# NATIONAL QUALITY FORUM

National Voluntary Consensus Standards for Patient Outcomes
Measure Summary

**Measure number: OT2-005-09**

**Measure name:** 30-day Post-hospital PNA (Pneumonia) Discharge Care Transition Composite Measure

**Description:** This measure scores a hospital on the incidence among its patients during the month following discharge form an inpatient stay having a primary diagnosis of PNA for three types of events: readmissions, ED visitis and evaluation and management (E&M) services.

These events are relatively common, measurable using readily available administrative data, and associated with effective care coordination of care after discharge. The input for this score is the result of measures for each of these three events that are being submitted concurrently under the Patient Outcomes Measures Phase II project's call for ranking. This composite measure is a weighted average of the deviations of the three risk-adjusted, standardized rates from the population mean for the measure across all patients in all hospitals. Again the composite measure is accompanied by a percentile ranking to help with its interpretation.

**Numerator statement:** The numerator is the weighted sum of the three deviations from their expected values for the individual measures comprising the component measure. The question of appropriate weights on the deviations is difficult and would probably least to a view variation in opinion. The weights of -4, -2, and 1 are selected to represent order of magnitude differences in seriousness of the three outcomes, which most would agree to (that is to say: readmission id more important than ED which is more important than ED whish in more important in a negative way than E & M service is in a positive way. The idea on not using weights was also considered, but this was noted to be itself a de facto weight scheme (with all weights the same), and as such, a weight scheme that was less appropriate than the one chosen.

**Denominator statement:** N/A. The composite measure is the weighted of three individual measures. Thus, the denominator is one.

**Level of Analysis:** Population: national

**Type of Measure:** Outcome

**Data Source:** Electronic adminstrative data/claims

**Measure developer:** Brandeis University/CMS

**Type of Endorsement: (full or time-limited):** Full Endorsement (Recommend-21, Do not Recommend-0, April 20-21, 2010 Meeting)

**Summary table of TAP ratings of sub criteria and comments:**

| IMPORTANCE TO MEASURE AND REPORT | | |
|---|---|---|
| 1a Impact | Complete | No data to support the combination reflects care transitions. |

| | | |
|---|---|---|
| 1b gap | Minimal | |
| 1c relation to outcomes | Minimal | |
| SCIENTIFIC ACCEPTABILTY | | |
| 2a specs | Complete | Same as component measures; Weightings are arbitrary – chosen by the design team – no factor analysis or data-driven analyses; developer acknowledges the weightings are a qualitative assessment; Developer notes that the weightings may need adjustment on further use |
| 2b reliability | Partial | |
| 2c validity | Partial | |
| 2d exclusions | Complete | |
| 2e risk adjustment | Partial | |
| 2f meaningful differences | Complete | |
| 2g comparability | Not applicable | |
| 2h disparities | Not addressed | |
| USEABILITY | | |
| 3a distinctive | Partial | Composite distinctive if a valid reflection of care coordination -- uncertain |
| 3b harmonization | Complete | |
| 3c Added value | Complete | |
| FEASIBILITY | | |
| 4a Data a by product of care | Partial | |
| 4b Electronic | Complete | |
| 4c Exclusions | Complete | |
| 4d Inaccuracies/errors | Partial | |
| 4e Implementation | Partial | |

**Summary of SC ratings of sub criteria and comments:**

| IMPORTANCE TO MEASURE AND REPORT | |
|---|---|
| Similar to the Care Transition Composite measures for AMI and heart failure, this measure evaluated aspects of care coordination and was viewed as important. | SC Vote on Importance<br><br>Yes - 21<br><br>No - 0 |
| SCIENTIFIC ACCEPTABILITY | |

| | |
|---|---|
| There was discussion of whether or not this measure should always be tied to an E&M visit. There are additional methods to reduce readmissions, such as the nurse making a follow-up call to the patient post hospital discharge, or the physician conducting a home visit. | SC vote on scientific acceptability<br>Completely - 2<br>Partially – 19<br>Minimally – 0<br>Not at all – 0 |
| USABILITY | |
| N/A | SC vote on usability<br>Completely - 0<br>Partially – 21<br>Minimally – 0<br>Not at all – 0 |
| FEASIBILITY | |
| N/A | SC vote on feasibility<br>Completely - 13<br>Partially – 8<br>Minimally – 0<br>Not at all – 0 |

**Summary of Biostatistical review:**

**None**

**Attachments:** None

# THE NATIONAL QUALITY FORUM

## COMPOSITE MEASURE SUBMISSION FORM
Version 4.0 August 2009

This form will be used by stewards to submit **composite** measures and by reviewers to evaluate the measures.

**Measure Stewards:** Complete all non-shaded areas of the form. All requested information should be entered directly into this form. The information requested is directly related to NQF's composite measure evaluation criteria and will be used by reviewers to determine if the evaluation criteria have been met. The specific relevant subcriteria language is provided in a Word comment within the form and will appear if your cursor is over the highlighted area.

The measure steward has the opportunity to identify and present the information that demonstrates the measure meets the criteria. Additional materials will only be considered supplemental. Do not rely solely on materials provided at URLs or in attached documents to provide measure specifications or to demonstrate meeting the criteria. If supplemental materials are provided, be sure to indicate specific page numbers/ web page locations for the relevant information (web page links preferred).

For questions about this form, contact the project director at 202-783-1300. Please email this form to the appropriate contact listed in the corresponding call for measures.

**Reviewers:** Complete all yellow highlighted areas of the form. Evaluate the extent to which each subcriterion is met and then overall, the extent to which each major criterion is met. Provide the rationale for your rating.

Evaluation ratings of the extent to which the criteria are met
H=High (unquestionably demonstrated to meet the criterion)
M=Moderate (demonstrated to moderately meet the criterion)
L=Low (addressed BUT demonstrated to only minimally meet the criterion)
N=No (NOT addressed; OR incorrectly addressed; OR demonstrated to NOT meet the criterion)
NA=Not applicable (only an option for a few subcriteria as indicated)

| |
|---|
| (for NQF staff use) **NQF Review #:** OT2-005-09 **NQF Project:** Patient Outcome Measures Phase I |
| **Title of Measure:** 30-day Post-Hospital PNA (Pneumonia) Discharge Care Transition Composite Measure |
| **Brief description of measure** (*including type of score, measure focus, target population, time, e.g., Percentage of adult patients aged 18-75 years receiving one or more HbA1c tests per year*):<br>This measure scores a hospital on the incidence among its patients during the month following discharge from an inpatient stay having a primary diagnosis of PNA for three types of events: readmissions, ED visits and evaluation and management (E&M) services.<br><br>These events are relatively common, measurable using readily available administrative data, and associated with effective coordination of care after discharge. The input for this score is the result of measures for each of these three events that are being submitted concurrently under the Patient Outcomes Measures Phase II project's call for measures. Each of these individual measures is a risk-adjusted, standardized rate together with a percentile ranking. This composite measure is a weighted average of the deviations of the three risk-adjusted, standardized rates from the population mean for the measure across all patients in all hospitals. Again, the composite measure is accompanied by a percentile ranking to help with its interpretation. |
| ▶**Type of Measure:** ☒ Composite |
| **Select the most relevant priority area(s), quality domain(s), and consumer need(s).**<br><br>▶**National Priority Partners Priority Area** ☐ patient and family engagement ☐ population health ☐ safety ☒ care coordination ☐ palliative and end of life care ☐ overuse<br><br>▶**IOM Quality Domain** ☐ effectiveness ☒ efficiency ☐ equity ☐ patient-centered ☐ safety ☐ timeliness |

►**Consumer Care Need** ☒ Getting Better ☐ Living With Illness ☐ Staying Healthy

| CONDITIONS FOR CONSIDERATION BY NQF | |
|---|---|
| Four conditions must be met before proposed measures may be considered and evaluated for suitability as voluntary consensus standards: | **NQF Staff** |
| **A.** The measure is in the public domain or an intellectual property agreement (measure steward agreement) is signed. *Public domain only applies to governmental organizations. All non-government organizations must sign a measure steward agreement even if measures are made publicly and freely available.*<br><br>►**Do you attest that the measure steward holds intellectual property rights to the measure and the right to use any aspects of the measure owned by another entity (e.g., component measures, risk model, code set)?** ☒ Yes<br><br>►**Measure Steward Agreement**<br>☐ Signed and Submitted **OR** ☒ Government entity–public domain<br>(If measure steward agreement not signed for non-government entities, do not submit)<br><br>►**Please check if either of the following apply:**<br>☐ Proprietary Measure ☐ Proprietary Complex Measure w/fees | **A**<br>Y☐<br>N☐ |
| **B.** The measure owner/steward verifies there is an identified responsible entity and process to maintain and update the measure on a schedule that is commensurate with the rate of clinical innovation, but at least every 3 years. ☒ Yes (If no, do not submit) | **B**<br>Y☐<br>N☐ |
| **C.** The intended use of the measure includes both public reporting and quality improvement.<br>►**Purpose:** ☒ Public reporting ☒ Internal quality improvement<br>☒ Accountability ☐ Accreditation ☒ Payment incentive ☐ Other, describe:<br>(If not intended for both public reporting and quality improvement, do not submit) | **C**<br>Y☐<br>N☐ |
| **D.** The requested measure submission information is complete. Generally, measures should be fully developed and tested so that all the evaluation criteria have been addressed and information needed to evaluate the measure is provided. Measures that have not been tested are only potentially eligible for a time-limited endorsement and in that case, measure owners must verify that testing will be completed within 24 months of endorsement.<br><br>►**Testing:** ☐ Fully developed and tested ☒ Testing will be completed within 24 months<br>(If not tested and no plans for testing within 24 months, do not submit)<br><br>**Component Measures** (*All components of the composite must be either NQF-endorsed or submitted for consideration for NQF endorsement*)<br>☐ All component measures are NQF-endorsed measures<br>☒ Some or all component measures are not NQF-endorsed and have been submitted using the online measure submission tool<br><br>►**Have NQF-endorsed measures been reviewed to identify if there are similar or related measures?**<br>☒ Yes (If no, do not submit) *If there are similar or related measures, be sure to address items 3b and 3c with specific information.*<br>►**Is all requested information entered into this form?** ☒ Yes (If no, do not submit) | **D**<br>Y☐<br>N☐ |
| (for NQF staff use) **Have all conditions for consideration been met?**<br>**Staff Notes (if submission returned):** | **Met**<br>Y☐<br>N☐ |

| 1. IMPORTANCE TO MEASURE AND REPORT | |
|---|---|
| Extent to which the specific measure focus is important to making significant gains in health care quality (safety, timeliness, effectiveness, efficiency, equity, patient-centeredness) and improving health outcomes | **Eval** |

for a specific high impact aspect of healthcare where there is variation in or overall poor performance. *Measures must be judged to be important to measure and report in order to be evaluated against the remaining criteria.* (composite measure evaluation criteria)

If the component measures are determined to meet the importance criteria 1a, 1b, and 1c, then the composite would meet 1a, 1b, and 1c.

(for NQF staff use) **Specific NPP goal**:

**1d. Purpose/objective of the Composite**

►**Describe the purpose/objective of the composite measure:** Measurement that extends a hospital's performance from its inpatient setting to requisite outpatient delivery systems facilitates acknowledgement of shared accountability in achieving optimal patient outcomes and results in the active transfer of accountability for the patients' treatment. This application extends the precedent set by 30-day time intervals (for mortality and readmission rates) to include other important indicators or criteria for inferring better versus worse care coordination. NQF has identified transitions or "hand-offs" as the fifth domain in their definition and framework for measuring care coordination (NQF, 2006). Transitions between care settings involve multiple providers and patients with complex needs, resulting in care that is often unsafe, disconnected, and uncoordinated. Furthermore, pilot programs and evaluations of efforts to improve care transitions often use service utilization as signals or indicators or performance, and criteria for whether the intended improvements are realized (Brown et al., 2006; Coleman & Berenson, 2004; Coleman, Parry, Chalmers, & Min, 2006; DeJonge, Taler, & Boling, 2009; Naylor, 2004; Naylor et al, 2004; Peikes, Chen, Schore, & Brown, 2009; Moore et al, 2003; Dudas et al, 2001; Forester et al, 2003) .

Hospital readmissions are recognized as system failures at least in part (Jencks, 2009). Ultimately, a composite measure examining the care trajectories of Medicare beneficiaries with PNA for the 30-days following hospital discharge would provide a more comprehensive picture of care provision during this critical window of time. It should be noted that two-thirds of elders admitted to the hospital with PNA have co-morbid chronic illness (HF, COPD/asthma, and DM being the most prevalent conditions) (Kaplan et al, 2002) that must be managed actively post a serious acute-care episode of PNA. Therefore, we examine the outcome of non-prescriptive, system-individualized and patient/family needs-based collaborative efforts to intervene appropriately with these high-risk patient cohorts at the lowest possible level of resource intensity. A hospital performance measure of E & M follow-up on Medicare beneficiaries discharged following acute treatment for PNA may encourage hospitals to develop discharge risk scores for specific cohorts that inform the most appropriate time frame for scheduled outpatient follow-up (Coleman & Williams, 2007). Although recently updated clinical practice guidelines for Community-Acquired Pneumonia and Hospital-Acquired Pneumonia do not specifically address appropriate ambulatory follow-up after a hospitalization given the high rate of readmissions for PNA (second in frequency only to HF, identified as a co-existing condition in many cases) and the recidivism following hospitalization with PNA in patients at highest risk a follow-up E&M service appearts intrinsically valuable and evidence of optimal transfer of patient accountability from inpatient to ambulatory care or SNF.

►**Describe the quality construct used in developing the composite:** Having derived hospital-level risk-adjusted expected rates for E & M services, ED visits and readmissions following index hospitalizations for PNA patients, we propose to combine these three measures into a weighted, post-hospital discharge care transition composite measure. If timely care transition is facilitated by the discharge hospital, one would expect to avoid preventable Emergency Department visits or readmissions to the hospital. As the E & M service is the link that presumably transfers physician accountability for treatment back to the primary care physician or specialist in the outpatient setting, the E & M service should be the first event observed following hospital discharge, and our proposed composite measure credits and weights positively such E & M services. Conversely, hospital readmissions and outpatient ED visits are considered negative events and weighted accordingly, as described below.

Due to their implicit seriousness as well as high level of resource use, any readmission within 30 days following a hospital PNA stay, identified by NQF-endorsed criteria, contributes negatively to our composite measure. An ED visit contributes, again negatively, if it occurs within 30 days and prior to any readmission. An E & M service contributes, but positively, if the E & M service is the first service received following the index hospitalization during the time period. Risk adjusted predicted rates for E & M services, ED visits and hospitalizations are calculated for each hospital and compared with risk-adjusted expected rates (designated as 'popavg' in our formulas). Deviations in readmission rate, ED visit rate and E & M service

**1d**
**H**☐
**M**☐
**L**☐
**N**☐

| | |
|---|---|
| rate, derived by subtracting risk-adjusted expected rate (popavg) from risk standardized rate (RSR) are combined into a composite rate using the weights of -4, -2, and 1 respectively to reflect the presumed relative seriousness of the three events. That is:<br><br>Post-discharge care composite measure = -4*(RSR-popaverage)-2*(RSR-popaverage)+1*(RSR-popaverage).<br><br>In addition, to help interpret the resulting measure values, the hospitals are also percentile ranked. | |
| **1e. Conceptual construct for quality**<br>►**Describe how the component measures are consistent with and representative of the quality construct:** The outcomes making up the composite measure, E&M service, ED visits and hospital readmissions, represent increasing levels of resouce use to medically manage PNA post-hospital discharge. These measures do not measure care transitions themselves or care coordination, but instead they represent the expectant result from improvement in such processes as evidenced by the numerous intervention programs and studies that utilize these measures as evidence of program/process effectiveness. If this composite is measured and reported, hospitals would be more motivated to develop the system-specific, needs-based processes unique to their inpatient-outpatient networks to provide the appropriate level of medical care at the right time and in the right setting. The proposed composite measure builds upon the previously endorsed measure for 30-day All-Cause Readmission following hospialization for PNA by incorporating two additional measures to differentiate hospital performance on the outcome of transitional care efforts. | **1e**<br>**H**☐<br>**M**☐<br>**L**☐<br>**N**☐ |
| **Staff Notes to Reviewers:** | |
| **Reviewer: Was the threshold criterion, Importance to Measure and Report, met?**<br>**Rationale:** | **1**<br>**Y**☐<br>**N**☐ |
| **2. SCIENTIFIC ACCEPTABILITY OF MEASURE PROPERTIES** | |
| Extent to which the measure, as specified, produces consistent (reliable) and credible (valid) results about the quality of care when implemented. (composite measure evaluation criteria) | **Eval** |
| 2a. MEASURE SPECIFICATIONS | |
| *In the future, NQF will require measure stewards to provide a URL link to a web page where current detailed specifications can be obtained?*<br>►Do you have a web page where current detailed measure specifications can be obtained?<br>►If yes, provide web page URL: TBA<br><br>2a. Precisely Specified<br><br>**Components of the Composite** (*List the components, i.e., domains/sub-composites and individual measures*)<br><br>►**List components:** (*If component measures NQF-endorsed, include NQF measure number*; if not NQF-endorsed, provide date of submission to NQF)<br>30-day Post-Hospital HF discharge evaluation and management measure, submitted to NQF on 10/30/2009;<br>30-day Post-Hospital HF discharge ED measure, submitted to NQF on 10/30/2009; and,<br>30-day Post-Hospital HF discharge All-Cause Readmission measure, submitted to NQF on 10/30/2009. | **2a-specs**<br>**H**☐<br>**M**☐<br>**L**☐<br>**N**☐ |

| | |
|---|---|
| **Composite Numerator Statement:** The numerator is the weighted sum of the three deviations from their expected values for the individual measures comprising the component measure. The question of appropriate weights on the deviations is difficult and would probably lead to a wide variation in opinion. The weights of -4, -2, and 1 are selected to represent order of magnitude differences in seriousness of the three outcomes, which most would agree to (that is to say: readmission is more important than ED which is more important in a negative way than E & M service is in a positive way). The idea on not using weights was also considered, but this was noted to be itself a de facto weight scheme (with all weights the same), and as such, a weight scheme that was less appropriate than the one chosen.<br><br>**Numerator Time Window:** Each of the individual measures in the composite is computed annually, as a three year rolling average.<br><br>**Numerator Details:** The details on each individual measure comprising the component measure are provided in their submission for NQF approval. | |
| **Composite Denominator Statement:** N/A The composite measure is the weighted of three individual measures. Thus, the denominator is one.<br><br>**Denominator Time Window:** N/A<br><br>**Denominator Details**: N/A | |
| **Composite Denominator Exclusions:** N/A<br><br>**Denominator Exclusion Details:** N/A | |

►**Type of Score:** Weighted score/comosite/scale ► If "Other", please describe:

►**Interpretation of Score** (*Classifies interpretation of score according to whether better quality is associated with a higher score, a lower score, a score falling within a defined interval, or a passing score*) Better quality = Higher score ► If "Other", please describe:

**Method of Scoring/Aggregation:** other **If "other" scoring method, describe:** Weighted sum of components, where each component is a deviation from an expected value.

**Missing Component Scores** (*Indicate how missing component scores are handled*): NA

**Weighting:** ☐ **Equal** ☒ **Differential If differential weighting, describe:** Readmission measure = -4* (RSR-popaverage); ED measure = -2*(RSR-popaverage); E&M measure = 1*(RSR-popaverage)

►**Calculation Algorithm** (*Describe the calculation of the measure as a flowchart or series of steps*)**:** Calculation Algorithm for 30-day Hospital Discharge PNA Care Transition Composite measure:

Step 1: Claims for all beneficiaries (regardless of clinical condition) from 2003-2007 Medicare Inpatient files were combined and cleaned to create a claims file with one claim per inpatient per provider stay. Next, a single-stay claims file for all beneficiaries (regardless of clinical condition) in which transfer claims are combined into a single inpatient stay record was created. This process is described in the "Input File Processing for 2009 CMS 30-day Mortality and Readmission Measures" documentation.

Step 2: Each stay in the five year period is then defined as either an index admission or a 30-day readmission. A single stay cannot count as both an index admission and a readmission for another index admission. Thus, additional admissions within 30-days of an index admission are not counted as index admissions. Index admissions with a qualifying primary discharge diagnosis from beneficiaries meeting the inclusion criteria were included in this measure. This process is described in the Hospital 30-Day PNA Readmission Measure Methodology submitted by YNHH-CORE, the Hospital 30-Day Acute Myocardial Infarction Readmission Measure Methodology submitted by YNHH-CORE, and the Hospital 30-Day Heart Failure Readmission Measure Methodology submitted by YNHH-CORE.

Step 3: For each qualifying index admission, the beneficiary's inpatient and outpatient claims in the 12-months prior to the hospitalization are examined. All diagnoses from non-DME, non-diagnostic testing claims are used to construct flags for 184 clinical Condition Categories (CCs). Secondary diagnoses (excluding diagnoses associated with potential complications) from the index admission are used also to assign the 184 CCs. The process for creating the CC flags is described in the RiskSmart Stand Alone Users Guide, v2.2. These flags are used for risk adjustment.

Step 4: The following three flags (0/1 indicators) are then set for each index admission.
- Readmission=1 if a subsequent readmission occurs within 30 days of discharge from the qualifying index admission
- ED visit=1 if an ED visit occurs in the 30 days after discharge from the index admission, and the ED visit is not associated with or after the first readmission.
- E&M service=1 if an E&M service occurs in the 30 days after discharge from the index admission, and the E&M service is not after the first readmission, and is not after the first ED visit.

Step 5:
- Calculate separately (a) the ratio of E&M service=1 events, (b) the ratio of ED visit=1 events, and (c) the ratio of Readmission=1 events over the total number of qualifying index admissions to get unadjusted E&M, ED visit, and Readmission rates, respectively. These ratios are for descriptive purposes only.

Step 6:
- Estimate separately risk adjustment regression models on (a) the E&M service indicator, (b) the ED visit indicator, and (c) the readmission indicator using the methodology developed for the CMS 30-day all cause readmission measure.

Step 7: Applying the CMS 30-day readmission measure methodology, compute separately the P/E ratio and corresponding risk standardized rates (the RSR is defined as P/E times overall population mean) for E&M service, ED visit, and readmission.It must be understood that the RSR for E&M services greater than expected (popavg) indicates better than anticipated performance, while RSR for ED visits and readmissions greater than expected indicates lower than anticipated performance. This explains why weights for E&M service deviation is positive (+1), while weights for ED visits and readmissions components are negative (-2

►**Describe the method for discriminating performance** *(e.g., significance testing)***:**

►**Sampling (Survey) Methodology** *If measure is based on a sample (or survey), provide instructions for obtaining the sample, conducting the survey and guidance on minimum sample size (response rate)*:
N/A

►**Stratification Details/Variables (***All information required to stratify the measure including the stratification variables, all codes, logic, and definitions***):**
N/A

►**Data Source** *Check all the source(s) used in the component measures.*

- ☒ Electronic administrative data/ claims
- ☐ Electronic Health/Medical Record
- ☐ Electronic Clinical Data *(e.g., MDS)*
- ☐ Registry data (or database)
- ☐ Lab data
- ☐ Pharmacy data
- ☐ Paper Medical Record/flowsheet
- ☐ Survey-patient *(e.g., CAHPS)*
- ☐ Survey-provider
- ☐ Documentation of original self-assessment *(e.g., SF-36)*
- ☐ Management data
- ☐ Public health data/vital statistics
- ☐ Special or unique data, specify:

►**Level of Measurement/Analysis** (*For what entity will the scores be computed?*)
*Check the level(s) for which the measure is specified and tested.*

**Clinician:** ☐ Individual ☐ Group ☐ Other
- ☐ Facility/Agency (e.g., hospital, nursing home)
- ☐ Multi-site/corporate chain
- ☐ Integrated delivery system
- ☐ Health plan
- ☐ Prescription drug plan

**Program:** ☐ Disease management ☐ QIO
- ☐ Other

**Population:** ☒ National ☐ Regional/network
- ☐ State ☐ Counties/Cities
- ☐ Other (*Please describe*):
- ☐ All levels

►**Applicable Care Settings**
*Check the setting(s) for which the measure is specified and tested.*
**Ambulatory Care:** ☐ Amb Surgery Center ☐ Office ☐ Clinic ☐ Emergency Dept ☐ Hospital Outpatient

- ☐ Assisted Living
- ☐ Behavioral health/psychiatric unit
- ☐ Dialysis Facility
- ☐ Emergency medical services/ambulance
- ☐ Group Home
- ☐ Home
- ☐ Hospice
- ☒ Hospital
- ☐ Long term acute care hospital
- ☐ Nursing home/ Skilled Nursing Facility (SNF)
- ☐ Rehabilitation Facility
- ☐ Other (*Please describe*):
- ☐ Unspecified or "not applicable"
- ☐ All settings

## TESTING/ANALYSIS

**2i. Component item/measure analysis to justify inclusion in composite**

**Data/sample:** Claims from 2004 through 2007 100% Medicare Inpatient SAF Files; 2004 through 2007 100% Medicare Outpatient SAF Files; 20 % sample of 2004 through 2007 Medicare Carrier Files

**Analytic Method:** Calculate correlation between the positive subgroup and the reverse of the negative subgroups of measures

**Testing Results:** We found that the Pearson correlation coefficient between component for E&M service within 30 days and the sum of the components for readmission and ambulatory ED visit was approximately 0.240 to 0.270 (p<.001), depending on composite formulation. This implied that the positive component (E&M service) and the reverse of the negative components (formed by combining ED visits with readmissions) can be used together to form a useful composite.

**2i**
H☐ M☐ L☐ N☐

**2j. Component item/measure analysis of contribution to variability in composite score**

**Data/sample:** Claims from 2004 through 2007 100% Medicare Inpatient SAF Files; 2004 through 2007 100% Medicare Outpatient SAF Files; 20 % sample of 2004 through 2007 Medicare Carrier Files

**2j**
H☐ M☐ L☐ N☐

**Analytic Method:** Correlation of each of the three component measures with the composite measure.

**Testing Results:** Correlations between each component and the overall composite measure were very strong ($p<.001$). For the predicted over expected composite measure based on three year rolling average, the correlations .613 with the readmission component, .457 with the ED visit component, and .806 with the E&M service component. For the one year composite measure (based on 2007 data), it was similarly strong – readmission component correlated at .670, ED visit correlated at .453, and E&M service component correlated at .745.

**2k. Analysis to support differential weighting of component scores**

**Data/sample:** N/A

**Analytic Method:** N/A

**Testing Results:** N/A

**Describe how the method of scoring/aggregation achieves the stated purpose and represents the quality construct:** The question of appropriate weights on the deviations is difficult and would probably lead to a wide variation in opinion. The weights of -4, -2, and 1 are selected to represent order of magnitude differences in seriousness of the three outcomes, which most would agree to (that is to say: readmission is more important than ED which is more important in a negative way than E & M service is in a positive way). The idea on not using weights was also considered, but this was noted to be itself a de facto weight scheme (with all weights the same), and as such, a weight scheme that was less appropriate than the one chosen.

**Indicate if any alternative scoring/aggregation methods were tested and why not chosen:**

**2k** H☐ M☐ L☐ N☐

**2l. Analysis of missing component scores**

**Data/sample:** Claims from 2004 through 2007 100% Medicare Inpatient SAF Files; 2004 through 2007 100% Medicare Outpatient SAF Files; 20 % sample of 2004 through 2007 Medicare Carrier Files

**Analytic Method:** search of data summaries for components with zero or low number of PNA admissions

**Testing Results:** Components are present or absent uniformly for all hospitals in our PNA dataset.

**2l** H☐ M☐ L☐ N☐

**2b. Reliability testing of composite score**

►**Data/sample** *(description of data/sample and size)*: 2004 through 2007 100% Medicare Inpatient SAF Files; 2004 through 2007 100% Medicare Outpatient SAF Files; and, 20 % sample of 2004 through 2007 Medicare Carrier Claim Files.

►**Analytic Method** *(type of reliability & rationale, method for testing)*: Reliability was examined two ways: through correlation of measure with incremental change, and through division into quintiles and calculating weighted kappa statistics. Both Pearson and Spearman (rank) correlations were computed between 2007 and average of first three years (2004 through 2006). This is a more stringent test than the straightforward test of correlating 2007 measures (based on three year rolling averages from 2005-2007) with 2006 measures (based on three year rolling averages from 2004-2006). The latter would share 2/3 of the data and have an inflated correlation as a result.

►**Testing Results** *(reliability statistics, assessment of adequacy in the context of norms for the test conducted)*: All tested correlations were significant at the .01 level. The Pearson correlation between 2007 and three year averages (using 2004- 2006) for predicted over expected was .258 (for comparison purposes, the observed over expected composites had a .129 correlation). The Spearman correlation (which are less sensitive to outliers) was similar: .225 for predicted over expected (and .123 for corresponding observed over expected composites). Weighted kappas measuring agreement within quintiles showed a similar pattern of reliability. Weight kappa was .138 for 2007 predicted over expected compared with prior composite measure based on three year rolling average. The 95% CI for this weighted kappa was (.111,.165).

**2b** H☐ M☐ L☐ N☐

**2c. Validity testing of composite score**

**2c**

| | |
|---|---|
| ►**Data/sample** *(description of data/sample and size)*: 2004 through 2007 100% Medicare Inpatient SAF Files 2004 through 2007 100% Medicare Outpatient SAF Files; 20 % sample of 2004 through 2007 Medicare Carrier claim Files<br><br>►**Analytic Method** *(type of validity & rationale, method for testing)*: N/A yet<br><br>►**Testing Results** *(statistical results, assessment of adequacy in the context of norms for the test conducted)*: As a weighted sum of three measures, the validity of this composite depends greatly on the validity of the three components. We hope to further test this validity through construct validation, predictive validation, and other analyses as follow-up to this submission. | H☐ M☐ L☐ N☐ |
| **2f. Identification of Meaningful Differences in Performance**<br><br>►**Data/sample from Testing or Current Use** *(description of data/sample and size)*: Medicare claims data, 2004-2007.<br><br>►**Methods to identify statistically significant and practically/meaningfully differences in performance** *(type of analysis & rationale)*: Two possible options: significance testing (three categories for significantly lower than mean, no significant difference from mean, and significantly higher than mean) or 5 categories based on percentile rank (lowest 15 percent = lowest category to highest 15 percent = highest category). Final decision will be determined from feedback obtained during three year provisional period.<br><br>► **Provide Measure Scores from Testing or Current Use** *(description of scores, e.g., distribution by quartile, mean, median, SD, etc.; identification of statistically significant and meaningfully differences in performance)* **:** This composite is not yet used. We are submitting it for provisional acceptance with the plan to test it in the near future. | **2f**<br>H☐ M☐ L☐ N☐ |
| **2h. Disparities in Care**<br><br>►**If measure is stratified, provide stratified results** *(scores by stratified categories/cohorts)*:<br>N/A<br><br>►**If disparities have been reported/identified, but measure is not specified to detect disparities, provide follow-up plans:** | **2h**<br>H☐ M☐ L☐ N☐ NA☐ |
| **Staff Notes to Reviewers:** | |
| **Reviewers: Overall, to what extent was the criterion,** *Scientific Acceptability of Measure Properties*, **met?**<br>**Rationale:** | **2**<br>H☐ M☐ L☐ N☐ |
| **3. USABILITY** | |
| **Extent to which intended audiences (e.g., consumers, purchasers, providers, policy makers) can understand the results of the measure and are likely to find them useful for decision making.**<br>(composite measure evaluation criteria) | **Eval** |
| **3a. Meaningful, Understandable, and Useful Information**<br><br>**Current Use:** ☐ In use ☐ Not in use, but testing completed ☒ Testing not yet completed<br><br>**If used in a public reporting initiative, Name of initiative(s), locations, Web page URL(s):**<br><br>**If used in other programs/initiatives (e.g., quality improvement), Name of initiative(s), locations, web page URL(s):**<br><br>**Testing of Interpretability** (*Testing that demonstrates the results are understood by the potential users for public reporting and quality improvement*) | **3a**<br>H☐ M☐ L☐ N☐ |

| | |
|---|---|
| ►**Data/sample** *(description of data/sample and size)*:<br><br>►**Methods** *(methods, e.g., focus group, survey, QI project)*:<br><br>►**Results** *(qualitative and/or quantitative results and conclusions)*: | |
| **3b/3c. Relation to other NQF-endorsed measures**<br>*Identify similar or related NQF-endorsed measures* (available at *www.qualityforum.org under Core Documents)*<br><br>☐ Other measures for same target population ☒ Other measures on same topic ☐ No similar measures<br><br>**NQF # and Title of similar or related measures:**<br><br>**Describe the distinctive or additive value this measure provides to existing NQF-endorsed measures:**<br>Adds two additional components to an exisiting readmission rate measure in building a composite measure of transitional care post-hospital discharge | |
| **3b. Harmonization**<br><br>►**Are the component measure specifications harmonized, or if not, why?** yes; employed the diagnositic coding specification for population cohorts and the risk-adjustment methodology of the currently NQF-endorsed hospital 30-day PNA, Heart Failure and AMI readmission rates (developed by Yale researchers) | **3b**<br>H☐<br>M☐<br>L☐<br>N☐<br>NA☐ |
| **3c. Distinctive or Additive Value**<br><br>►**Describe the distinctive, improved, or additive value this measure provides to existing NQF-endorsed measures:**<br>It builds upon the foundation of the NQF-endorsed 30-day PNA, Heart Failure, and AMI readmission rates providing a more comprehensive picture of transitional care and resource use immediately post-discharge for a frequent and high-cost condition in the Medicare population. | **3c**<br>H☐<br>M☐<br>L☐<br>N☐<br>NA☐ |
| **3d. Decomposition of Composite**<br>►**Describe the information from decomposing the composite into its components that is available:**<br>1) NQF endorsed Hospital 30-day Pneumonia Readmission measure<br>2) 30-day Post-hospital PNA discharge ED visit rate<br>3) 30-day Post-hospital PNA discharge evaluation and management service rate | **3d**<br>H☐<br>M☐<br>L☐<br>N☐ |
| **3e. Achieved stated purpose**<br>**Describe how the results reported above demonstrate that the composite achieves the stated purpose:**<br>Ideal care following hospitalization for PNA is evidence of an evaluation and management (E & M)services visit that presumably links the inpatient care back to the outpatient setting thereby transferring physician accountability for treatment from the hospitalist or hospital physician to the primary care physician or specialist. If the discharged patient required an Emergency Department visit or readmission prior to this E & M it can be implied that optimal care transition did not occur. | **3e**<br>H☐<br>M☐<br>L☐<br>N☐ |
| **Staff Notes to Reviewers (including additions/changes to related or similar measures):** | |
| **Steering Committee/TAP: Overall, to what extent was the criterion,** *Usability*, **met?**<br>**Rationale:** | **3**<br>H☐<br>M☐<br>L☐<br>N☐ |
| **4. FEASIBILITY** | |
| **Extent to which the required data are readily available, retrievable without undue burden, and can be implemented for performance measurement.** (composite measure evaluation criteria) | **Eval** |
| **4a. Data Generated as a Byproduct of Care Processes** | **4a** |

| | |
|---|---|
| **How are <u>all</u> the data elements that are needed to compute measure scores generated?** *Check all that apply*<br>☐ Data are generated as a byproduct of care processes during care delivery (*Data are generated and used by healthcare personnel during the provision of care, e.g., blood pressure, lab value, medical condition)*<br>☒ Coding/abstraction performed by someone other than person obtaining original information *(e.g., DRG, ICD-9 codes on claims; chart abstraction for quality measure, registry)*<br>☐ Other *(e.g., patient experience of care surveys, provider surveys, observation)*, *Please describe*: | H☐ M☐ L☐ N☐ NA☐ |
| **4b. Electronic Sources**<br><br>►**Are <u>all</u> the data elements available electronically?** (*elements that are needed to compute measure scores are in defined, computer-readable fields, e.g., electronic health record, electronic claims*)<br>☒ Yes ☐ No<br>►**If no, specify the near-term path to achieve electronic capture by most providers.**<br><br>*Note: Measure stewards will be asked to specify the data elements for electronic health records at a later date* | **4b**<br>H☐ M☐ L☐ N☐ |
| **4d. Susceptibility to Inaccuracies, Errors, or Unintended Consequences**<br><br>►**Identify susceptibility to inaccuracies, errors, or unintended consequences of the measure and describe how these potential problems could be audited. If audited, provide results.** | **4d**<br>H☐ M☐ L☐ N☐ |
| **4e. Data Collection Strategy/Implementation**<br><br>►**Describe what you have learned/modified as a result of testing and/or operational use of the composite/component measures regarding data collection, availability of data/missing data, timing/frequency of data collection, patient confidentiality, time/cost of data collection, other feasibility/ implementation issues:**<br>As a completely claims-based measure once measure specification has been coded it is not difficult to derive.<br><br>►**Costs to implement the measure** (*costs of data collection, fees associated with proprietary measures*)**:**<br><br>►**Evidence for costs:**<br>►**Business case documentation:** | **4e**<br>H☐ M☐ L☐ N☐ |
| **Staff Notes to Reviewers:** | |
| **Reviewers: Overall, to what extent was the criterion, Feasibility, met?**<br>**Rationale:** | **4**<br>H☐ M☐ L☐ N☐ |
| | |
| **Reviewers: Overall, to what extent were all the criteria met?**<br>**Rationale:** | H☐ M☐ L☐ |
| | |
| **Steering Committee only**<br>**Recommendation: ☐ Endorsement ☐ Time-limited endorsement ☐ Do not recommend**<br>**Conditions: ☐ No ☐ Yes, Specify:** | |
| **CONTACT INFORMATION** | |
| **Measure Steward (Intellectual Property Owner)** | |

**Organization:** Centers for Medicare and Medicaid Services
**Street Address:** **City:** Washington D.C. **State:** **ZIP:** 21244

**Point of Contact: First Name:** Shaheen **MI:** **Last Name:** Halim **Credentials (MD, MPH, etc.):** Ph.D.
**Email:** shaheen.halim@cms.hhs.gov **Telephone:** 401-786-0644 ext:

**Measure Developer If different from Measure Steward**
**Organization:** Brandeis University
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**Point of Contact: First Name:** Christopher **MI:** **Last Name:** Tompkins **Credentials (MD, MPH, etc.):** Ph.D.
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**Submitter If different from Measure Steward Point of Contact**
**First Name:** Christopher **MI:** **Last Name:** Tompkins **Credentials (MD, MPH, etc.):** Ph.D.
**Email:** tompkins@brandeis.edu **Telephone:** 781-736-3913 ext:
**Organization:** ☐ Measure Steward ☒ Measure Developer

**Additional Measure Developer Organizations:**

## ADDITIONAL INFORMATION

**Workgroup/Expert Panel involved in measure development**
►Provide a list of sponsoring organizations and workgroup/panel members' names and organizations.
►Describe the members' role in measure development.

Technical Expert Panel (TEP):
Lisa Latts, MD, MBA -WellPoint
Julie Bynum, MD, MPH -Dartmouth Medical School
Joanne Lynn, MD -DC Department of Health – Chronic Disease and Cancer Community Health Administration
Anthony Armada, MHA, MBA -Henry Ford Hospital

TEP Role:
The Technical Expert Panel assisted our workgroup developing measures by providing input to:
- Supplement, and provide texture, to the knowledge gathered through the literature review prior to measure development;
- Discussing existing measures and providing input as to next steps for CMS to adopt, adapt, and/or develop measures of care coordination relevant to the hospital setting; and
- Reviewing and providing input on draft measures and measure development testing.

Workgroup

Kristine Martin Anderson, MBA -Booz Allen Hamilton
Sandra Lesikar, PhD-Booz Allen Hamilton
Arlene Ash, PhD-Boston University
James Burgess, PhD-Boston University
Gary Young, MD-Boston University
Christopher Tompkins, PhD-Brandeis University
John Chapman, PhD-Brandeis University
Timothy Martin, PhD-Brandeis University
Grant RItter, PhD-Brandeis University
Sue Lee, MS-Brandeis University
Marian Ryan, Ph.D.Candidate-Brandeis University

Workgroup Role:
The workgroup participated in development of measures, review of interim results during development, and the review of NQF submission forms. Listed members participated on the CMS project team working on the development of measures under a hospital VBP program.

►**If adapted, provide name of original measure:** 30-day Post-hospital PNA Discharge Care Transition Measure
►**If adapted, provide original specifications** ☐ **attachment or web page URL:**

| |
|---|
| **Measure Developer/Steward Updates and Ongoing Maintenance**<br>►Year the measure was first released:<br>►Month and Year of most recent revision:<br>►What is the frequency for review/update of this measure?<br>►When is the next scheduled review/update for this measure? |
| **Copyright statement/disclaimers:** NA |
| **Additional Information web page URL:** |
| **I have checked that the submission is complete and all the information needed to evaluate the measure is provided in the form; any blank fields indicate that no information is provided.** ☒ |
| **Date of Submission** (*MM/DD/YY*)**:** 10/30/2009 |

# Pneumonia 30-Day Post-Hospital Discharge Care Transition Composite Measure

## Supporting Material for Scientific Acceptability

Brandeis University

## 1. Introduction

This document elaborates and supports the statements on scientific acceptability in Brandeis University's October 30, 2009 submission of a measure titled "30-Day Post-Hospital Pneumonia Discharge Care Transition Composite Measure" to the National Quality Forum's Consensus Development Project on Proposed Patient Outcomes Measures (Phase I) in response to its call for candidate standards.

### 1.1. Data Sample

All data used for the analyses described in this document are from the Dartmouth Atlas 20% sample of Medicare Carrier Claim files for 2003-2007. Data from 2003 are used only for pre-admission information about patients admitted during 2004, and are not included directly in any of the analysis presented. December 2007 is used only for information about the 30-day post-discharge period; there are no December 2007 index admissions in the results presented here. These data were processed in accordance with the measure definitions described in the submission. All resulting index admissions were used in the model for testing and estimation and are reflected in the individual level expected and predicted values used in computing the component measures. However, composite measure scores were analyzed only for hospitals having 10 or more index admissions in 2006. These are the same hospitals used for the analysis presented in support of the accompanying submissions for the ED visit and E&M service measures used for this composite.

More information about the ED visit and E&M service component scores used for this analysis can be found in the submissions for those measures. Similar information about the readmission component data and scores used for this analysis is presented in Appendix B.

### 1.2. Measure Methods

The component measures of this composite use three years of data, updated annually (i.e., rolling average), borrowing power longitudinally in order to increase the signal-to-noise ratio relative to simple annual calculations. This supporting analysis provides one-year and three-year computations to show what is gained in exchange for the loss of 'currentness' resulting from the three-year approach.

Analysis considered observed-to-expected (O/E) ratios as well as the proposed predicted-to-expected (P/E) ratios. Results of both approaches are documented below. The O/E rate for three years is a weighted average of three one-year rates, with weights of 0.5 for the most recent year, 0.3 for the prior year and 0.2 for the first year. The P/E rate for three years is computed using the results of the HGLM model estimated for three years. Other weighting approaches will be investigated during the provisional period.

2. Component item/measure analysis to justify inclusion in composite (Measure evaluation criterion 2i)

   Table 1 displays coefficients of correlation among the three component measures, for each of the method and time period combinations. All are significant at $p<0.0001$. There is substantial consistency among the method and period combinations, with the three-year and P/E variations having slightly larger values.

**Table 1: Pneumonia 30-Day Care Transition Composite – Correlation Among Component Measures**

| | Pearson Coefficient | | Spearman Coefficient | |
|---|---|---|---|---|
| **Measure, Method and Period** | **Readmission** | **ED Visit** | **Readmission** | **ED Visit** |
| **One-Year Using O/E** | | | | |
| • ED Visit | -0.056 | . | -0.052 | . |
| • E & M Service | 0.156 | 0.186 | 0.134 | 0.176 |
| **One-Year Using P/E** | | | | |
| • ED Visit | -0.035 | . | -0.036 | . |
| • E & M Service | 0.142 | 0.203 | 0.137 | 0.198 |
| **Three-Years Using O/E** | | | | |
| • ED Visit | -0.074 | . | -0.066 | . |
| • E & M Service | 0.160 | 0.172 | 0.132 | 0.176 |
| **Three-Years Using P/E** | | | | |
| • ED Visit | -0.045 | . | -0.043 | . |
| • E & M Service | 0.165 | 0.209 | 0.160 | 0.225 |

Note: For clarity of presentation, the directions of the measures were aligned before computing the correlation coefficients.

We present correlation coefficients because reviewers and users may find them of interest. They were not the basis for our decision to include these measures in the composite. Rather, as articulated in our submissions for NQF endorsement of these measures, we believe that each is an intrinsically valid indicator of the outcome of care coordination and hence belongs in the care transition composite measure.

Interpretation of the negative correlation between the readmission and ambulatory ED visit measures is warranted. In many cases the independent components of a composite are intended to measure imperfectly the same underlying construct, these are called reflective measures. In such cases, the correlations between components will be positive. In other cases, some components of a composite will note events which somewhat substitute for each other or are uncorrelated with each other, and it is reasonable to add the measures together to make what is called a formative measure even though some of the underlying constructs are negatively correlated. This is the situation for our readmissions and ambulatory ED visit components. Both measure a lack of care coordination, but since the same patient can not be readmitted and have an ambulatory ED visit during the same trip to the hospital, the correlation between them can be negative.

Checking further, we find that the Pearson correlation coefficient between the E&M service within 30 days rate and the sum of the readmission and ambulatory ED visit components is approximately 0.240 to 0.270, depending on composite formulation. This correlation is higher than between any two individual components and provides justification for combining the three components. The Cronbach alphas for the three components (standardized) are in the range of 0.220 to 0.272, again reflecting agreement among them.

3. Component item/measure analysis of contribution to variability in composite score (Measure evaluation criterion 2j)

   Each of the three component measures is substantially correlated with the composite. These coefficients are in Table 2. There is little variation by method or time period.

**Table 2: Pneumonia 30-Day Care Transition Composite – Correlation With Component Measures**

| Period and Method | Readmission | ED Visit | E&M Service |
|---|---|---|---|
| One Year – Using O/E | | | |
| • Pearson | -0.896 | -0.315 | 0.457 |
| • Spearman | -0.881 | -0.297 | 0.423 |
| One Year – Using P/E | | | |
| • Pearson | -0.670 | -0.453 | 0.745 |
| • Spearman | -0.651 | -0.428 | 0.718 |
| Three Years – Using O/E | | | |
| • Pearson | -0.881 | -0.308 | -0.491 |
| • Spearman | -0.865 | -0.300 | 0.450 |
| Three Years – Using P/E | | | |
| • Pearson | -0.613 | -0.457 | 0.806 |
| • Spearman | -0.602 | -0.457 | 0.776 |

4. Identification of Meaningful Differences in Performance (Measure evaluation criterion 2f)

   Table 3 summarizes the distribution of the composite scores using each of the methods and time periods for the 2,571 hospitals having 10 or more index admissions in 2006 Table 4 breaks these rates down by hospital pneumonia volume (quartile of index admissions in 2006). These data are illustrated by histograms in Appendix A.

**Table 3: Pneumonia 30-Day Care Transition Composite -- Distribution Among Hospitals, by Estimation Period**

| | P5 | P25 | Median | P75 | P95 |
|---|---|---|---|---|---|
| **One-Year Composite Scores** | | | | | |
| • **Using O/E** | -.725 | -.236 | 0.038 | 0.280 | 0.585 |
| • **Using P/E** | -.106 | -.036 | 0.005 | 0.041 | 0.087 |
| **Three-Year** | | | | | |
| • **Using O/E** | -.447 | -.150 | 0.019 | 0.180 | 0.395 |
| • **Using P/E** | -.112 | -.036 | 0.010 | 0.049 | 0.106 |

**Table 4: Pneumonia 30-Day Care Transition Composite -- Distribution Among Hospitals, By Volume Quartile**

| | | P5 | P25 | Median | P75 | P95 |
|---|---|---|---|---|---|---|
| **Composite Score - O/E** | **Vol. Quartile** | | | | | |
| | **Q1: 10 - 13** | -.982 | -.330 | 0.035 | 0.370 | 0.751 |
| | **Q2: 14 - 19** | -.740 | -.260 | 0.025 | 0.295 | 0.636 |
| | **Q3: 20 - 29** | -.629 | -.240 | 0.021 | 0.252 | 0.524 |
| | **Q4: 30 - 160** | -.437 | -.132 | 0.063 | 0.232 | 0.432 |
| **Composite Score - P/E** | **Vol. Quartile** | | | | | |
| | **Q1: 10 - 13** | -.094 | -.038 | -.002 | 0.031 | 0.062 |
| | **Q2: 14 - 19** | -.106 | -.035 | -.003 | 0.032 | 0.078 |
| | **Q3: 20 - 29** | -.114 | -.039 | 0.005 | 0.041 | 0.089 |
| | **Q4: 30 - 160** | -.108 | -.030 | 0.019 | 0.059 | 0.106 |
| **Composite Score - O/E 3-yr Wtd.** | **Vol. Quartile** | | | | | |
| | **Q1: 10 - 13** | -.598 | -.238 | -.005 | 0.218 | 0.512 |
| | **Q2: 14 - 19** | -.485 | -.176 | 0.003 | 0.191 | 0.416 |
| | **Q3: 20 - 29** | -.390 | -.134 | 0.012 | 0.169 | 0.354 |
| | **Q4: 30 - 160** | -.277 | -.080 | 0.045 | 0.155 | 0.322 |
| **Composite Score - P/E 3-yr** | **Vol. Quartile** | | | | | |
| | **Q1: 10 - 13** | -.127 | -.046 | -.000 | 0.032 | 0.076 |
| | **Q2: 14 - 19** | -.119 | -.043 | 0.002 | 0.039 | 0.090 |
| | **Q3: 20 - 29** | -.108 | -.035 | 0.016 | 0.054 | 0.109 |
| | **Q4: 30 - 160** | -.094 | -.024 | 0.024 | 0.070 | 0.128 |

5. Reliability Testing (Measure evaluation criterion 2b)

Reliability was assessed by correlating the one-year scores for 2007 with both the one-year scores for 2006 and the three-year scores for 2006. In each case, both Pearson and Spearman correlations were calculated, the latter being less susceptible to outliers. As an additional assessment, scores were grouped in quintiles and weighted kappa statistics were computed. These results are all in Table 9, with each value being statistically significant ($p<.001$). Correlation statistics between the three-year average ending in 2007 and the three-year average ending in 2006 are not calculated because the two scores share two years of data in common.

**Table 5: Pneumonia 30-Day Care Transition Composite -- Reliability When Comparing Across Years**

| Statistic | One Year (2006) | | Three Years (2004-6) | |
|---|---|---|---|---|
| | Obs./Exp. Ratio | Pred./Exp. Ratio | Obs./Exp. Ratio | Pred./Exp. Ratio |
| **Correlation Coefficients** | | | | |
| • **Pearson** | 0.087 | 0.216 | .0129 | .0258 |
| • **Spearman** | 0.090 | 0.165 | 0.123 | 0.225 |
| **Kappa Statistic** | | | | |
| • **Weighted Kappa** | 0.066 | 0.095 | 0.094 | 0.138 |
| • **95% CI – Lower** | 0.039 | 0.068 | 0.066 | 0.111 |
| • **95% CI -- Upper** | 0.094 | 0.122 | 0.121 | 0.165 |

# Appendix A

**Figure 1: Distribution of Hospital 30-Day Pneumonia Discharge Care Transition Composite Rates (O/E Method -- One Year – 2006)**

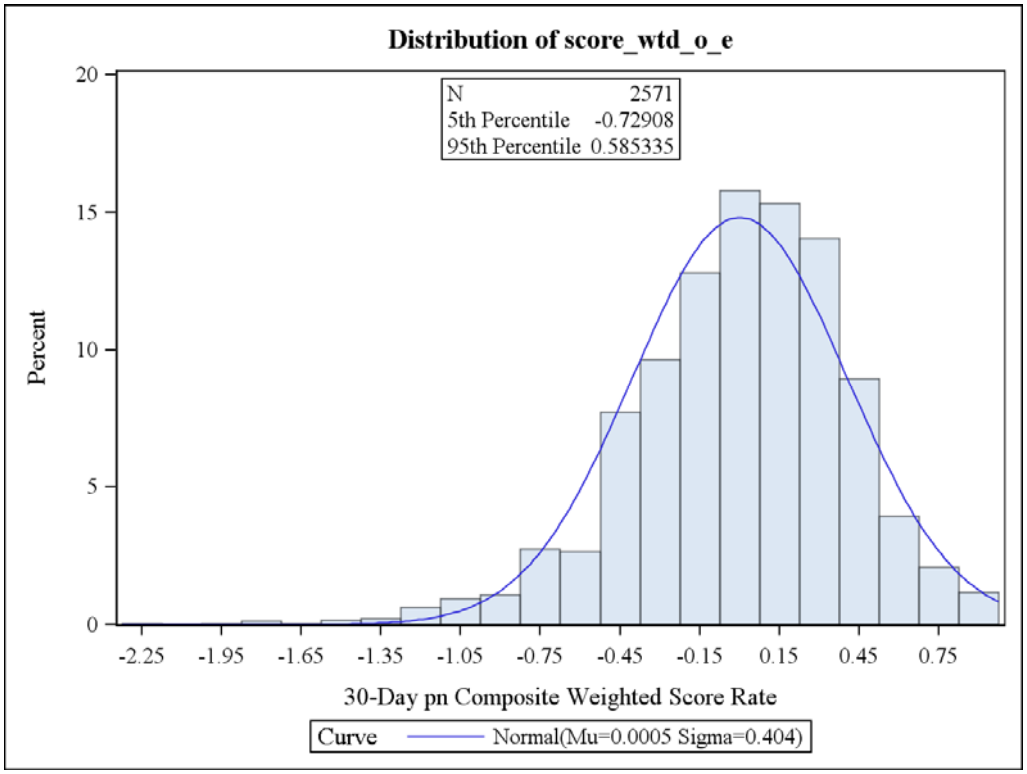



**Figure 2: Distribution of Hospital 30-Day Pneumonia Discharge Care Transition Composite Rates (O/E Method -- One Year – 2006), By Volume Quartile**

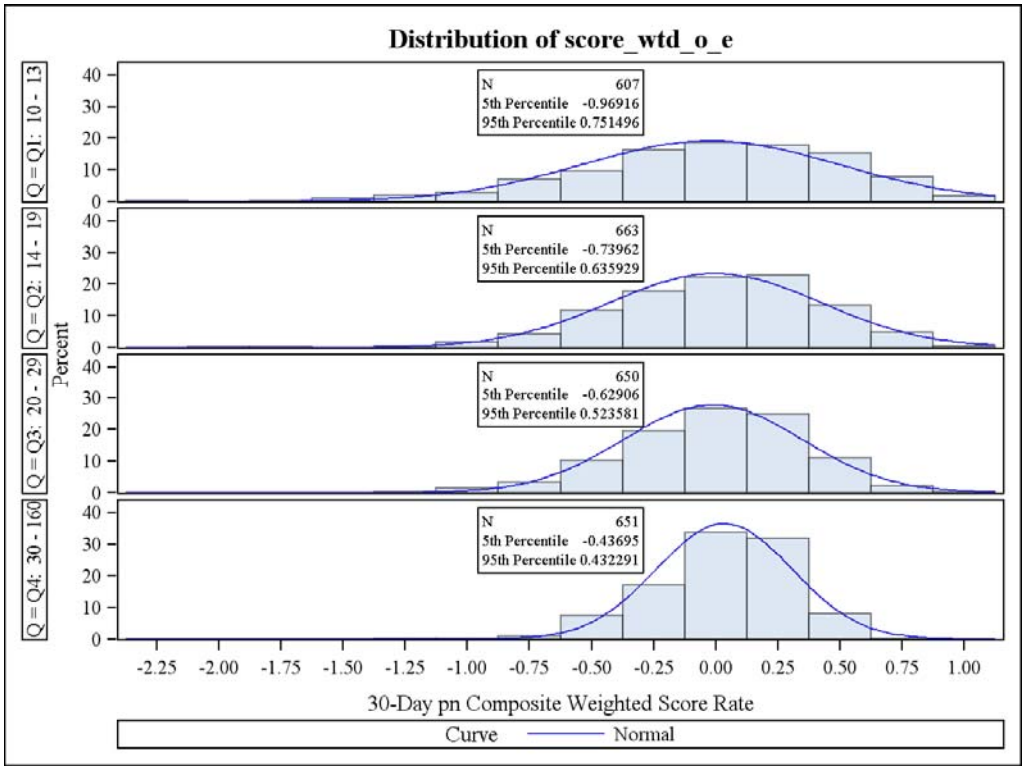


**Figure 3: Distribution of Hospital 30-Day Pneumonia Discharge Care Transition Composite Rates (P/E Method -- One Year – 2006)**

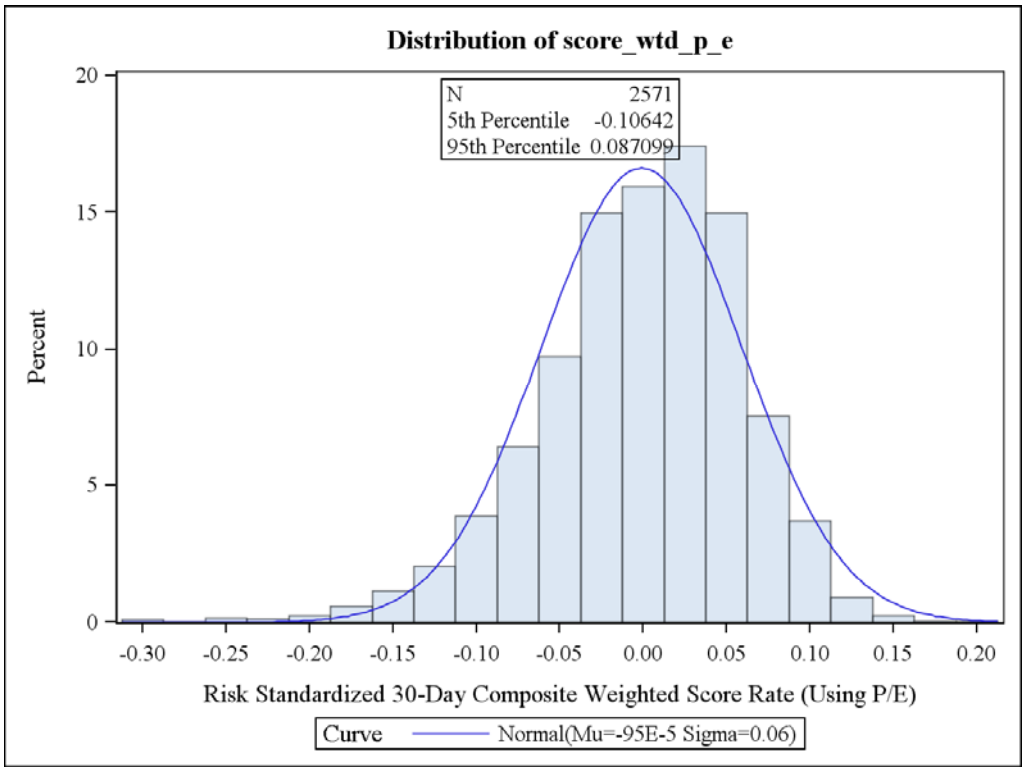



**Figure 4: Distribution of Hospital 30-Day Pneumonia Discharge Care Transition Composite Rates (O/E Method -- One Year – 2006), By Volume Quartile**

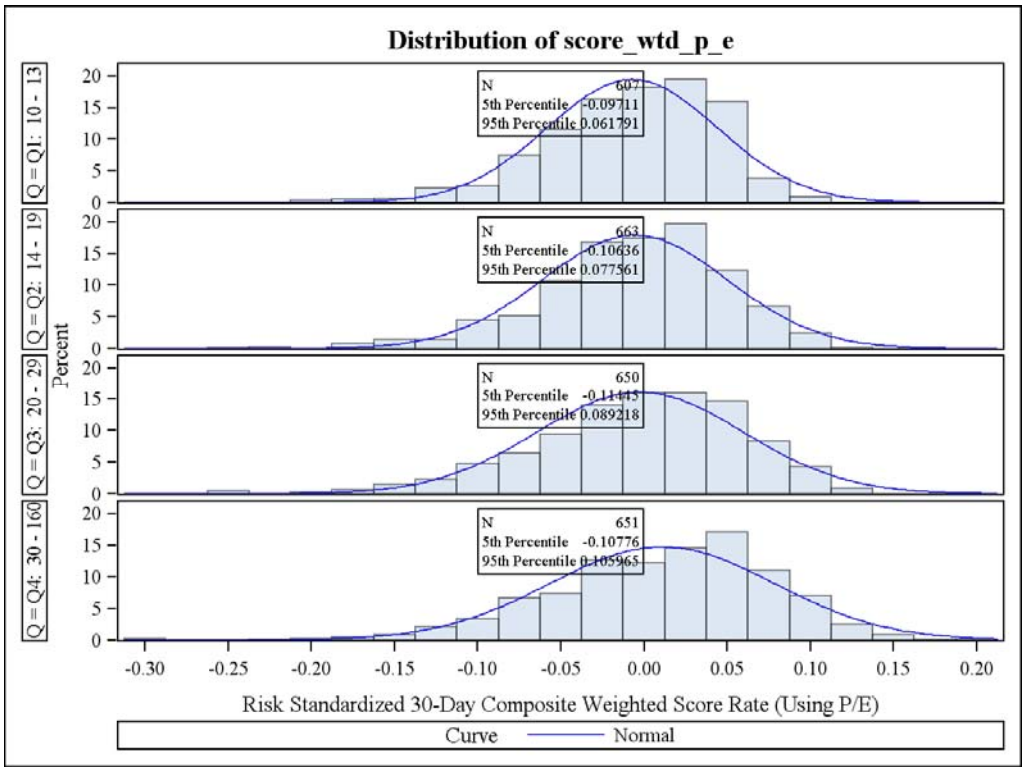


**Figure 5: Distribution of Hospital 30-Day Pneumonia Discharge Care Transition Composite Rates (O/E Method -- Three Years – 2004-6)**

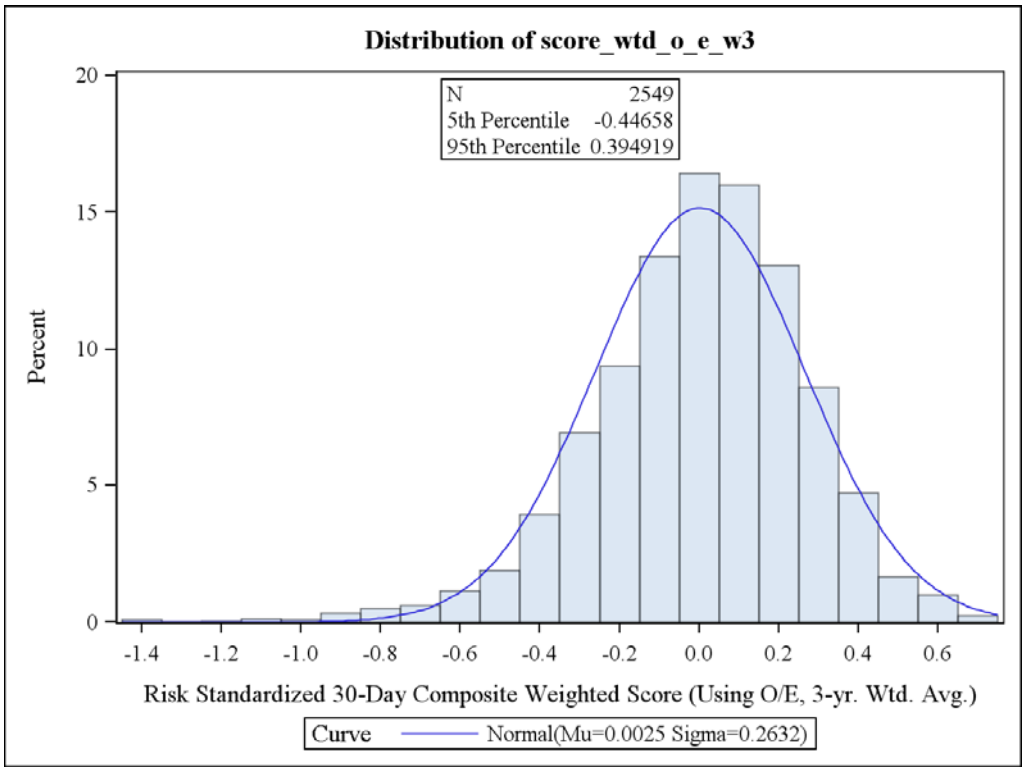



**Figure 6: Distribution of Hospital 30-Day Pneumonia Discharge Care Transition Composite Rates (O/E Method -- Three Years – 2004-6), By Volume Quartile**

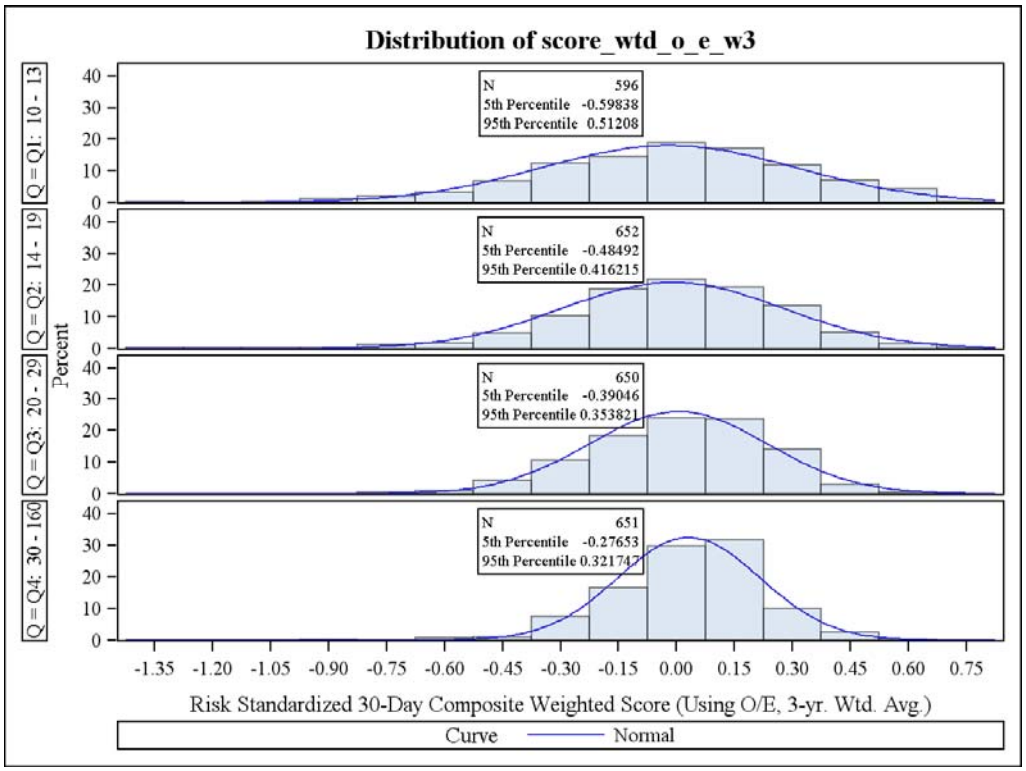


Figure 7: **Distribution of Hospital 30-Day Pneumonia Discharge Care Transition Composite Rates (P/E Method -- Three Years – 2004-6)**

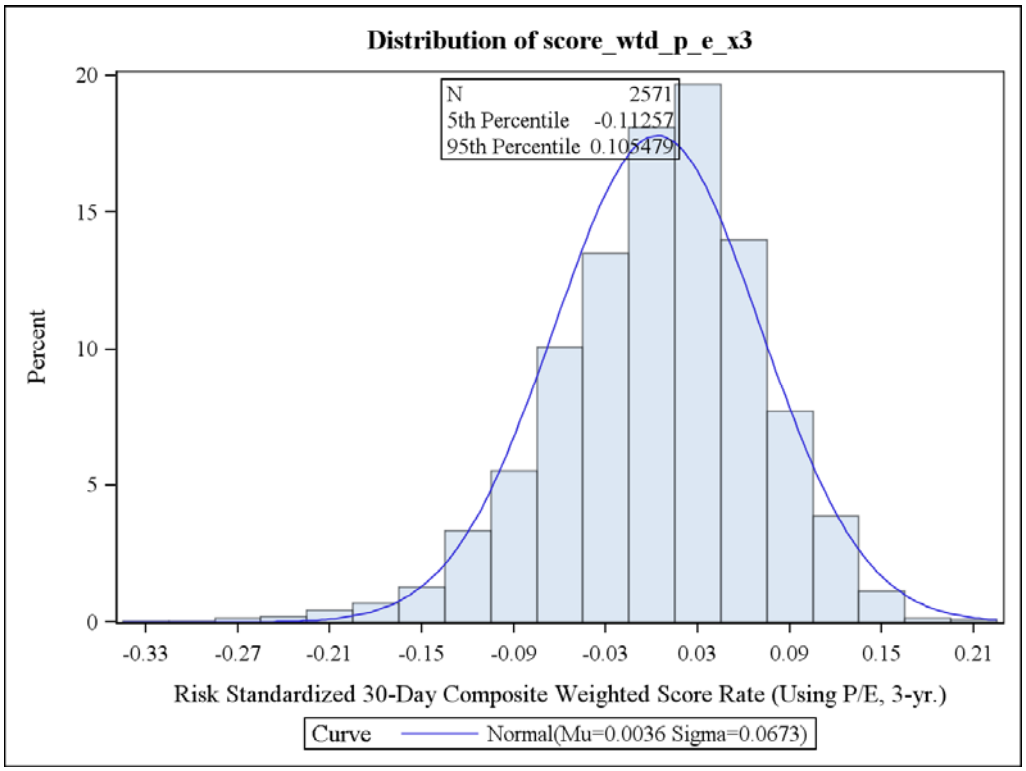
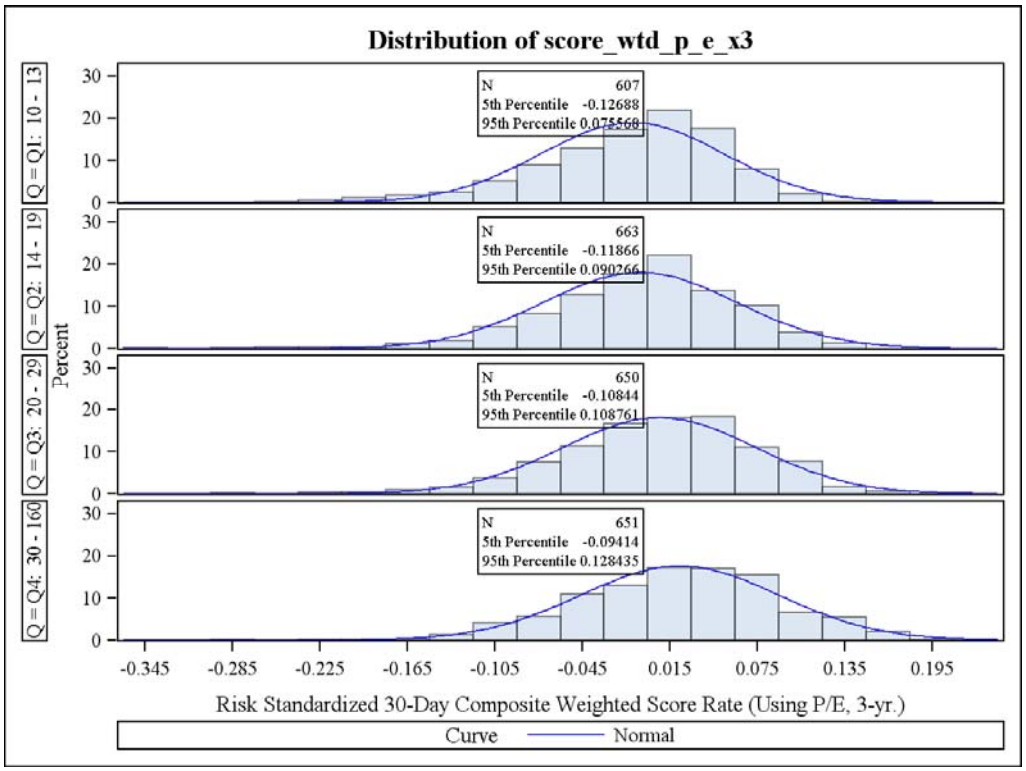



**Figure 8: Distribution of Hospital 30-Day Pneumonia Discharge Care Transition Composite Rates (P/E Method -- Three Years – 2004-6), By Volume Quartile**



**Appendix B**

# 30-Day Post-Hospital Pneumonia Discharge Readmission Measure Scores Used for Composite Measure Assessment

## 1. Introduction

This appendix describes and assesses the 30-day post-hospital pneumonia readmission rates used for the analyses of the proposed 30-Day Post-Hospital Pneumonia Discharge Care Transition Composite Measure.

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### 1.1. Data Sample

All data used for the analyses described in this document are from the Dartmouth Atlas 20% sample of Medicare Carrier Claim files for 2003-2007. Data from 2003 are used only for pre-admission information about patients admitted during 2004, and are not included directly in any of the analysis presented. December 2007 is used only for information about the 30-day post-discharge period; there are no December 2007 index admissions in the results presented here. These data were processed in accordance with the measure definitions described in the submission. All resulting index admissions were used in the model for testing and estimation and are reflected in the results presented in section 2 on Risk Adjustment. Scores and their analysis discussed in sections 3 and 4 were analyzed only for hospitals having 10 or more index admissions in 2006. Table 1 summarizes the number of resulting hospitals and index admissions with a primary diagnosis of pneumonia, and the rate of a 30-day post-discharge readmission following these admissions.

### 1.2. Summary of Sample by Year

The proposed composite measure uses three years of data, updated annually (i.e., rolling average) in order to increase the signal-to-noise ratio relative to simple annual calculations. This supporting analysis provides one-year and three-year computations to show what is gained in exchange for the loss of ‘currentness’ resulting from the three-year approach.

**Table 6: Count of Pneumonia Index Admissions and 30-Day Readmission Rate, By Year**

| | All Hospitals | | | Hospitals With 10+ Index Admissions in 2006 | | |
|---|---|---|---|---|---|---|
| | Number of Index Admissions | 30-Day Readmission Rate | Number of Hospitals | Number of Index Admissions | 30-Day Readmission Rate | Number of Hospitals |
| **Year** | | | | | | |
| **2004** | 80,585 | 0.156 | 4,731 | 65,443 | 0.156 | 2,484 |
| **2005** | 88,446 | 0.155 | 4,710 | 72,956 | 0.155 | 2,549 |
| **2006** | 70,935 | 0.154 | 4,511 | 61,453 | 0.156 | 2,571 |
| **2007** | 57,740 | 0.151 | 4,472 | 48,591 | 0.152 | 2,559 |

Analysis to-date has considered observed-to-expected (O/E) ratios as well as the proposed predicted-to-expected (P/E) ratios. Results of both approaches are documented below. The O/E rate for three years is a weighted average of three one year rates, with weights of 0.5 for the most recent year, 0.3 for the prior year and 0.2 for the first year. The P/E rate for three years is computed using the results of the HGLM model estimated for three years. Other approaches will be investigated during the provisional period.

2. Risk Adjustment

2.1. Method

The risk adjustment strategy is one of indirect adjustment, with predicted and expected 30-day post-discharge readmission rates calculated for each hospital using a hierarchical logistic regression model. The statistical model is that of the Hospital 30-Day Pneumonia Readmission Measure Methodology prepared for CMS by the Yale University/Yale-New Haven Hospital Center for Outcomes Research and Evaluation (YNHH-CORE, 2008), with the level 1 demographic and condition covariates from that methodology and each hospital in our data as a level 2 unit. We are using the fixed covariates selected by YNHH-CORE for readmission following a pneumonia stay.

2.2. Analysis

YNHH-CORE tested and validated their selected covariates using a generalized linear model (GLM) with a logistic link function. We assessed the application of that model to our data for 2004-6. Results are summarized in Table 2.

**Table 7: Pneumonia 30-Day Readmission Rate -- GLM Model (covariates only) Performance (2004-6)**

| Statistic | | Value |
|---|---|---|
| Actual Rate | | 0.155 |
| Max. Re-scaled $R^2$ | | 0.041 |
| Predictive Ability (Lowest Decile, Highest Decile) [1] | | 0.073 - 0.269 |
| c-statistic | | 0.623 |
| Residuals Lack of Fit (Pearson Residual Fall %) | <-2<br>[-2, 0)<br>[0, 2)<br>[2+ | -<br>84.5<br>4.6<br>10.9 |
| Model Wald chi-squared (number of covariates) | | 5,777 (40) |

Table 3 lists the covariates with their incidence among the pneumonia index admissions for 2004-6 and results of the GLM logistic estimates using those admissions.

2.2.1. The composite measure is specified to be computed annually, using the most recent three years of data. Analysis was done with both one year of data, and three. Table 4 gives parameter estimates for the fixed covariates in the HGLM model using data for one year, 2006, and table 5 for three years, 2004-6.

## Table 8: Pneumonia 30-Day Readmission Rate -- GLM (2004-6) – Fixed Covariates and Statistics

| Effect | Mean, Std. Dev., or Proportion | Estimate | Standard Error | Std. Est. | Odds Ratio Estimate | OR 95% CI |
|---|---|---|---|---|---|---|
| Intercept | . | -2.550 | 0.020 | _ | . | |
| Age-65 (years above 65, continuous) | 15.4219 | 0.002 | 0.001 | 0.0087 | 1.002 | 1.000 - 1.004 |
| Age - Std. Dev. | 7.9334 | . | . | . | . | |
| Sex (Male) | 0.4407 | 0.032 | 0.006 | _ | 1.067 | 1.041 - 1.093 |
| History of CABG | 0.0574 | -0.056 | 0.024 | -0.0073 | 0.946 | 0.901 - 0.992 |
| CC 1, 3-6 History of infection | 0.0033 | -0.060 | 0.097 | -0.0019 | 0.942 | 0.778 - 1.140 |
| CC 2 Septicemia/shock | 0.0684 | 0.069 | 0.021 | 0.0097 | 1.072 | 1.028 - 1.117 |
| CC 7 Metastatic cancer and acute leukemia | 0.0352 | 0.263 | 0.031 | 0.0270 | 1.301 | 1.225 - 1.382 |
| CC 8 Lung, upper digestive tract, and other severe cancers | 0.0555 | 0.282 | 0.025 | 0.0358 | 1.326 | 1.263 - 1.391 |
| CC 9, 10 Lymphatic, head and neck, brain, and other major cancers; breast, prostate, colorectal and other cancers and tumors | 0.1377 | 0.019 | 0.017 | 0.0036 | 1.019 | 0.986 - 1.053 |
| CC 15-20, 119, 120 Diabetes and DM complications | 0.3473 | 0.051 | 0.012 | 0.0133 | 1.052 | 1.027 - 1.078 |
| CC 21 Protein-calorie malnutrition | 0.0645 | 0.115 | 0.022 | 0.0156 | 1.121 | 1.075 - 1.170 |
| CC 22, 23 Disorders of fluid/electrolyte/acid-base | 0.4861 | 0.078 | 0.012 | 0.0215 | 1.081 | 1.056 - 1.107 |
| CC 36 Other gastrointestinal disorders | 0.5448 | 0.083 | 0.012 | 0.0228 | 1.087 | 1.061 - 1.113 |
| CC 44 Severe hematological disorders | 0.0294 | 0.162 | 0.030 | 0.0153 | 1.176 | 1.108 - 1.248 |
| CC 47 Iron deficiency and other/unspecified anemias and blood disease | 0.3986 | 0.105 | 0.012 | 0.0283 | 1.110 | 1.083 - 1.138 |
| CC 49, 50 Dementia and senility | 0.2643 | 0.078 | 0.014 | 0.0191 | 1.081 | 1.051 - 1.111 |
| CC 51-53 Drug/alcohol abuse/dependence/psychosis | 0.1105 | 0.078 | 0.018 | 0.0135 | 1.081 | 1.042 - 1.120 |
| CC 54-56 Major pysch disorders | 0.1118 | 0.046 | 0.018 | 0.0081 | 1.047 | 1.011 - 1.084 |
| CC 60 Other psychiatric disorders | 0.1264 | 0.100 | 0.017 | 0.0187 | 1.105 | 1.070 - 1.142 |
| CC 67-69, 100-102, 177, 178 Hemiplegia, paraplegia, paralysis, functional disability | 0.0515 | 0.089 | 0.024 | 0.0111 | 1.093 | 1.043 - 1.146 |
| CC 79 Cardio-respiratory failure and shock | 0.2338 | 0.065 | 0.014 | 0.0151 | 1.068 | 1.039 - 1.097 |
| CC 80 Congestive heart failure | 0.4780 | 0.222 | 0.013 | 0.0613 | 1.249 | 1.217 - 1.282 |
| CC 81, 82 Acute coronary syndrome | 0.0884 | 0.050 | 0.019 | 0.0079 | 1.051 | 1.012 - 1.091 |
| CC 83, 84 Chronic atherosclerosis | 0.4564 | 0.054 | 0.013 | 0.0148 | 1.055 | 1.029 - 1.082 |
| CC 86 Valvular and rheumatic heart disease | 0.2303 | 0.031 | 0.014 | 0.0074 | 1.032 | 1.004 - 1.060 |
| CC 92, 93 Arrhythmias | 0.4281 | 0.111 | 0.012 | 0.0303 | 1.117 | 1.090 - 1.145 |
| CC 95, 96 Stroke | 0.1069 | 0.075 | 0.018 | 0.0132 | 1.078 | 1.041 - 1.117 |
| CC 104-106 Vascular or circulatory disease | 0.4294 | 0.084 | 0.012 | 0.0231 | 1.088 | 1.062 - 1.115 |
| CC 108 COPD | 0.5651 | 0.188 | 0.013 | 0.0512 | 1.206 | 1.176 - 1.237 |
| CC 109 Fibrosis of lung and other chronic lung disorders | 0.1619 | 0.097 | 0.015 | 0.0201 | 1.102 | 1.069 - 1.135 |
| CC 110 Asthma | 0.1248 | -0.004 | 0.017 | -0.0008 | 0.996 | 0.963 - 1.030 |
| CC 111-113 History of pneumonia | 0.3769 | 0.027 | 0.013 | 0.0072 | 1.027 | 1.001 - 1.053 |
| CC 114 Pleural effusion/pneumothorax | 0.1455 | 0.126 | 0.016 | 0.0248 | 1.134 | 1.100 - 1.169 |
| CC 115 Other lung disorder | 0.4401 | 0.017 | 0.012 | 0.0046 | 1.017 | 0.992 - 1.042 |
| CC 129, 130 End-stage renal disease or dialysis | 0.0147 | 0.210 | 0.041 | 0.0140 | 1.234 | 1.138 - 1.337 |
| CC 131 Renal failure | 0.1855 | 0.184 | 0.016 | 0.0386 | 1.202 | 1.166 - 1.239 |
| CC 135 Urinary tract infection | 0.2727 | 0.090 | 0.014 | 0.0222 | 1.094 | 1.065 - 1.123 |
| CC 136 Other urinary tract disorders | 0.2313 | 0.073 | 0.014 | 0.0174 | 1.076 | 1.047 - 1.106 |
| CC 148, 149 Decubitus ulcer or chronic skin ulcer | 0.0994 | 0.123 | 0.018 | 0.0207 | 1.131 | 1.092 - 1.172 |
| CC 157 Vertebral fractures | 0.0443 | 0.134 | 0.025 | 0.0155 | 1.143 | 1.088 - 1.202 |
| CC 162 Other injuries | 0.3087 | 0.043 | 0.012 | 0.0112 | 1.044 | 1.019 - 1.070 |

## Table 9: Pneumonia 30-Day Readmission Rate -- HGLM Parameter Estimates, 2006

| Effect | Estimate | Standard Error | t Value | Pr > \|t\| |
|---|---|---|---|---|
| Intercept | -2.573 | 0.039 | -66.66 | <.0001 |
| Sex (Male) | 0.046 | 0.023 | 2.02 | 0.0431 |
| Age-65 (years above 65, continuous) | 0.001 | 0.001 | 0.50 | 0.6159 |
| History of CABG | -0.168 | 0.049 | -3.40 | 0.0007 |
| CC 1, 3-6 History of infection | -0.274 | 0.194 | -1.41 | 0.1584 |
| CC 2 Septicemia/shock | 0.105 | 0.039 | 2.67 | 0.0076 |
| CC 7 Metastatic cancer and acute leukemia | 0.339 | 0.056 | 6.04 | <.0001 |
| CC 8 Lung, upper digestive tract, and other severe cancers | 0.302 | 0.044 | 6.82 | <.0001 |
| CC 9, 10 Lymphatic, head and neck, brain, and other major cancers; breast, prostate, colorectal and other cancers and tumors | -0.001 | 0.031 | -0.02 | 0.9819 |
| CC 15-20, 119, 120 Diabetes and DM complications | 0.056 | 0.023 | 2.46 | 0.0140 |
| CC 21 Protein-calorie malnutrition | 0.113 | 0.040 | 2.83 | 0.0047 |
| CC 22, 23 Disorders of fluid/electrolyte/acid-base | 0.075 | 0.022 | 3.36 | 0.0008 |
| CC 36 Other gastrointestinal disorders | 0.051 | 0.022 | 2.31 | 0.0207 |
| CC 44 Severe hematological disorders | 0.162 | 0.057 | 2.86 | 0.0043 |
| CC 47 Iron deficiency and other/unspecified anemias and blood disease | 0.113 | 0.023 | 4.95 | <.0001 |
| CC 49, 50 Dementia and senility | 0.074 | 0.026 | 2.91 | 0.0037 |
| CC 51-53 Drug/alcohol abuse/dependence/psychosis | 0.074 | 0.034 | 2.22 | 0.0267 |
| CC 54-56 Major pysch disorders | 0.038 | 0.033 | 1.16 | 0.2478 |
| CC 60 Other psychiatric disorders | 0.094 | 0.031 | 3.07 | 0.0022 |
| CC 67-69, 100-102, 177, 178 Hemiplegia, paraplegia, paralysis, functional disability | 0.071 | 0.046 | 1.55 | 0.1220 |
| CC 79 Cardio-respiratory failure and shock | 0.012 | 0.025 | 0.47 | 0.6381 |
| CC 80 Congestive heart failure | 0.199 | 0.024 | 8.29 | <.0001 |
| CC 81, 82 Acute coronary syndrome | 0.086 | 0.036 | 2.40 | 0.0162 |
| CC 83, 84 Chronic atherosclerosis | 0.044 | 0.024 | 1.87 | 0.0611 |
| CC 86 Valvular and rheumatic heart disease | 0.068 | 0.025 | 2.72 | 0.0065 |
| CC 92, 93 Arrhythmias | 0.126 | 0.023 | 5.54 | <.0001 |
| CC 95, 96 Stroke | 0.115 | 0.033 | 3.45 | 0.0006 |
| CC 104-106 Vascular or circulatory disease | 0.125 | 0.022 | 5.56 | <.0001 |
| CC 108 COPD | 0.224 | 0.023 | 9.55 | <.0001 |
| CC 109 Fibrosis of lung and other chronic lung disorders | 0.109 | 0.028 | 3.86 | 0.0001 |
| CC 110 Asthma | -0.002 | 0.032 | -0.07 | 0.9481 |
| CC 111-113 History of pneumonia | 0.036 | 0.024 | 1.54 | 0.1231 |
| CC 114 Pleural effusion/pneumothorax | 0.118 | 0.029 | 4.07 | <.0001 |
| CC 115 Other lung disorder | 0.001 | 0.023 | 0.03 | 0.9775 |
| CC 129, 130 End-stage renal disease or dialysis | 0.278 | 0.074 | 3.78 | 0.0002 |
| CC 131 Renal failure | 0.203 | 0.027 | 7.51 | <.0001 |
| CC 135 Urinary tract infection | 0.124 | 0.025 | 4.96 | <.0001 |
| CC 136 Other urinary tract disorders | 0.035 | 0.026 | 1.35 | 0.1778 |
| CC 148, 149 Decubitus ulcer or chronic skin ulcer | 0.129 | 0.033 | 3.90 | <.0001 |
| CC 157 Vertebral fractures | 0.136 | 0.046 | 2.95 | 0.0032 |
| CC 162 Other injuries | 0.068 | 0.023 | 2.99 | 0.0028 |

## Table 10: Pneumonia 30-Day Readmission Rate -- HGLM Parameter Estimates, 2004 - 2006

| Effect | Estimate | Standard Error | t Value | Pr > \|t\| |
|---|---|---|---|---|
| Intercept | -2.582 | 0.021 | -121.91 | <.0001 |
| Sex (Male) | 0.066 | 0.012 | 5.39 | <.0001 |
| Age-65 (years above 65, continuous) | 0.002 | 0.001 | 2.54 | 0.0111 |
| History of CABG | -0.055 | 0.024 | -2.27 | 0.0234 |
| CC 1, 3-6 History of infection | -0.062 | 0.097 | -0.64 | 0.5195 |
| CC 2 Septicemia/shock | 0.066 | 0.021 | 3.14 | 0.0017 |
| CC 7 Metastatic cancer and acute leukemia | 0.264 | 0.031 | 8.64 | <.0001 |
| CC 8 Lung, upper digestive tract, and other severe cancers | 0.282 | 0.024 | 11.57 | <.0001 |
| CC 9, 10 Lymphatic, head and neck, brain, and other major cancers; breast, prostate, colorectal and other cancers and tumors | 0.019 | 0.017 | 1.12 | 0.2639 |
| CC 15-20, 119, 120 Diabetes and DM complications | 0.050 | 0.012 | 4.09 | <.0001 |
| CC 21 Protein-calorie malnutrition | 0.117 | 0.022 | 5.41 | <.0001 |
| CC 22, 23 Disorders of fluid/electrolyte/acid-base | 0.078 | 0.012 | 6.43 | <.0001 |
| CC 36 Other gastrointestinal disorders | 0.084 | 0.012 | 6.93 | <.0001 |
| CC 44 Severe hematological disorders | 0.163 | 0.030 | 5.42 | <.0001 |
| CC 47 Iron deficiency and other/unspecified anemias and blood disease | 0.105 | 0.012 | 8.44 | <.0001 |
| CC 49, 50 Dementia and senility | 0.076 | 0.014 | 5.40 | <.0001 |
| CC 51-53 Drug/alcohol abuse/dependence/psychosis | 0.078 | 0.018 | 4.25 | <.0001 |
| CC 54-56 Major pysch disorders | 0.044 | 0.018 | 2.48 | 0.0132 |
| CC 60 Other psychiatric disorders | 0.099 | 0.017 | 5.98 | <.0001 |
| CC 67-69, 100-102, 177, 178 Hemiplegia, paraplegia, paralysis, functional disability | 0.087 | 0.024 | 3.62 | 0.0003 |
| CC 79 Cardio-respiratory failure and shock | 0.068 | 0.014 | 4.84 | <.0001 |
| CC 80 Congestive heart failure | 0.222 | 0.013 | 16.87 | <.0001 |
| CC 81, 82 Acute coronary syndrome | 0.048 | 0.019 | 2.51 | 0.0119 |
| CC 83, 84 Chronic atherosclerosis | 0.051 | 0.013 | 3.97 | <.0001 |
| CC 86 Valvular and rheumatic heart disease | 0.034 | 0.014 | 2.44 | 0.0145 |
| CC 92, 93 Arrhythmias | 0.111 | 0.012 | 8.93 | <.0001 |
| CC 95, 96 Stroke | 0.075 | 0.018 | 4.19 | <.0001 |
| CC 104-106 Vascular or circulatory disease | 0.083 | 0.012 | 6.77 | <.0001 |
| CC 108 COPD | 0.186 | 0.013 | 14.46 | <.0001 |
| CC 109 Fibrosis of lung and other chronic lung disorders | 0.098 | 0.015 | 6.48 | <.0001 |
| CC 110 Asthma | -0.004 | 0.017 | -0.21 | 0.8360 |
| CC 111-113 History of pneumonia | 0.026 | 0.013 | 2.02 | 0.0429 |
| CC 114 Pleural effusion/pneumothorax | 0.125 | 0.016 | 7.97 | <.0001 |
| CC 115 Other lung disorder | 0.017 | 0.012 | 1.40 | 0.1628 |
| CC 129, 130 End-stage renal disease or dialysis | 0.213 | 0.041 | 5.21 | <.0001 |
| CC 131 Renal failure | 0.185 | 0.016 | 11.89 | <.0001 |
| CC 135 Urinary tract infection | 0.088 | 0.013 | 6.57 | <.0001 |
| CC 136 Other urinary tract disorders | 0.073 | 0.014 | 5.34 | <.0001 |
| CC 148, 149 Decubitus ulcer or chronic skin ulcer | 0.123 | 0.018 | 6.83 | <.0001 |
| CC 157 Vertebral fractures | 0.137 | 0.025 | 5.41 | <.0001 |
| CC 162 Other injuries | 0.044 | 0.012 | 3.55 | 0.0004 |

3. Differences in Performance

The between-hospital variance and intra-class correlation coefficients from both the one- and three-year versions of the HGLM indicate the existence of significant, though small, differences among hospitals in the rate at which their pneumonia patients receive at least one readmission within the month following discharge. Table 6 summarizes these statistics for 2006. Results using data from other years were consistent.

**Table 11: Pneumonia 30-Day Readmission Rate -- Variation Among Hospitals**

| Statistic | One-Year (2006) | Three-Year (2004-6) |
|---|---|---|
| **Between-Hospital Variance (SE)** | 0.043 (0.003) | 0.025 (0.003) |
| **Residual Variance (SE)** | 0.972 (0.005) | 0.983 (0.003) |
| **Intra-Class Correlation** | 0.042 | 0.025 |

For purposes of analysis, risk standardized rates were computed using (a) observed-to-expected (O/E) rates and (b) predicted-to-expected (P/E) rates, each for one-year and three-year time periods. The O/E rate for three years is a weighted average of three one-year rates, with weights of 0.5 for the most recent year, 0.3 for the prior year and 0.2 for the first year. The P/E rate for three years is computed using the results of the HGLM model estimated for three years. Table 7 summarizes the distribution of the underlying actual, predicted and respective risk-standardized rates computed using each of the time periods. The distribution is of hospital-level rates, for the 2,571 hospitals having 10 or more index admissions in 2006 Table 8 breaks these rates down by hospital pneumonia volume (quartile of index admissions in 2006). These data are illustrated by histograms in Appendix B-1.

**Table 12: Pneumonia 30-Day Readmission Rate -- Distribution Among Hospitals of Actual and Risk-Standardized Rates, by Estimation Period**

| | Mean | P5 | P25 | Median | P75 | P95 |
|---|---|---|---|---|---|---|
| **One-Year** | | | | | | |
| • **Actual** | 0.154 | 0.000 | 0.091 | 0.147 | 0.205 | 0.308 |
| • **Risk-Standardized Rate (Using O/E)** | 0.154 | 0.000 | 0.095 | 0.146 | 0.205 | 0.310 |
| • **Predicted** | 0.154 | 0.126 | 0.141 | 0.153 | 0.166 | 0.188 |
| • **Risk-Standardized Rate (Using P/E)** | 0.154 | 0.142 | 0.148 | 0.153 | 0.160 | 0.170 |
| **Three-Year** | | | | | | |
| • **Actual** | 0.155 | 0.067 | 0.115 | 0.152 | 0.189 | 0.252 |
| • **Risk-Standardized Rate (Using O/E)** | 0.153 | 0.067 | 0.114 | 0.151 | 0.188 | 0.247 |
| • **Predicted** | 0.155 | 0.130 | 0.143 | 0.154 | 0.164 | 0.183 |
| • **Risk-Standardized Rate (Using P/E)** | 0.154 | 0.141 | 0.148 | 0.153 | 0.159 | 0.169 |

**Table 13: Pneumonia 30-Day Readmission Rate -- Distribution of Hospital-Level Actual and Risk-Standardized Rates, By Volume Quartile**

| | | Mean | P5 | P25 | Median | P75 | P95 |
|---|---|---|---|---|---|---|---|
| **Readmit - Actual** | **Vol. Quartile** | | | | | | |
| | **Q1: 10 - 13** | 0.146 | 0.000 | 0.000 | 0.143 | 0.222 | 0.375 |
| | **Q2: 14 - 19** | 0.141 | 0.000 | 0.071 | 0.133 | 0.200 | 0.333 |
| | **Q3: 20 - 29** | 0.156 | 0.000 | 0.083 | 0.145 | 0.214 | 0.333 |
| | **Q4: 30 - 160** | 0.154 | 0.043 | 0.105 | 0.149 | 0.200 | 0.276 |
| **Readmit - Risk Standardized Rate(Obs.)** | **Vol. Quartile** | | | | | | |
| | **Q1: 10 - 13** | 0.152 | 0.000 | 0.000 | 0.140 | 0.232 | 0.393 |
| | **Q2: 14 - 19** | 0.145 | 0.000 | 0.072 | 0.138 | 0.208 | 0.338 |
| | **Q3: 20 - 29** | 0.157 | 0.000 | 0.086 | 0.148 | 0.214 | 0.322 |
| | **Q4: 30 - 160** | 0.154 | 0.046 | 0.107 | 0.149 | 0.199 | 0.276 |
| **Readmit - Pred.** | **Vol. Quartile** | | | | | | |
| | **Q1: 10 - 13** | 0.148 | 0.116 | 0.133 | 0.145 | 0.161 | 0.188 |
| | **Q2: 14 - 19** | 0.150 | 0.121 | 0.138 | 0.149 | 0.160 | 0.180 |
| | **Q3: 20 - 29** | 0.152 | 0.128 | 0.141 | 0.150 | 0.161 | 0.180 |
| | **Q4: 30 - 160** | 0.154 | 0.131 | 0.144 | 0.153 | 0.162 | 0.180 |
| **Readmit - Risk Standardized Rate(Pred.)** | **Vol. Quartile** | | | | | | |
| | **Q1: 10 - 13** | 0.153 | 0.147 | 0.150 | 0.153 | 0.156 | 0.161 |
| | **Q2: 14 - 19** | 0.153 | 0.146 | 0.150 | 0.153 | 0.156 | 0.163 |
| | **Q3: 20 - 29** | 0.154 | 0.144 | 0.149 | 0.153 | 0.158 | 0.165 |
| | **Q4: 30 - 160** | 0.154 | 0.143 | 0.148 | 0.153 | 0.158 | 0.168 |
| **Readmit - Actual - 3 yr.** | **Vol. Quartile** | | | | | | |
| | **Q1: 10 - 13** | 0.148 | 0.029 | 0.088 | 0.140 | 0.198 | 0.285 |
| | **Q2: 14 - 19** | 0.146 | 0.045 | 0.099 | 0.142 | 0.186 | 0.262 |
| | **Q3: 20 - 29** | 0.157 | 0.072 | 0.114 | 0.150 | 0.193 | 0.262 |
| | **Q4: 30 - 160** | 0.155 | 0.083 | 0.124 | 0.153 | 0.183 | 0.236 |
| **Readmit - Risk Standardized Rate(Obs. - 3 yr.)** | **Vol. Quartile** | | | | | | |
| | **Q1: 10 - 13** | 0.152 | 0.032 | 0.091 | 0.142 | 0.205 | 0.293 |
| | **Q2: 14 - 19** | 0.148 | 0.045 | 0.100 | 0.144 | 0.192 | 0.260 |
| | **Q3: 20 - 29** | 0.157 | 0.072 | 0.114 | 0.151 | 0.192 | 0.265 |
| | **Q4: 30 - 160** | 0.153 | 0.084 | 0.124 | 0.150 | 0.180 | 0.228 |
| **Readmit - Pred. - 3 yr.** | **Vol. Quartile** | | | | | | |
| | **Q1: 10 - 13** | 0.149 | 0.121 | 0.136 | 0.147 | 0.160 | 0.181 |
| | **Q2: 14 - 19** | 0.152 | 0.126 | 0.140 | 0.151 | 0.162 | 0.180 |
| | **Q3: 20 - 29** | 0.155 | 0.133 | 0.144 | 0.154 | 0.165 | 0.182 |
| | **Q4: 30 - 160** | 0.157 | 0.132 | 0.147 | 0.157 | 0.167 | 0.183 |
| **Readmit - Risk Standardized Rate(Pred. - 3 yr.)** | **Vol. Quartile** | | | | | | |
| | **Q1: 10 - 13** | 0.154 | 0.142 | 0.148 | 0.153 | 0.158 | 0.167 |
| | **Q2: 14 - 19** | 0.153 | 0.140 | 0.146 | 0.153 | 0.159 | 0.169 |
| | **Q3: 20 - 29** | 0.154 | 0.139 | 0.146 | 0.154 | 0.161 | 0.172 |
| | **Q4: 30 - 160** | 0.153 | 0.136 | 0.145 | 0.153 | 0.161 | 0.173 |

4. Reliability Testing (Measure evaluation criterion 2b)

   Reliability was assessed by correlating the one-year measures for 2007 with both the one-year measures for 2006 and the three-year measures ending with 2006. In each case, both Pearson and Spearman correlations were calculated, the latter being less susceptible to outliers. As an additional assessment, measures were grouped in quintiles and weighted kappa statistics were computed. The results are in Table 9. All values are significant ($p<.001$). Correlation statistics between the three-year average ending in 2007 and the three-year average ending in 2006 are not calculated because the two measures share two years of data in common.

**Table 14: Pneumonia 30-Day Readmission Rate -- Reliability When Comparing Across Years**

| Statistic | One-Year (2006) | | Three-Year (2004-6) | |
|---|---|---|---|---|
| | Obs./Exp. Ratio | Pred./Exp. Ratio | Obs./Exp. Ratio | Pred./Exp. Ratio |
| **Correlation Coefficients** | | | | |
| • **Pearson** | 0.083 | 0.128 | 0.114 | 0.139 |
| • **Spearman** | 0.090 | 0.110 | 0.116 | 0.131 |
| **Kappa Statistic** | | | | |
| • **Weighted Kappa** | 0.062 | 0.071 | 0.090 | 0.081 |
| • **95% CI – Lower** | 0.034 | 0.044 | 0.062 | 0.054 |
| • **95% CI -- Upper** | 0.089 | 0.099 | 0.118 | 0.109 |

## Reference

Yale University/Yale-New Haven Hospital Center for Outcomes Research and Evaluation (YNHH-CORE). “Hospital 30-Day Pneumonia Readmission Measure Methodology”. Prepared for Centers for Medicare & Medicaid Services (CMS), June 9, 2008.

## Appendix B-1
## Histograms of Hospital 30-Day Pneumonia Readmission Rate Distributions

**Figure 9: Distribution of Hospital Actual (unadjusted) 30-Day Pneumonia Readmission Rates (One Year – 2006)**

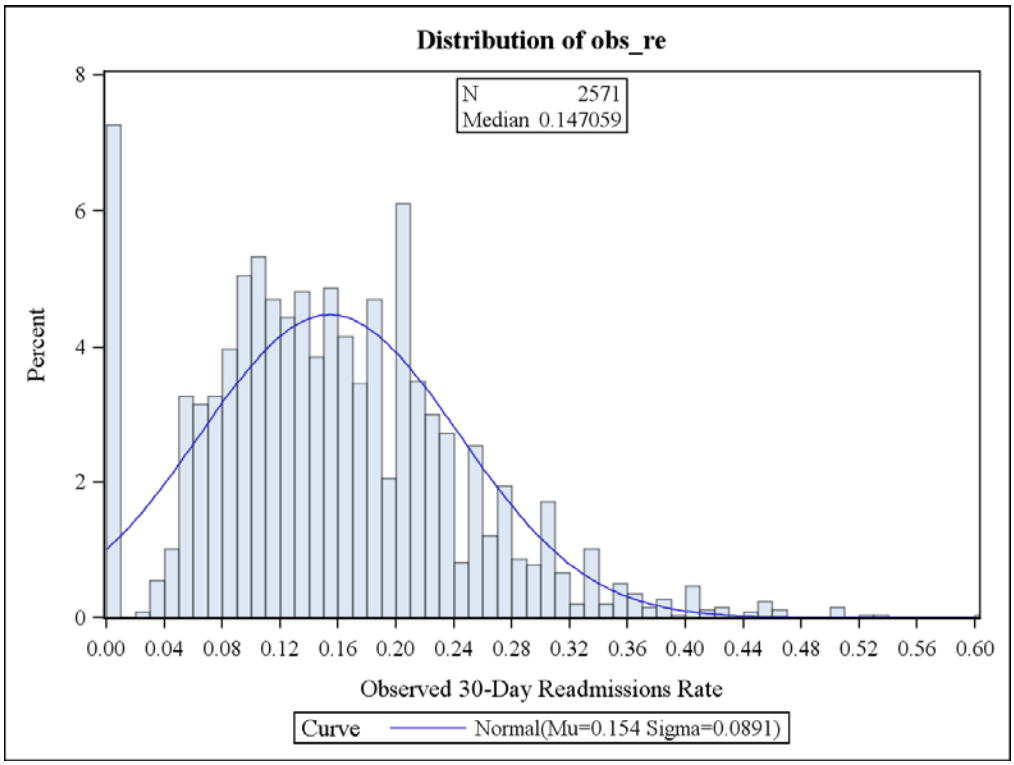


**Figure 10: Distribution of Hospital Actual (unadjusted) 30-Day Pneumonia Readmission Rates (One Year – 2006) -- By Hospital Pneumonia Volume Quartile**

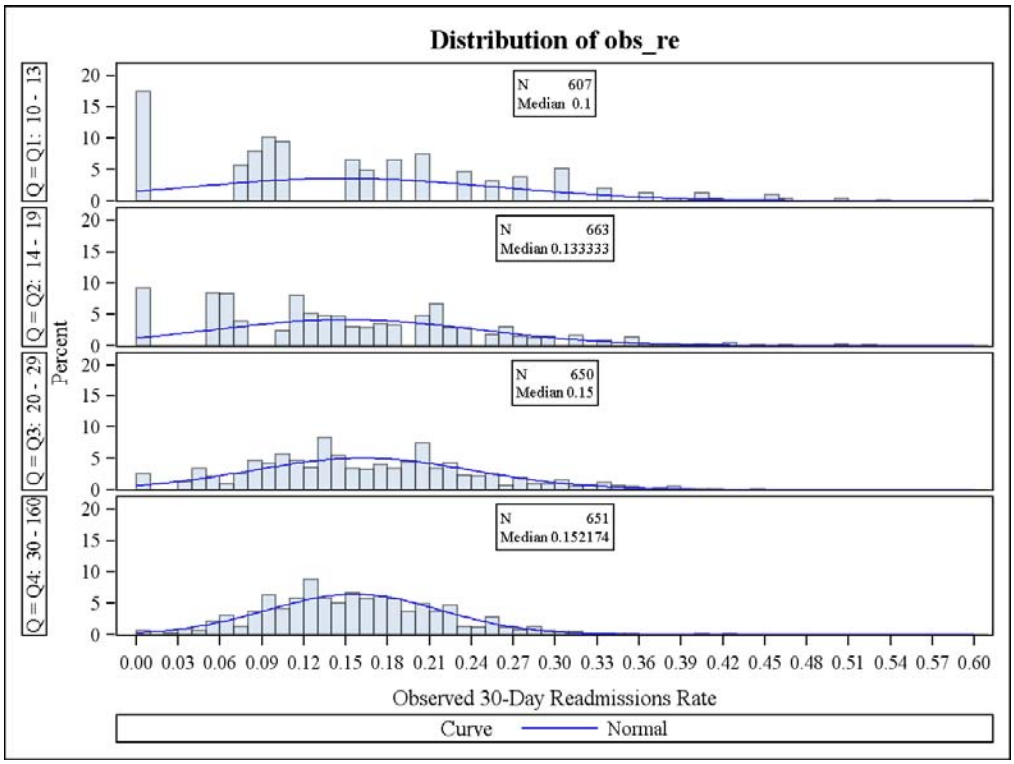

**Figure 11: Distribution of Hospital Risk Adjusted 30-Day Pneumonia Readmission Rates (Using P/E Method, One Year – 2006)**

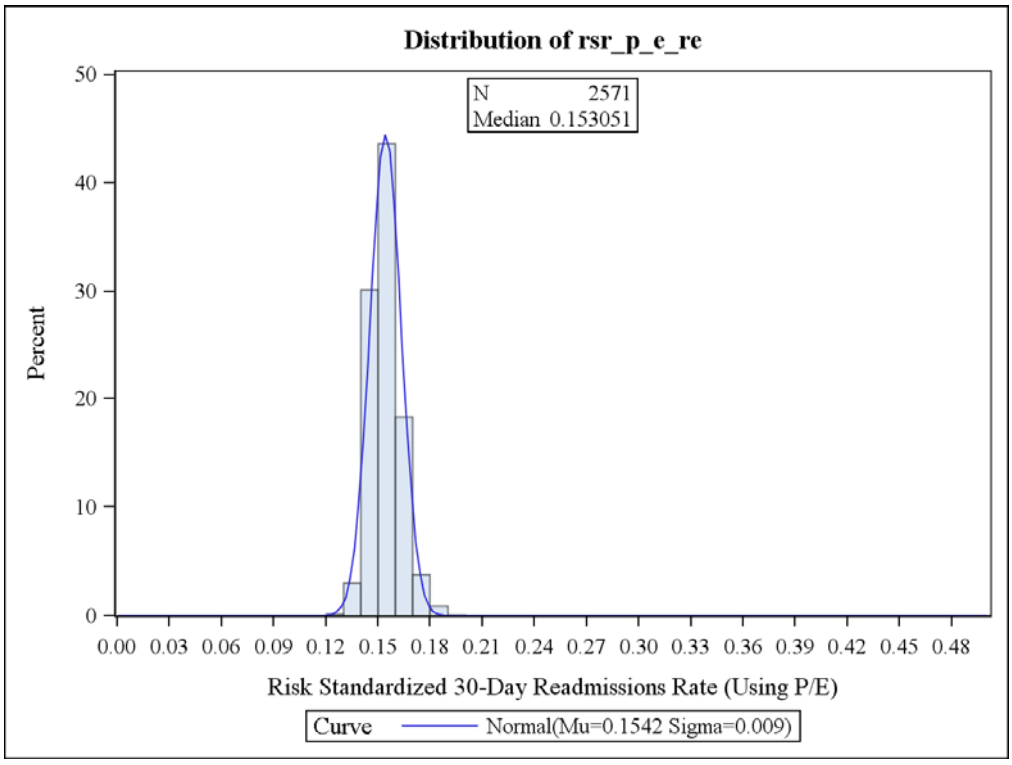


**Figure 12: : Distribution of Hospital Risk Adjusted 30-Day Pneumonia Readmission Rates (Using P/E Method, One Year – 2006) -- By Hospital Pneumonia Volume Quartile**

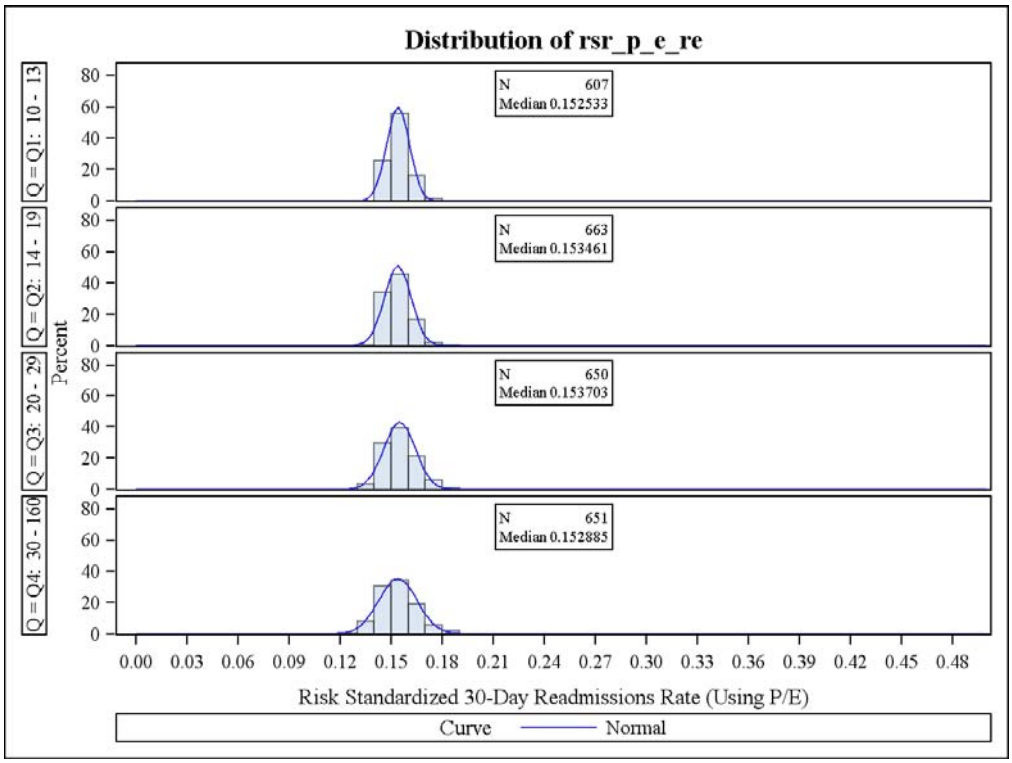

**Figure 13: Distribution of Hospital Risk Adjusted 30-Day Pneumonia Readmission Rates (Using O/E Method, Three-Year – 2004-6)**

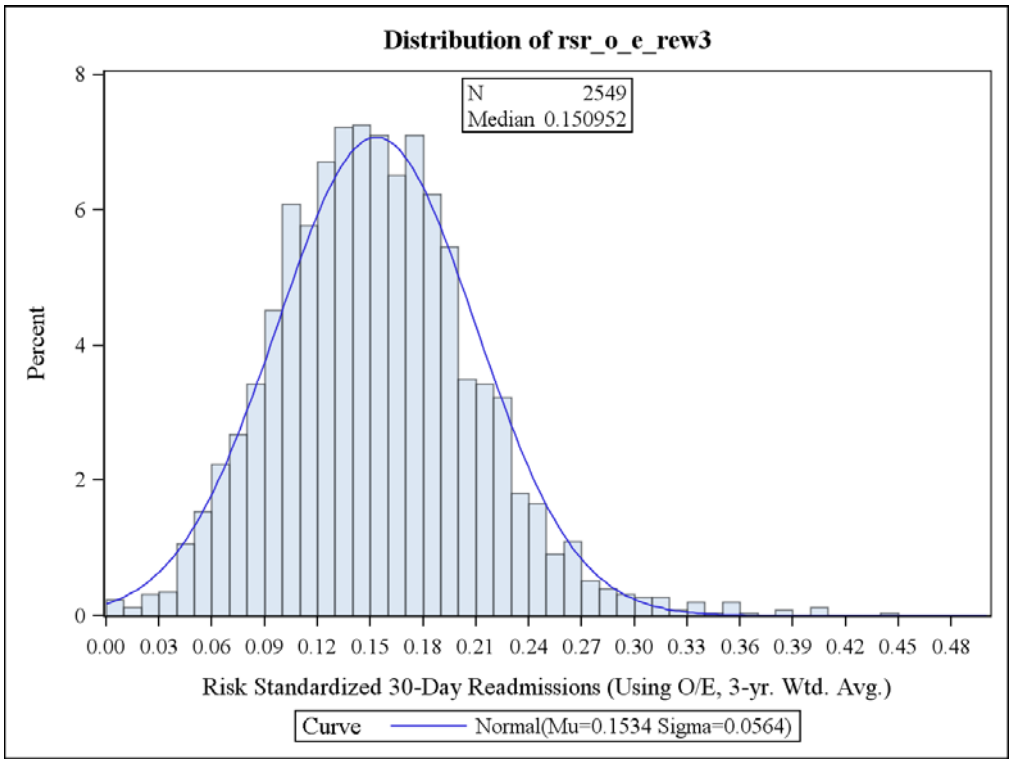


**Figure 14: : Distribution of Hospital Risk Adjusted 30-Day Pneumonia Readmission Rates (Using O/E Method, Three-Year – 2004-6) -- By Hospital Pneumonia Volume Quartile**

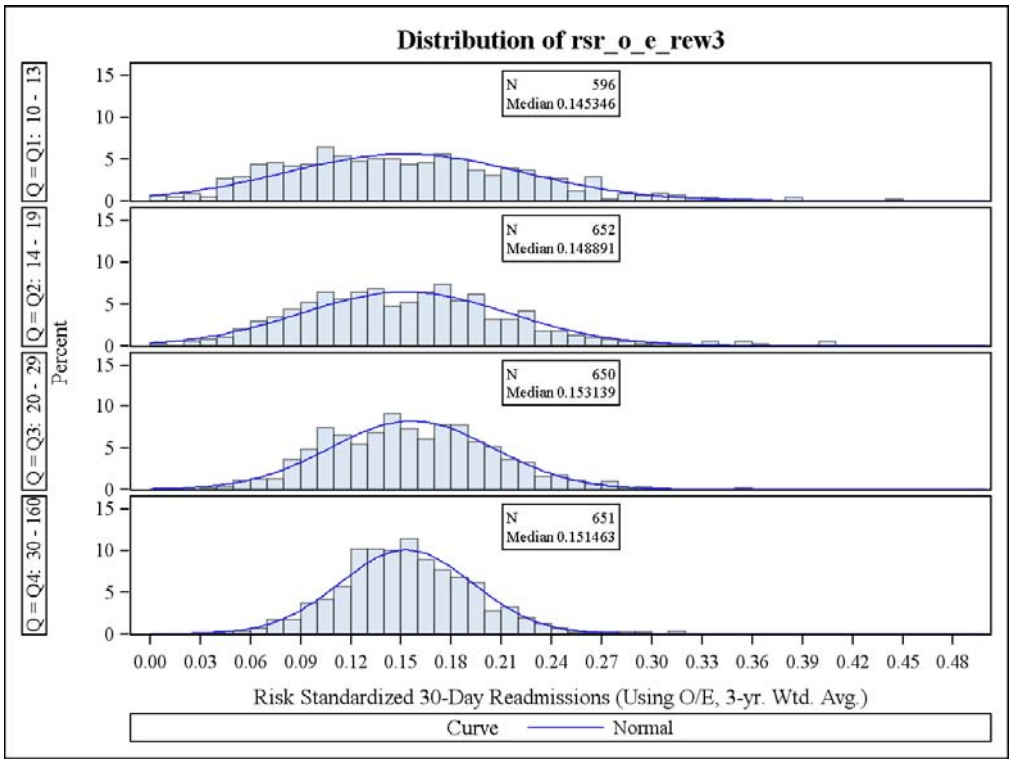

**Figure 15: Distribution of Hospital Risk Adjusted 30-Day Pneumonia Readmission Rates (Using P/E Method, Three-Year – 2004-6)**

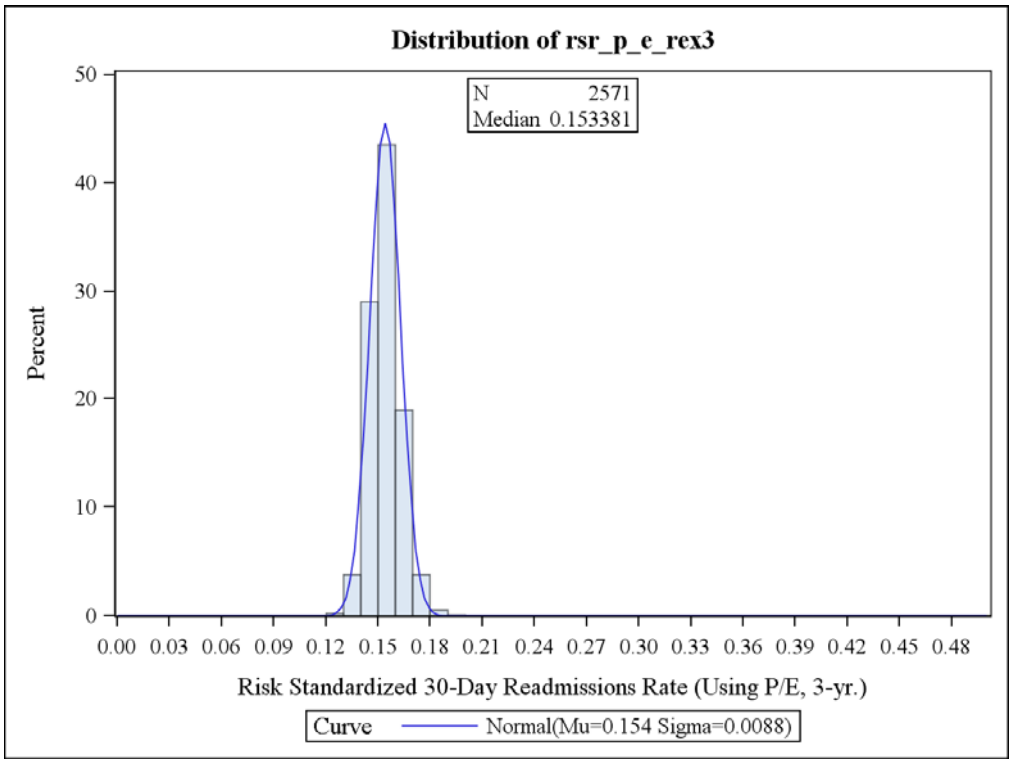


**Figure 16: : Distribution of Hospital Risk Adjusted 30-Day Pneumonia Readmission Rates (Using P/E Method, Three-Year – 2004-6) -- By Hospital Pneumonia Volume Quartile**