing acute care hospitalization. Tao et al reported on factors predicting rehospitalization for 1268 home health care patients with all diagnoses. With an underlying 20.7 percent rehospitalization rate, the Cox hazard ratio was 1.7 for higher likelihood of rehospitalization based on an investigator-developed clinical status score (diagnoses, incontinence and so on) and functional status score (Activities of Daily Living [ADL] items) where more clinical severity and higher functional impairment increased the likelihood of rehospitalization.[3]

Madigan and colleagues reported on predictors of 30 day rehospitalization for the national population of home health care patients with heart failure (HF). The factors with the most influence for multilevel and Cox proportional hazard models included the number of prior hospital stays, more frequent home health care visits and higher severity of dyspnea on admission to home health care. There were significant numbers of potentially avoidable rehospitalizations (34 percent).[4]

Daley reported a small study (N = 89 patients with HF) where care coordination was conducted that included health literary assessment, medication reconciliation and cardiologist follow up after a hospitalization. A group of hospitalized patients served as the control group. The findings indicated that patients who received "care coordination" had a lower hospitalization rate than expected (15 percent versus 20 percent). Russell and colleagues provided preliminary findings on a care transition project within one home health care agency (N = 446) using an observational study design. Patients with heart failure were the focus of the program. The intervention was multifaceted and included both hospital discharge planning and home health care follow-up. The researchers did not report the actual hospitalization rates between the groups. They reported that the intervention group was 57 percent less likely (adjusted odds ratio, $p < .01$) to be rehospitalized.[5]

Fleming and Haney reported on the effectiveness of a care transitions coordinator (CTC) within the acute care setting and the impact on hospitalization rates in three academic medical centers where the CTC provided enhanced care during the transition into home health care. The enhanced care included coaching, physician appointment scheduling and patient/caregiver education. The impact was a reduction in the average number of rehospitalizations (rolling 12 month average) from 17 percent to 12 percent (the sample size was not noted).[6]

[3] Tao, et al. 2012
[4] Madigan, et al. 2012
[5] Daley 2010
[6] Fleming, et al. 2013

Tinetti and colleagues reported on the effectiveness of restorative home health care compared to usual home health care. Restorative home health care is multidisciplinary and multi-faceted, addressing functional status through patient self-management and focused health care provider interventions. Restorative home health care reduced rehospitalization by 32 percent (odds ratio = .68).[7]

Finally, Markley and colleagues reported on the CMS Care Transitions project in Texas where multiple providers worked together to address 30-day rehospitalization. HHAs used performance improvement methods to identify and address the issue, including the use of best practice interventions (e.g. frontloading visits, identifying patients at highest risk and providing education, medication reconciliation). Specific to home health care, there was a 4 percent absolute reduction in 30 day rehospitalization rates.[8]

2.1.2 Performance Gaps

Using a three-year reporting period, CMS intends to publicly report the performance of Medicare-certified HHAs (with at least 20 home health stays) on the *Rehospitalization* measure under three performance categories: "better than expected," "same as expected," and "worse than expected" (each HHA's expected rate is the average of the predicted rates across stays within the agency). Pursuing a categorical reporting method is consistent with condition-specific hospital readmission measures. The goal of this method is to assign a HHA to the "Better than Expected" category if the agency's rate of rehospitalization is lower than expected based on patient case mix by a statistically significant amount, and to assign a HHA to the "Worse than Expected" category if the agency's rate of rehospitalization is higher than expected based on patient case mix by a statistically significant amount. The size of the difference between a HHA's observed rate and expected rate that is statistically significant at a specified level (e.g., 5 percent) depends on the number of home health stays eligible for the measure and the case-mix characteristics of the agency's specific patients.[9]

Table 2.1 shows the number and percentage of HHAs, by performance category and size (i.e., by number of stays), with at least 20 home health stays beginning in the period between July 1, 2010 and June 30, 2013 for the *Rehospitalization* measure.[10] There were 7,273 such HHAs representing a total of 2,515,969 home health stays and 2,275,207 patients. With the categorical reporting method, consumers may see that most HHAs in their area are average (i.e., same as expected, which applies to 90.6 percent of HHAs). Additionally, they will be informed if a particular agency is outstanding (i.e., better than expected, which applies to 4.6 percent of all HHAs and 7.1 percent of HHAs with at least 20 stays for the *Rehospitalization* measure).

[7] Tinetti, et al. 2002
[8] Markley, et al. 2012
[9] Appendix A describes in detail the statistical hypothesis test that this method implements.
[10] Only HHAs with at least 20 stays will have results publicly reported.

Finally, they will be informed if a particular agency is sub-standard (i.e., worse than expected, which applies to 4.8 percent of all HHAs and 6.8 percent of HHAs with at least 20 stays for the *Rehospitalization* measure). Therefore, health care consumers would not make false distinctions between HHAs when both HHAs are performing as expected, even if their observed rates are different.

Table 2.1: Percentage Distribution of HHAs across Performance Categories for the *Rehospitalization* Measure, by Agency Size

Number of Stays	Better than Expected		Same as Expected		Worse than Expected		Total
	# HHAs	% of Total	# HHAs	% of Total	# HHAs	% of Total	
<20	15	0.3	4,217	98.2	63	1.5	4,295
20-49	53	3.1	1,597	94.0	49	2.9	1,699
50-99	69	4.6	1,359	91.1	64	4.3	1,492
100-199	96	7.1	1,190	87.6	72	5.3	1,358
200-399	86	7.6	965	84.9	86	7.6	1,137
400-999	129	12.8	767	75.9	115	11.4	1,011
1,000+	87	15.1	384	66.7	105	18.2	576
Total	**535**	**4.6**	**10,479**	**90.6**	**554**	**4.8**	**11,568**

To understand why HHAs' risk-adjusted rates (i.e., calculated by appending the difference between observed and expected rates to a national average) are not suitable for public reporting, consider the differences between HHAs' observed and expected rates. Tables 2.2 and 2.3 show the distribution of observed and expected agency rates by agency size, respectively, using home health stays beginning between July 1, 2010 and June 30, 2013. Note that the range of expected rates is quite wide, suggesting that much of the variation in observed rates is due to variation in patient case-mix (and thus is accounted for in the expected rates). Table 2.4 shows the differences between the observed and expected agency rates, by agency size; the range of deviation is much larger for HHAs with 20-49 stays than for HHAs with 1000+ stays. This shows that risk adjusting by re-centering deviations from expected on the national mean rate will result in many small HHAs having very small or very large risk-adjusted rates.

Table 2.2: Distribution of Observed Agency Rates of Rehospitalization, by Agency Size

Total Stays	# HHAs	Mean (%)	St. Dev. (%)	Min (%)	10th (%)	25th (%)	50th (%)	75th (%)	90th (%)	Max (%)	Inter. Range (%)
20 -49	1,699	14.0	6.7	0.0	5.6	9.1	13.5	18.2	22.7	40.6	9.1
50 - 99	1,492	13.8	5.0	1.5	7.5	10.3	13.5	16.9	20.3	32.8	6.6
100 – 199	1,358	13.6	4.0	0.8	8.7	11.0	13.5	16.1	18.7	31.8	5.1
200 – 399	1,137	13.4	3.5	3.2	9.1	11.2	13.6	15.9	17.8	23.3	4.7
400 – 999	1,011	13.4	3.0	3.4	9.3	11.5	13.5	15.5	17.0	21.9	4.0
1,000+	576	13.6	2.5	3.7	10.1	12.2	13.8	15.3	16.5	20.5	3.1

Table 2.3: Distribution of Expected Agency Rates of Rehospitalization, by Agency Size

Total Stays	# HHAs	Mean (%)	St. Dev. (%)	Min (%)	10th (%)	25th (%)	50th (%)	75th (%)	90th (%)	Max (%)	Inter. Range (%)
20 -49	1,699	14.5	2.8	4.7	11.2	12.8	14.5	16.2	18.0	25.9	3.5
50 - 99	1,492	14.0	2.3	5.3	11.3	12.7	14.1	15.4	16.7	26.3	2.7
100 – 199	1,358	13.8	2.1	4.6	11.3	12.6	13.9	15.1	16.3	20.3	2.5
200 – 399	1,137	13.5	2.2	5.0	10.7	12.4	13.8	15.0	15.9	20.6	2.6
400 – 999	1,011	13.4	2.0	4.2	10.9	12.4	13.7	14.7	15.7	18.5	2.3
1,000+	576	13.4	1.9	4.8	11.0	12.6	13.7	14.7	15.5	18.8	2.1

Table 2.4: Differences between Observed & Expected Agency Rates of Rehospitalization, by Agency Size[11]

Total Stays	# HHAs	Mean (%)	St. Dev. (%)	Min (%)	10th (%)	25th (%)	50th (%)	75th (%)	90th (%)	Max (%)
20 -49	1,699	-0.6	6.1	-18.5	-7.9	-4.9	-1.1	3.4	7.4	22.6
50 - 99	1,492	-0.3	4.3	-12.7	-5.7	-3.3	-0.4	2.4	5.6	14.3
100 – 199	1,358	-0.2	3.2	-11.3	-4.3	-2.4	-0.3	1.9	4.0	13.7
200 – 399	1,137	0.0	2.4	-7.9	-3.1	-1.7	-0.1	1.6	3.0	8.4
400 – 999	1,011	0.0	2.0	-7.0	-2.5	-1.4	-0.2	1.2	2.5	8.7
1000+	576	0.1	1.4	-4.1	-1.7	-0.8	0.1	1.0	2.0	6.0

2.1.3 High Priority

Avoidable hospital readmissions are a national priority for Medicare beneficiaries. Research indicates that 20 percent of all Medicare beneficiaries who were hospitalized had a return hospital stay within 30 days. In 2004, this cost the Medicare program $17.4 billion.[12] Within home health care, an analysis of Medicare claims shows that 13.6 percent of home health patients are rehospitalized within 30 days of the start of home health care.[13] One study reporting on patients with heart failure found that more than 40 percent of the 30-day rehospitalizations may have been avoidable.[14,15] In addition, there is evidence from studies of Medicare patients in general that there are interventions to reduce the need for hospital care within a substantial proportion of these Medicare beneficiaries.[16,17] As a result, addressing avoidable hospital

[11] The measure developer first calculated the difference between the observed rate and expected rate for each agency. Then, the distribution of the differences by agency size was calculated.
[12] Jencks, et al. 2009
[13] The national rate of rehospitalization was calculated from claims data using home health stays beginning between July 2010 and June 2013.
[14] Madigan, et al. 2012
[15] There is, however, limited research on the extent to which hospital readmissions are avoidable within home health care.
[16] Jencks, et al. 2009

readmissions is a major focus of several national initiatives (e.g.,QIOs, National Priorities Partnership, CMS, Institute for Healthcare Improvement).

The National Priorities Partnership has identified care coordination as one strategy to address high rates of hospital care. Models of care coordination and transitional care have been identified and tested in randomized controlled trials and are currently being tested in national demonstration projects with expectations that health care reform activities will incorporate care coordination for persons at high risk of hospitalization and rehospitalization.[18] While there has been limited testing of these models within the existing home health care system, there is evidence of effectiveness: Daley reported a small study (N = 89 patients with heart failure) where care coordination resulted in a reduction in hospitalization rate beyond that expected (15 percent versus 20 percent).[19] Russell and colleagues provide preliminary findings on a care transition project within home health care that provided a 57 percent less likely need for hospital care for persons with heart failure.[20] Finally, Markley and colleagues, as part of the CMS Care Transitions project, identified that home health care HHAs using care coordination had 30 day rehospitalization rates of 16.5 percent, 4.5 percent lower than the average overall rate for the community.[21] Fleming and Haney report a reduction from 17 percent to 12 percent in three academic medical centers using a care transitions approach.[22]

In addition to care transition interventions, there is evidence that additional strategies like telehealth (TH) may be beneficial in reducing hospitalizations among home health care patients, although the evidence on TH is more mixed in effectiveness in meta-analyses.[23,24,25] However, complicating the understanding of effectiveness of TH is that much TH research is done outside the existing home health care system. An additional strategy that has been found to reduce the likelihood of rehospitalization for home health care patients includes prompt physician follow up after a hospital stay. Wolff et al. found that 77.6 percent of home health recipients who received at least one physician evaluation and management visit during their home health stay were discharged to the community (rather than transferred to an inpatient facility) while only 70.6 percent of patients who did not receive physician visits were discharged to the community, suggesting that increasing physician visits may be cost effective. [26]

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[17] Schade, et al. 2009
[18] Boult, et al. 2009
[19] Daley 2010
[20] Russell, et al. 2011
[21] Markley, et al. 2012
[22] Fleming, et al. 2013
[23] Bowles, et al. 2009
[24] Polisena J, et al. 2009
[25] Polisena J, et al. 2010
[26] Wolff, et al. 2009

2.2 ED Use without Hospital Readmission Measure

The *ED Use without Hospital Readmission* measure evaluates readmission to the ED within 30 days after starting home health care for patients who have recently been discharged from an inpatient setting. Section 2.2.1 presents evidence from the scientific literature to support the relationship of the health outcome to processes or structures of care. Section 2.2.2 demonstrates the performance gap and opportunity for HHAs to improve on the *ED Use without Hospital Readmission* measure. Section 2.2.3 explains why the *ED Use without Hospital Readmission* measure is a high priority aspect of CMS' health care improvement efforts.

2.2.1 Measure Evidence

As the differences in health care system structure (i.e., organization and payment) impacts how care is delivered, the measure developer limited searches for individual studies to the last five years and to US-based studies only. The measure developer included only those studies with patients receiving home health care services. There were three studies focused on TH and one descriptive study examining home health care patient contact prior to an ED visit. There was one study of the Veterans' Affairs (VA) home based primary care system that examined ED use.

In two randomized controlled trials, Finkelstein et al reported that a home health care based TH system was associated with fewer ED visits[27] while Bowles and colleagues compared home visits, home visits plus telephone calls and home visits plus TH found no differences in ED visits between the three groups.[28] Woods and Snow found TH patients had significantly fewer ED visits (1.9 vs. 5.3 per 1000 patient days) in patients with cardiac and/or respiratory conditions.[29] Tzeng et al examined home health care patient contact prior to an ED visit in 31 home health care patients. They found that more than half had called their primary care providers prior to making an ED visit and more than a quarter had contacted the home health care agency.[30] Chang et al., in related research from the VA using a retrospective design (single site study of 183 patients), found that home-based primary care did not have an effect on ED visit use.[31]

2.2.2 Performance Gaps

Using a three-year reporting period, CMS intends to publicly report the performance of Medicare-certified HHAs (with at least 20 home health stays) on the *ED Use without Hospital Readmission* measure under three performance categories: "better than expected," "same as

[27] Finkelstein, et al. 2011
[28] Bowles, et al. 2009
[29] Woods, et al. 2013
[30] Tzeng 2011
[31] Chang, et al. 2009

expected," and "worse than expected" (each HHA's expected rate is the average of the predicted rates across stays within the agency). Pursuing a categorical reporting method is consistent with condition-specific hospital readmission measures. The goal of this method is to assign a HHA to the "Better than Expected" category if the agency's rate of ED use without hospital readmission is lower than expected based on patient case mix by a statistically significant amount and to assign a HHA to the "Worse than Expected" category if the agency's rate of ED use without hospital readmission is higher than expected based on patient case mix by a statistically significant amount. The size of the difference between a HHA's observed rate and expected rate that is statistically significant at a specified level (e.g., 5 percent) depends on the number of home health stays eligible for the measure and the case-mix characteristics of the agency's specific patients.[32]

Table 2.5 shows the number and percentage of HHAs, by performance category and size, with at least 20 home health stays beginning in the period between July 1, 2010 and June 30, 2013 for the *ED Use without Hospital Readmission* measure.[33] There were 7,273 such HHAs representing a total of 2,515,969 home health stays and 2,275,207 patients. With the categorical reporting method, consumers may see that most HHAs in their area are average (i.e., same as expected, which applies to 89.1 percent of HHAs). Additionally, they will be informed if a particular agency is outstanding (i.e., better than expected, which applies to 4.5 percent of all HHAs and 7.2 percent of HHAs with at least 20 stays for the *ED Use without Hospital Readmission* measure). Finally, they will be informed if a particular agency is sub-standard (i.e., worse than expected, which applies to 6.4 percent of all HHAs and 9.0 percent of HHAs with at least 20 stays for the *ED Use without Hospital Readmission* measure). Therefore, health care consumers would not make false distinctions between HHAs when both HHAs are performing as expected, even if their observed rates are different.

[32] Appendix A describes in detail the statistical hypothesis test that this method implements.
[33] Only HHAs with at least 20 stays will have results publicly reported.

Table 2.5: Percentage Distribution of HHAs across Performance Categories for the *ED Use without Hospital Readmission* Measure, by Agency Size

Number of Stays	Better than Expected		Same as Expected		Worse than Expected		Total
	# HHAs	% of Total	# HHAs	% of Total	# HHAs	% of Total	
<20	0	0.0	4,209	98.0	86	2.0	4,295
20-49	32	1.9	1,611	94.8	56	3.3	1,699
50-99	64	4.3	1,356	90.9	72	4.8	1,492
100-199	74	5.4	1,172	86.3	112	8.2	1,358
200-399	95	8.4	931	81.9	111	9.8	1,137
400-999	121	12.0	701	69.3	189	18.7	1,011
1,000+	140	24.3	323	56.1	113	19.6	576
Total	**526**	**4.5**	**10,303**	**89.1**	**739**	**6.4**	**11,568**

To understand why HHAs' risk-adjusted rates (calculated by appending the difference between observed and expected rates to a national average, for example) are not suitable for public reporting, consider the differences between HHAs' observed and expected rates. Tables 2.6 and 2.7 show the distribution of observed and expected agency rates by agency size, respectively, using home health stays beginning between July 1, 2010 and June 30, 2013. Note that the range of expected rates is quite wide, suggesting that much of the variation in observed rates is due to variation in patient case-mix (and thus is accounted for in the expected rates). Table 2.8 shows the differences between the observed and expected agency rates, by agency size; the range of deviation is much larger for HHAs with 20-49 stays than for HHAs with 1000+ stays. This shows that risk adjusting by re-centering deviations from expected on the national mean rate will result in many small HHAs having very small or very large risk-adjusted rates.

Table 2.6: Distribution of Observed Agency Rates of ED Use without Hospital Readmission, by Agency Size

Total Stays	# HHAs	Mean (%)	St. Dev. (%)	Min (%)	10th (%)	25th (%)	50th (%)	75th (%)	90th (%)	Max (%)	Inter. Range (%)
20 -49	1,699	9.6	5.8	0.0	2.9	5.0	9.1	13.2	17.8	31.8	8.2
50 - 99	1,492	9.5	4.2	0.0	4.5	6.5	9.1	12.2	15.1	26.7	5.8
100 – 199	1,358	9.8	3.3	0.0	5.7	7.5	9.7	12.1	14.1	21.2	4.5
200 – 399	1,137	9.6	2.7	2.1	6.1	7.7	9.6	11.5	13.0	21.5	3.7
400 – 999	1,011	9.6	2.3	3.7	6.8	8.0	9.5	11.1	12.6	17.8	3.1
1,000+	576	9.1	1.8	4.5	6.7	7.7	9.0	10.3	11.3	15.6	2.6

Table 2.7: Distribution of Expected Agency Rates of ED Use without Hospital Readmission, by Agency Size

Total Stays	# HHAs	Mean (%)	St. Dev. (%)	Min (%)	10th (%)	25th (%)	50th (%)	75th (%)	90th (%)	Max (%)	Inter. Range (%)
20 -49	1,699	9.7	1.3	6.0	8.1	8.8	9.5	10.4	11.4	14.8	1.6
50 - 99	1,492	9.5	1.1	6.3	8.3	8.8	9.4	10.2	10.9	15.1	1.4
100 – 199	1,358	9.6	1.0	6.0	8.4	8.9	9.5	10.2	10.9	13.8	1.3
200 – 399	1,137	9.4	1.0	6.4	8.2	8.7	9.4	10.0	10.6	13.1	1.2
400 – 999	1,011	9.3	0.8	6.2	8.3	8.8	9.2	9.8	10.3	13.6	1.0
1,000+	576	9.1	0.7	6.8	8.3	8.7	9.1	9.5	10.0	10.9	0.9

Table 2.8: Differences between Observed & Expected Agency Rates of ED Use without Hospital Readmission, by Agency Size[34]

Total Stays	# HHAs	Mean (%)	St. Dev. (%)	Min (%)	10th (%)	25th (%)	50th (%)	75th (%)	90th (%)	Max (%)
20 -49	1,699	0.0	5.5	-12.9	-6.5	-4.0	-0.7	3.2	7.6	21.0
50 - 99	1,492	0.0	3.8	-9.4	-4.8	-2.6	-0.3	2.4	5.2	16.2
100 – 199	1,358	0.3	3.0	-8.9	-3.5	-1.8	0.1	2.2	4.3	11.3
200 – 399	1,137	0.2	2.3	-6.8	-2.7	-1.3	0.1	1.7	3.1	9.7
400 – 999	1,011	0.4	1.9	-5.2	-2.1	-0.9	0.3	1.7	2.8	6.5
1,000+	576	0.0	1.5	-4.0	-1.8	-1.1	-0.1	0.9	1.8	5.3

2.2.3 High Priority

Measuring ED use in addition to inpatient readmission can help identify potential areas to improve care. The ED serves an important function in post-acute care that has not been sufficiently recognized, with reports that one third of hospital revisits are missed if ED visits are not included.[35] ED visits have been described as gateway encounters for hospital re-admissions. A recent study highlighted the importance of measuring both ED visits and inpatient readmissions after a hospital discharge.[36] In this study from a single hospital, measures which evaluate readmission to the inpatient setting and do not include a return to the ED would miss 54 percent of all ED use after an inpatient stay.

Within home health care, 9.2 percent of patients experience ED use without hospital readmission during the first 30 days of home health care.[37] The research in this area is not

[34] The measure developer first calculated the difference between the observed rate and expected rate for each agency. Then, the distribution of the differences by agency size was calculated.
[35] Jencks, et al. 2009.
[36] Rising, et al. 2013
[37] The national rate of ED use without hospital readmission was calculated from claims data using home health stays beginning between July 2010 and June 2013.

specific to home health care patients but applies to such patients, who are most likely community-dwelling older people. There are two systematic reviews that report that older persons are more likely to use the ED, compared to younger age cohorts,[38,39] even though they also have higher rates of use of primary care providers (from a single site study).[40] There are interventions that have been tested to reduce ED use (e.g., geriatric nursing assessment, home care follow up, TH increasing primary care accessibility, educational interventions and cost sharing)[41,42,43,44,45] with the strongest evidence for TH[46,47] and increasing primary care access. [48] There is room for improvement in this measure because of the size of the population that is impacted and the extent of ED use in the home health patient population.

[38] Boult, et al. 2009
[39] Daley 2010
[40] Russell, et al. 2011
[41] Boult, et al. 2009
[42] Daley 2010
[43] Polisena, et al. July 2009
[44] Polisena, et al. October 2009
[45] Polisena, et al. 2010
[46] Polisena, et al. October 2009
[47] Polisena, et al. 2010
[48] Polisena, et al. July 2009

3 MEASURE SPECIFICATIONS

The *Rehospitalization* and *ED Use without Hospital Readmission* measures evaluate the outcomes of acute care rehospitalization and ED use without hospital readmission, respectively, for home health patients who were recently discharged from the hospital. The measures include home health stays beginning within 5 days of an inpatient hospital discharge and measure rehospitalization or use of the ED without hospital readmission during the 30 days following the beginning of home care. To account for beneficiary factors that may affect rates of hospitalization but are outside of the HHA's control, the measures use a multinomial logistic model, which incorporates measures of beneficiary demographics, health status, prior care setting, Medicare enrollment status, and other interaction terms. The model estimates the three possible outcomes of inpatient rehospitalization, ED use without hospital readmission, and no acute event. The *Rehospitalization* and *ED Use without Hospital Readmission* measures are calculated from Medicare claims.

The remainder of this section describes the measure specifications in greater detail. Section 3.1 describes how home health stays are constructed from claims data. Section 3.2 defines the outcomes (i.e., numerator information) for the *Rehospitalization* and *ED Use without Hospital Readmission* measures. Section 3.3 defines the eligible patient population. Finally, Section 3.4 explains the proposed approach for adjusting the measure rates to account for risk factors that may contribute to different patient outcomes. Appendices B and C include the algorithm for calculating the *Rehospitalization* and *ED Use without Hospital Readmission* measures respectively.

3.1 Construction of Home Health Stays

A home health stay is a sequence of home health payment episodes separated from other home health payment episodes by at least 60 days. Each home health payment episode is associated with a Medicare home health claim, so home health stays are constructed from claims data using the following procedure:

1. First, retrieve home health claims with a "from" date (FROM_DT) during the 12-month observation period or the 120 days prior to the beginning of the observation period and sequence these claims by "from" date for each beneficiary.
2. Second, drop claims with the same "from" date and "through" date (THROUGH_DT) and claims listing no visits and no payment. Additionally, if multiple claims have the same "from" date, keep only the claim with the most recent process date.
3. Third, set Stay_Start_Date(1) equal to the "from" date on the beneficiary's first claim. Step through the claims sequentially to determine which claims begin new home health

stays. If the claim "from" date is more than 60 days after the "through" date on the previous claim, then the claim begins a new stay. If the claim "from" date is within 60 days of the "through" date on the previous claim, then the claim continues the stay associated with the previous claim.

4. Fourth, for each stay, set Stay_Start_Date(n) equal to the "from" date of the first claim in the sequence of claims defining that stay. Set Stay_End_Date(n) equal to the "through" date on the last claim in that stay. Confirm that Stay_Start_Date(n) minus Stay_End_Date(n-1) is greater than 60 days for all adjacent stays.
5. Fifth, drop stays that begin before the 12-month observation window.
6. Finally, only stays that begin within 5 days of discharge from a short-term inpatient hospital are included in the denominator as follows:
    a. Link to Part A claims for 6 months prior to Stay_Start_Date for each beneficiary.
    b. Define Hosp_Discharge_DT = Thru_Dt of the inpatient claim with the latest through date (thru_Dt) prior to Stay_Start_Date,.
7. Limit to home health stays where the Stay_Start_Date minus the Hosp_Discharge_DT is equal to or less than 5. Exclude stays where the IP claim is from a provider type that is not a short stay hospital. Short term hospitals are defined using the following CCN ranges in the third through sixth positions: 001-0879, 0880-0899, and 1300-1399.

Note the examining claims from the 120 days before the beginning of the 12-month observation period is necessary to ensure that stays beginning during the observation period are in fact separated from previous home health claims by at least 60 days.

3.2 Outcome Definition

The *Rehospitalization* and *ED Use without Hospital Readmission* measures evaluate the outcomes of acute care rehospitalization and ED use without hospital readmission, respectively, for home health patients who were recently discharged from the hospital. Observation stays that begin in a hospital ED will be captured in the *ED Use without Hospital Readmission* measure. The remainder of this section describes the numerator definitions and exclusion criteria for each patient outcome.

3.2.1 Rehospitalization Measure

The *Rehospitalization* measure numerator includes inpatient stays for patients who have a Medicare claim for an admission to an acute care hospital in the 30 days following the start of home health stay. The 30-day time window is calculated by adding 30 days to the "from" date in the first home health claim in the series of home health claims that comprise the home health

stay. If the patient has at least one Medicare IP claim from short-term or critical access hospitals during the 30 day window, then the stay is included in the measure numerator.[49]

Because planned hospitalizations do not necessarily reflect the quality of home health care, inpatient claims for planned hospitalizations are excluded from the rehospitalization measure numerator. Planned hospitalizations are defined using the same criteria as the HWR measure.[50] Specifically, a small set of readmissions, defined using the Agency for Healthcare Research and Quality (AHRQ) Procedure and Diagnosis Clinical Classification Software (CCS), are always considered "planned." An additional set of admissions are categorized as "potentially planned" and are also excluded from being counted as unplanned admissions in the measure numerator unless they have a discharge condition category considered "acute or complication of care," which is defined using AHRQ Diagnosis CCS.[51]

3.2.2 ED Use without Hospital Readmission Measure

The *ED Use without Hospital Readmission* measure numerator includes inpatient stays for patients who have a Medicare claim for outpatient emergency use and no claims for acute care hospitalization in the 30 days following the start of the home health stay. The 30-day time window is calculated by adding 30 days to the "from" date in the first home health claim in the series of home health claims that comprise the home health stay. If the patient has any Medicare outpatient claims with an ER revenue center code during the 30 day window *and* if the patient has no Medicare inpatient claims for admission to an acute care hospital during the 30 day window, then the stay is included in the measure numerator.[52] The *ED Use without Hospital Readmission* measure does not have numerator exclusions.

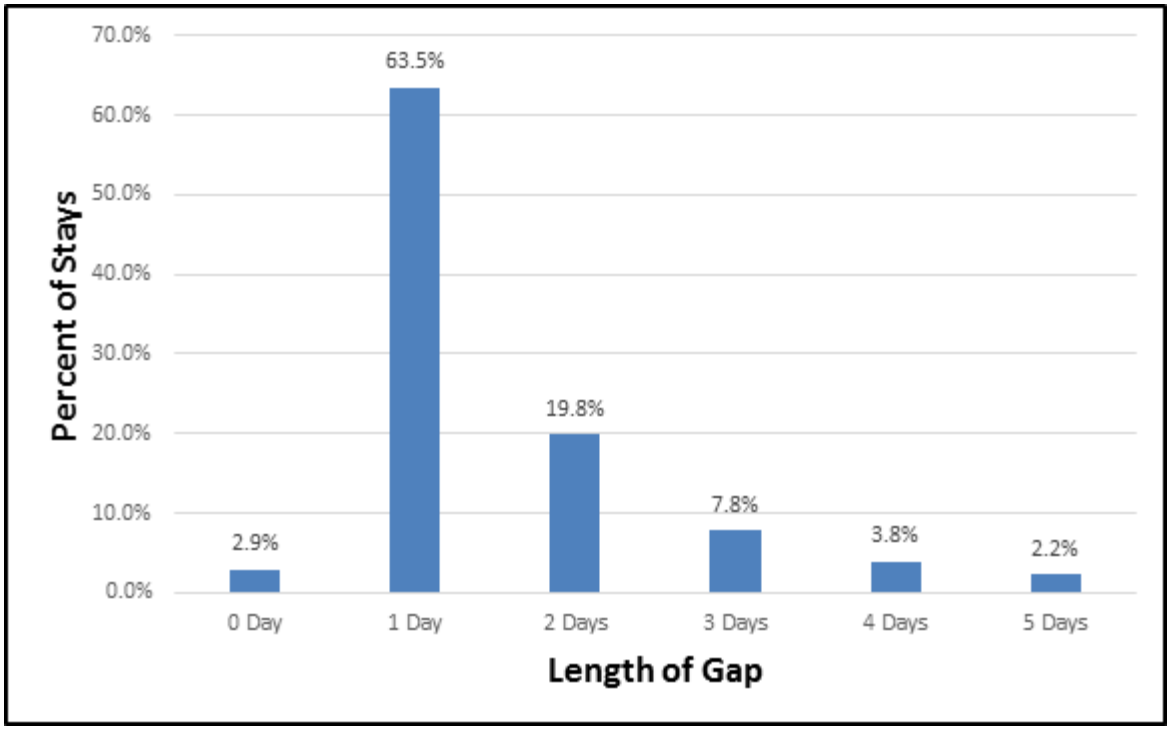
3.3 Eligible Patient Population

While other post-acute care readmission measures exclude patients with any gap between hospital discharge and post-acute admission, the *Rehospitalization* and *ED Use without Hospital Readmission* measures only include home health patients who were discharged from an acute inpatient hospital within *five* days of the start of home care. The remainder of this section explains the rationale underlying the five-day timeframe used to specify the eligible patient population.

[49] Short-term and critical access hospitals are identified by a CMS Certification Number ending in 0001-0879, 0800-0899, or 1300-1399.
[50] The planned readmission algorithm for the HWR measure was revised in late 2012. The measures rates reported in this technical report were calculated using this revised HWR planned readmission algorithm.
[51] The definitions of AHRQ CCS can be found here: http://www.hcup-us.ahrq.gov/toolssoftware/ccs/ccs.jsp. The code lists to define these categories can be found in Appendix C.
[52] ER revenue center codes include 0450-0459 and 0981. Short-term and critical access hospitals are identified by a CMS Certification Number ending in 0001-0879, 0800-0899, or 1300-1399.

First, the five-day timeframe enables a sizable proportion of home health patients to be captured in the measure denominator. Unlike post-acute care in other settings, home health is provided in the patient's home, and thus the patient returns to their home after hospital discharge. This results in some gap between hospital discharge and the initial visit from a HHA. The Medicare Conditions of Participation for HHAs require home health care to begin within 48 hours of hospital discharge or on the physician-ordered start of care date (which is usually within 1-3 calendar days of hospital discharge). Figure 3.1 shows the distribution of home health stays beginning between July 2010 – June 2013 for patients starting home health care within 30 days of hospital discharge, by length of gap between hospital discharge and start of home health care. Thus, the measures as specified apply to 90 percent of patients who begin home health within 30 days of hospital discharge.

Figure 3.1: Percentage Distribution of Stays, by Length of Gap



Additionally, lengthening the window beyond five days would create two problems. First, it would substantially increase the heterogeneity of the measured population. Patients with longer gaps between hospital discharge and home care are more likely to be seen in another post-acute setting (such as a skilled nursing facility or an Inpatient Rehabilitation Facility). These patients may also have been discharged home without orders for home care and have only received orders for home care after a significant deterioration of their condition. Thus, including patients who begin home care more than five days after hospital discharge may discourage HHAs from accepting patients who only receive orders for home care several days after hospital

discharge. Second, lengthening the gap beyond five days would mean the observation window (30 days after the beginning of home health care) substantially exceeds the 30-day post hospital discharge window used in CMS' HWR measure. Under the current specification, the total length of time from the hospital discharge to the end of the observation (numerator) window is at most 35 days. This ensures the measures are similar to the HWR measure and other post-acute care setting rehospitalization measures.

Finally, shortening the five-day window is undesirable for several reasons. First, it would exclude some patients from the measures who are not cared for in any other post-acute setting. Additionally, a shorter window (such as a two-day window to be consistent with the Conditions of Participation) may encourage HHAs to delay the start of care for particularly unstable patients so that they are not held accountable for the rehospitalization of such patients. In addition, all home health stays for Medicare FFS beneficiaries, including those that begin more than 5 days after a hospital discharge, are included in the ACH and ED Use quality measures.

3.3.1 Exclusions from the Measure Denominators

The following types of home health stays are excluded from the measure denominators of both the *Rehospitalization* and *ED Use without Hospital Readmission* measures:

(1) Home health stays for patients who are not continuously enrolled in fee-for-service Medicare during the measure numerator window (30 days following the start of the home health stay) or until death. Both enrollment status and beneficiary death date are identified using the Medicare Enrollment Database (EDB). These stays lack full information about the patient's utilization of health care services and so it cannot determined if care was sought in an ED during the numerator window.

(2) Home health stays that begin with a Low Utilization Payment Adjustment (LUPA) claim. Exclude the stay if LUPAIND = L for the first claim in the home health stay. Home health stays designated as LUPAs are excluded because it is unclear that the initial HHA had an opportunity to impact the patient's health outcomes.

(3) Home health stays in which the patient receives service from multiple HHAs during the first 30 days. Define Initial_Provider = PROVIDER on the first claim in the home health stay. If Initial_Provider does not equal PROVIDER for a subsequent claim in the home health stay AND if the "from" date of the subsequent claim is within 60 days of Stay_Start_Date, then exclude the stay. These home health stays are excluded because it is unclear that the initial HHA had an opportunity to impact the patient's health outcomes.

(4) Home health stays for patients who are not continuously enrolled in fee-for-service Medicare for the six months prior to the start of the home health stay. Enrollment status is identified using the Medicare EDB. These stay are excluded because we lack information about the patient's health status prior to the beginning of home health that is needed for risk adjustment.

(5) Home health stays for admissions for the medical treatment of cancer, primary psychiatric diseases, rehabilitation care and the fitting of prostheses and adjustment devices, and admissions ending in patient discharge against medical advice. Admissions for cancer have very different mortality and readmission rates than the remainder of the population. Admissions for psychiatric diseases are treated in separate psychiatric facilities not comparable to treatment received in acute care hospitals, and admissions for rehabilitation care typically do not occur in an acute care setting. Finally, admissions that end in patient discharge against medical advice are excluded because the hospital did not have a full opportunity to treat the patient. Appendix E describes the exclusion algorithm for these stays in greater detail.

(6) Home health stays for patients who receive intervening care in the window between the index hospital discharge and the start of home health care. Intervening care is identified as any inpatient hospital use (which includes care received at inpatient rehabilitation facilities and long-term care hospitals), ED use without hospitalization, and skilled nursing facility treatment. These home health stays are excluded because patients' health outcomes may be affected by the care they receive between hospital discharge and the start of home care.

(7) Home health stays with missing payment-episode authorization strings. These stays do not include all the information needed for risk adjustment.

3.4 Risk Model Specifications

The *Rehospitalization* and *ED Use without Hospital Readmission* measures use a multinomial logistic model to account for beneficiary factors that may affect rates of hospitalization but are outside of the HHA's control. 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 without hospital readmission, and rehospitalization. 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. The risk adjustment model uses six months of claims prior to the start of home health care to obtain information about the beneficiary.

Although several other models are potentially applicable, none is appropriate for these measures. One potential model is individual logits modeling rehospitalization and ED use without hospital readmission separately. 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 rehospitalization would include and be affected by ED use without hospital readmission, and vice versa. A second possible model is an ordered logit, but this model is also not appropriate because the risk factors cannot be said to affect the probability of the three events in identical proportions. Finally, because there are no

alternative factors to distinguish the nests of either rehospitalization or ED use without hospital readmission as opposed to no event, a nested logit model generalizes to a multinomial logit.

The multinomial logistic model for the *Rehospitalization* and *ED Use without Hospital Readmission* measures incorporate five categories of risk factors; Section 3.4.1 describes these variables in greater detail. Using these risk factor categories, the measure developer identified a set of 404 covariates that consisted of statistically significant predictors of acute care rehospitalization or ED use without hospital readmission. Section 3.4.2 describes the variable selection process in greater detail. The attachment titled "ClaimsBased_RehospitalizationMeasures_Model_Coefficients_P-Values_and_Marginal_Effects.xlsx" presents the coefficients and marginal effects for each risk factor in the final calibrated model. This model would be used to calculate the predicted probabilities of the two outcomes for each home health stay for the home health quality reporting program.

3.4.1 Variable Specification

The multinomial logistic model for the *Rehospitalization* and *ED Use without Hospital Readmission* measures incorporate five categories of risk factors, including (i) prior care setting, (ii) age and sex interactions, (iii) health status, (iv) Medicare enrollment status, and (v) other interaction terms. The remainder of this section explains each risk factor category.

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. The categorical variables included in this risk factor are defined by examining Medicare claims for the six months prior to the start of the home health stay. One categorical variable captures prior care use in the 30 days prior to the start of home health (and prior to the index hospitalization). A second variable includes information about care received more than 30 days prior to home health but within six months of the start of the home health stay and identifies patients with hospitalizations, skilled nursing facility care, or ED use during this time frame. Finally, the risk adjustment model accounts for the length of index hospital stay (i.e., one to two weeks, and greater than two weeks).

Factor 2: Age and Sex Interactions

The risk adjustment model includes age and sex interactions from the Medicare EDB as covariates to account for the differing effects of age on the outcomes for each sex. Age is subdivided into 12 bins for each sex: aged 0 to 34, 35 to 44, 45 to 54, five-year age bins from 55 to 95, and a 95 and older category. Age is determined based on the patient's age at the start of the home health stay. The model includes a binary indicator for each age-bin, sex combination. The omitted category is 65-69 year old males.

Factor 3: Health Status

To account for beneficiary health status, the risk adjustment model uses three measures of health status: (i) CMS' Hierarchical Condition Categories (HCCs), (ii) Diagnosis-Related Groupings (DRGs), (iii) and Activities of Daily Living (ADLs). The remainder of this section describes each in turn.

Hierarchical Condition Categories

The risk adjustment uses CMS' HCCs. 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.[53] While the CMS-HHC model uses a full year of claims data to calculate HCCs,[54] the *Rehospitalization* and *ED Use without Hospital Readmission* measures use only six months of data to limit the number of home health stays excluded due to missing claims history. Binary indicators for all HCCs and CCs from the 2008 CMS HCC model that are not hierarchically ranked and that were statistically significant predictors of rehospitalization or ED use without hospital readmission are included in the model.

Diagnosis-Related Groupings

The risk adjustment model includes the DRG of the qualifying inpatient stay. DRGs are used for Medicare payment to classify inpatient stays that are clinically related and are expected to have similar levels of resource use. Most DRGs are classified based largely on the primary diagnosis on the inpatient claim.[55]

Activities of Daily Living

Finally, risk adjustment for these measures also takes into account patient functional status by including the four separate ADL scores that appear on the home health claim. These four scores range from 0 to 16 and are calculated as part of the home health payment process by combining information from several OASIS items:

(1) Dressing upper or lower body (OASIS fields M1810 or M1820)

(2) Bathing (M1830)

(3) Toileting (M1840)

(4) Transferring (M1850)

(5) Ambulation (M1860)

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[53] A description of the development of the CMS-HCC model can be found here: https://www.cms.gov/HealthCareFinancingReview/Downloads/04Summerpg119.pdf

[54] Details of the CMS-HCC model and the code lists for defining the HCCs can be found here: https://www.cms.gov/MedicareAdvtgSpecRateStats/06_Risk_adjustment.asp

[55] Details of the DRG system can be found here: http://www.cms.gov/Outreach-and-Education/Medicare-Learning-Network-MLN/MLNProducts/downloads/AcutePaymtSysfctsht.pdf

While each of the four ADL scores is calculated from these OASIS items, the weight assigned to each item differs across scores. Thus, all four scores convey distinct information about patient functional status and are used for risk adjustment.[56] Directly including OASIS items as risk factors is not currently feasible, due to challenges associated with linking OASIS assessments to home health claims.

Factor 4: Medicare Enrollment Status

The model employs reason for Medicare eligibility, including 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 sex.

Factor 5: Additional Interaction Terms

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 and chronic obstructive pulmonary disease may be at greater risk for hospitalization than would be estimated by adding the risk of hospitalization for each condition separately. All interaction terms included in the 2008 and 2012 HCC risk adjustment models that were statistically significant predictors of rehospitalization or ED use without readmission were included.

3.4.2 Variable Selection

The same multinomial logit model is used to predict both the *Rehospitalization* and the *ED Use without Hospital Readmission* measures. Of the 1,460,995 qualifying home health stays beginning from July 1, 2010 to June 30, 2012, a random 80 percent sample without replacement was chosen to calibrate the multinomial logit model and to estimate marginal effects for model development purposes. The remaining 20 percent of the stays were used to cross-validate the model.

To determine which risk factors should be included in the risk adjustment model, a Wald test of joint restrictions was applied to each variable in each of 1,150 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 current risk adjustment model includes only covariates that were significant at a level of 0.05 for either outcome in at least 80 percent of bootstrap samples. This restriction reduces the number of variables included in the current model, thus streamlining the model and avoiding over-fitting.

[56] This methodology differs from the ADL score included in the Home Health Resource Grouper (HHRG), which is a categorization of one of the four ADL scores. Further information can be found at: http://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/HomeHealthPPS/CaseMixGrouperSoftware.html

To evaluate the impact of each risk factor, the marginal effects were calculated. The marginal effect represents the relative impact of each risk factor on the outcome. Each risk factor has an associated marginal effect value that can be interpreted as the change in the population value of the measure if all patients in the population had the risk factor but had the observed distribution of all other risk factors. Goodness-of-fit statistics were then calculated for the calibrated model and the 20 percent sample was used for cross-validation. The measure developer identified a set of 404 covariates that consisted of statistically significant predictors of acute care rehospitalization or ED use without hospital readmission.

Once the significant risk factors were identified in the development stage, the model was then calibrated using 100 percent of home health stays.[57] This model would be used to calculate the predicted probabilities of the two outcomes for each home health stay for the home health quality reporting program.[58]

In May 2014, the measure developer re-calibrated the model using three years of data (i.e., all home health stays beginning between July 1, 2010 and June 30, 2013) to reflect the three-year reporting period planned for the public reporting of the *Rehospitalization* and the *ED Use without Hospital Readmission* measures. The attachment titled "ClaimsBased_RehospitalizationMeasures_Model_Coefficients_P-Values_and_Marginal_Effects.xlsx" presents the coefficients and marginal effects for each risk factor in the model calibrated using all home health stays beginning between July 1, 2010 and June 30, 2013.[59]

[57] Section 4.2.3 provides details about the risk model performance and testing results.
[58] Appendix A describes how CMS intends to use a categorical reporting method to publicly report the *Rehospitalization* and *ED Use without Hospital Readmission* measures.
[59] The measure developer will periodically re-calibrate the model using the most recent three years of data and publish the resulting updated model coefficients.

4 MEASURE TESTING

Ensuring that quality measures developed for public reporting are robust and accurately portray HHA performance is a crucial part of the measure development process. To ensure that the *Rehospitalization* and *ED Use without Hospital Readmission* measures would produce consistent and reliable results about the quality of care when implemented for quality reporting, the measure developer tested the measures' scientific acceptability, including their reliability and validity. Reliability testing demonstrates that HHAs' performance categorizations are repeatable, producing the same results a high proportion of the time when assessed in the same population in the same time period. Validity evaluation involves an assessment of the consistency between measure specifications and that the measure specifications provide a correct and credible reflection of the quality of care that adequately identifies differences in quality. Sections 4.1 and 4.2 provide details about the testing performed on the *Rehospitalization* and *ED Use without Hospital Readmission* measures, respectively.

4.1 Reliability Testing

The measure developer conducted reliability testing at the level of the performance measure score and found a high level of internal consistency for both the *Rehospitalization* and *ED Use without Hospital Readmission* measures; Section 4.1.1 describes the data, methodology, and results in detail.

4.1.1 Split-Half Test

To assess the internal consistency of the *Rehospitalization* and *ED Use without Hospital Readmission* measures, the measure developer conducted a split-half reliability test[60] on each measure using 100 percent of each eligible HHA's stays. The measure developer restricted the reliability analysis to HHAs with at least 40 valid stays beginning between July 1, 2010 and June 30, 2013, so that each 50 percent sample had at least 20 stays (i.e., the minimum number of stays required to protect patient confidentiality in public reporting). There were 6,004 such HHAs in the data sample, representing a total of 2,450,674 home health stays and 2,192,292 patients.

The split-half test involved several steps. First, stays for each HHA were randomly divided into two 50 percent samples. Second, simulations were run on each 50 percent sample to group the agency into the "Better than Expected", "Same as Expected", or "Worse than

[60] The Intra-class Correlation (ICC) measures between-agency variation and within-agency variation. An ICC would not be appropriate for assessing measure reliability in the case of the *Rehospitalization* and *ED Use without Hospital Readmission* measures. CMS intends to publicly report the Rehospitalization and ED Use without Hospital Readmission measures using a categorical reporting method. The categorical reporting method does NOT attempt to distinguish between high and low performing agencies by comparing agencies' risk-adjusted rates; rather, each home health agency is classified into a performance category based on each home health agency's expected and observed rates. Therefore, instead of computing an ICC, the measure developer conducted a split-half test to assess the measure reliability.

Expected" categories.[61] Finally, the results between the two samples for each HHA were compared to assess how consistently the HHA was grouped into the same category ("Better than Expected", "Same as Expected", or "Worse than Expected") across the two samples. The remainder of this section presents the testing results.

Results for the Rehospitalization Measure

Using each HHA's 50 percent samples to produce two simulations and groupings, the majority of the HHAs were grouped into the same performance category. Figure 4.1 below depicts the results of the split-half test; as represented by the numbers and percentages along the diagonal (i.e., upper-left to bottom-right), 4,916 (82 percent) were grouped into the same performance category as a result of the split-half test. Five-hundred and forty (9 percent) HHAs shifted between the "Better than Expected" and "Same as Expected" categories, and 535 (9 percent) HHAs shifted between the "Worse than Expected" and "Same as Expected" categories. Only 13 HHAs shifted between the "Better than Expected" and "Worse than Expected" categories.

Figure 4.1: Split-Half Test Results for the *Rehospitalization* Measure

	Better than Expected	**Same as Expected**	**Worse than Expected**	
Better than Expected	64 (1%)	266 (4%)	9 (0%)	**339 (6%)**
Same as Expected	274 (5%)	4,788 (80%)	260 (4%)	**5,322 (89%)**
Worse than Expected	4 (0%)	275 (5%)	64 (1%)	**343 (6%)**
	342 (6%)	**5,329 (89%)**	**333 (6%)**	

The categorization method is robust. The split-half test results show that the majority of the HHAs were grouped into the same performance category using both sub-samples. Some HHAs shifted between the "Same as Expected" category and "Better than Expected" or "Worse than Expected" categories (which is reasonable because the categorization requires statistical confidence). While many HHAs are categorized as "Same as Expected" in both periods,

[61] Appendix A describes the performance categorization method in greater detail.

transitions between the "Better than Expected" and "Worse than Expected" categories are extremely rare.

Results for the ED Use without Hospital Readmission Measure

Using each HHA's 50 percent samples to produce two simulations and groupings, the majority of the HHAs were grouped into the same performance category. Figure 4.2 below depict the results of the split-half test; as represented by the numbers and percentages along the diagonal (i.e., upper-left to bottom-right), 4,826 HHAs (80 percent) were grouped into the same performance category as a result of the split-half test. Four-hundred and sixty-seven (8 percent) HHAs shifted between the "Better than Expected" and "Same as Expected" categories, and 700 HHAs (12 percent) shifted between the "Worse than Expected" and "Same as Expected" categories. Only 11 HHAs shifted between the "Better than Expected" and "Worse than Expected" categories.

Figure 4.2: Split-Half Test Results for the *ED Use without Hospital Readmission* Measure

	Better than Expected	**Same as Expected**	**Worse than Expected**	
Better than Expected	88 (1%)	249 (4%)	5 (0%)	**342 (6%)**
Same as Expected	218 (4%)	4,642 (77%)	340 (6%)	**5,200 (87%)**
Worse than Expected	6 (0%)	360 (6%)	96 (2%)	**462 (8%)**
	312 (5%)	**5,251 (87%)**	**441 (7%)**	

The categorization method is robust. The majority of the HHAs were grouped into the same performance category using either sub-sample, as the split half results show. Some HHAs shifted between the "Same as Expected" category and "Better than Expected" or "Worse than Expected" categories (which is reasonable because the categorization requires statistical confidence). While most HHAs were in the "Same as Expected" category using either sub-sample, transitions between the "Better than Expected" and "Worse than Expected" categories are extremely rare.

4.2 Validity Testing

Evaluation of a measure's validity involves an assessment of the consistency between measure specifications and that the measure specifications provide a correct and credible reflection of the quality of care that adequately identifies differences in quality. Therefore, evaluation of a measure's validity requires reviewing the measure specifications (e.g., numerator, denominator, exclusions, risk factors) and the evidence that supports them. The measure developer considered a range of evidence in assessing the validity of the *Rehospitalization* and *ED Use without Hospital Readmission* measures, including (i) the measures' convergent validity, (ii) the measure exclusions, (iii) the risk model performance, and (iv) whether the categorical reporting method would enable health care consumers to make practical and meaningful distinctions between the quality of care across HHAs. The remainder of this section summarizes our findings.

First, the measure developer assessed the convergent validity of the measure. Convergent validity refers to the extent to which measures that are designed to assess the same construct are related to each other. The measure developer found that HHAs that performed "better than expected" on the *Rehospitalization* and *ED Use without Hospital Readmission* measures also performed better on several OASIS assessment measures, compared to HHAs in the pooled "worse than expected" or "same as expected" category. Second, the measure developer found no evidence of distortion by the measure exclusions. Third, the risk 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. Finally, with the categorical reporting method, health care consumers may see that most HHAs in their area are average (i.e., "Same as Expected"), whereas a small number of HHAs are outstanding (i.e., "Better than Expected") or sub-standard (i.e., "Worse than Expected").

The remainder of this section describes our validity testing findings in greater detail. Section 4.2.1 presents the convergent validity analysis. Section 4.2.2 describes our exclusion analysis. Finally, Section 4.2.3 describes our risk model performance. Section 4.2.4 explains how the categorical reporting method would enable consumers to make meaningful distinctions in the quality of care across HHAs.

4.2.1 Convergent Validity

The measure developer also assessed the convergent validity of the measure. Convergent validity refers to the extent to which measures that are designed to assess the same construct are related to each other. The measure developer restricted the validity analysis to include Medicare-certified HHAs with at least 20 home health stays beginning between July 2010 and June 2013 and meeting the measure denominator criteria. There were 7,273 such HHAs representing a total of 2,515,969 home health stays and 2,275,207 patients. To evaluate the

convergent validity of the measure, the measure developer compared the mean performance rates of HHAs in the "better than expected" category on four measures of home health quality derived from OASIS assessments, compared to the performance of HHAs who were not identified as "better than expected" (i.e., HHAs in the "same as expected" plus "worse than expected" categories). The remainder of this section describes our analytic findings.

Results for Rehospitalization Measure

Table 4.3 compares the mean performance rates between HHAs in the "Better than Expected" category and other HHAs (i.e., HHAs in the "Same as Expected" plus "Worse than Expected" categories) on five measures of home health quality derived from OASIS assessments. On average, "Better than Expected" HHAs performed better on the five OASIS assessment measures below compared to HHAs in the pooled "Worse than Expected" or "Same as Expected" category, which lends evidence to the measure's validity. The percent point difference ranges from 3.1 percent on the "How often patients got better at getting in and out of bed" measure to 6.0 percent on the "how often patients' breathing improved" measure. It may be that strong performance on the other measures directly reduces rehospitalizations (e.g., patients who receive the flu vaccine are less likely to catch the flu and require hospitalization). It may also be the case that high quality HHAs perform well on both the *Rehospitalization* measure and other OASIS-based measures due to cultural or organization factors.

Table 4.1: Convergent Validity, *Rehospitalization* Measure

OASIS Assessment Measure	Mean Performance Rates		
	"Better than Expected" HHAs (%)	"Worse than Expected" or "Same as Expected" HHAs (%)	Percent Point Difference (%)
How often patients' breathing improved	64.2	58.2	6.0
How often patients got better at taking their drugs correctly by mouth	48.8	44.4	4.4
How often the home health team determined whether their patients received a pneumococcal vaccine (pneumonia shot)	68.3	64.5	3.8
How often patients got better at bathing	65.9	62.3	3.6
How often patients got better at getting in and out of bed	54.4	51.3	3.1

Results for ED Use without Hospital Readmission Measure

Table 4.4 compares the mean performance rates between HHAs in the "Better than Expected" category and other HHAs (i.e., HHAs in the "Same as Expected" plus "Worse than Expected" categories) on five measures of home health quality derived from OASIS assessments. On average, "Better than Expected" HHAs perform better on the four OASIS assessment measures below compared to HHAs in the pooled "Worse than Expected" or "Same as Expected" category, which lends evidence to the measure's validity. The percent point difference ranges from 3.4 percent on the "how often patients got better at bathing" measure to 6.8 percent on the "how often patients' breathing improved" measure. It may be that strong performance on the other measures directly reduces ED use without hospital readmission (e.g., patients who got better at taking their drugs correctly by mouth may be less likely to overdose and be sent to the ED). It may also be the case that high quality HHAs perform well on both the *ED Use without Hospital Readmission* measure and other OASIS-based measures due to cultural or organization factors.

Table 4.2: Convergent Validity, *ED Use without Hospital Readmission* Measure

OASIS Assessment Measure	Mean Performance Rates		
	"Better than Expected" HHAs (%)	"Worse than Expected" or "Same as Expected" HHAs (%)	Percent Point Difference (%)
How often patients' breathing improved	65.0	58.2	6.8
How often patients got better at taking their drugs correctly by mouth	49.2	44.4	4.8
How often patients got better at getting in and out of bed	55.7	51.2	4.5
How often patients had less pain when moving around	68.6	64.6	4.0
How often patients got better at bathing	65.7	62.3	3.4

4.2.2 Exclusion Analysis

As part of the exclusion analysis, the measure developer calculated the frequency of occurrence of each exclusion type in the data; the remainder of this section presents these calculations and provides empirical and conceptual justifications for the exclusions.

Exclusion Frequencies

The measure developer calculated the frequency of exclusions by exclusion type using all home health stays between July 1, 2010 and June 30, 2013. Table 4.5 provides the percentage

distribution of home health stays being excluded for the reasons outlined in Section 3.3.1. The sample included all 10,076,054 home health stays; of these, 3,288,400 home health stays (32.6 percent) began within 5 days of hospital discharge. After applying the exclusion criteria, 2,515,969 stays (25 percent) remain eligible for each measure denominator.

Table 4.3: Measure Denominator Exclusion, July 2010 – June 2013

Home Health Stays	# of Stays Excluded	% of Stays Excluded	# of Stays Remaining
A. Total home health stays beginning within 5 days of hospital discharge	N/A	N/A	3,288,400
B. Home health stays that meet the denominator criteria for all-patient claims-based *ACH* and *ED Use* measure	577,961	17.58	2,710,439
C. Home health stays from B that meet the denominator criteria for the HWR measure	159,597	5.89	2,550,842
D. Home health stays from C that exclude stays in which the patient receives treatment in another setting in the 5 days between hospital discharge and the start of home health	33,827	1.33	2,517,015
E. Home health stays with all risk adjustment data available (i.e., stays with missing payment-episode authorization strings are dropped)	1,046	0.04	2,515,969

Of the 2,515,969 stays that remain in the measure denominator after applying the exclusions above, there are **342,856** eligible home health stays across all HHAs with an unplanned rehospitalization.

Measure Exclusion Justifications

The measure developer found the exclusions to be justified. First, the measure developer imposed the exclusions in Steps B and C of Table 4.5 for consistency with the existing all-patient claims-based home health measures (i.e., *ACH* and *ED Use* measures) and the HWR measure. The measure developer compared each home health agency's risk-adjusted rate with and without the LUPA exclusion and found the two rates to be highly correlated (overall Pearson correlation coefficient [r] = 0.96) for both the *Rehospitalization* and *ED Use without Hospital Readmission* measures, indicating that the LUPA exclusion does not result in distortion of the measure rate. The measure developer conducted no additional analyses on other exclusions.

Second, regarding the exclusion of stays in which the patient receives treatment in another setting in the 5 days between hospital discharge and the start of home health (i.e., Step D in Table 4.5), the measure developer found that 33,827 of stays (~1 percent) were excluded based on this criterion; this exclusion criterion is justified because the health outcomes of patients who had intervening inpatient (which includes care received at inpatient rehabilitation facilities and long-term care hospitals), ED, or skilled nursing facility care in the window between the index hospital discharge and the start of home health care may be affected by this care. Additionally, for both the *Rehospitalization* and *ED Use without Hospital Readmission* measures, the measure developer compared each HHA's observed rates on each measure with and without this exclusion; the two rates were found to be highly correlated with Pearson correlation coefficients ~1. Table 4.6 summarizes the overall Pearson correlation coefficient between the observed rates for each measure with and without this exclusion.

Table 4.4: Pearson Correlation Coefficients

Measure	Correlation Between Observed Rates with and without the Exclusion
Rehospitalization	0.996
ED Use without Hospital Readmission	0.995

Finally, regarding the exclusion for stays with missing payment-episode authorization strings, the measure developer found that 1,046 stays (< 0.1 percent) are excluded based on this criterion; this exclusion criterion is justified because these stays do not include all the information needed to risk-adjust the measures.

4.2.3 Risk Model Performance

This section evaluates the risk adjustment model and illustrates its appropriateness for the *Rehospitalization* and *ED Use without Hospital Readmission* measures using three approaches. The first section examines how risk adjustment affects the distribution of the overall measure rates. The second section discusses how risk adjustment affects the rating of HHAs' measure rates. Finally, the third section evaluates how well the model predicts outcomes on the data on which it was calibrated and outside the data on which it was calibrated.

Distributions of Rates across Specifications

At the agency level, the unadjusted rate of rehospitalization averages 14.13 percent and the unadjusted rate of ED use without hospital readmission averages 9.98 percent. Table 4.7 presents the distribution of agency-level unadjusted and risk-adjusted rates of rehospitalization for all home health stays beginning between July 1, 2010 to June 30, 2013 across specifications,

and Table 4.8 presents the results for the rates of ED use without hospital readmission.[62] In Tables 4.7 and 4.8, the risk-adjusted rates are bottom-coded and top-coded to range from 0 to 100 percent. The agency-level risk-adjusted rates of rehospitalization and ED use without hospital readmission average 13.01 percent and 9.44 percent, respectively, meaning that HHAs on average perform slightly better when taking into account their beneficiaries' health status, demographics, and prior care.[63]

Risk adjustment also decreases the variation in agency-level outcomes, as measured by the standard deviation. Both the unadjusted and risk-adjusted agency rates range from 0 to 100 because HHAs can have as few as one patient included in the measures. Some HHAs have too few stays included in the measures to have their outcome rates reliably reported. While 11,568 HHAs had at least one home health stay included in the measures, only 7,273 had at least 20 stays included. After restricting to HHAs with at least 20 home health stays, the average risk-adjusted rate of rehospitalization increases slightly from 13.01 percent to 13.40 percent, as presented in Table 4.7. Table 4.8 shows that after restricting to HHAs with at least 20 stays, the average risk-adjusted rate of ED use without hospital readmission decreases slightly from 9.44 percent to 9.36 percent. As measured by the standard deviation, restricting to HHAs with at least 20 stays greatly decreases the variability of the measure.

Table 4.5: Distribution of Agency-Level Rehospitalization Rates

Specification		Mean (%)	St. Dev. (%)	Min (%)	10th (%)	25th (%)	50th (%)	75th (%)	90th (%)	Max (%)
All HHAs	Observed	14.13	12.98	0.00	0.00	8.26	13.04	17.03	25.00	100.00
	Risk Adjusted	13.01	12.46	0.00	0.63	8.46	12.87	16.00	21.72	100.00
HHAs with at least 20 home health stays	Observed	13.66	4.71	0.00	8.00	10.78	13.56	16.25	19.26	40.63
	Risk Adjusted	13.40	4.01	0.00	8.68	11.17	13.35	15.45	18.10	36.23

[62] The measure developer calculated the risk-adjusted rate for each measure at each home health agency using the following formula: Risk-Adjusted Rate for each HHA = National Predicted Rate + (Observed Rate for HHA – Predicted Rate for each HHA).

[63] CMS does not intend to publicly report HHAs' risk-adjusted rates. Using a three-year reporting period, CMS intends to publicly report the performance of Medicare-certified HHAs (with at least 20 home health stays) on the *Rehospitalization* and *ED Use without Hospital Readmission* measures under three performance categories: "Better than Expected," "Same as Expected," and "Worse than Expected." Appendix A describes how CMS intends to use a categorical reporting method to publicly report the *Rehospitalization* and *ED Use without Hospital Readmission* measures.

Table 4.6: Distribution of Agency-Level ED Use without Hospital Readmission Rates

Specification		Mean (%)	St. Dev. (%)	Min (%)	10th (%)	25th (%)	50th (%)	75th (%)	90th (%)	Max (%)
All HHAs	Observed	9.98	11.91	0.00	0.00	4.14	8.71	12.14	17.65	100.00
	Risk Adjusted	9.44	11.60	0.00	0.00	4.23	8.58	11.58	16.71	100.00
HHAs with at least 20 home health stays	Observed	9.60	3.95	0.00	4.94	7.20	9.38	11.74	14.33	31.82
	Risk Adjusted	9.36	3.64	0.00	5.13	7.24	9.18	11.25	13.66	30.21

Provider Rankings across Specifications

If providers' observed rates of rehospitalization and ED use without hospital readmission were reported, providers with beneficiaries that were sicker or otherwise more predisposed to hospitalization before entering home health care would be penalized. To quantify the impact of risk adjustment on provider rankings, the measure developer risk-adjusted the agency rates and calculated how much providers move in their relative ranks.[64] Risk adjustment changes the relative rankings for the *Rehospitalization* measure for about 8.2 percent of HHAs and changes the rankings for *ED Use without Hospital Readmission* measure for about 2.7 percent of HHAs. Table 4.9 presents the Spearman rank correlations of HHAs' observed rates and their risk-adjusted rates using all home health stays beginning between July 1, 2010 and June 30, 2013. In this case, the rank correlation expresses the relationship between the relative ranks of providers when ordered by their actual rehospitalization and ED use without hospital readmission rates and when ordered by their risk-adjusted rehospitalization and ED use without hospital readmission rates. A correlation score of 1.0 would indicate that the ranking of HHAs did not change at all after risk adjustment.

Table 4.7: Provider Rank Correlations

Measure	Rank Correlation Between Observed and Risk Adjusted Rate
Rehospitalization	0.918
ED Use without Hospital Readmission	0.973

To investigate the impact of risk adjustment on HHAs, the measure developer also evaluated the movement of provider rankings around the average using all home health stays beginning between July 1, 2010 and June 30, 2013. Table 4.10 presents the percent of providers with below-average observed rates that moved to above-average risk adjusted rates, and vice versa. For the *Rehospitalization* measure, 9.88 percent of HHAs had below-average observed

[64] 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.

rates that moved to above average after risk adjustment, while 4.41 percent of HHAs had rates that moved from above average to below. For the *ED Use without Hospital Readmission* measure, 4.43 percent of HHAs had observed rates that moved from below to above average after risk adjustment and 2.54 percent that moved from above to below average.

Table 4.8: Provider Rates Movement after Risk Adjustment

Measure	Below to Above Avg. (%)	Above to Below Avg. (%)
Rehospitalization	9.88	4.41
ED Use without Hospital Readmission	4.43	2.54

Predictive Power

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 measure developer evaluated the predictive power of the risk adjustment model using two measures of predictive power on both the development sample and the validation sample, including the c-statistic and the range of predicted probabilities.

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.[65] 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. To calculate c-statistics for binomial outcomes (i.e., acute care rehospitalization vs. no event and ED use without hospital readmission 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.

The c-statistics results show that the risk model differentiates between outcomes as well on new data as it does on the development data. To evaluate the model's performance, a simple random sampling of all home health stays beginning between July 1, 2010 and June 30, 2013 was split into an 80 percent development sample, comprising 2,011,698 stays, and a 20 percent validation sample, comprising 502,913 stays. The c-statistic for the *Rehospitalization* measure

[65] For more information on this extension of the c-statistic, please refer to: Hand, et al. 2001

development sample is 0.707, which is identical to the validation sample value. For the *ED Use without Hospital Readmission* measure, the c-statistic for the development sample is 0.645, which is almost identical to the validation sample value of 0.643. Finally, the total AUC for the model in the development sample is 0.657, which is identical to the validation sample value.[66] Table 4.11 presents these values.

Table 4.9: AUC Statistics

AUC Statistic	Development Sample	Validation Sample
***Rehospitalization* measure c-statistic**	0.707	0.707
***ED Use without Hospital Readmission* measure c-statistic**	0.645	0.643
Total AUC	0.657	0.657

To further evaluate the predictive power of the model, the range of differences between the 90th and 10th percentile of predicted probabilities were calculated using all eligible home health stays beginning between July 1, 2010 and June 30, 2013. In this case, a larger range of predicted values indicates that the model is better at discriminating between beneficiaries at high risk for rehospitalization or ED use without hospital readmission than beneficiaries at low risk. In the development sample, the range of predicted probabilities for the *Rehospitalization* measure is between 4.3 percent to 25.1 percent, which is identical to the range in the validation sample. In the development sample, the range of predicted probabilities for the *ED use without hospital readmission* measure is 5.5 percent to 15.4 percent; which is identical to the range in the validation sample. Table 4.12 presents these ranges.

Table 4.10: Range of Differences between 90th and 10th Percentile of Predicted Probabilities

Measure	Development Sample		Validation Sample	
	Minimum (%)	Maximum (%)	Minimum (%)	Maximum (%)
Rehospitalization	4.3	25.1	4.3	25.1
ED Use without Hospital Readmission	5.5	15.4	5.5	15.4

Finally, the measure developer evaluated the extent to which differences in case-mix would lead to differences in observed rates of rehospitalization. Table 4.13 shows the distribution of expected agency rates of rehospitalization, by agency size. The interquartile ranges range from 2.1 percent for large HHAs with 1000+ stays to 3.5 percent for small HHAs with 20-49 stays. Table 4.14 shows the distribution of expected agency rates of ED use without

[66] 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 rehospitalization and ED use without hospital readmission, which is not shown. For more information on this statistic, refer to the footnote above.

hospital readmission, by agency size. The interquartile ranges range from 0.9 percent for large HHAs with 1000+ stays to 1.6 percent for small HHAs with 20-49 stays.

Table 4.11: Impact of Risk Adjustment on Rates of Rehospitalization, by Agency Size

Total Stays	# HHAs	Mean (%)	St. Dev. (%)	Min (%)	10th (%)	25th (%)	50th (%)	75th (%)	90th (%)	Max (%)	Inter. Range (%)
20-49	1,699	14.5	2.8	4.7	11.2	12.8	14.5	16.2	18.0	25.9	3.5
50-99	1,492	14.0	2.3	5.3	11.3	12.7	14.1	15.4	16.7	26.3	2.7
100–199	1,358	13.8	2.1	4.6	11.3	12.6	13.9	15.1	16.3	20.3	2.5
200 – 399	1,137	13.5	2.2	5.0	10.7	12.4	13.8	15.0	15.9	20.6	2.6
400 – 999	1,011	13.4	2.0	4.2	10.9	12.4	13.7	14.7	15.7	18.5	2.3
1,000+	576	13.4	1.9	4.8	11.0	12.6	13.7	14.7	15.5	18.8	2.1

Table 4.12: Impact of Risk Adjustment on Rates of ED Use without Hospital Readmission, by Agency Size

Total Stays	# HHAs	Mean (%)	St. Dev. (%)	Min (%)	10th (%)	25th (%)	50th (%)	75th (%)	90th (%)	Max (%)	Inter. Range (%)
20-49	1,699	9.7	1.3	6.0	8.1	8.8	9.5	10.4	11.4	14.8	1.6
50-99	1,492	9.5	1.1	6.3	8.3	8.8	9.4	10.2	10.9	15.1	1.4
100–199	1,358	9.6	1.0	6.0	8.4	8.9	9.5	10.2	10.9	13.8	1.3
200 – 399	1,137	9.4	1.0	6.4	8.2	8.7	9.4	10.0	10.6	13.1	1.2
400 – 999	1,011	9.3	0.8	6.2	8.3	8.8	9.2	9.8	10.3	13.6	1.0
1,000+	576	9.1	0.7	6.8	8.3	8.7	9.1	9.5	10.0	10.9	0.9

4.2.4 Categorical Reporting Performance

Using a three-year reporting period, CMS intends to publicly report the performance of Medicare-certified HHAs (with at least 20 home health stays) on the *Rehospitalization* and *ED Use without Hospital Readmission* measures under three performance categories: "Better than Expected," "Same as Expected," and "Worse than Expected." Due to a large number of relatively small home health agencies treating previously hospitalized patients, the measure developer determined that reporting home health agencies' risk-adjusted rates could lead to misleading conclusions, since small home health agencies' risk-adjusted rates tend to be unstable, and small home health agencies experience large deviations between their observed and expected rates that are due to chance alone. Using the categorical reporting method would mitigate this issue, since each home health agency is classified into one of three performance

categories based on its expected[67] and observed rates, rather than based on a comparison of risk-adjusted rates amongst home health agencies.

The goal of the categorical reporting method is to assign a HHA to the "Better than Expected" category if the agency's performance rate is lower than expected based on patient case mix by a statistically significant amount and to assign a HHA to the "Worse than Expected" category if the agency's performance rate of rehospitalization is higher than expected based on patient case mix by a statistically significant amount. The size of the difference between a HHA's observed rate and expected rate that is statistically significant at a specified level (e.g., 5 percent) depends on the number of home health stays eligible for the measure and the case-mix characteristics of the agency's specific patients.

Using patient-level predicted rates from the multinomial logistic model, 20,000 simulated distributions of rehospitalization rates were generated using SAS, and were used to categorize HHAs into the three performance categories. The measure developer computed the fraction of simulations that resulted in a measure performance rate less than are equal to the observed rate. If this fraction was less than .05, the agency was assigned to the "Better than Expected" category. Analogously, the measure developer computed the fraction of simulations that resulted in a measure performance rate of greater than or equal to the observed rate. If this fraction was less than .05, the agency was assigned to the "Worse than Expected" category. All other HHAs were categorized as "Same as Expected." Using a value of .05 means that the risk of categorizing a truly average or worse than average agency as better than average is less than 5 percent.[68] With the categorical reporting method, health care consumers may see that most HHAs in their area are average, but will be informed if a particular agency is outstanding (i.e., "Better than Expected") or sub-standard (i.e., "Worse than Expected"). The remainder of this section presents the results of categorizing the performance of HHAs using this methodology.

Performance Categorization Results, by Agency Size

Tables 4.15 and 4.16 show the number and percentage of HHAs, by performance category and size, with at least 20 home health stays beginning in the period between July 1, 2010 and June 30, 2013 for the *Rehospitalization* and *ED Use without Hospital Readmission* measures, respectively.[69] There were 7,273 such HHAs representing a total of 2,515,969 home health stays and 2,275,207 patients. With the categorical reporting method, consumers may see that most HHAs in their area are average (i.e., same as expected, which applies to ~90 percent of HHAs for both measures).

[67] Each HHA's expected rate is the average of the predicted rates across stays within the agency.
[68] Appendix A describes in detail the statistical hypothesis test that this method implements.
[69] Only HHAs with at least 20 stays will have results publicly reported.

Additionally, they will be informed if a particular agency is outstanding (i.e., "Better than Expected", which applies to 4.6 percent of all HHAs and 7.1 percent of HHAs with at least 20 stays for the *Rehospitalization* measure, and to 4.5 percent of all HHAs and 7.2 percent of HHAs with at least 20 stays for the *ED Use without Hospital Readmission* measure).

Finally, they will be informed if a particular agency is sub-standard (i.e., worse than expected, which applies to 4.8 percent of all HHAs and 6.8 percent of HHAs with at least 20 stays for the *Rehospitalization* measure, and to 6.4 percent of all HHAs and 9.0 percent of HHAs with at least 20 stays for the *ED Use without Hospital Readmission* measure). Therefore, health care consumers would not make false distinctions between HHAs when both HHAs are performing as expected, even if their observed rates are different.

Table 4.13: Percentage Distribution of HHAs across Performance Categories for the *Rehospitalization* Measure, by Agency Size

Number of Stays	Better than Expected		Same as Expected		Worse than Expected		Total
	# HHAs	% of Total	# HHAs	% of Total	# HHAs	% of Total	
<20	15	0.3	4,217	98.2	63	1.5	4,295
20-49	53	3.1	1,597	94.0	49	2.9	1,699
50-99	69	4.6	1,359	91.1	64	4.3	1,492
100-199	96	7.1	1,190	87.6	72	5.3	1,358
200-399	86	7.6	965	84.9	86	7.6	1,137
400-999	129	12.8	767	75.9	115	11.4	1,011
1000+	87	15.1	384	66.7	105	18.2	576
Total	**535**	**4.6**	**10,479**	**90.6**	**554**	**4.8**	**11,568**

Table 4.14: Percentage Distribution of HHAs across Performance Categories for the *ED Use without Hospital Readmission* Measure, by Agency Size

Number of Stays	Better than Expected		Same as Expected		Worse than Expected		Total
	# HHAs	% of Total	# HHAs	% of Total	# HHAs	% of Total	
<20	0	0.0	4,209	98.0	86	2.0	4,295
20-49	32	1.9	1,611	94.8	56	3.3	1,699
50-99	64	4.3	1,356	90.9	72	4.8	1,492
100-199	74	5.4	1,172	86.3	112	8.2	1,358
200-399	95	8.4	931	81.9	111	9.8	1,137
400-999	121	12.0	701	69.3	189	18.7	1,011
1000+	140	24.3	323	56.1	113	19.6	576
Total	**526**	**4.5**	**10,303**	**89.1**	**739**	**6.4**	**11,568**

While it is true that most small agencies are classified as having performance that is no different than expected, small agencies serve a relatively small proportion of all eligible patients. Table 4.17 shows the distribution of patients across home health agencies (based on home health stays beginning between July 2010 to June 2013), by agency size. Small agencies of fewer than 199 stays (76.5 percent of all agencies) serve only 15.9 percent of all patients eligible for the measure denominator, whereas large agencies of 200+ stays (23.5 percent of all agencies) serve 84.1 percent of patients. CMS suppresses measure rates for the smallest agencies (i.e., agencies with <20 eligible stays) from public reporting.

Table 4.15: Distribution of Patients across HHAs, by Agency Size

Agency Size (# of Stays)	# of Agencies	# of Patients	% of Patients
<20	4,295	27,955	1.2
20-49	1,699	53,140	2.3
50-99	1,492	101,774	4.4
100-199	1,358	183,863	8.0
200-399	1,137	297,800	12.9
400-999	1,011	577,557	25.1
1,000+	576	1,061,073	46.1
Total	**11,568**	**2,303,162**	**100.0**

Performance Categorization Results, by CMS Region

The measure developer also categorized HHAs by CMS region. [70] Table 4.18 shows the number and percentage of HHAs across performance categories, by CMS region, with at least 20 home health stays beginning in the period between July 1, 2010 and June 30, 2013 for the *Rehospitalization* measure.[71] The proportion of HHAs within each CMS region categorized as "Better than Expected" ranges from 3.8 percent in the Philadelphia region to 18.3 percent in the Seattle region. The proportion of HHAs within each CMS region categorized as "Same than Expected" ranges from 77.2 percent in the New York region to 90.0 percent in the Denver region. The proportion of HHAs within each CMS region categorized as "Worse than Expected" ranges from 1.2 percent in the Seattle region to 15.5 percent in the New York region.

[70] For the CMS region mapping definitions, see http://www.cms.gov/center/freedom-of-information-act/regional-contacts.html

[71] Only HHAs with at least 20 stays will have results publicly reported.

Table 4.16: Percentage Distribution of HHAs across Performance Categories for the *Rehospitalization* Measure, by CMS Region

CMS Region	Better than Expected		Same as Expected		Worse than Expected		Total
	# HHAs	% of Total	# HHAs	% of Total	# HHAs	% of Total	
Atlanta	100	6.8	1,266	85.7	111	7.5	1,477
Boston	18	6.7	214	79.9	36	13.4	268
Chicago	53	3.9	1,185	86.7	128	9.4	1,366
Dallas	113	7.3	1,361	88.4	65	4.2	1,539
Denver	21	7.8	242	90.0	6	2.2	269
Kansas	24	5.5	379	86.9	33	7.6	436
New York	17	7.3	179	77.2	36	15.5	232
Philadelphia	21	3.8	487	87.0	52	9.3	560
San Francisco	123	12.8	817	84.9	22	2.3	962
Seattle	30	18.3	132	80.5	2	1.2	164
Total	**520**	**7.1**	**6,262**	**86.1**	**491**	**6.8**	**7,273**

Table 4.19 shows the number and percentage of HHAs across performance categories, by CMS region,[72] with at least 20 home health stays beginning in the period between July 1, 2010 and June 30, 2013 for the *ED Use without Hospital Readmission* measure.[73] The proportion of HHAs within each CMS region categorized as "Better than Expected" ranges from 1.2 percent in the Seattle region to 27.2 percent in the New York region. The proportion of HHAs within each CMS region categorized as "Same than Expected" ranges from 68.5 percent in the New York region to 89.4 percent in the Kansas region. The proportion of HHAs within each CMS region categorized as "Worse than Expected" ranges from 4.3 percent in the New York region to 27.4 percent in the Seattle region.

[72] For the CMS region mapping definitions, see http://www.cms.gov/center/freedom-of-information-act/regional-contacts.html

[73] Only HHAs with at least 20 stays will have results publicly reported.

Table 4.17: Percentage Distribution of HHAs across Performance Categories for the *ED Use without Hospital Readmission* Measure, by CMS Region

CMS Region	Better than Expected		Same as Expected		Worse than Expected		Total
	# HHAs	% of Total	# HHAs	% of Total	# HHAs	% of Total	
Atlanta	168	11.4	1,185	80.2	124	8.4	1,477
Boston	10	3.7	222	82.8	36	13.4	268
Chicago	87	6.4	1,173	85.9	106	7.8	1,366
Dallas	47	3.1	1,368	88.9	124	8.1	1,539
Denver	6	2.2	225	83.6	38	14.1	269
Kansas	23	5.3	390	89.4	23	5.3	436
New York	63	27.2	159	68.5	10	4.3	232
Philadelphia	38	6.8	463	82.7	59	10.5	560
San Francisco	82	8.5	792	82.3	88	9.1	962
Seattle	2	1.2	117	71.3	45	27.4	164
Total	**526**	**7.2**	**6,094**	**83.8**	**653**	**9.0**	**7,273**

5 RELATED MEASURES

The *Rehospitalization* and *ED Use without Hospital Readmission* measures are harmonized with other existing CMS measures, including the home health claims-based measures (i.e., *ACH* and *ED Use* measures), the HWR measure, and readmissions measures for other post-acute care settings. Section 5.1 compares the *Rehospitalization* and *ED Use without Hospital Readmission* measures to the existing *ACH* and *ED Use* claims-based measures. Section 5.2 compares them to the HWR measure. Section 5.3 compares them to other CMS post-acute care readmissions measures.

5.1 Relationship to Existing Home Health Claims-Based Measures

The *Rehospitalization* and *ED Use without Hospital Readmission* measures are harmonized with the existing *ACH* and *ED* Use measures respectively. Section 5.1.1 compares the *Rehospitalization* measure to the *ACH* measure. Section 5.1.2 compares the *ED Use without Hospital Readmission* measure to the *ED Use* measure.

5.1.1 Measure Pair 1: Rehospitalization During the First 30 Days of Home Health & Acute Care Hospitalization

The *Rehospitalization* and *ACH* measures are different in measure focus. Whereas the *ACH* measure evaluates patient admission to an acute care hospital during the 60 days following the start of home health stay, the *Rehospitalization* measure evaluates *re*admission to the hospital within 30 days after starting home health care for patients who were recently discharged from an inpatient setting. Home health agencies can track their own performance on both utilization measures to gain an accurate picture of how much acute care is being used by their patients. Additionally, the measures assess distinct domains of care under the CMS Quality Strategy and reflect related, but distinct care quality concepts; whereas the *Rehospitalization* measure assesses the efficacy of care coordination during patients' transition from inpatient acute care to outpatient home health services, the *ACH* measure assesses the efficacy of clinical care provided to all patients, as indicated by rates of hospitalization after entry into home health services. The measure developer compared each home health agency's risk-adjusted rates on the *Rehospitalization* and *ACH* measures and found the two rates to be moderately correlated (overall Pearson correlation coefficient [r] = 0.39).

Although the *Rehospitalization* measure is different from the *ACH* measure, they are both harmonized to the extent feasible. Table 5.1 explains the extent of measure harmonization and compares these measures along several key dimensions.

Table 5.1 Harmonization between the *Rehospitalization* and *ACH* Measures

Measure Dimension	Harmonization Description
Data Source	Both measures are calculated from Medicare Fee For Service claims.
Population	The *Rehospitalization* measure is designed to be a subset of the *ACH* measure. Whereas the *ACH* measure captures acute care hospitalization use for *all* home health patients, the *Rehospitalization* measure is restricted to home health patients who were recently treated in an inpatient setting.
Denominator Exclusions	The measure denominator for the *Rehospitalization* measure excludes the following home health stays that are also excluded from the all-patient claims-based *ACH* measure: (i) Stays for patients who are not continuously enrolled in fee-for-service Medicare during the measure numerator window; (ii) Stays that begin with a LUPA. Stays with four or fewer visits to the beneficiary qualify for LUPAs; (iii) Stays in which the patient is transferred to another home health agency within a home health payment episode (60 days); and (iv) Stays in which the patient is not continuously enrolled in Medicare fee-for-service during the previous six months. The measure denominator for the *Rehospitalization* measure also excludes additional types of home health stays (e.g., exclusions for HWR measure denominator, stays in which the patient receives treatment in another setting in the 5 days between hospital discharge and the start of home health)
Numerator	Measures' outcome windows are different. The *Rehospitalization* measure uses a 30-day outcome window to be consistent with other post-acute care setting readmissions measures. The *ACH* measure uses a 60-day outcome window because most home health stays are paid a bundled 60-day rate. Planned hospitalizations (as defined by the HWR measure) are excluded from both measures.
Risk Adjustment	To create a risk adjustment model for the *Rehospitalization* measure, the measure developers modified the risk model for the *ACH* measure to add DRG indicators[74] on the hospitalization that immediately preceded the home health stay and to include the patient's ADL data[75] from the initial home health stay directly following the index inpatient stay.

[74] Details of CMS' DRG system can be found here: http://www.cms.gov/Outreach-and-Education/Medicare-Learning-Network-MLN/MLNProducts/downloads/AcutePaymtSysfctsht.pdf
[75] Details of the OASIS ADLs can be found here: http://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/HomeHealthPPS/CaseMixGrouperSoftware.html

5.1.2 Measure Pair 2: Emergency Department Use without Hospital Readmission During the First 30 Days of Home Health & Emergency Department Use without Hospitalization

The *ED Use without Hospital Readmission* and the *ED Use* measures are different in measure focus. Whereas *ED Use* evaluates patient admission to an emergency department (without hospitalization) during the 60 days following the start of home health stay, *ED Use without Hospital Readmission* evaluates admission to the emergency department (without hospital readmission) within 30 days after starting home health care for patients who were recently discharged from an inpatient setting. Home health agencies can track their own performance on both utilization measures to gain an accurate picture of how much acute care is being used by their patients. Additionally, the measures assess distinct domains of care under the CMS Quality Strategy and reflect related, but distinct care quality concepts; whereas the *ED Use without Hospital Readmission* measure assesses the efficacy of care coordination during patients' transition from inpatient acute care to outpatient home health services, the *ED Use* measure assesses the efficacy of clinical care provided to all patients, as indicated by rates of ED use without hospitalization after entry into home health services. The measure developer compared each HHA's risk-adjusted rates on the *ED Use without Hospital Readmission* and the *ED Use* measures and found the two rates to be moderately correlated (overall Pearson correlation coefficient [r] = 0.42).

Although the *ED Use without Hospital Readmission* measure is different from the *ED Use* measure, they both harmonized to the extent feasible. Table 5.2 explains the extent of measure harmonization and compares these measures along several key dimensions.

Table 5.2: Harmonization between *ED Use without Hospital Readmission* and *ED Use* Measures

Measure Dimension	Harmonization Description
Data Source	Both measures are calculated from Medicare Fee For Service claims.
Population	The *ED Use without Hospital Readmission* measure is designed to be a subset of *ED Use* measure. Whereas the *ED Use* measure captures emergency department use (without hospitalization) for *all* home health patients, the *ED Use without Hospital Readmission* measure is restricted to home health patients who were recently treated in an inpatient setting.
Denominator Exclusions	The measure denominator for the *ED Use without Hospital Readmission* measure excludes the following home health stays that are also excluded from the all-patient claims-based *ED Use* measure: (i) Stays for patients who are not continuously enrolled in fee-for-service Medicare during the measure numerator window; (ii) Stays that begin with a LUPA. Stays with four or fewer visits to the beneficiary qualify for LUPAs; (iii) Stays in which the patient is transferred to another home health agency within a home health payment episode (60 days); and (iv) Stays in which the patient is not continuously enrolled in Medicare fee-for-service during the previous six months. The measure denominator for the *ED Use without Hospital Readmission* measure also excludes additional types of home health stays (e.g., exclusions for the HWR measure denominator, stays in which the patient receives treatment in another setting in the 5 days between hospital discharge and the start of home health)
Numerator	Measures' outcome windows are different. The *ED Use without Hospital Readmission* measure uses a 30-day outcome window to be consistent with other post-acute care setting readmissions measures. The *ED Use* measure uses a 60-day outcome window because most home health stays are paid a bundled 60-day rate.
Risk Adjustment	To create a risk adjustment model for the *ED Use without Hospital Readmission* measure, the measure developers modified the risk model for the *ED Use without Hospitalization* measure to add DRG indicators[76] on the hospitalization that immediately preceded the home health stay and to include the patient's ADL data[77] from the initial home health stay directly following the index inpatient stay.

[76] Details of CMS' DRG system can be found here: http://www.cms.gov/Outreach-and-Education/Medicare-Learning-Network-MLN/MLNProducts/downloads/AcutePaymtSysfctsht.pdf

[77] Details of the OASIS ADLs can be found here: http://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/HomeHealthPPS/CaseMixGrouperSoftware.html

5.2 Relationship to the Hospital-Wide All-Cause Unplanned Readmission Measure

The *Rehospitalization* and *ED Use without Hospital Readmission* measures alter the HWR measure specifications to fit their unique patient populations and data structures. The key differences between the home-health claims-based readmissions measures and HWR measure lie mainly in their risk adjustment approach; the remainder of this section explains these differences.

First, the home health measures use a different risk adjustment model specification than the HWR. The home health rehospitalization risk adjustment is modeled from the ACH and ED Use claims-based home health quality measures, which were developed in conjunction with each other. The home health rehospitalization measures use a multiple logistic regression to model the three possible outcomes of inpatient rehospitalization, ED use without hospital readmission, and no event. These three events are distinct outcomes which may be affected differently by each covariate. In other words, if a simple logistic regression were used to model acute inpatient hospitalization versus no event, the coefficients of the "no event" outcome would be affected by the ED use outcome which is included within that category. The use of a multinomial logistic framework allows for the same risk factors to affect the possible outcomes in different ways and constrains the predicted probabilities of the two measures and the no event category to sum to one hundred percent.

Second, the home health rehospitalization measures use a different set of health status indicators than the HWR. The HWR measure uses only the AHRQ CCS to avoid using information from the inpatient stay to predict rehospitalization. The home health measures use the Medicare Severity DRGs from the index hospitalization, the ADLs on the claims from the previous home health stay, if any, and CMS' HCCs from the prior six months of claims to account for the beneficiary's health status. If the HWR measure used information from the index hospitalization to predict subsequent hospitalization, hospital physicians would be incentivized to code diagnoses more severely on claims to make the patient appear sicker and thus increase the hospital's predicted rehospitalization rate. HHAs, however, are not frequently associated with or owned by a single hospital. Thus, information from the index hospitalization can provide more detail to increase the accuracy of risk adjustment while providing no negative incentives to hospital physicians, who are usually unassociated with the HHAs to which their patients are discharged.

Third, while the HWR measure uses a full year of claims data to risk adjust the rehospitalization rate, the home health measures only use six months. Risk adjustment requires the beneficiary to be continuously enrolled in Medicare Part A or B to ensure that all of the beneficiary's health conditions and treatments are accounted for. In home health, requiring a full year of continuous enrollment would exclude some of the population. Thus, to make the

measures applicable to as many patients as possible, the home health measures use only six months of claims data for risk adjustment.

5.3 Relationship to Other Post-Acute Care Readmissions Measures

The *Rehospitalization* and *ED Use without Hospital Readmission* measures are similar to readmissions measures for other post-acute care settings. The home health rehospitalization measures, as well as the rehospitalization measures for skilled nursing facilities, long-term care hospitals, and end-stage renal disease patients, are all designed to align with the HWR. The remainder of this section explains the three key ways in which the home health rehospitalization measures differ from other post-acute measures.

First, while other measures exclude patients with a gap between hospital discharge and post-acute admission, the home health measures allow a gap of up to five days. Unlike other post-acute settings, HH is provided in the patient's home, and thus the patient returns to their home after hospital discharge. This results in some gap between hospital discharge and the initial visit from a HHA. The Medicare Conditions of Participation for HHAs require home health care to begin within 48 hours of hospital discharge or on the physician-ordered start of care date (which is usually within 1-3 days of hospital discharge). Thus, the measures as specified apply to ~ 90 percent of patients who begin home health within 30 days of hospital discharge.

Second, the other measures use different risk factors and a different functional form for risk adjustment. For consistency with the ACH and ED Use measures, which apply to all home health stays, the measure developer recommended using a similar set of risk factors and the same multinomial logistic form for the home health rehospitalization measures.

Third, the risk-adjusted rates for the home health rehospitalization measures would not be publicly reported. Due to a large number of relatively small HHAs treating previously hospitalized patients, the measure developer determined that reporting HHAs' risk-adjusted rates could lead to misleading conclusions, since small HHAs' risk-adjusted rates tend to be unstable. Using the categorical reporting method would mitigate this issue, since each home health agency is classified into one of three performance categories based on its expected and observed rates, rather than based on a comparison of risk-adjusted rates amongst home health agencies.

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APPENDIX A: PERFORMANCE CATEGORIZATION METHOD

This appendix describes a method for categorizing HHAs as "Better than Expected", "Same as Expected", and "Worse than Expected" for the purposes of publicly reporting the newly developed measures of *Rehospitalization During the First 30 Days of Home Health* and *ED Use without Hospital Readmission During the First 30 Days of Home Health* measures (henceforth called the "Rehospitalization and "ED Use without Hospital Readmission" measures, respectively).

The goal of this method is to assign an HHA to the "better than expected" category if the agency's rate of Rehospitalization (resp. ED Use without Hospital Readmission) is lower than expected based on patient case mix by a statistically significant amount and to assign an HHA to the "worse than expected" category if the HHA's rate of Rehospitalization (resp. ED Use without Hospital Readmission) is higher than expected based on patient case mix by a statistically significant amount. The size of the difference between an HHA's observed rate and expected rate that is statistically significant at a specified level (e.g., 5 percent) depends on the number of home health stays eligible for the measure and the case-mix characteristics of the HHA's specific patients.

This appendix is structured as follows: The first section describes the underlying data model and defines each HHA's observed rehospitalization (resp. ED Use without Hospital Readmission) rate as a random variable with a distribution that depends on the number of home health stays and the patient level predicted probability of rehospitalization (resp. ED Use without Hospital Readmission) for each home health stay. The second section precisely states the null and alternative hypotheses that correspond to classifying an HHA as "better than expected" and the null and alternative hypotheses that correspond to classifying an HHA as "worse than expected". The third section identifies an appropriate test-statistic and describes how to compute the appropriate p-values for rejecting each null hypothesis. The final section describes how the method was implemented and presents results.

A.1 Underlying Data Model

The underlying assumption of this method is that rehospitalization or ED use without hospital readmission by home health patients during the first 30 days of home health care is a random process that HHAs can influence but cannot entirely control. The extent to which agency *j* influences rehospitalization (resp. ED use without hospital readmission) is called the "care effect" and denoted ξ_j^{Rehosp} (ξ_j^{ED}). ξ_j is greater than 0 and scaled such that the average HHA has $\xi_j = 1$. Each home health stay also has stay-specific probabilities of rehospitalization

and ED use without hospital readmission, denoted p_i^{Rehosp} and p_i^{ED}. These probabilities are computed using a multinomial logistic risk-adjustment model that relates 404 patient level risk factors to the outcomes "Rehospitalization", "ED Use without Hospital Readmission", and "No Acute Event".[78] If patient *i* is treated by HHA *j*, the probability of rehospitalization and ED use without hospital readmission are $\xi_j^{Rehosp} p_i^{Rehosp}$ and $\xi_j^{ED} p_i^{ED}$, respectively.

A.1.1 Realization of stay level outcome

The outcome for each home health stay (X_{ij}) follows a multinomial distribution over the set {"No Event", "ED Use without Hospital Readmission", "Rehospitalization"}. Specifically,

- $Pr(X_{ij} = Rehospitalization) = \xi_j^{Rehosp} p_i^{Rehosp}$
- $Pr(X_{ij} = EDUse) = \xi_j^{ED} p_i^{ED}$
- $Pr(X_{ij} = NoEvent) = 1 - \xi_j^{ED} p_i^{ED} - \xi_j^{Rehosp} p_i^{Rehosp}$

A.1.2 HHA observed rate as a random variable

Suppose agency *j* provides care for n_j home health stays and has care effects ξ_j^{Rehosp} and ξ_j^{ED}. Define agency *j*'s rates of rehospitalization and ED use without hospital readmission as:

$$Y_j^{Rehosp} = \frac{1}{n_j} \sum_{i=1}^{n_j} \mathbf{1}\{X_{ij} = Rehospitalization\}$$

$$Y_j^{ED} = \frac{1}{n_j} \sum_{i=1}^{n_j} \mathbf{1}\{X_{ij} = EDUse\}$$

For ease of notation, we will omit the superscript on Y_j and focus the remainder of our discussion on rehospitalization. Y_j is a random variable with a scaled Poisson binomial distribution with mean $\frac{1}{n_j} \sum_{i=1}^{n_j} \xi_j p_i$ and variance $\frac{1}{n_j^2} \sum_{i=1}^{n_j} \xi_j p_i (1 - \xi_j p_i)$. We observe one realization of Y_j for each agency.

A.2 Hypothesis Testing

If agency care effects ξ_j were directly observed, then HHAs with $\xi_j < 1$ would be categorized as "better than expected" and those with $\xi_j > 1$ would be categorized as "worse than

[78] See "Home Health Claims-Based Rehospitalization Measures: Risk Adjustment Methodology", November 2013, Acumen, LLC. http://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/HomeHealthQualityInits/HHQIQualityMeasures.html.

expected". However, ξ_j is not observed. Rather, we must infer whether it is less than (greater than) 1 based on the realized rate of rehospitalization (resp. ED use without hospital readmission). The relevant test statistic is the HHAs observed rate of rehospitalization (resp. ED use without hospital readmission), $ObsRate_j$, computed as per the measure specification.

A.2.1 Null and Alternate Hypotheses for "Better Than Expected" category

Determining if agency *j* is better than average requires rejecting the null hypothesis that care by agency *j* does not reduce the risk of rehospitalization by any more than average. Formally, we have the following pair of hypotheses:

$$(0.1)\quad H_0 : \xi_j \geq 1$$

$$(0.2)\quad H_1 : \xi_j < 1$$

Under the null hypothesis, the expected value of Y_j is at least $\frac{1}{n_j}\sum p_i$. Rejecting the null hypothesis at the 95 percent level requires that the p-value associated with $ObsRate_j$ to be less than 5 percent.

A.2.2 Null and Alternate Hypotheses for "Worse Than Expected" category

Determining if agency *j* is worse than average requires rejecting the null hypothesis that care by agency *j* does not increase the risk of rehospitalization by any more than average. Formally, we have the following pair of hypotheses:

$$(0.3)\quad H_0 : \xi_j \leq 1$$

$$(0.4)\quad H_1 : \xi_j > 1$$

Under the null hypothesis, the expected value of Y_j is at most $\frac{1}{n_j}\sum p_i$. Rejecting the null hypothesis at the 95 percent level requires that the p-value associated with $ObsRate_j$ to be less than 5 percent.

A.3 Computing P-values using a Simulated Distribution

Under each of the null hypotheses described above, $ObsRate_j$ is a realization Y_j which follows a scaled Poisson-binomial distribution with mean $\frac{1}{n_j}\sum_{i=1}^{n_j} p_i$ and variance $\frac{1}{n_j^2}\sum_{i=1}^{n_j} p_i(1-p_i)$. This is a discrete distribution over all attainable rates between 0 and 1. Only rates equal to $\frac{i}{n_j}$ for $i \in 0,\ldots,n_j$ have non-zero probability.

The p-value associated with the "Better Than Expected" hypothesis test for an agency with $ObsRate_j$ is $Pr(Y_j \le ObsRate_j \mid H_0)$. This p-value can be determined by simulating the distribution of Y_j. For all n_j home health stays at agency *j*, conduct *N* multinomial trials assuming $\xi_j = 1$ to realize stay-level outcomes X_{ij}. For each simulation $k \in 1,\ldots,N$, calculate the agency's rate of rehospitalization $Y_j^k = \frac{1}{n_j}\sum_{i=1}^{n_j} \mathbf{1}\{X_{ij} = Rehospitalization\}$. The simulated rates Y_j^k form the distribution of $Y_j \mid H_0$. The p-value associated with rejecting the null hypothesis (eq 1.1) is $Pr(Y_j \le ObsRate_j \mid H_0) = \frac{\sum_{k=1}^{N} \mathbf{1}\{Y_j^k \le ObsRate_j\}}{N}$. That is, the p-value equals the fraction of simulations that result in a simulated rate of rehospitalization less than or equal to the observed rate.

The p-value associated with the "Worse Than" hypothesis test for an agency with $ObsRate_j$ is $Pr(Y_j \ge ObsRate_j \mid H_0) = \frac{\sum_{k=1}^{N} \mathbf{1}\{Y_j^k \ge ObsRate_j\}}{N}$. In other words, the p-value for rejecting the null hypothesis that HHA *j* is no worse than average equals the fraction of simulations that result in a simulated rate of rehospitalization greater than or equal to the observed rate.

A.4 Implementation

Based on patient-level predicted rates from the multinomial logistic model, 20,000 simulated distributions of rehospitalization and ED use without hospital readmission rates were generated using SAS, and were used to categorize HHAs into "Better than Expected", "Same as Expected" and "Worse than Expected" categories. As defined above, each agency received p-values associated with the "Better Than Expected" category and the "Worse Than Expected"

category. If the p-value for a category was less than or equal to .05, the HHA was classified as within that category. If neither p-value was less than or equal to .05, the HHA was categorized as "Same as Expected." Using a value of .05 means that the risk of categorizing a truly average or worse than average agency as better than average is less than 5 percent. Sections 2.1.2 and 2.2.2 present the performance categorization results for the *Rehospitalization* and *ED Use without Hospital Readmission* measures respectively, using home health stays from HHAs with at least 20 stays beginning in the period between July 1, 2010 and June 30, 2013.

APPENDIX B: CALCULATION ALGORITHM FOR THE REHOSPITALIZATION MEASURE

1. Construct home health stays from home health claims.
2. Link stays to enrollment data by beneficiary.
3. Identify numerator window (30 days following Stay_Start_Date) for each stay and exclude stays for patients who are not continuously enrolled in fee-for-service Medicare during the numerator window or until patient death.
4. Exclude stays that begin with a LUPA or that involve a provider change during the numerator window.
5. Exclude stays for patients who are not continuously enrolled in fee-for-service Medicare during the 6 months prior to Stay_Start_Date.
6. Link to Part A and Part B claims for 6 months prior to Stay_Start_Date for each beneficiary.
7. Calculate demographic risk factors for each stay (age, sex, etc.) using enrollment data.
8. Limit to home health stays where the Stay_Start_Date minus the Thru_Dt of an Inpatient (IP) claims is equal to or less than 5. Exclude stays where the IP claim is not for a short-term hospital or has an AHRQ Diagnosis CCS or stus_cd that excludes it from being an index admission. Retain the DRG of the index admission as a risk factor.
9. Calculate prior care setting indicators, ADLs, HCCs, and HCC interactions.
10. Exclude stays that have prior care setting indicators whose claim Thru_Dt is in between the Thru_Dt of the index hospitalization and the Stay_Start_Dt.
11. Link to Inpatient (IP) claims from Short Stay and Critical Access hospitals for numerator window (30 days following Stay_Start_Date).
12. Link to Outpatient claims with revenue center codes indicating ED use for the numerator window (30 days following Stay_Start_Date).
13. Calculate measure flags for each stay:
    a. Set Hospital Admission indicator (Hosp_Admit = 1) if any IP claims are linked to the stay in step 11.
14. Using coefficients from the multinomial logit risk model and risk factors calculated in steps 7 through 9, calculate the predicted probability of being included in the measure numerator, for each stay (Pred_Hosp). Additionally calculate the average of Pred_Hosp

across all stays that are included in the measure denominator (not excluded in steps 3 to 5) and call these values National_Pred_Hosp.

15. Calculate observed and expected rates for the measure at each HHA (Initial_Provider):
    a. Observed Rates:
        i. Calculate the observed rate of acute care hospitalization as the fraction all (non-excluded) home health stays with that agency as Initial_Provider that are also included in the measure numerator (Hosp_Admit = 1). Call the value Agency_Obs_Hosp.
    b. Expected Rates:
        i. Calculate the agency expected rate of acute care hospitalization by taking the average of Pred_ Hosp across all (non-excluded) stays with that agency as Initial_Provider. Call this value Agency_Pred_Hosp.
16. For each agency, simulate the distribution of expected rates:
    a. For each stay, randomly choose an outcome (i.e. no outcome, re-hospitalization, or ED use without hospital readmission) using the stay-level predicted probability of hospitalization (Pred_Hosp). Repeat simulation 20,000 times. Call these values $X_1 - X_{20,000}$.
    b. For each simulation, calculate the agency predicted rate of hospitalization by taking the average of all stays with that agency. Call these values $Agency\_sim\_Hosp_1 - Agency\_sim\_Hosp_{20000}$.
17. Classify HHAs as "Better than Expected" if fewer than 5 percent of the Agency_sim_hosp values are less than or equal to Agency_Obs_Hosp. Classify HHAs as "Worse than Expected" if fewer than 5 percent of the Agency_sim_Hosp values are greater than or equal to Agency_Obs_Hosp. Classify all other HHAs as "Same as Expected." See Appendix A for additional details about assigning HHAs to performance categories.

APPENDIX C: CALCULATION ALGORITHM FOR THE ED USE WITHOUT HOSPITAL READMISSION MEASURE

1. Construct home health stays from home health claims.
2. Link stays to enrollment data by beneficiary.
3. Identify numerator window (30 days following Stay_Start_Date) for each stay and exclude stays for patients who are not continuously enrolled in fee-for-service Medicare during the numerator window or until patient death.
4. Exclude stays that begin with a LUPA or that involve a provider change during the numerator window.
5. Exclude stays for patients who are not continuously enrolled in fee-for-service Medicare during the 6 months prior to Stay_Start_Date.
6. Link to Part A and Part B claims for 6 months prior to Stay_Start_Date for each beneficiary.
7. Calculate demographic risk factors for each stay (age, sex, etc.) using enrollment data.
8. Limit to home health stays where the Stay_Start_Date minus the Thru_Dt of an Inpatient (IP) claims is equal to or less than 5. Exclude stays where the IP claim is not for a short-term hospital or has an AHRQ CCS or stus_cd that excludes it from being an index admission. Retain the DRG of the index admission as a risk factor.
9. Calculate prior care setting indicators, ADLs, HCCs, and HCC interactions.
10. Exclude stays that have prior care setting indicators whose claim Thru_Dt is in between the Thru_Dt of the index hospitalization and the Stay_Start_Dt.
11. Link to Inpatient (IP) claims from Short Stay and Critical Access hospitals for numerator window (30 days following Stay_Start_Date).
12. Link to Outpatient claims with revenue center codes indicating ED use for the numerator window (30 days following Stay_Start_Date).
13. Calculate measure flags for each stay:
    a. Set Hospital Admission indicator (Hosp_Admit = 1) if any IP claims are linked to the stay in step 11.
    b. Set Outpatient ED Use indicator (OP_ED = 1) if any outpatient claims are linked to the stay in step 12.

c. Set ED Use without Hospitalization indicator (ED_noHosp = 1) if OP_ED =1 and NOT Hosp_Admit = 1.

14. Using coefficients from the multinomial logit risk model and risk factors calculated in steps 7 through 9, calculate the predicted probability of being included in the measure numerator, for each stay (Pred_ED). Additionally calculate the average of Pred_ED across all stays that are included in the measure denominator (not excluded in steps 3 to 5) and call these values National_Pred_ED.
15. Calculate observed and expected rates for the measure at each HHA (Initial_Provider):
    a. Observed Rates:
        i. Calculate the observed rate of acute care hospitalization as the fraction all (non-excluded) home health stays with that agency as Initial_Provider that are also included in the measure numerator (ED_noHosp = 1). Call the value Agency_Obs_ED_NoHosp
    b. Expected Rates:
        i. Calculate the agency expected rate of ED use without hospital readmission by taking the average of Pred_ED across all (non-excluded) stays with that agency as Initial_Provider. Call this value Agency_Pred_ED.
16. For each agency, simulate the distribution of expected rates:
    a. For each stay, randomly choose an outcome (i.e. no outcome, re-hospitalization, or ED use without hospital readmission) using the stay-level predicted probability of hospitalization (Pred_ED). Repeat simulation 20,000 times. Call these values $X_1 - X_{20,000}$.
    b. For each simulation, calculate the agency predicted rate of ED use without rehospitalization by taking the average of all stays with that agency. Call these values $Agency\_sim\_ED_1 - Agency\_sim\_ED_{20000}$.
17. Classify HHAs as "Better than Expected" if fewer than 5 percent of the Agency_sim_ED values are less than or equal to Agency_Obs_ED_NoHosp. Classify HHAs as "Worse than Expected" if fewer than 5 percent of the Agency_sim_ED values are greater than or equal to Agency_Obs_ED_NoHosp. Classify all other HHAs as "Same as Expected." See Appendix A for additional details about assigning HHAs to performance categories.

APPENDIX D: PLANNED READMISSION ALGORITHM

The AHRQ CCS that define procedures that are always planned include:

Procedure CCS	Description
64	Bone marrow transplant
105	Kidney transplant
176	Other organ transplantation

The AHRQ CCS that define diagnoses that are always planned include:

Diagnosis CCS	Description
45	Maintenance chemotherapy
254	Rehabilitation

The AHRQ CCS that define potentially planned hospitalizations include:

Procedure CCS	Description
3	Laminectomy; excision intervertebral disc
5	Insertion of catheter or spinal stimulator and injection into spinal
9	Other OR therapeutic nervous system procedures
10	Thyroidectomy; partial or complete
12	Other therapeutic endocrine procedures
33	Other OR therapeutic procedures on nose; mouth and pharynx
36	Lobectomy or pneumonectomy
38	Other diagnostic procedures on lung and bronchus
40	Other diagnostic procedures of respiratory tract and mediastinum
43	Heart valve procedures
44	Coronary artery bypass graft (CABG)
45	Percutaneous transluminal coronary angioplasty (PTCA)
47	Diagnostic cardiac catheterization; coronary arteriography
48	Insertion; revision; replacement; removal of cardiac pacemaker or cardioverter/defibrillator
49	Other OR heart procedures
51	Endarterectomy; vessel of head and neck
52	Aortic resection; replacement or anastomosis
53	Varicose vein stripping; lower limb
55	Peripheral vascular bypass
56	Other vascular bypass and shunt; not heart
59	Other OR procedures on vessels of head and neck
62	Other diagnostic cardiovascular procedures
66	Procedures on spleen
67	Other therapeutic procedures; hemic and lymphatic system

Procedure CCS	Description
74	Gastrectomy; partial and total
78	Colorectal resection
79	Local excision of large intestine lesion (not endoscopic)
84	Cholecystectomy and common duct exploration
85	Inguinal and femoral hernia repair
86	Other hernia repair
99	Other OR gastrointestinal therapeutic procedures
104	Nephrectomy; partial or complete
106	Genitourinary incontinence procedures
107	Extracorporeal lithotripsy; urinary
109	Procedures on the urethra
112	Other OR therapeutic procedures of urinary tract
113	Transurethral resection of prostate (TURP)
114	Open prostatectomy
119	Oophorectomy; unilateral and bilateral
120	Other operations on ovary
124	Hysterectomy; abdominal and vaginal
129	Repair of cystocele and rectocele; obliteration of vaginal vault
132	Other OR therapeutic procedures; female organs
142	Partial excision bone
152	Arthroplasty knee
153	Hip replacement; total and partial
154	Arthroplasty other than hip or knee
157	Amputation of lower extremity
158	Spinal fusion
159	Other diagnostic procedures on musculoskeletal system
166	Lumpectomy; quadrantectomy of breast
167	Mastectomy
169	Debridement of wound; infection or burn
170	Excision of skin lesion
172	Skin graft
211	Therapeutic radiology for cancer treatment
224	Cancer chemotherapy

The individual ICD-9 procedure codes that define potentially planned hospitalizations include:

ICD-9 Code	Description
30.1, 30.29, 30.3, 30.4, 31.74, 34.6	Laryngectomy, revision of tracheostomy, scarification of pleura (from Proc CCS 42- Other OR Rx procedures on respiratory system and mediastinum)
38.18	Endarterectomy leg vessel (from Proc CCS 60- Embolectomy and endarterectomy of lower limbs)
55.03, 55.04	Percutaneous nephrostomy with and without fragmentation (from Proc CCS 103- Nephrotomy and nephrostomy)
94.26, 94.27	Electroshock therapy (from Proc CCS 218- Psychological and psychiatric evaluation and therapy)

Discharge AHRQ Diagnosis CCS that are considered "acute or complication of care" and *disqualify* a potentially planned readmission from being considered planned include:

Diagnosis CCS	Description
1	Tuberculosis
2	Septicemia (except in labor)
3	Bacterial infection; unspecified site
4	Mycoses
5	HIV infection
7	Viral infection
8	Other infections; including parasitic
9	Sexually transmitted infections (not HIV or hepatitis)
54	Gout and other crystal arthropathies
55	Fluid and electrolyte disorders
60	Acute posthemorrhagic anemia
61	Sickle cell anemia
63	Diseases of white blood cells
76	Meningitis (except that caused by tuberculosis or sexually transmitted disease)
77	Encephalitis (except that caused by tuberculosis or sexually transmitted disease)
78	Other CNS infection and poliomyelitis
82	Paralysis
83	Epilepsy; convulsions
84	Headache; including migraine
85	Coma; stupor; and brain damage
87	Retinal detachments; defects; vascular occlusion; and retinopathy
89	Blindness and vision defects
90	Inflammation; infection of eye (except that caused by tuberculosis or sexually transmitted disease)
91	Other eye disorders
92	Otitis media and related conditions
93	Conditions associated with dizziness or vertigo

Diagnosis CCS	Description
100	Acute myocardial infarction (with the exception of ICD-9 codes 410.x2)
102	Nonspecific chest pain
104	Other and ill-defined heart disease
107	Cardiac arrest and ventricular fibrillation
109	Acute cerebrovascular disease
112	Transient cerebral ischemia
116	Aortic and peripheral arterial embolism or thrombosis
118	Phlebitis; thrombophlebitis and thromboembolism
120	Hemorrhoids
122	Pneumonia (except that caused by TB or sexually transmitted disease)
123	Influenza
124	Acute and chronic tonsillitis
125	Acute bronchitis
126	Other upper respiratory infections
127	Chronic obstructive pulmonary disease and bronchiectasis
128	Asthma
129	Aspiration pneumonitis; food/vomitus
130	Pleurisy; pneumothorax; pulmonary collapse
131	Respiratory failure; insufficiency; arrest (adult)
135	Intestinal infection
137	Diseases of mouth; excluding dental
139	Gastroduodenal ulcer (except hemorrhage)
140	Gastritis and duodenitis
142	Appendicitis and other appendiceal conditions
145	Intestinal obstruction without hernia
146	Diverticulosis and diverticulitis
148	Peritonitis and intestinal abscess
153	Gastrointestinal hemorrhage
154	Noninfectious gastroenteritis
157	Acute and unspecified renal failure
159	Urinary tract infections
165	Inflammatory conditions of male genital organs
168	Inflammatory diseases of female pelvic organs
172	Ovarian cyst
197	Skin and subcutaneous tissue infections
198	Other inflammatory condition of skin
225	Joint disorders and dislocations; trauma-related
226	Fracture of neck of femur (hip)

Diagnosis CCS	Description
227	Spinal cord injury
228	Skull and face fractures
229	Fracture of upper limb
230	Fracture of lower limb
232	Sprains and strains
233	Intracranial injury
234	Crushing injury or internal injury
235	Open wounds of head; neck; and trunk
237	Complication of device; implant or graft
238	Complications of surgical procedures or medical care
239	Superficial injury; contusion
240	Burns
241	Poisoning by psychotropic agents
242	Poisoning by other medications and drugs
243	Poisoning by nonmedicinal substances
244	Other injuries and conditions due to external causes
245	Syncope
246	Fever of unknown origin
247	Lymphadenitis
249	Shock
250	Nausea and vomiting
251	Abdominal pain
252	Malaise and fatigue
253	Allergic reactions
259	Residual codes; unclassified
650	Adjustment disorders
651	Anxiety disorders
652	Attention-deficit, conduct, and disruptive behavior disorders
653	Delirium, dementia, and amnestic and other cognitive disorders
656	Impulse control disorders, NEC
658	Personality disorders
660	Alcohol-related disorders
661	Substance-related disorders
662	Suicide and intentional self-inflicted injury
663	Screening and history of mental health and substance abuse codes
670	Miscellaneous disorders

Discharge individual ICD-9 procedure codes that are considered “acute or complication of care” and *disqualify* a potentially planned readmission from being considered planned include:

ICD-9 Diagnosis Code	Description
03282	Diphtheritic myocarditis
03640	Meningococcal carditis nos
03641	Meningococcal pericarditis
03642	Meningococcal endocarditis
03643	Meningococcal myocarditis
07420	Coxsackie carditis nos
07421	Coxsackie pericarditis
07422	Coxsackie endocarditis
07423	Coxsackie myocarditis
11281	Candidal endocarditis
11503	Histoplasma capsulatum pericarditis
11504	Histoplasma capssulatum endocarditis
11513	Histoplasma duboisii pericarditis
11514	Histoplasma duboisii endocarditis
11593	Histoplasmosis pericarditis
11594	Histoplasmosis endocarditis
1303	Toxoplasma myocarditis
3910	Acute rheumatic pericarditis
3911	Acute rheumatic endocarditis
3912	Acute rheumatic myocarditis
3918	Acute rheumatic heart disease nec
3919	Acute rheumatic heart disease nos
3920	Rheumatic chorea w heart involvement
3980	Rheumatic myocarditis
39890	Rheumatic heart disease nos
39899	Rheumatic heart disease nec
4200	Acute pericarditis in other disease
42090	Acute pericarditis nos
42091	Acute idiopath pericarditis
42099	Acute pericarditis nec
4210	Acute/subacute bacterial endocarditis
4211	Acute endocarditis in other diseases
4219	Acute/subacute endocarditis nos
4220	Acute myocarditis in other diseases
42290	Acute myocarditis nos
42291	Idiopathic myocarditis
42292	Septic myocarditis
42293	Toxic myocarditis
42299	Acute myocarditis nec
4230	Hemopericardium

ICD-9 Diagnosis Code	Description
4231	Adhesive pericarditis
4232	Constrictive pericarditis
4233	Cardiac tamponade
4290	Myocarditis nos
4260	Atrioventricular
42610	Atrioventricular block nos
42611	Atrioventricular block-1st degree
42612	Atrioventricular block-mobitz ii
42613	Atrioventricular block-2nd degree nec
4262	Left bundle branch hemiblock
4263	Left bundle branch block nec
4264	Right bundle branch block
42650	Bundle branch block nos
42651	Right bundle branch block/left posterior fascicular block
42652	Right bundle branch block/left ant fascicular block
42653	Bilateral bundle branch block nec
42654	Trifascicular block
4266	Other heart block
4267	Anomalous atrioventricular excitation
42681	Lown-ganong-levine syndrome
42682	Long qt syndrome
4269	Conduction disorder nos
4272	Paroxysmal tachycardia nos
7850	Tachycardia nos
42789	Cardiac dysrhythmias nec
4279	Cardiac dysrhythmia nos
42769	Premature beats nec
39891	Rheumatic heart failure
4280	Congestive heart failure
4281	Left heart failure
42820	Unspecified systolic heart failure
42821	Acute systolic heart failure
42823	Acute on chronic systolic heart failure
42830	Unspecified diastolic heart failure
42831	Acute diastolic heart failure
42833	Acute on chronic diastolic heart failure
42840	Unpec combined syst & dias heart failure
42841	Acute combined systolic & diastolic heart failure
42843	Acute on chronic combined systolic & diastolic heart failure
4289	Heart failure nos

APPENDIX E: MEASURE DENOMINATOR EXCLUSION ALGORITHM

The following four types of prior admissions are excluded from being the index hospitalization:

(1) Admissions for the treatment of cancer. Exclude admissions with discharge diagnosis for treatment of cancer. AHRQ Diagnosis CCS are used to define cancer discharge condition categories. AHRQ Diagnosis CCS considered cancer include:

AHRQ CCS	Description
11	Cancer of head and neck
12	Cancer of esophagus
13	Cancer of stomach
14	Cancer of colon
15	Cancer of rectum and anus
16	Cancer of liver and intrahepatic bile duct
17	Cancer of pancreas
18	Cancer of other GI organs; peritoneum
19	Cancer of bronchus; lung
20	Cancer; other respiratory and intrathoracic
21	Cancer of bone and connective tissue
22	Melanomas of skin
23	Other non-epithelial cancer of skin
24	Cancer of breast
25	Cancer of uterus
26	Cancer of cervix
27	Cancer of ovary
28	Cancer of other female genital organs
29	Cancer of prostate
30	Cancer of testis
31	Cancer of other male genital organs
32	Cancer of bladder
33	Cancer of kidney and renal pelvis
34	Cancer of other urinary organs
35	Cancer of brain and nervous system
36	Cancer of thyroid
37	Hodgkin's disease
38	Non-Hodgkin's lymphoma
39	Leukemias
40	Multiple myeloma
41	Cancer; other and unspecified primary
42	Secondary Malignancies
43	Malignant neoplasm without specification of site
44	Neoplasms of unspecified nature or uncertain behavior
45	Maintenance chemotherapy; radiotherapy

(2) Admissions for the treatment of psychiatric diseases. Exclude admissions with discharge diagnosis for treatment of psychiatric disease. AHRQ Diagnosis CCS are used to define psychiatric disease discharge condition categories. AHRQ Diagnosis CCS considered psychiatric disease include:

AHRQ CCS	Description
650	Adjustment disorders
651	Anxiety disorders
652	Attention-deficit, conduct, and disruptive behavior disorders
654	Developmental disorders
655	Disorders usually diagnosed in infancy, childhood, or adolescence
656	Impulse control disorders, NEC
657	Mood disorders
658	Personality disorders
659	Schizophrenia and other psychotic disorders
662	Suicide and intentional self-inflicted injury
670	Miscellaneous disorders

(3) Admissions for rehabilitation care and the fitting of prostheses and adjustment devices. Exclude admissions with admitting diagnosis of "rehabilitation care; fitting of prostheses and adjustment devices." The AHRQ Diagnosis CCS 254 is used to define rehabilitation care.

(4) Admission ending in patient discharge against medical advice. Exclude admissions with "Stus_cd"=07.