NATIONAL QUALITY FORUM

TO: Cardiovascular Endorsement Maintenance Steering Committee

FR: Reva Winkler, MD, MPH and Kathryn Streeter, MS

RE: Revised Specifications for AMI and HF Mortality and Readmission Measures

DA: September 7, 2011

At the conference call on September 12, 2011 the Committee will review updates submissions and new testing data for three measures from CMS/Yale:

- **# 229**: **Hospital 30-day, all-cause, risk-standardized mortality rate (RSMR) following heart failure (HF) hospitalization**
- **# 230 Acute myocardial infarction 30-day mortality**
- **# 330 30-day all-cause risk standardized readmission rate following heart failure hospitalization (risk adjusted)**

The measure evaluation summaries for the original measures are presented below:

0230 Hospital 30-day, all-cause, risk-standardized mortality rate (RSMR) following acute myocardial infarction (AMI) hospitalization
Description: The measure estimates a hospital-level risk-standardized mortality rate (RSMR), defined as death from any cause within 30 days after the index admission date, for patients discharged from the hospital with a principal diagnosis of AMI. Measure Steward: CMS
STEERING COMMMITTEE EVALUATION
1. Importance to Measure and Report: Y-19; N-0 *(1a. Impact; 1b. Performance gap; 1c. Outcome or Evidence)* Rationale: • This is an important indicator, as mortality rates after MI are high. • There is wide variation in performance among hospitals, and this variation persists after adjustment for patient-level characteristics.
2. Scientific Acceptability of Measure Properties: C-19; P-1; M-0; N-0 *(2a. Precise specifications; 2b. Reliability testing; 2c. Validity testing; 2d. Exclusions justified; 2e. Risk adjustment/stratification; 2f. Meaningful differences; 2g. Comparability; 2h. Disparities)* Rationale: • The measure is precise. • Reliability demonstrated in split-half analysis. Validity demonstrated by chart-based audit. • Fully risk adjusted with hierarchical general linear modeling. • Analysis indicates that disparities are small at the hospital level. • Limited to patients great than 65 years.
3. Usability: C-18; P-2; M-0; N-0 *(3a. Meaningful/useful for public reporting and quality improvement; 3b. Harmonized; 3c. Distinctive or additive value to existing measures)* Rationale: • The measure is publicly reported.

0230 Hospital 30-day, all-cause, risk-standardized mortality rate (RSMR) following acute myocardial infarction (AMI) hospitalization

- The statistical adjustment method is the same one used for heart failure and pneumonia.
- AHRQ reports in-hospital mortality, but 30-day mortality is independent of length of stay and cannot be influenced by care decisions like early discharge.

NOTE: Developer indicates it is working on expanding the age range to include all patients in the near future.

4. Feasibility: C-20; P-0; M-0; N-0

(4a. Clinical data generated during care process; 4b. Electronic sources; 4c. Exclusions—no additional data source; 4d. Susceptibility to inaccuracies/ unintended consequences identified; 4e. Data collection strategy can be implemented)

Rationale:

- Data are byproduct of routine medical record coding.
- Data are available electronically, and no additional sources are required.
- Measure is already in use.

Does the Measure Meet Criteria for Endorsement: Y-18; N-0; A-0

Rationale:

- Risk-adjusted outcome measure.
- Well developed and tested.
- In use for public reporting.
- Complete measure information in submission, including disparities data.

If Applicable, Conditions/Questions for Developer:

- Developer indicated that they are working on expanding the measure to apply to all patients, not just those over 65 years. On June 3, 2011 the developer forwarded testing results for the AMI 30-day mortality applied to all payer data. The Committee will review these results in the coming months and perform a full evaluation as an addendum.

RECOMMENDATION: MAINTAIN ENDORSEMENT

The Committee will further evaluate the all patient testing results as an addendum to this recommendation.

0229 Hospital 30-day, all-cause, risk-standardized mortality rate (RSMR) following heart failure (HF) hospitalization

Description: The measure estimates a hospital-level risk-standardized mortality rate (RSMR), defined as death from any cause within 30 days after the index admission date, for patients discharged from the hospital with a principal diagnosis of HF.

Measure Steward: Centers for Medicare & Medicaid Services,

STEERING COMMMITTEE EVALUATION

1. Importance to Measure and Report: Y-19; N-0

(1a. Impact; 1b. Performance gap; 1c. Outcome or Evidence)

Rationale:

- Most common admission under Medicare; second most costly total bill.
- Outcome measure.
- Important outcome measure

2. Scientific Acceptability of Measure Properties: C-19; P-1; M-0; N-0

(2a. Precise specifications; 2b. Reliability testing; 2c. Validity testing; 2d. Exclusions justified; 2e. Risk adjustment/stratification; 2f. Meaningful differences; 2g. Comparability; 2h. Disparities)

Rationale:

- Data were published in a manuscript last year, looking at long-term trends in cardiovascular quality and outcomes.
- Risk adjustment used is administrative data. Methodology was validated against clinical data.

0229 Hospital 30-day, all-cause, risk-standardized mortality rate (RSMR) following heart failure (HF) hospitalization
3. Usability: C-17; P-2; M-0; N-0 *(3a. Meaningful/useful for public reporting and quality improvement; 3b. Harmonized; 3c. Distinctive or additive value to existing measures)* Rationale: • Measure is currently in use. • Public may not view data on website as often as was hoped, but doctors and administrators are using the data for internal quality improvement.
4. Feasibility: C-19; P-1; M-0; N-0 *(4a. Clinical data generated during care process; 4b. Electronic sources; 4c. Exclusions – no additional data source; 4d. Susceptibility to inaccuracies/ unintended consequences identified 4e. Data collection strategy can be implemented)* Rationale: • Measure is in use and publicly reported. • Uses administrative data.
Does the Measure Meet Criteria for Endorsement?: Y-17; N-1; A-0 Rationale: • A detailed, comprehensive submission form demonstrates that the measure meets all the criteria. • Published in the literature. • In use and publicly reported.
If Applicable, Conditions/Questions for Developer: Disparities in race and socioeconomic status have been reported at the patient level. Does CMS plan on stratifying the measure? Developer Response: Disparities at the hospital level haven't been seen in facilities with higher percentages of African-American patients.
RECOMMENDATION: MAINTAIN ENDORSEMENT On June 3, 2011, NQF and the Steering Committee were advised that the developer will complete testing of this measure on all payer data. The Committee will evaluate possible revisions to the measure as an addendum.

0330 Hospital 30-day, all-cause, risk-standardized readmission rate following heart failure hospitalization
Description: The measure estimates a hospital 30-day risk-standardized readmission rate (RSRR), defined as readmission for any cause within 30 days after the date of discharge of the index admission for patients discharged from the hospital with a principal diagnosis of heart failure (HF). Measure Steward: Centers for Medicare & Medicaid Services,
STEERING COMMMITTEE EVALUATION
1. Importance to Measure and Report: Y-19; N-0 *(1a. Impact; 1b. Performance gap; 1c. Outcome or Evidence)* Rationale: • Heart failure is the number one cause of hospitalization and readmission among Medicare members.
2. Scientific Acceptability of Measure Properties: C-18; P-1; M-0; N-0 *(2a. Precise specifications; 2b. Reliability testing; 2c. Validity testing; 2d. Exclusions justified; 2e. Risk adjustment/stratification; 2f. Meaningful differences; 2g. Comparability; 2h. Disparities)* Rationale: • Very well specified. • Disparities information should be publicly disclosed on Hospital Compare. • Stratified analyses is done instead of controlling for socioeconomic status.

0330 Hospital 30-day, all-cause, risk-standardized readmission rate following heart failure hospitalization
3. Usability: C-18; P-1; M-0; N-0 *(3a. Meaningful/useful for public reporting and quality improvement; 3b. Harmonized; 3c. Distinctive or additive value to existing measures)* Rationale: • Has been in use without any major issues for some time. • Captures an important domain of quality that's not captured in the mortality measure or other measures reviewed.
4. Feasibility: C-18; P-1; M-0; N-0 *(4a. Clinical data generated during care process; 4b. Electronic sources; 4c. Exclusions – no additional data source; 4d. Susceptibility to inaccuracies/ unintended consequences identified 4e. Data collection strategy can be implemented)* Rationale: • Data generated during care process. Uses administrative data. • Data could be obtained from electronic health records or paper. • Isn't particularly susceptible to inaccuracies and is easily implemented.
Does the Measure Meet Criteria for Endorsement?: Y-20; N-0; A-0 Rationale: • High readmission rates—20% within 30 days; 50% within 1 years • Significant variation • Addresses all criteria
If applicable, Conditions/Questions for Developer: Strongly recommend that disparities data be reported on Hospital Compare. Developer Response: Disparities surveillance is on-going and reported on another CMS website. Will consider recommendation to include in Hospital Compare.
RECOMMENDATION: MAINTAIN ENDORSEMENT On June 3, 2011, NQF and the Steering Committee were advised that the developer will complete testing of this measure on all payer data. The Committee will evaluate possible revisions to the measure as an addendum.

Comments received July – August 2011 on the original measures

0330: Hospital 30-day, all-cause, risk-standardized readmission rate following heart failure hospitalization (Yale/CMS)

Several comments were submitted suggesting that the measure does not meet the NQF measure evaluation criteria for endorsement:

- "Exclusions. We urge the Steering Committee to request an analysis from the measure developer on a list of risk-adjustment variables (Appendix A) that should be considered as candidates for measure exclusions. We recommend the Steering Committee re-examine this measure for scientific acceptability. We are concerned that the criteria included in section *2d: exclusions justified* of the Consensus Development Process has not been properly met. Currently, this measure only includes exclusions in five-limited categories: In-hospital death; Without at least 30 days post-discharge enrollment in fee-for-service Medicare; Transferred to another acute care facility; Discharged against medical advice; Admitted with heart failure within 30 days of discharge from an index admission."
- "The measure developer has included a list of risk-adjustment variables (Appendix A) that are applied to claims data. However, these variables are not being applied to ensure that cases that are not truly

readmissions are left out of the measures rate. Rather than use these variables in the risk-adjustment methodology, these variables should be considered candidates for additional exclusions. We urge the Steering Committee to ask the developer to provide evidence that these variables are not distorting the measure results. The developer should provide the following: Count of the frequency of these variables; Sensitivity analysis with and without the exclusions; and Variability of exclusions across hospital types (i.e., teaching and non-teaching)."

Developer response:

In the above comments the AHA raises two issues regarding measure exclusions. The first is a request to consider using current risk-adjustment variables (those listed in their Appendix A) instead as exclusions to the measure. We feel the measure is a much stronger measure as designed because it includes a greater proportion of a hospitals' heart failure (or AMI) patients while adequately risk-adjusting for differences in hospitals' case-mix. The goal in developing outcomes measures is to create a clinically cohesive cohort that includes as many patients as possible admitted with the given condition (e.g., heart failure). We aim to limit exclusions to factors that preclude fair assessment of care quality for an admission, such as lack of continuous enrollment, which prevents us from assessing patient risk factors, or patients' leaving AMA, since hospitals do not have the opportunity to provide all recommend care for these patients. Greatly expanding our list of exclusions to all the conditions listed in the Appendix would result in a measure that was less useful and meaningful, as it would reflect the care of the small number of a hospital's patients that presented without significant co-morbidities. It also could create incentives for hospitals to code risk-factors in order to exclude patients from the measures. To fairly profile hospitals' performance risk adjustment, it is critical to place hospitals on a level playing field and account for their differences in the patients that present for care. This is accomplished through adequate risk adjustment for patients' clinical presentation rather than exclusion of patients.

The second issue raised by the commenter above is the "exclusion" of planned cases and unrelated admissions. In this case the comment is referring to "excluding" readmissions that is, not counting certain admission as readmissions (as opposed to excluding hospitalizations from the cohort assessed for readmissions). The readmission measures are designed as all-cause readmission measures for a number of reasons.

First, from the patient perspective, unplanned readmission for any reason is an undesirable outcome of care, even though not all readmissions are related to the index admission or preventable. Second, limiting the outcome to "related readmissions" may limit the focus of efforts to improve care to a narrow set of approaches as opposed to encouraging broader initiatives aimed overall at improving the care within the hospital and transitions from the hospital setting. Moreover, there is no reliable way to exclude quality issues and accountability based on the documented cause of readmission. For example, a patient admitted for heart failure who develops a line infection may ultimately be readmitted for sepsis. It would be inappropriate to treat this readmission as unrelated to the care the patient received during the initial hospitalization. The goal of an all-cause readmission measure is not to reduce readmissions to zero, but to assess hospital performance relative to what is expected given the performance of other hospitals with similar case mixes while minimizing the potential for systematic coding misclassifications (gaming).

We do however aim, in the development of readmission measures to identify planned readmissions. Planned readmissions are admissions that include a planned procedure as follow-on care from the index hospitalization. At the time of measure development, clinical experts were asked whether there were common follow-up causes of readmissions for a scheduled procedure that represented a continuation of care after a HF admission. No such related, planned procedures were identified as occurring commonly after the index admissions for HF.

- "Risk adjustment. We urge the Steering Committee to have additional dialogue with the measure developer on the use of stratification to properly risk adjust the HF readmission measure. We recommend the Steering Committee re-examine this measure for scientific acceptability. We are concerned that the criteria included in section 2e: risk adjustment/stratification of the Consensus Development Process has not properly been met. The NQF criteria in the maintenance report states, "It is preferable to stratify measures by race and socioeconomic status rather than adjusting out differences." However, the measure developer states, "The measure is not stratified."
  At a minimum this data must be made publicly available in order for this measure to pass the test of scientific acceptability and remain endorsed under this maintenance review.

- "Disparities. We urge the Steering Committee to have additional dialogue with the measure developer on stratification to properly account for the disparities underlying the HF readmission measure. We recommend the Steering Committee re-examine this measure for scientific acceptability. We are concerned that the criteria included in section 2h: disparities of the Consensus Development Process has not been properly met. The NQF criteria in the maintenance report states, "If disparities in care have been identified, measure specifications, scoring and analysis allow for identification of disparities through stratification of results (e.g., by race, ethnicity, socioeconomic status, gender); or rationale/data justifies why stratification is not necessary or not feasible." However, the measure developer states: "Disparities in race and socio-economic status have been reported at the patient level [for the heart failure readmission measure]."

Developer response:

Performance on the measure nationally confirms that the measure is fair to hospitals with relatively high proportions of minority and low SES patients. Examination of the current publicly-reported readmission measures demonstrates that hospitals serving high proportions of African-American patients or patients of low SES often perform well on the measures. We have grouped hospitals according to the proportion of their patients who are African-American or the median income level of their patients and compared the performance of these groups on the readmission measures based on discharges for 2007-2009. We have also compared the performance of safety-net and non-safety-net hospitals. In each of these analyses, the primary finding is that the range of performance for hospitals in the group serving the highest proportion of African-American or poorer patients overlaps almost completely with the performance of hospitals with lower percentages of vulnerable populations. In all subgroups of hospitals we find both high and low performers. These analyses support a standard benchmark for hospitals regardless of the racial or SES mix of the patients they serve. Furthermore, stratifying patients in these measures by race and/or socioeconomic status would set a double standard for quality measurement. Therefore, we have neither risk adjusted for race and/or socioeconomic status in order to ensure any disparities present are not masked and we have not stratified the measure to prevent the creation of a double standard of quality performance based upon race and/or socioeconomic status.

- "I have real concerns about readmission rates as quality measures. One reason is our data from the VA system showed over a 5-year period in patients who were hospitalized for heart failure that there was a progressive rise in readmission rates associated with a progressive decline in mortality rates. (Heidenreich JACC 2010;56:362-68). A likely reason for this may be that systems which have programs in place to see patients early post-discharge and/or employ various forms of remote monitoring, home visits, and contact with trained NPs will recognize clinical deterioration earlier and admit the patient. This measure has the potential to discourage timely readmissions."

Developer response:

As noted, a readmission measure could provide an incentive to deny a patient a needed admission, thereby reducing access for patients and ultimately resulting in worse outcomes. The Centers for Medicare and Medicaid Services (CMS) publicly reports both mortality and all-cause readmission measures for AMI, heart failure, and pneumonia, mitigating concerns that hospital actions that affect both readmission and mortality will not be fully captured in performance assessment. Importantly, many hospitals perform well on both the readmission and mortality measures demonstrating that good performance on the mortality measure does not limit performance on the readmission measures. In addition, CMS monitors and maintains their publicly reported measures on an ongoing basis.

Furthermore, readmission has several important strengths as an outcome for evaluating hospital quality of care: 1) It is patient-centered in that patients experience the outcome and incur the disruption, risk, and indirect (and sometimes the direct) costs of the hospitalization and the clinical events that led to it; 2) As an outcome, readmission incorporates many aspects of a patient's care, including actions that are difficult to measure directly. Successful transition from the hospital and an uneventful recovery requires that many aspects of healthcare are successfully delivered; 3) although not all readmissions are preventable, many readmissions could be prevented if care were improved. Research has shown that readmission rates are influenced by the quality of inpatient and outpatient care, and that improvement in care, such as improved discharge processes, can reduce readmission rates; 4) Readmissions are costly and a reduction in these events would not only enhance the patient experience but could also reduce health care spending.

- "All cause readmission loses its meaning to clinicians and providers as this does not provide information that could lead to performance improvement."

ACTION ITEM: The Steering Committee should address these issues raised during the comment period during the discussion of the revised measure specification and testing of all payer data.

ACTION ITEM: How does the Committee rate the reliability, validity, and scientific acceptability of the revised specifications for all patients? Do the revised specifications change the Committee's ratings on Importance to Measure and Report, Usability and Feasibility? Does the Committee recommend the revised measures for endorsement?

NATIONAL QUALITY FORUM

Measure Evaluation 4.1
December 2009

This form contains the measure information submitted by stewards. Blank fields indicate no information was provided. Attachments also may have been submitted and are provided to reviewers. The subcriteria and most of the footnotes from the evaluation criteria are provided in Word comments within the form and will appear if your cursor is over the highlighted area. Hyperlinks to the evaluation criteria and ratings are provided in each section.

TAP/Workgroup (if utilized)**:** Complete all yellow highlighted areas of the form. Evaluate the extent to which each subcriterion is met. Based on your evaluation, summarize the strengths and weaknesses in each section.

Note: *If there is no TAP or workgroup, the SC also evaluates the subcriteria (yellow highlighted areas).*

Steering Committee: Complete all pink highlighted areas of the form. Review the workgroup/TAP assessment of the subcriteria, noting any areas of disagreement; then evaluate the extent to which each major criterion is met; and finally, indicate your recommendation for the endorsement. Provide the rationale for your ratings.

Evaluation ratings of the extent to which the criteria are met
C = Completely (unquestionably demonstrated to meet the criterion)
P = Partially (demonstrated to partially meet the criterion)
M = Minimally (addressed BUT demonstrated to only minimally meet the criterion)
N = Not at all (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 #:** 0229 **NQF Project:** Cardiovascular Endorsement Maintenance 2010

MEASURE DESCRIPTIVE INFORMATION
De.1 **Measure Title:** Hospital 30-day, all-cause, risk-standardized mortality rate (RSMR) following heart failure (HF) hospitalization for patients 18 and older
De.2 **Brief description of measure**: The measure estimates a hospital-level risk-standardized mortality rate (RSMR), defined as death from any cause within 30 days after the index admission date, for patients 18 and older discharged from the hospital with a principal diagnosis of HF.
1.1-2 **Type of Measure:** Outcome De.3 **If included in a composite or paired with another measure, please identify composite or paired measure** This measure is paired with a measure of hospital-level, all-cause, 30-day, risk-standardized readmission rate (RSRR) following an HF hospitalization.
De.4 **National Priority Partners Priority Area:** Safety De.5 **IOM Quality Domain**: Effectiveness, Patient-centered, Safety De.6 **Consumer Care Need:** Getting better

CONDITIONS FOR CONSIDERATION BY NQF	NQF Staff
Four conditions must be met before proposed measures may be considered and evaluated for suitability as voluntary consensus standards:	
A. The measure is in the public domain or an intellectual property (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.* A.1 **Do you attest that the measure steward holds intellectual property rights to the measure and the right to use aspects of the measure owned by another entity (e.g., risk model, code set)?** Yes A.2 **Indicate if Proprietary Measure** (*as defined in measure steward agreement*)**:** A.3 **Measure Steward Agreement:** Government entity and in the public domain - no agreement necessary A.4 **Measure Steward Agreement attached:**	**A** **Y**☐ **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, information provided in contact section	**B** Y☐ N☐
C. The intended use of the measure includes both public reporting and quality improvement. ►**Purpose:** Public Reporting, Quality Improvement with Benchmarking (external benchmarking to multiple organizations)	**C** Y☐ 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 12 months of endorsement. D.1**Testing:** Yes, fully developed and tested D.2 **Have NQF-endorsed measures been reviewed to identify if there are similar or related measures?** Yes	**D** Y☐ N☐
(for NQF staff use**)** **Have all conditions for consideration been met?** **Staff Notes to Steward** (*if submission returned*)**:**	**Met** Y☐ N☐
Staff Notes to Reviewers (*issues or questions regarding any criteria*)**:**	
Staff Reviewer Name(s):	

TAP/Workgroup Reviewer Name:	
Steering Committee Reviewer Name:	
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 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.* (evaluation criteria) **1a. High Impact**	**Eval Rating**
(for NQF staff use) **Specific NPP goal**:	
1a.1 **Demonstrated High Impact Aspect of Healthcare:** Affects large numbers, Leading cause of morbidity/mortality, High resource use, Severity of illness, Patient/societal consequences of poor quality 1a.2 1a.3 **Summary of Evidence of High Impact:** HF incidence approaches 10 per 1000 population after 65 years of age (NHLBI 2007), and is the most common discharge diagnosis among the elderly (Jessup and Brozena 2003); prevalence of HF in the U.S. is estimated at nearly 6 million. (Lloyd-Jones 2009), and is suspected as the leading cause of death in people over age 65. Many current hospital interventions are known to decrease the risk of death within 30 days of hospital admission (Jha 2007). Current process-based performance measures, however, cannot capture all the ways that care within the hospital might influence outcomes. As a result, many stakeholders, including patient organizations, are interested in outcomes measures that allow patients and providers to assess relative outcomes performance for hospitals. 1a.4 **Citations for Evidence of High Impact:** Jessup M, Brozena S. Medical progress: heart failure. N Engl J Med 2003;348:2007-18. National Heart, Lung, and Blood Institute. Unpublished tabulation of NHANES, 1971-1975, 1976-1980, 1988-1994, 1999-2002, 2003-2006, and extrapolation to the U.S. population, 2007.	**1a** C☐ P☐ M☐ N☐

Comment [KP1]: 1a. The measure focus addresses:
- a specific national health goal/priority identified by NQF's National Priorities Partners; OR
- a demonstrated high impact aspect of healthcare (e.g., affects large numbers, leading cause of morbidity/mortality, high resource use (current and/or future), severity of illness, and patient/societal consequences of poor quality).

Lloyd-Jones D et al,American Heart Association Statistics Committee and Stroke Statistics Subcommittee. Heart disease and stroke statistics--2010 update: a report from the American Heart Association. Circulation. 2010 Feb 23;121(7):e46-e215. Epub 2009 Dec 17

Jha AK, Orav EJ, Li Z, Epstein AM. The inverse relationship between mortality rates and performance in the Hospital Quality Alliance measures. Health Aff (Millwood) 2007 Jul-Aug;26(4):1104-10.

1b. Opportunity for Improvement

1b.1 Benefits (improvements in quality) envisioned by use of this measure: The goal of this measure is to improve patient outcomes by providing patients, physicians, and hospitals with information about hospital-level, risk-standardized mortality rates following hospitalization for HF. Measurement of patient outcomes allows for a broad view of quality of care that encompasses more than what can be captured by individual process-of-care measures. Complex and critical aspects of care, such as communication between providers, prevention of, and response to, complications, patient safety and coordinated transitions to the outpatient environment, all contribute to patient outcomes but are difficult to measure by individual process measures. The goal of outcomes measurement is to risk-adjust for patients' conditions at the time of hospital admission and then evaluate patient outcomes. This mortality measure was developed to identify institutions, whose performance is better or worse than would be expected based on their patient case-mix, and therefore promote hospital quality improvement and better inform consumers about care quality.

1b.2 Summary of data demonstrating performance gap (variation or overall poor performance) across providers:
Recent analyses of Medicare FFS data show substantial variation in HF RSMRs among hospitals. For the most recently reported three years of data (7/2006-6/2009) the mean hospital RSMR was 10.8% with a range of 6.6% to 18.2%. The 5th percentile was 8.4% and the 95th percentile was 13.4%. The interquartile range was 9.9% to 11.7%.

Bernheim SM, Grady JN, Lin Z, Wang Y, Wang Y, Savage SV, Bhat KR, Ross JS, Desai MM, Merrill AR, Han LF, Rapp MT, Drye EE, Normand SL, Krumholz HM. National patterns of risk-standardized mortality and readmission for acute myocardial infarction and heart failure. Update on publicly reported outcomes measures based on the 2010 release. Circ Cardiovasc Qual Outcomes. 2010 Sep 1;3(5):459-67. Epub 2010 Aug 24.

1b.3 Citations for data on performance gap:
The information on the performance gap is based on RSMRs calculated for HF hospitalizations among Medicare FFS patients aged 65 and over (65+) from July 1, 2006- June 30, 2009 and includes 1,096,751 hospitalizations from 4,743 hospitals. The index hospitalizations are those included in the measure and reported in the 2010 update to Hospital Compare.

1b.4 Summary of Data on disparities by population group:
The measure is a hospital-level measure and therefore CMS assessed evidence of disparities by examining hospital performance based on the proportion of African-American patients or the proportion of low-income patients served by a hospital.

The analyses analyses of Medicare FFS data examining the proportion of patients that a hospital served who are African-American show slightly better performance on RSMR for hospitals with higher proportions of African-American patients, but that the range of performance across all levels is similar. We divided hospitals into deciles based on the proportions of their patients that were African-American and looked at hospital performance on the measures across deciles. The combined lowest 5 deciles of hospitals include hospitals that have fewer than 5% African-American patients and have a median HF RSMR of 11.3% (range 6.4%- 19.4%). In comparison, hospitals in the highest decile with >25% African American patients have a median HF RSMR of 10.5% (range 6.7%-15.1%). These analyses demonstrate wide variation in hospital performance regardless of the proportion of minority patients and suggest that hospitals with large proportions of African American patients are not consistently performing at a lower or higher level than other hospitals.

1b
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Comment [KP2]: 1b. Demonstration of quality problems and opportunity for improvement, i.e., data demonstrating considerable variation, or overall poor performance, in the quality of care across providers and/or population groups (disparities in care).

Comment [k3]: 1 Examples of data on opportunity for improvement include, but are not limited to: prior studies, epidemiologic data, measure data from pilot testing or implementation. If data are not available, the measure focus is systematically assessed (e.g., expert panel rating) and judged to be a quality problem.

Similar analyses were completed to evaluate hospital differences in performance on RSMR based on the socioeconomic status (SES) of their patients. The SES analyses show a slightly higher median HF RSMR at the hospitals in the lowest quartile based on the SES of their patients (as measured by median of the patients' ZIP-code level median income). The median RSMR in the lowest quartile is 11.3% as compared to median RSMR of 10.8% for hospitals in highest quartile. However, as in the above analyses by race, the ranges for the two groups are largely overlapping (6.7%-19.4% vs. 6.9%-16.1%, respectively) demonstrating that substantial numbers of hospitals serving low SES patients perform well on the measure.

Overall these analyses provide little compelling evidence of clinically significant disparities at the hospital level.

1b.5 Citations for data on Disparities:
The sample for the above analyses is from a similar 3-year cohort of Medicare FFS hospitalizations as the data for the performance gap analysis above (January 2006- December 2008) but limited to hospitals with at least 25 HF cases over the 3-year period, a total of 4,175 hospitals.

1c. Outcome or Evidence to Support Measure Focus

1c.1 Relationship to Outcomes (*For non-outcome measures, briefly describe the relationship to desired outcome. For outcomes, describe why it is relevant to the target population*)**:** This measure calculates hospital-level, 30-day all-cause mortality rates after hospitalization for an HF. The goal is to directly affect patient outcomes by measuring risk-standardized rates of mortality.

1c.2-3. Type of Evidence: Systematic synthesis of research

1c.4 Summary of Evidence (*as described in the criteria; for outcomes, summarize any evidence that healthcare services/care processes influence the outcome*)**:**
Numerous studies have demonstrated that appropriate and timely treatment for HF patients can reduce the risk of mortality within 30 days of hospital admission. (Hunt 2009, Jha 2007) Additionally, trials of interventions which improve patient education upon discharge have been shown to improve survival for HF patients. (Mcalister 2001) Current process-based performance measures, however, cannot capture all the ways that care within the hospital might influence outcomes. As a result, many stakeholders, including patient organizations, are interested in outcomes measures that allow patients and providers to assess relative outcomes performance for hospitals.

References:

Hunt SA, Abraham WT, Chin MH, Feldman AM, Francis GS, Ganiats TG, Jessup M,Konstam MA, Mancini DM, Michl K, Oates JA, Rahko PS, Silver MA, Stevenson LW,Yancy CW; American College of Cardiology Foundation; American Heart Association.2009 Focused update incorporated into the ACC/AHA 2005 Guidelines for the Diagnosis and Management of Heart Failure in Adults A Report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines Developed in Collaboration With the International Society for Heart and Lung Transplantation. J Am Coll Cardiol. 2009 Apr 14;53(15):e1-e90.

Jha AK, Orav EJ, Li Z, Epstein AM. The inverse relationship between mortality rates and performance in the Hospital Quality Alliance measures. Health Aff (Millwood) 2007 Jul-Aug;26(4):1104-10.

McAllister FA, Lawson FME, Teo KK, Armstrong PW: A systematic review of
randomized trials of disease management programs in heart failure. Am J Med 2001, 110:378-384

1c.5 Rating of strength/quality of evidence (*also provide narrative description of the rating and by whom***):**
N/A (outcomes measure)

1c.6 Method for rating evidence: N/A (outcomes measure)

1c.7 Summary of Controversy/Contradictory Evidence: Use of Hierarchical Generalized Linear Modeling
Hierarchical modeling is the appropriate statistical approach for hospital outcomes measures given the structure of the data and the underlying assumption of such measures, which is that hospital quality of care influences 30-day mortality rates. However, CMS frequently receives comments and questions about this

1c
C ☐
P ☐
M ☐
N ☐

Comment [k4]: 1c. The measure focus is:
•an outcome (e.g., morbidity, mortality, function, health-related quality of life) that is relevant to, or associated with, a national health goal/priority, the condition, population, and/or care being addressed;
OR
•if an intermediate outcome, process, structure, etc., there is **evidence** that supports the specific measure focus as follows:
oIntermediate outcome – evidence that the measured intermediate outcome (e.g., blood pressure, Hba1c) leads to improved health/avoidance of harm or cost/benefit.
oProcess – evidence that the measured clinical or administrative process leads to improved health/avoidance of harm and
if the measure focus is on one step in a multi-step care process, it measures the step that has the greatest effect on improving the specified desired outcome(s).
oStructure – evidence that the measured structure supports the consistent delivery of effective processes or access that lead to improved health/avoidance of harm or cost/benefit.
oPatient experience – evidence that an association exists between the measure of patient experience of health care and the outcomes, values and preferences of individuals/ the public.
oAccess – evidence that an association exists between access to a health service and the outcomes of, or experience with, care. ... [1]

Comment [k5]: 4 Clinical care processes typically include multiple steps: assess → identify problem/potential problem → choose/plan intervention (with patient input) → provide intervention → evaluate impact on health status. If the measure focus is one step in such a multi-step process, the step with the greatest effect on the desired outcome should be selected as the focus of measurement. For example, although assessment of immunization status and recommending immunization are necessary steps, they are not sufficient to achieve the desired impact on health status – patients must be vaccinated to achieve immunity. This does not preclude consideration of measures of preventive screening interventions where there is a strong link with desired outcomes (e.g., mammography) or measures for multiple care processes that affect a single outcome.

Comment [k6]: 3 The strength of the body of evidence for the specific measure focus should be systematically assessed and rated (e.g., USPSTF grading system http://www.ahrq.gov/clinic/uspstf07/methods/benefit.htm). If the USPSTF grading system was not used, the grading system is explained including how it relates to the USPSTF grades or why it does not. However, evidence is not limited to quantitative studies and the best type of evidence depends upon the question being studied (e.g., randomized controlled trials appropriate for studying drug efficacy are not well suited for complex system changes). When qualitative studies are used, appropriate qualitative research criteria are used to judge the strength of the evidence.

approach, so we are concisely reiterating the rationale for and merits of using hierarchiacal logistic regression. Patients are clustered within hospitals and, as such, have a shared exposure to the hospital quality and processes. The use of hierarchical modeling accounts for the clustering of patients within hospitals. Second, hierarchical models distinguish within-hospital variation and between-hospital variation to estimate the hospital's contribution to the risk of readmission. This allows for an estimation of the hospital's influence on patient outcomes. Finally, within hierarchical models we can account for both differences in case mix and sample size to fairly profile hospital performance. If we did not use hierarchical modeling we could overestimate variation and potentially misclassify hospitals' performance. Accurately estimating variation is an important objective for models used in public reporting and potentially used in value-based purchasing programs.

Effect of Patient Preferences Regarding End of Life Care
Some stakeholders have expressed concerns that our measure cannot adequately exclude patients who choose comfort measures or palliative care during their index hospitalization. Stakeholders are concerned that this could lead to unintended consequences, such as prolonging lives against patient wishes. To address these issues CMS has taken the following steps when applying the measure to the Medicare FFS population aged 65 years or older:

(1) We have added an exclusion for patients who are enrolled in hospice prior to, or on the day of, admission.

(2) We chose not to exclude patients who are discharged to hospice or seek a palliative care consult during admission to account for the fact that the choice of palliative/comfort care may be the result of poor care.

(3) To account for risk-factors associated with the end of life we include markers of frailty within our risk-adjustment variables, including: protein-calorie malnutrition, dementia or senility, and hemiplegia, paraplegia, paralysis and functional disability.

(4) Although CMS is confident in the current model, CMS will further consider clinical and measurement issues for patients for whom survival is not an objective.

1c.8 Citations for Evidence (*other than guidelines***):** N/A

1c.9 Quote the Specific guideline recommendation (*including guideline number and/or page number***):**
N/A

1c.10 Clinical Practice Guideline Citation: N/A
1c.11 National Guideline Clearinghouse or other URL: N/A

1c.12 Rating of strength of recommendation (*also provide narrative description of the rating and by whom***):**
N/A

1c.13 Method for rating strength of recommendation (*If different from USPSTF system, also describe rating and how it relates to USPSTF)***:**
N/A

1c.14 Rationale for using this guideline over others:
N/A

TAP/Workgroup: What are the strengths and weaknesses in relation to the subcriteria for *Importance to Measure and Report*?	**1**
Steering Committee: Was the threshold criterion, *Importance to Measure and Report***, met?** **Rationale:**	**1** **Y☐** **N☐**
2. SCIENTIFIC ACCEPTABILITY OF MEASURE PROPERTIES	

Comment [k7]: USPSTF grading system **http://www.ahrq.gov/clinic/uspstf/grades.htm**: **A -** The USPSTF recommends the service. There is high certainty that the net benefit is substantial. **B -** The USPSTF recommends the service. There is high certainty that the net benefit is moderate or there is moderate certainty that the net benefit is moderate to substantial. **C -** The USPSTF recommends against routinely providing the service. There may be considerations that support providing the service in an individual patient. There is at least moderate certainty that the net benefit is small. Offer or provide this service only if other considerations support the offering or providing the service in an individual patient. **D -** The USPSTF recommends against the service. There is moderate or high certainty that the service has no net benefit or that the harms outweigh the benefits. **I -** The USPSTF concludes that the current evidence is insufficient to assess the balance of benefits and harms of the service. Evidence is lacking, of poor quality, or conflicting, and the balance of benefits and harms cannot be determined.

Extent to which the measure, as specified, produces consistent (reliable) and credible (valid) results about the quality of care when implemented. (evaluation criteria)	Eval Rating
2a. MEASURE SPECIFICATIONS	
S.1 Do you have a web page where current detailed measure specifications can be obtained? **S.2 If yes, provide web page URL:** **2a. Precisely Specified**	
2a.1 Numerator Statement (*Brief, text description of the numerator - what is being measured about the target population, e.g. target condition, event, or outcome***):** This outcome measure does not have a traditional numerator and denominator like a core process measure (e.g., percentage of adult patients with diabetes aged 18-75 years receiving one or more hemoglobin A1c tests per year); thus, we are using this field to define the outcome. The outcome for this measure is 30-day all-cause mortality. We define mortality as death from any cause within 30 days of the index admission date for patients 18 and older discharged from the hospital with a principal diagnosis of HF. **2a.2 Numerator Time Window (***The time period in which cases are eligible for inclusion in the numerator***):** Patients who die within 30 days of the index admission date. **2a.3 Numerator Details (***All information required to collect/calculate the numerator, including all codes, logic, and definitions***):** Measure includes deaths from any cause within 30 days from admission date of index hospitalization.	
2a.4 Denominator Statement (*Brief, text description of the denominator - target population being measured***):** Note: This outcome measure does not have a traditional numerator and denominator like a core process measure; thus, we are using this field to define the patient cohort and to define exclusions to the patient cohort. This claims-based measure can be used in either of two patient cohorts: (1) patients aged 65 years or older or (2) patients aged 18 years or older. While the measure can be applied to populations aged 18 years or older, nationally data are often only available for patients aged 65 years or older. We have explicitly tested the measure in both age groups. The cohort includes admissions for patients discharged from the hospital with a principal diagnosis of HF (ICD-9-CM codes 402.01, 402.11, 402.91, 404.01, 404.03, 404.11, 404.13, 404.91, 404.93, and 428.xx) and with a complete claims history for the 12 months prior to admission. Patients who are transferred from one acute care facility to another must have a principal discharge diagnosis of HF at both hospitals. The initial hospital for a transferred patient is designated as the responsible institution for the episode. If a patient has more than one HF admission in a year, one hospitalization is randomly selected for inclusion in the measure. **2a.5 Target population gender:** Female, Male **2a.6 Target population age range:** The target population is age 18 years or older **2a.7 Denominator Time Window (***The time period in which cases are eligible for inclusion in the denominator***):** This measure was developed with 12 months of data. Currently the measure is publicly-reported with three years of index hospitalizations. **2a.8 Denominator Details (***All information required to collect/calculate the denominator - the target population being measured - including all codes, logic, and definitions***):** The denominator includes patients aged 18 and older admitted to non-federal acute care hospitals for an HF defined by a principal discharge diagnosis of (ICD-9-CM codes 402.01, 402.11, 402.91, 404.01, 404.03,	**2a-specs** C☐ P☐ M☐ N☐

Comment [KP8]: 2a. The measure is well defined and precisely specified so that it can be implemented consistently within and across organizations and allow for comparability. The required data elements are of high quality as defined by NQF's Health Information Technology Expert Panel (HITEP) .

404.11, 404.13, 404.91, 404.93, and 428.xx) and with a complete claims history for the 12 months prior to admission.

ICD-9-CM codes that define the patient cohort:
402.01 Hypertensive heart disease, malignant, with heart failure
402.11 Hypertensive heart disease, benign, with heart failure
402.91 Hypertensive heart disease, unspecified, with heart failure
404.01 Hypertensive heart and chronic kidney disease, malignant, with heart failure and with chronic kidney disease stage I through stage IV, or unspecified
404.03 Hypertensive heart and chronic kidney disease, malignant, with heart failure and with chronic kidney disease stage V or end stage renal disease
404.11 Hypertensive heart and chronic kidney disease, benign, with heart failure and with chronic kidney disease stage I through stage IV, or unspecified
404.13 Hypertensive heart and chronic kidney disease, benign, with heart failure and chronic kidney disease stage V or end stage renal disease
404.91 Hypertensive heart and chronic kidney disease, unspecified, with heart failure and with chronic kidney disease stage I through stage IV, or unspecified
404.93 Hypertensive heart and chronic kidney disease, unspecified, with heart failure and chronic kidney disease stage V or end stage renal disease
428.0 Congestive heart failure, unspecified
428.1 Left heart failure
428.20 Unspecified systolic heart failure
428.21 Acute systolic heart failure
428.22 Chronic systolic heart failure
428.23 Acute on chronic systolic heart failure
428.30 Unspecified diastolic heart failure
428.31 Acute diastolic heart failure
428.32 Chronic diastolic heart failure
428.33 Acute on chronic diastolic heart failure
428.40 Unspecified combined systolic and diastolic heart failure
428.41 Acute combined systolic and diastolic heart failure
428.42 Chronic combined systolic and diastolic heart failure
428.43 Acute on chronic combined systolic and diastolic heart failure
428.9 Heart Failure, unspecified

2a.9 Denominator Exclusions (*Brief text description of exclusions from the target population***):** For all cohorts, the measure excludes admissions for patients:
• who were discharged on the day of admission or the following day and did not die or get transferred (because it is less likely they had a significant HF diagnosis);
• who were transferred from another acute care hospital (because the death is attributed to the hospital where the patient was initially admitted);
• with inconsistent or unknown mortality status or other unreliable data (e.g. date of death precedes admission date);
• who were discharged alive and against medical advice (AMA) (because providers did not have the opportunity to deliver full care and prepare the patient for discharge);
• that were not the first hospitalization in the 30 days prior to a patient's death. We use this criteria to prevent attribution of a death to two admissions.

For Medicare FFS patients, the measure additionally excludes admissions for patients:
• enrolled in the Medicare Hospice program any time in the 12 months prior to the index hospitalization including the first day of the index admission (since it is likely these patients are continuing to seek comfort measures only). Although this exclusion currently applies to Medicare FFS patients, it could be expanded to include all payer data if an acceptable method for identifying hospice patients outside of Medicare becomes available.

2a.10 Denominator Exclusion Details (*All information required to collect exclusions to the denominator, including all codes, logic, and definitions***):**
See "Denominator Exclusions" section.

Comment [k9]: 11 Risk factors that influence outcomes should not be specified as exclusions.
12 Patient preference is not a clinical exception to eligibility and can be influenced by provider interventions.

2a.11 Stratification Details/Variables (*All information required to stratify the measure including the stratification variables, all codes, logic, and definitions***):**
Results of this measure will not be stratified.

2a.12-13 Risk Adjustment Type: Risk-adjustment devised specifically for this measure/condition

2a.14 Risk Adjustment Methodology/Variables (*List risk adjustment variables and describe conceptual models, statistical models, or other aspects of model or method***):**
Our approach to risk adjustment was tailored to and appropriate for a publicly reported outcome measure, as articulated in the American Heart Association (AHA) Scientific Statement, "Standards for Statistical Models Used for Public Reporting of Health Outcomes" (Krumholz et al. 2006).

The measure employs a hierarchical logistic regression model (a form of hierarchical generalized linear model [HGLM]) to create a hospital-level 30-day RSMR. This approach to modeling appropriately accounts for the structure of the data (patients clustered within hospitals), the underlying risk due to patients' comorbidities, and sample size at a given hospital when estimating hospital mortality rates. In brief, the approach simultaneously models two levels (patient and hospital) to account for the variance in patient outcomes within and between hospitals (Normand and Shahian et al. 2007). At the patient level, each model adjusts the log-odds of mortality within 30-days of admission for age, sex, selected clinical covariates and a hospital-specific intercept. The second level models the hospital-specific intercepts as arising from a normal distribution. The hospital intercept, or hospital-specific effect, represents the hospital contribution to the risk of mortality, after accounting for patient risk and sample size, and can be inferred as a measure of quality. The hospital-specific intercepts are given a distribution in order to account for the clustering (non-independence) of patients within the same hospital. If there were no differences among hospitals, then after adjusting for patient risk, the hospital intercepts should be identical across all hospitals.

Candidate and Final Risk-adjustment Variables: The measure was developed using Medicare FFS claims data. Candidate variables were patient-level risk-adjustors that are expected to be predictive of mortality, based on empirical analysis, prior literature, and clinical judgment, including demographic factors (age, sex) and indicators of comorbidity and disease severity. For each patient, covariates were obtained from Medicare claims extending 12 months prior to and including the index admission. The model adjusted for case differences based on the clinical status of the patient at the time of admission. We used condition categories (CCs), which are clinically meaningful groupings of more than 15,000 ICD-9-CM diagnosis codes. We did not risk-adjust for CCs that were possible adverse events of care and that were only recorded in the index admission. In addition, only comorbidities that conveyed information about the patient at that time or in the 12-months prior, and not complications that arose during the course of the hospitalization were included in the risk-adjustment.

The final set of risk-adjustment variables is:

Demographic

• Age-65 (years above 65, continuous) for 65 and over cohorts; or Age (years, continuous) for 18 and over cohorts
• Male

Cardiovascular
• History of PTCA
• History of CABG
• Congestive heart failure
• Acute myocardial infarction
• Unstable angina
• Chronic atherosclerosis
• Cardio-respiratory failure and shock
• Valvular and rheumatic heart disease

Comorbidity
• Hypertension
• Stroke

- Renal failure
- Pneumonia
- Diabetes and DM complications
- Protein-calorie malnutrition
- Dementia and senility
- Hemiplegia, paraplegia, paralysis, functional disability
- Peripheral vascular disease
- Metastatic cancer, acute leukemia, and other severe cancers
- Trauma in last year
- Major psych disorders
- Chronic liver disease

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References:
Krumholz HM, Brindis RG, Brush JE, et al. 2006. Standards for Statistical Models Used for Public Reporting of Health Outcomes: An American Heart Association Scientific Statement From the Quality of Care and Outcomes Research Interdisciplinary Writing Group: Cosponsored by the Council on Epidemiology and Prevention and the Stroke Council Endorsed by the American College of Cardiology Foundation. Circulation 113: 456-462.

Normand S-LT, Shahian DM. 2007. Statistical and Clinical Aspects of Hospital Outcomes Profiling. Stat Sci 22 (2): 206-226.

2a.15-17 Detailed risk model available Web page URL or attachment: URL N/A
http://www.qualitynet.org/dcs/ContentServer?c=Page&pagename=QnetPublic%2FPage%2FQnetTier3&cid=1163010421830

2a.18-19 Type of Score: Rate/proportion
2a.20 Interpretation of Score: Better quality = Lower score
2a.21 Calculation Algorithm (*Describe the calculation of the measure as a flowchart or series of steps***):**
The RSMR is calculated as the ratio of the number of "adjusted actual" deaths (also known as "predicted") to the number of "expected" deaths at a given hospital, multiplied by the national unadjusted mortality rate. For each hospital, the "numerator" of the ratio is the number of deaths within 30 days predicted on the basis of the hospital's performance with its observed case mix, and the "denominator" is the number of deaths expected on the basis of the nation's performance with that hospital's case mix. This approach is analogous to a ratio of "observed" to "expected" used in other types of statistical analyses. It conceptually allows for a comparison of a particular hospital's performance given its case-mix to an average hospital's performance with the same case-mix. Thus a lower ratio indicates lower-than-expected mortality or better quality and a higher ratio indicates higher-than-expected mortality or worse quality.

The "adjusted actual" deaths (the numerator)is calculated by regressing the risk factors and the hospital-specific intercept on the risk of mortality, multiplying the estimated regression coefficients by the patient characteristics in the hospital, transforming, and then summing over all patients attributed to the hospital to get a value. The expected number of deaths (the denominator) is obtained by regressing the risk factors and a common intercept on the mortality outcome using all hospitals in our sample, multiplying the subsequent estimated regression coefficients by the patient characteristics observed in the hospital, transforming, and then summing over all patients in the hospital to get a value.

To assess hospital performance in any reporting period, the model coefficients are re-estimated using the years of data in that period.

2a.22 Describe the method for discriminating performance *(e.g., significance testing)***:**
CMS currently estimates an interval estimate for each risk-standardized rate to characterize the amount of uncertainty associated with the rate, compares the interval estimate to the national crude rate for the outcome, and categorizes hospitals as "better than," "worse than," or "no different than" the US national rate.

2a.23 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 –This measure is not based on a sample or survey.

2a.24 Data Source (*Check the source(s) for which the measure is specified and tested)*
Administrative claims, Other

2a.25 Data source/data collection instrument (*Identify the specific data source/data collection instrument, e.g. name of database, clinical registry, collection instrument, etc.***):**
Two data sources were used to create the measure:
1. Medicare Part A Inpatient and Outpatient and Part B outpatient claims: This database contains claims data for fee-for service inpatient and outpatient services including: Medicare inpatient hospital care, outpatient hospital services, skilled nursing facility care, some home health agency services, and hospice care, as well as inpatient and outpatient claims for the 12 months prior to an index admission.

2. Medicare Enrollment Database (EDB): This database contains Medicare beneficiary demographic, benefit/coverage, and vital status information. This dataset was used to obtain information on several inclusion/exclusion indicators such as Medicare status on admission as well as vital status. These data have previously been shown to accurately reflect patient vital status (Fleming Fisher et al. 1992).

The measure was originally developed with claims data from a 1998 sample of 222,424 cases from 5,087 hospitals. The models have been maintained and re-evaluated each year since public reporting of the measures began in 2007. For details, see measure methodology and measure maintenance reports posted at http://qualitynet.org/dcs/ContentServer?c=Page&pagename=QnetPublic%2FPage%2FQnetTier3&cid=1219069855841

The measure was subsequently applied to California Patient Discharge Data, a large, linked all-payer database of patient hospital admissions. Records are linked by a unique patient identification number, allowing us to determine patient history from previous hospitalizations. In addition, the unique patient ID number is used to link with state vital statistics records to assess 30-day mortality.
To apply the measure to Medicare data, Medicare Part A inpatient and outpatient and Part B outpatient claims are used. To apply the measure to a non-Medicare population, inpatient claims data are used.

Fleming C., Fisher ES, Chang CH, Bubolz D, Malenda J. Studying outcomes and hospital utilization in the elderly: The advantages of a merged data base for Medicare and Veterans Affairs Hospitals. Medical Care. 1992; 30(5): 377-91.

2a.26-28 Data source/data collection instrument reference web page URL or attachment: URL N/A
http://qualitynet.org/dcs/ContentServer?c=Page&pagename=QnetPublic%2FPage%2FQnetTier3&cid=1219069855841

2a.29-31 Data dictionary/code table web page URL or attachment: URL N/A Condition Category/ICD-9 Code Map available at:
http://www.qualitynet.org/dcs/ContentServer?c=Page&pagename=QnetPublic%2FPage%2FQnetTier3&cid=1182785083979

2a.32-35 Level of Measurement/Analysis (*Check the level(s) for which the measure is specified and tested)*
Facility

2a.36-37 Care Settings (*Check the setting(s) for which the measure is specified and tested)*
Hospital/Acute Care Facility

2a.38-41 Clinical Services (*Healthcare services being measured, check all that apply*)

TESTING/ANALYSIS

2b. Reliability testing — **2b** C☐ P☐ M☐ N☐

2b.1 Data/sample *(description of data/sample and size)***:** The reliability of the model was tested by randomly selecting 50% of Medicare FFS patients aged 65+ in the initial one-year cohort and developing a risk-adjusted model for this group. We then developed a second model for the remaining 50% of patients.

Comment [KP10]: 2b. Reliability testing demonstrates the measure results are repeatable, producing the same results a high proportion of the time when assessed in the same population in the same time period.

Furthermore, in each subsequent year of measure maintenance we have re-fit the model and compared the frequencies of comorbidities and model fit across 3 years.

2b.2 Analytic Method *(type of reliability & rationale, method for testing)*:
In measure development and testing, for all cohorts, we computed diagnostics that describe their respective performance in terms of discriminant ability, overall fit, and generated hospital RSMRs and corresponding interval estimates for the development sample.

2b.3 Testing Results *(reliability statistics, assessment of adequacy in the context of norms for the test conducted)*:
See results under "Risk-Adjustment Strategy" Section 2e.3 below.

2c. Validity testing

2c.1 Data/sample *(description of data/sample and size)*: Measure development and testing included medical record validation. For the derivation of the chart-based model, we used cases identified through a Health Care Financing Administration (now CMS) quality initiative, which sampled admissions from fee-for-service Medicare beneficiaries for several clinical conditions, including HF. Cases were identified over a 6-month period within each state, plus the District of Columbia and Puerto Rico, during the period April 1, 1998 through October 31, 1999. Based on the principal discharge diagnosis, approximately 800 HF discharges per state were identified, and the corresponding medical records were abstracted by 2 clinical data abstraction centers. In states with fewer than 900 HF discharges, all cases were used. The abstractors first sorted the universe of eligible claims by age, race, sex, and hospital, then systematically sampled cases from a random starting point. Patients must have been enrolled in fee-for-service Medicare; Medicare managed care (Medicare + Choice) beneficiaries were excluded. CMS subsequently conducted a re-measurement using the same data collection methodology for 2000 and 2001 discharges, and the combined 1998-2001 data, including 73,832 patients, served as the national heart failure (NHF) dataset for development of the chart-based model.

2c.2 Analytic Method *(type of validity & rationale, method for testing)*:
Medical-record validation: We developed a medical record measure to compare with the administrative measure. We developed a measure cohort with the medical record data using the inclusion/exclusion criteria and risk-adjustment strategy that was consistent with the claims-based administrative measure but using chart-based risk adjusters, such as blood pressure, not available in the claims data. We then matched a sample of the same patients in the administrative data for comparison. The matched sample included 46,700 patients. We compared the output of the two measures, that is the state performance results, in the same group of patients.

2c.3 Testing Results *(statistical results, assessment of adequacy in the context of norms for the test conducted)*:
The results of the medical-record validation were produced at the state level. The mortality medical record model had a c-statistic of 0.78. The correlation coefficient for the results of the administrative model compared to the medical-record model was very high, at 0.95.

2c
C☐
P☐
M☐
N☐

2d. Exclusions Justified

2d.1 Summary of Evidence supporting exclusion(s):
Rationale for exclusions described in "Denominator Exclusions"

2d.2 Citations for Evidence:
See "Denominator Exclusions"

2d.3 Data/sample *(description of data/sample and size)*: N/A

2d.4 Analytic Method *(type analysis & rationale)*:
N/A

2d.5 Testing Results *(e.g., frequency, variability, sensitivity analyses)*:
N/A

2d
C☐
P☐
M☐
N☐
NA☐

Comment [k11]: 8 Examples of reliability testing include, but are not limited to: inter-rater/abstractor or intra-rater/abstractor studies; internal consistency for multi-item scales; test-retest for survey items. Reliability testing may address the data items or final measure score.

Comment [KP12]: 2c. Validity testing demonstrates that the measure reflects the quality of care provided, adequately distinguishing good and poor quality. If face validity is the only validity addressed, it is systematically assessed.

Comment [k13]: 9 Examples of validity testing include, but are not limited to: determining if measure scores adequately distinguish between providers known to have good or poor quality assessed by another valid method; correlation of measure scores with another valid indicator of quality for the specific topic; ability of measure scores to predict scores on some other related valid measure; content validity for multi-item scales/tests. Face validity is a subjective assessment by experts of whether the measure reflects the quality of care (e.g., whether the proportion of patients with BP < 140/90 is a marker of quality). If face validity is the only validity addressed, it is systematically assessed (e.g., ratings by relevant stakeholders) and the measure is judged to represent quality care for the specific topic and that the measure focus is the most important aspect of quality for the specific topic.

Comment [KP14]: 2d. Clinically necessary measure exclusions are identified and must be:
•supported by evidence of sufficient frequency of occurrence so that results are distorted without the exclusion;
AND
•a clinically appropriate exception (e.g., contraindication) to eligibility for the measure focus;
AND
•precisely defined and specified:
–if there is substantial variability in exclusions across providers, the measure is specified so that exclusions are computable and the effect on the measure is transparent (i.e., impact clearly delineated, such as number of cases excluded, exclusion rates by type of exclusion);
if patient preference (e.g., informed decision-making) is a basis for exclusion, there must be evidence that it strongly impacts performance on the measure and the measure must be specified so that the information about patient preference and the effect on the measure is transparent (e.g., numerator category computed separately, denominator exclusion category computed separately).

Comment [k15]: 10 Examples of evidence that an exclusion distorts measure results include, but are not limited to: frequency of occurrence, sensitivity analyses with and without the exclusion, and variability of exclusions across providers.

2e. Risk Adjustment for Outcomes/ Resource Use Measures

2e.1 Data/sample *(description of data/sample and size)*: When applied to Medicare FFS beneficiaries, the prior year of data from Medicare Part A inpatient and outpatient data and Part B outpatient data are used to identify variables for risk-adjustment. Specifically, Medicare Part A inpatient data areused to identify variables for risk adjustment in the index admission. Part A and B outpatient data are used to identify variables for risk adjustment in the 12-month period preceding the index date of admission.

Application to Medicare FFS Beneficiaries Using Inpatient Data Only for Risk Adjustment
As part of testing the model in all-payer data, we also applied the model to CMS data for Medicare FFS 65+ patients in California hospitals using only inpatient data for risk adjustment. California is a diverse state, and, with more than 37 million residents, California represents 12% of the US population. Specifically, we created a 2006 measure cohort with complete one-year history data and 30-day follow-up data (N= 24,035).

Application to Patients Aged 18 and Older
We also applied the model to all-payer data from California. The analytic sample included 60,022 cases aged 18 and older in the 2006 California Patient Discharge Data. When used in all-payer data, only admission claims data are used for risk adjustment, as the hospital discharge databases do not have outpatient claims.

2e.2 Analytic Method *(type of risk adjustment, analysis, & rationale)*:
This measure is fully risk-adjusted using a hierarchical logistic regression model to calculate hospital RSMRs accounting for differences in hospital case-mix. (See "risk adjustment methodology" for additional details.)
Approach to assessing model performance:
During measure development, we computed five summary statistics for assessing model performance (Harrell and Shih 2001) for the development and validation cohort:
(1) over-fitting indices (over-fitting refers to the phenomenon in which a model accurately describes the relationship between predictive variables and outcome in the development dataset but fails to provide valid predictions in new patients)
(2) predictive ability
(3) area under the receiver operating characteristic (ROC) curve
(4) distribution of residuals
(5) model chi-square (A test of statistical significance usually employed for categorical data to determine whether there is a good fit between the observed data and expected values; i.e., whether the differences between observed and expected values are attributable to true differences in characteristics or instead the result of chance variation).

Application to Medicare FFS Beneficiaries Using Inpatient Data Only for Risk Adjustment
To help determine whether the measure could be applied to Medicare FFS 65+ patients using only Medicare Part A data, we performed analyses to assess how the model performs when using only admission claims data for risk adjustment, as all-payer hospital discharge databases do not have outpatient claims. To assess the validity of using only admission claims data for risk adjustment, we fit the model separately using the full data and using only admission claims data and (a) compared the odds ratios (ORs) for the various risk factors; (b) conducted a reclassification analysis to compare risk prediction at the patient level; (c) compared model performance in terms of the c-statistic (discrimination); and (d) compared hospital-level risk-standardized rates (scatterplot, correlation coefficient, and R2) to assess whether the model with only admission claims data is different from the current model in profiling hospital rates.

Application to Patients Aged 18 and Older
To help determine whether the measure could be applied to an population of patients aged 18+, we examined the interaction terms between age (18-64 vs. 65+) and each of the other risk factors. Specifically, we fit the model in all patients 18+ with and without interaction terms and (a) conducted a reclassification analysis to compare risk prediction at the patient level; (b) compared the c-statistic; and (c) compared hospital-level risk-standardized rates (scatterplot, correlation coefficient, and R2) to assess whether the model with interactions is different from the current model in profiling hospital rates.

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Reference: Harrell FE, Shih YCT. Using full probability models to compute probabilities of actual interest to decision makers. Int J Technol Assess Health Care. 2001;17:17-26.

2e
C☐
P☐
M☐
N☐
NA ☐

Comment [KP16]: 2e. For outcome measures and other measures (e.g., resource use) when indicated:
•an evidence-based risk-adjustment strategy (e.g., risk models, risk stratification) is specified and is based on patient clinical factors that influence the measured outcome (but not disparities in care) and are present at start of care;[Error! Bookmark not defined.] OR rationale/data support no risk adjustment.

Comment [k17]: 13 Risk models should not obscure disparities in care for populations by including factors that are associated with differences/inequalities in care such as race, socioeconomic status, gender (e.g., poorer treatment outcomes of African American men with prostate cancer, inequalities in treatment for CVD risk factors between men and women). It is preferable to stratify measures by race and socioeconomic status rather than adjusting out differences.

2e.3 Testing Results *(risk model performance metrics)*:
During initial measure development, using Medicare FFS beneficiaries age 65 and over, we tested the performance of the model developed in a random selected half of the 1998 hospitalizations for HF (representing 222,424 cases discharged from 5,087 hospitals) against hospitalizations from the other half(representing 222,157 cases discharged from 5,088 hospitals). The performance was not substantively different in the validation sample (ROC area = 0.70) compared with the development sample (1998). The models appear well calibrated, with over-fitting indices of (-0.0035, 0.9928).

For the development cohort, model performance results are summarized below:
Residuals lack of fit (<2, [-2,0),[0,2),[2+): 0.00, 87.85, 3.76, 8.39
Model Chi-square [# of covariates]: 11,521 [24]
Predictive ability (lowest decile %, highest decile %): 3.0%-28.5%
Area under ROC curve: .71

For the validation cohort the results are summarized below:
Residuals lack of fit (<2, [-2,0),[0,2),[2+): 0.00, 87.76, 3.83, 8.41
Model Chi-square [# of covariates]: 11444 [24]
Predictive ability (lowest decile %, highest decile %): 2.8%- 29.0%
Area under ROC curve: .70

In subsequent years, during annual measure maintenance we looked at the distributions of comorbid conditions, hospital volume, crude rates, hospital RSMR, risk-adjusted odds ratios and 95% confidence intervals, and between-hospital variance over each subsequent year since 2005 and the and the parameters have remained consistent. For the 2005-2007 and 2006-2008 calendar year datasets, we reported each individual year results as well as the 3-year combined results. Model performance was stable over all time periods.

Model Performance in Medicare FFS Beneficiaries Using Inpatient Data Only for Risk Adjustment Using CMS data for Medicare FFS 65+ beneficiaries in California hospitals: (a) the magnitude of odds ratios for most risk factors was similar when comparing the model using full data and using only admission claims data; (b) when comparing the model with full data and with only admission claims data, the reclassification analysis demonstrated good patient-level risk prediction; (c) the c-statistic was similar (0.681 vs. 0.684); and (d) hospital-level risk-standardized rates were highly correlated (r=0.993).

Model Perfomance in Patients Aged 18 and Older
When the model was applied to all patients 18 and over (18+), overall discrimination was good (c-statistic=0.718). In addition, there was good discrimination and predictive ability in both those aged 18-64 and those aged 65+. Moreover, the distribution of Pearson residuals was comparable across the patient subgroups. When comparing the model with and without interaction terms, (a) the reclassification analysis demonstrated good patient-level risk prediction (1.9% to 25.4% vs. 2.0% to 25.1%, respectively, from the bottom decile to the top decile of the prediction values); (b) the c-statistic was nearly identical (0.720 vs. 0.718); and (c) hospital-level risk-standardized rates were highly correlated (r=1.000). Thus, the inclusion of the interactions did not substantively affect either patient-level model performance or hospital-level results.

Therefore, the measure can be applied to all payer data for patients 18 and older.

References:

Krumholz HM, Normand S-LT, Galusha DH, Mattera JA, Rich AS, Wang YF, Wang Y. et al. Risk-Adjustment Models for AMI and HF: 30-Day Mortality: Report prepared for the Centers for Medicare & Medicaid Services; 2005. Available at: http://www.qualitynet.org/

Bernheim SM, et al. 2010 Measures Maintenance Technical Report: Acute Myocardial Infarction, Heart Failure and Pneumonia 30-day Risk Standardized Mortality Rate. 2010 Available at: http://www.qualitynet.org/dcs/ContentServer?c=Page&pagename=QnetPublic/Page/QnetTier3&cid=1163010421830

2e.4 If outcome or resource use measure is not risk adjusted, provide rationale: N/A—The measure is risk-adjusted

2f. Identification of Meaningful Differences in Performance

2f.1 Data/sample from Testing or Current Use *(description of data/sample and size)***:** The data below are based on RSMRs calculated for HF hospitalizations among Medicare FFS patients aged 65+ from July 1, 2006-June 30, 2009 and includes 1,096,751 hospitalizations from 4,743 hospitals. The index hospitalizations are those included in the measure and reported in the 2010 update to Hospital Compare.

2f.2 Methods to identify statistically significant and practically/meaningfully differences in performance *(type of analysis & rationale)***:**
For each RSMR, CMS characterizes the uncertainty associated with the RSMR by estimating the 95% interval estimate. This is similar to a 95% confidence interval but is calculated differently. If the RSMR's interval estimate does not include the national crude mortality rate (is lower or higher than the rate), then CMS is confident that the hospital's RSMR is different from the national rate, and describes the hospital on the Hospital Compare Web site as "better than the U.S. national rate" or "worse than the U.S. national rate." If the interval includes the national rate, then CMS describes the hospital's RSMR as "no different than the U.S. national rate" or "the difference is uncertain." CMS does not classify performance for hospitals that have fewer than 25 HF cases in the three-year period.

2f.3 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)***:**
Recent analyses of Medicare FFS data show substantial variation in HF RSMRs among hospitals. For the most recently reported three years of data (7/2006-6/2009) the mean hospital RSMR was 10.8% with a range of 6.6% to 18.2%. The 5th percentile was 8.4% and the 95th percentile was 13.4%. The interquartile range was 9.9% to 11.7%.

Bernheim SM, Grady JN, Lin Z, Wang Y, Wang Y, Savage SV, Bhat KR, Ross JS, Desai MM, Merrill AR, Han LF, Rapp MT, Drye EE, Normand SL, Krumholz HM. National patterns of risk-standardized mortality and readmission for acute myocardial infarction and heart failure. Update on publicly reported outcomes measures based on the 2010 release. Circ Cardiovasc Qual Outcomes. 2010 Sep 1;3(5):459-67. Epub 2010 Aug 24.

2f
C☐ P☐ M☐ N☐

2g. Comparability of Multiple Data Sources/Methods

2g.1 Data/sample *(description of data/sample and size)***:** The measure performs well in both Medicare FFS data and all-payer data.

2g.2 Analytic Method *(type of analysis & rationale)***:**
See above

2g.3 Testing Results *(e.g., correlation statistics, comparison of rankings)***:**
See above

2g
C☐ P☐ M☐ N☐ NA☐

2h. Disparities in Care

2h.1 If measure is stratified, provide stratified results *(scores by stratified categories/cohorts)***:** N/A – Measure is not stratified

2h.2 If disparities have been reported/identified, but measure is not specified to detect disparities, provide follow-up plans:
The analyses performed by CMS (described in section 1b) demonstrate that hospitals have similar and overlapping performance on the measure regardless of the proportion of patients of low socioeconomic status or of African-American race. Importantly, the analyses show that hospitals with high proportions of low socioeconomic status patients or high proportions of African-American patients are able to perform well on the measure. For this reason CMS does not plan to stratify the measure.

2h
C☐ P☐ M☐ N☐ NA☐

Comment [KP18]: 2f. Data analysis demonstrates that methods for scoring and analysis of the specified measure allow for identification of statistically significant and practically/clinically meaningful differences in performance.

Comment [k19]: 14 With large enough sample sizes, small differences that are statistically significant may or may not be practically or clinically meaningful. The substantive question may be, for example, whether a statistically significant difference of one percentage point in the percentage of patients who received smoking cessation counseling (e.g., 74% v. 75%) is clinically meaningful; or whether a statistically significant difference of $25 in cost for an episode of care (e.g., $5,000 v. $5,025) is practically meaningful. Measures with overall poor performance may not demonstrate much variability across providers.

Comment [KP20]: 2g. If multiple data sources/methods are allowed, there is demonstration they produce comparable results.

Comment [KP21]: 2h. If disparities in care have been identified, measure specifications, scoring, and analysis allow for identification of disparities through stratification of results (e.g., by race, ethnicity, socioeconomic status, gender);OR rationale/data justifies why stratification is not necessary or not feasible.

TAP/Workgroup: What are the strengths and weaknesses in relation to the subcriteria for *Scientific Acceptability of Measure Properties?*	**2**
Steering Committee: Overall, to what extent was the criterion, *Scientific Acceptability of Measure Properties*, **met?** **Rationale:**	*2* C☐ P☐ M☐ 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. (evaluation criteria)

Eval Rating

3a. Meaningful, Understandable, and Useful Information

3a.1 **Current Use:** In use

3a.2 **Use in a public reporting initiative (disclosure of performance results to the public at large)** (*If used in a public reporting initiative, provide name of initiative(s), locations, Web page URL(s). If not publicly reported, state the plans to achieve public reporting within 3 years*)**:**
The measure has been publicly reported on Hospital Compare (www.hospitalcompare.hhs.gov) since June 2007 and is used in CMS' Hospital Inpatient Quality Reporting Program (Formerly RHQDAPU).

3a.3 **If used in other programs/initiatives (***If used in quality improvement or other programs/initiatives, name of initiative(s), locations, Web page URL(s). If not used for QI, state the plans to achieve use for QI within 3 years***):**

Testing of Interpretability (*Testing that demonstrates the results are understood by the potential users for public reporting and quality improvement*)
3a.4 **Data/sample** *(description of data/sample and size)***:**

3a.5 **Methods** *(e.g., focus group, survey, QI project)***:**
This measure was NQF endorsed in 2007. Prior to public reporting in 2007, CMS conducted a dry run in December 2006 to provide hospitals and the public with an opportunity to preview the measure methodology, proposed information for public reporting and hospital-specific information Additionally, CMS has also conducted consumer testing of the language on Hospital Compare to ensure clarity and ease of interpretation of the information to be posted publicly.

3a.6 **Results** *(qualitative and/or quantitative results and conclusions)***:**

3a
C☐
P☐
M☐
N☐

3b/3c. Relation to other NQF-endorsed measures

3b.1 **NQF # and Title of similar or related measures:**

(for NQF staff use) **Notes on similar/related endorsed or submitted measures:**

3b. Harmonization
If this measure is related to measure(s) already endorsed by NQF (e.g., same topic, but different target population/setting/data source or different topic but same target population):
3b.2 **Are the measure specifications harmonized? If not, why?**
Yes, the risk-adjustment strategy is similar.

3b
C☐
P☐
M☐
N☐
NA☐

3c. Distinctive or Additive Value
3c.1 **Describe the distinctive, improved, or additive value this measure provides to existing NQF-endorsed measures:**
The measure looks at a different condition, HF, than the AMI and pneumonia measures listed in 3b.1.

3c
C☐
P☐
M☐

Comment [KP22]: 3a. Demonstration that information produced by the measure is meaningful, understandable, and useful to the intended audience(s) for both public reporting (e.g., focus group, cognitive testing) and informing quality improvement (e.g., quality improvement initiatives). An important outcome that may not have an identified improvement strategy still can be useful for informing quality improvement by identifying the need for and stimulating new approaches to improvement.

Comment [KP23]: 3b. The measure specifications are harmonized with other measures, and are applicable to multiple levels and settings.

Comment [k24]: 16 Measure harmonization refers to the standardization of specifications for similar measures on the same topic (e.g., *influenza immunization* of patients in hospitals or nursing homes), or related measures for the same target population (e.g., eye exam and HbA1c for *patients with diabetes*), or definitions applicable to many measures (e.g., age designation for children) so that they are uniform or compatible, unless differences are dictated by the evidence. The dimensions of harmonization can include numerator, denominator, exclusions, and data source and collection instructions. The extent of harmonization depends on the relationship of the measures, the evidence for the specific measure focus, and differences in data sources.

Comment [KP25]: 3c. Review of existing endorsed measures and measure sets demonstrates that the measure provides a distinctive or additive value to existing NQF-endorsed measures (e.g., provides a more complete picture of quality for a particular condition or aspect of healthcare, is a more valid or efficient way to measure).

5.1 If this measure is similar to measure(s) already endorsed by NQF (i.e., on the same topic and the same target population), Describe why it is a more valid or efficient way to measure quality: NQF #0358 Congestive Heart Failure Mortality (IQI 16). Inpatient mortality rates can be influenced by hospital length of stay, thus 30-day measures, that establish a standard follow-up period are more appropriate for profiling a diverse group of hospitals.	**N☐ NA☐**
TAP/Workgroup: What are the strengths and weaknesses in relation to the subcriteria for *Usability*?	**3**
Steering Committee: Overall, to what extent was the criterion, *Usability*, met? **Rationale:**	**3** **C☐ P☐ M☐ N☐**
4. FEASIBILITY	
Extent to which the required data are readily available, retrievable without undue burden, and can be implemented for performance measurement. (evaluation criteria)	**Eval Rating**
4a. Data Generated as a Byproduct of Care Processes **4a.1-2 How are the data elements that are needed to compute measure scores generated?** Coding/abstraction performed by someone other than person obtaining original information (E.g., DRG, ICD-9 codes on claims, chart abstraction for quality measure or registry)	**4a** **C☐ P☐ M☐ N☐**
4b. Electronic Sources **4b.1 Are all 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*) Yes **4b.2 If not, specify the near-term path to achieve electronic capture by most providers.**	**4b** **C☐ P☐ M☐ N☐**
4c. Exclusions **4c.1 Do the specified exclusions require additional data sources beyond what is required for the numerator and denominator specifications?** No **4c.2 If yes, provide justification.**	**4c** **C☐ P☐ M☐ N☐ NA☐**
4d. Susceptibility to Inaccuracies, Errors, or Unintended Consequences **4d.1 Identify susceptibility to inaccuracies, errors, or unintended consequences of the measure and describe how these potential problems could be audited. If audited, provide results.** Using administrative claims variables for risk adjustment: This measure uses variables from claims data submitted by hospitals for payment as clinical risk adjusters. Our analyses have demonstrated that administrative claims data can be used to develop a risk-adjusted outcome measure for mortality following admission for HF and that the model produced estimates of RSMRs that are very similar to rates estimated by models based on chart data. This high level of agreement in the results based on the two different approaches supports the use of the claims-based model for public reporting. The model has also demonstrated consistent performance across years of claims data. The approach to gathering risk factors for patients also mitigates the potential limitations of claims data. Because not every diagnosis is coded at every visit, we use inpatient, outpatient, and physician claims data for the year prior to admission, and diagnosis codes during the index admission, for risk adjustment when the measure is used in Medicare FFS data. When the measure is used in all-payer data, only admission claims data (from the index hospitalization and prior year) are used for risk adjustment; however, model testing demonstrated both strong patient-level model performance and consistent hospital-level results when using	**4d** **C☐ P☐ M☐ N☐**

Comment [KP26]: 4a. For clinical measures, required data elements are routinely generated concurrent with and as a byproduct of care processes during care delivery. (e.g., BP recorded in the electronic record, not abstracted from the record later by other personnel; patient self-assessment tools, e.g., depression scale; lab values, meds, etc.)

Comment [KP27]: 4b. The required data elements are available in electronic sources. If the required data are not in existing electronic sources, a credible, near-term path to electronic collection by most providers is specified and clinical data elements are specified for transition to the electronic health record.

Comment [KP28]: 4c. Exclusions should not require additional data sources beyond what is required for scoring the measure (e.g., numerator and denominator) unless justified as supporting measure validity.

Comment [KP29]: 4d. Susceptibility to inaccuracies, errors, or unintended consequences and the ability to audit the data items to detect such problems are identified.

only admission claims data. The 1-year time frame provides a more comprehensive view of patients' medical histories than is provided by the secondary diagnosis codes from the index hospitalization alone. If a diagnosis appears in some visits and not others, it is included, minimizing the effect of incomplete coding. We were careful, however, to include information about each patient's status at admission and not to adjust for possible complications of the admission. Although some codes, by definition, represent conditions that are present before admission (e.g. cancer), other codes and conditions cannot be differentiated from complications during the hospitalization (e.g. infection or shock). If these are secondary diagnoses from the index admission, then they are not adjusted for in the analysis.	
4e. Data Collection Strategy/Implementation 4e.1 **Describe what you have learned/modified as a result of testing and/or operational use of the measure regarding data collection, availability of data/missing data, timing/frequency of data collection, patient confidentiality, time/cost of data collection, other feasibility/ implementation issues:** N/A 4e.2 **Costs to implement the measure** (*costs of data collection, fees associated with proprietary measures*)**:** The measure is developed using administrative claims data and does not necessitate any additional cost/burden on hospitals. 4e.3 **Evidence for costs:** N/A 4e.4 **Business case documentation:** N/A	**4e** C☐ P☐ M☐ N☐
TAP/Workgroup: What are the strengths and weaknesses in relation to the subcriteria for *Feasibility*?	**4**
Steering Committee: Overall, to what extent was the criterion, *Feasibility*, **met?** **Rationale:**	**4** C☐ P☐ M☐ N☐
RECOMMENDATION	
(for NQF staff use) **Check if measure is untested and only eligible for time-limited endorsement.**	**Time-limited** ☐
Steering Committee: Do you recommend for endorsement? **Comments:**	Y☐ N☐ A☐

Comment [KP30]: 4e. Demonstration that the data collection strategy (e.g., source, timing, frequency, sampling, patient confidentiality, etc.) can be implemented (e.g., already in operational use, or testing demonstrates that it is ready to put into operational use).

CONTACT INFORMATION
Co.1 **Measure Steward (Intellectual Property Owner)** Co.1 **Organization** Centers for Medicare & Medicaid Services, 7500 Security Boulevard , Mail Stop S3-02-01, Baltimore, Maryland, 21244-9045 Co.2 **Point of Contact** Lein, Han, PhD, Government Task Leader, lein.han@cms.hhs.gov, 410-786-0205-
Measure Developer If different from Measure Steward Co.3 **Organization** Yale New Haven Health Services Corporation (YNHHSC), 1 Church Street, Suite 200, New Haven, Connecticut, 06510 Co.4 **Point of Contact** Susannah, Bernheim, MD, MHS, susannah.bernheim@yale.edu, 203-764-3271-

Co.5 Submitter If different from Measure Steward POC Susannah, Bernheim, MD, MHS, susannah.bernheim@yale.edu, 203-764-7231-, Yale New Haven Health Services Corporation (YNHHSC)
Co.6 Additional organizations that sponsored/participated in measure development MPR: Mathematica Policy Research; RTI-Research Triangle Institute
ADDITIONAL INFORMATION
Workgroup/Expert Panel involved in measure development **Ad.1 Provide a list of sponsoring organizations and workgroup/panel members' names and organizations. Describe the members' role in measure development.** The working group involved in the initial measure development is detailed in the original technical report available at www.qualitynet.org
Ad.2 If adapted, provide name of original measure: Heart Failure 30-day Mortality **Ad.3-5 If adapted, provide original specifications URL or attachment** URL N/A www.qualitynet.org
Measure Developer/Steward Updates and Ongoing Maintenance **Ad.6 Year the measure was first released:** 2007 **Ad.7 Month and Year of most recent revision:** 04, 2011 **Ad.8 What is your frequency for review/update of this measure?** Yearly **Ad.9 When is the next scheduled review/update for this measure?** 08, 2011
Ad.10 Copyright statement/disclaimers: N/A
Ad.11 -13 Additional Information web page URL or attachment: URL N/A www.qualitynet.org for Measure Methodology report and Maintenance reports
Date of Submission (*MM/DD/YY*)**:** 12/14/2010

Page 4: [1] Comment [k4]	Karen Pace	10/5/2009 8:59:00 AM

1c. The measure focus is:

- an outcome (e.g., morbidity, mortality, function, health-related quality of life) that is relevant to, or associated with, a national health goal/priority, the condition, population, and/or care being addressed;

OR

- if an intermediate outcome, process, structure, etc., there is **evidence** that supports the specific measure focus as follows:
  - Intermediate outcome – evidence that the measured intermediate outcome (e.g., blood pressure, Hba1c) leads to improved health/avoidance of harm or cost/benefit.
  - Process – evidence that the measured clinical or administrative process leads to improved health/avoidance of harm and
    if the measure focus is on one step in a multi-step care process, it measures the step that has the greatest effect on improving the specified desired outcome(s).
  - Structure – evidence that the measured structure supports the consistent delivery of effective processes or access that lead to improved health/avoidance of harm or cost/benefit.
  - Patient experience – evidence that an association exists between the measure of patient experience of health care and the outcomes, values and preferences of individuals/ the public.
  - Access – evidence that an association exists between access to a health service and the outcomes of, or experience with, care.
  - Efficiency – demonstration of an association between the measured resource use and level of performance with respect to one or more of the other five IOM aims of quality.

NATIONAL QUALITY FORUM

Measure Evaluation 4.1
December 2009

This form contains the measure information submitted by stewards. Blank fields indicate no information was provided. Attachments also may have been submitted and are provided to reviewers. The subcriteria and most of the footnotes from the evaluation criteria are provided in Word comments within the form and will appear if your cursor is over the highlighted area. Hyperlinks to the evaluation criteria and ratings are provided in each section.

TAP/Workgroup (if utilized)**:** Complete all yellow highlighted areas of the form. Evaluate the extent to which each subcriterion is met. Based on your evaluation, summarize the strengths and weaknesses in each section.

Note: *If there is no TAP or workgroup, the SC also evaluates the subcriteria (yellow highlighted areas).*

Steering Committee: Complete all pink highlighted areas of the form. Review the workgroup/TAP assessment of the subcriteria, noting any areas of disagreement; then evaluate the extent to which each major criterion is met; and finally, indicate your recommendation for the endorsement. Provide the rationale for your ratings.

Evaluation ratings of the extent to which the criteria are met
C = Completely (unquestionably demonstrated to meet the criterion)
P = Partially (demonstrated to partially meet the criterion)
M = Minimally (addressed BUT demonstrated to only minimally meet the criterion)
N = Not at all (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 #:** 0230 **NQF Project:** Cardiovascular Endorsement Maintenance 2010

MEASURE DESCRIPTIVE INFORMATION
De.1 **Measure Title:** Hospital 30-day, all-cause, risk-standardized mortality rate (RSMR) following acute myocardial infarction (AMI) hospitalization for patients 18 and older
De.2 **Brief description of measure**: The measure estimates a hospital-level risk-standardized mortality rate (RSMR), defined as death from any cause within 30 days after the index admission date, for patients 18 and older discharged from the hospital with a principal diagnosis of AMI.
1.1-2 **Type of Measure:** Outcome De.3 **If included in a composite or paired with another measure, please identify composite or paired measure** This measure is paired with a measure of hospital-level, all-cause, 30-day, risk-standardized readmission rate (RSRR) following an AMI hospitalization.
De.4 **National Priority Partners Priority Area:** Safety De.5 **IOM Quality Domain**: Effectiveness, Patient-centered, Safety De.6 **Consumer Care Need:** Getting better

CONDITIONS FOR CONSIDERATION BY NQF	NQF Staff
Four conditions must be met before proposed measures may be considered and evaluated for suitability as voluntary consensus standards:	
A. The measure is in the public domain or an intellectual property (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.* A.1 **Do you attest that the measure steward holds intellectual property rights to the measure and the right to use aspects of the measure owned by another entity (e.g., risk model, code set)?** Yes A.2 **Indicate if Proprietary Measure** (*as defined in measure steward agreement*)**:** A.3 **Measure Steward Agreement:** Government entity and in the public domain - no agreement necessary A.4 **Measure Steward Agreement attached:**	**A** **Y**☐ **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, information provided in contact section	**B** Y☐ N☐
C. The intended use of the measure includes both public reporting and quality improvement. ►**Purpose:** Public Reporting, Quality Improvement (Internal to the specific organization)	**C** Y☐ 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 12 months of endorsement. D.1**Testing:** Yes, fully developed and tested D.2 **Have NQF-endorsed measures been reviewed to identify if there are similar or related measures?** Yes	**D** Y☐ N☐
(for NQF staff use) **Have all conditions for consideration been met?** **Staff Notes to Steward** (*if submission returned*)**:**	**Met** Y☐ N☐
Staff Notes to Reviewers (*issues or questions regarding any criteria*)**:**	
Staff Reviewer Name(s):	

TAP/Workgroup Reviewer Name:	
Steering Committee Reviewer Name:	
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 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.* (evaluation criteria) **1a. High Impact**	**Eval Rating**
(for NQF staff use) **Specific NPP goal**:	
1a.1 **Demonstrated High Impact Aspect of Healthcare:** Affects large numbers, Leading cause of morbidity/mortality, High resource use, Severity of illness 1a.2 1a.3 **Summary of Evidence of High Impact:** Acute myocardial infarction (AMI) is one of the most common principal hospital discharge diagnoses among older adults and is associated with high mortality. The high prevalence and considerable morbidity and mortality associated with AMI create an economic burden on the healthcare system (American Heart Association, 2010). In 2005, AMI was the fourth most expensive condition treated in US hospitals, accounting for nearly 4% of the national hospital bill. It was also the fourth most expensive condition billed to Medicare that year, accounting for 4.5% of Medicare´s hospital bill (Andrews and Elixhauser, 2007). Many current hospital interventions are known to decrease the risk of death within 30 days of hospital admission (Jha et al. 2007; Rathore et al. 2009). Current process-based performance measures, however, cannot capture all the ways that care within the hospital might influence outcomes. As a result, many stakeholders, including patient organizations, are interested in outcomes measures that allow patients and providers to assess relative outcomes performance for hospitals. 1a.4 **Citations for Evidence of High Impact:** American Heart Association. Heart Disease and Stroke Statistics – 2010 Update. Dallas, Texas: American Heart Association; 2010. c2010, American Heart Association. Andrews RM, Elixhauser A. The national hospital bill: growth trends and 2005 update on the most expensive	**1a** C☐ P☐ M☐ N☐

Comment [KP1]: 1a. The measure focus addresses:
•a specific national health goal/priority identified by NQF's National Priorities Partners; OR
•a demonstrated high impact aspect of healthcare (e.g., affects large numbers, leading cause of morbidity/mortality, high resource use (current and/or future), severity of illness, and patient/societal consequences of poor quality).

conditions by payer. Rockville, MD: Agency for Healthcare Research and Quality (AHRQ); 2007 Dec. (HCUP statistical brief; no. 42).

Jha AK, Orav EJ, Li Z, Epstein AM. The inverse relationship between mortality rates and performance in the Hospital Quality Alliance measures. Health Aff (Millwood). 2007 Jul-Aug;26(4):1104-10.

Rathore SS, Curtis JP, Chen J, Wang Y, Nallamothu BK, Epstein AJ, Krumholz HM; National Cardiovascular Data Registry. Association of door-to-balloon time and mortality in patients admitted to hospital with ST elevation myocardial infarction: national cohort study. BMJ. 2009 May 19;338:b1807 .

1b. Opportunity for Improvement

1b.1 Benefits (improvements in quality) envisioned by use of this measure: The goal of this measure is to improve patient outcomes by providing patients, physicians, and hospitals with information about hospital-level, risk-standardized mortality rates following hospitalization for AMI. Measurement of patient outcomes allows for a broad view of quality of care that encompasses more than what can be captured by individual process-of-care measures. Complex and critical aspects of care, such as communication between providers, prevention of and response to complications, patient safety, and coordinated transitions to the outpatient environment, all contribute to patient outcomes but are difficult to measure by individual process measures. The goal of outcomes measurement is to risk-adjust for patients' conditions at the time of hospital admission and then evaluate patient outcomes. This mortality measure was developed to identify institutions whose performance is better or worse than would be expected based on their patient case-mix, and therefore promote hospital quality improvement and better inform consumers about care quality.

1b.2 Summary of data demonstrating performance gap (variation or overall poor performance) across providers:
Recent analyses of Medicare FFS data show substantial variation in RSMRs among hospitals. For the most recently reported three years of data (7/2006-6/2009), the mean hospital RSMR was 15.9%, with a range of 10.3% to 24.6%. The 5th percentile was 13.2% and the 95th percentile was 18.4%. The interquartile range was 15.0% to 16.8%.

This work also demonstrated ongoing geographic variation in hospital RSMRs for AMI.

Bernheim SM, Grady JN, Lin Z, Wang Y, Wang Y-F, Savage SV, Bhat KR, Ross JS, Desai MM, Merrill AR, Han LF, Rapp MT, Drye EE, Normand SL, Krumholz HM. National patterns of risk-standardized mortality and readmission for acute myocardial infarction and heart failure. Update on publicly reported outcomes measures based on the 2010 release. Circ Cardiovasc Qual Outcomes. 2010 Sep 1;3(5):459-67. Epub 2010 Aug 24.

1b.3 Citations for data on performance gap:
The information on the performance gap is based on RSMRs calculated for AMI hospitalizations among Medicare FFS patients aged 65 and over (65+) from July 1, 2006-June 30, 2009, and includes 558,665 hospitalizations from 4,569 hospitals. The index hospitalizations are those included in the measure and reported in the 2010 update to the Hospital Compare website.

1b.4 Summary of Data on disparities by population group:
CMS supported analyses to evaluate disparities in performance by hospitals based on the proportion of patients that they serve who are African-American. These analyses of Medicare FFS data show that the range of performance is similar for hospitals with higher proportions of African-American patients compared with hospitals with lower proportions. We divided hospitals into deciles based on the proportion of their patients that were African-American and looked at hospitals across deciles. The combined lowest five deciles have fewer than 5% African-American patients and a median AMI RSMR of 16.3% (range 10.6%-23.2%) vs. hospitals in the highest decile with >25% African-American patients and a median AMI RSMR of 16.2% (range 11.8%-24.6%).

Similar analyses were completed to evaluate hospital differences in performance based on the socioeconomic status (SES) of their patients. These analyses suggest a slightly higher median AMI RSMR at the hospitals in the lowest quartile based on the SES of their patients (as measured by median income of the patient's ZIP code). The lowest quartile hospitals' median RSMR was 16.8% compared to median RSMR of 15.8% for

1b
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Comment [KP2]: 1b. Demonstration of quality problems and opportunity for improvement, i.e., data demonstrating considerable variation, or overall poor performance, in the quality of care across providers and/or population groups (disparities in care).

Comment [k3]: 1 Examples of data on opportunity for improvement include, but are not limited to: prior studies, epidemiologic data, measure data from pilot testing or implementation. If data are not available, the measure focus is systematically assessed (e.g., expert panel rating) and judged to be a quality problem.

hospitals in highest quartile of patient SES. However, the range for the two groups was largely overlapping (11.6%-24.6% vs. 10.6%-22.0%, respectively), demonstrating that substantial numbers of hospitals serving low SES patients perform well on the measure. A recently published study also demonstrated that patient SES accounted for a very small portion of variation in hospital performance on the AMI RSMR measure (Bradley et al. 2010).

Reference: Bradley EH, Herrin J, Curry L, Cherlin EJ, Wang Y-F, Webster TR, Drye EE, Normand SL, Krumholz HM. Variation in hospital mortality rates for patients with acute myocardial infarction. Am J Cardiol. 2010 Oct 15;106(8):1108-12.

1b.5 Citations for data on Disparities:
The sample for the above analyses is from a similar 3-year cohort of Medicare FFS hospitalizations as the data for the performance gap analysis above (January 2006- December 2008) but limited to hospitals with at least 25 AMI cases over the 3-year period, a total of 2,943 hospitals.

1c. Outcome or Evidence to Support Measure Focus

1c.1 Relationship to Outcomes (*For non-outcome measures, briefly describe the relationship to desired outcome. For outcomes, describe why it is relevant to the target population*)**:** This measure calculates hospital-level, 30-day all-cause mortality rates after hospitalization for an AMI. The goal is to directly affect patient outcomes by measuring risk-standardized rates of mortality.

1c.2-3. Type of Evidence: Systematic synthesis of research

1c.4 Summary of Evidence (*as described in the criteria; for outcomes, summarize any evidence that healthcare services/care processes influence the outcome*)**:**
Many hospital interventions, such as use of appropriate medications, timely percutaneous coronary interventions and prevention of complications, are known to decrease the risk of death within 30 days of hospital admission (Rathore et al. 2009; Antman et al. 2008; Jha et al. 2007). Over the last 10 years, nationally, risk-standardized mortality rates have decreased for AMI (Krumholz et al. 2009). Yet, continued variation in performance suggests continued opportunities for improvements.

In addition, recent qualitative research funded by AHRQ, Commonwealth Fund, and UnitedHealthcare identified common system-level approaches to care and, specifically, the tailored use of protocols in those hospitals that have low RSMRs compared with hospitals with high RSMRs (Curry et al. 2011). These findings are being validated in a large national hospital survey (paper in submission).

References:

Rathore SS, Curtis JP, Chen J, Wang Y-F, Nallamothu BK, Epstein AJ, Krumholz HM; National Cardiovascular Data Registry. Association of door-to-balloon time and mortality in patients admitted to hospital with ST elevation myocardial infarction: national cohort study. BMJ. 2009 May 19;338:b1807 .

Antman EM, Hand M, Armstrong PW, et al. 2007 focused update of the ACC/AHA 2004 guidelines for the management of patients with ST-elevation myocardial infarction: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. J Am Coll Cardiol. 2008 Jan 15;51(2):210-247.

Jha AK, Orav EJ, Li Z, Epstein AM. The inverse relationship between mortality rates and performance in the Hospital Quality Alliance measures. Health Aff (Millwood). 2007 Jul-Aug;26(4):1104-10.

Krumholz HM, Wang Y, Chen J, Drye EE, Spertus JA, Ross JS, Curtis JP, Nallamothu BK, Lichtman JH, Havranek EP, Masoudi FA, Radford MJ, Han LF, Rapp MT, Straube BM, Normand SL. Reduction in acute myocardial infarction mortality in the United States: risk-standardized mortality rates from 1995-2006. JAMA. 2009 Aug 19;302(7):767-73.

Curry LA, Spatz E, Cherlin E, Thompson JW, Berg D, Ting HH, Decker C, Krumholz HM, Bradley EH . What Distinguishes Top-Performing Hospitals in Acute Myocardial Infarction Mortality Rates? A Qualitative Study.

1c
C☐
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N☐

Comment [k4]: 1c. The measure focus is:
•an outcome (e.g., morbidity, mortality, function, health-related quality of life) that is relevant to, or associated with, a national health goal/priority, the condition, population, and/or care being addressed;
OR
•if an intermediate outcome, process, structure, etc., there is **evidence** that supports the specific measure focus as follows:
oIntermediate outcome – evidence that the measured intermediate outcome (e.g., blood pressure, Hba1c) leads to improved health/avoidance of harm or cost/benefit.
oProcess – evidence that the measured clinical or administrative process leads to improved health/avoidance of harm and
if the measure focus is on one step in a multi-step care process, it measures the step that has the greatest effect on improving the specified desired outcome(s).
oStructure – evidence that the measured structure supports the consistent delivery of effective processes or access that lead to improved health/avoidance of harm or cost/benefit.
oPatient experience – evidence that an association exists between the measure of patient experience of health care and the outcomes, values and preferences of individuals/ the public.
oAccess – evidence that an association exists between access to a health service and the outcomes of, or experience with, care.
oEfficiency – demonstration of an association between the measured resource use and level of performance with respect to one or more of the other five IOM aims of quality.

Comment [k5]: 4 Clinical care processes typically include multiple steps: assess → identify problem/potential problem → choose/plan intervention (with patient input) → provide intervention → evaluate impact on health status. If the measure focus is one step in such a multi-step process, the step with the greatest effect on the desired outcome should be selected as the focus of measurement. For example, although assessment of immunization status and recommending immunization are necessary steps, they are not sufficient to achieve the desired impact on health status – patients must be vaccinated to achieve immunity. This does not preclude consideration of measures of preventive screening interventions where there is a strong link with desired outcomes (e.g., mammography) or measures for multiple care processes that affect a single outcome.

Ann Intern Med. 2011;154:384-390.

1c.5 Rating of strength/quality of evidence (*also provide narrative description of the rating and by whom***):** N/A (outcomes measure)

1c.6 Method for rating evidence: N/A (outcomes measure)

1c.7 Summary of Controversy/Contradictory Evidence: Use of Hierarchical Generalized Linear Modeling
Hierarchical modeling for hospital outcomes measurement is the appropriate statistical approach for hospital outcomes measures given the structure of the data and the underlying assumption of such measures, which is that hospital quality of care influences 30-day mortality rates. However, CMS frequently receives comments and questions about this approach, so we are concisely reiterating the rationale for and merits of using hierarchical logistic regression. Patients are clustered within hospitals and, as such, have a shared exposure to the hospital quality and processes. The use of hierarchical modeling accounts for the clustering of patients within hospitals. Second, hierarchical models distinguish within-hospital variation and between-hospital variation to estimate the hospital's contribution to the risk of mortality. This allows for an estimation of the hospital's influence on patient outcomes. Finally, within hierarchical models we can account for both differences in case mix and sample size to fairly profile hospital performance. If we did not use hierarchical modeling we could overestimate variation and potentially misclassify hospitals' performance. Accurately estimating variation is an important objective for models used in public reporting and potentially used in value-based purchasing programs.

Effect of patient-preferences regarding end-of-life care
In certain cases, the best quality care may ultimately be that which supports patients' goals and comfort at the end of life rather than that which prolongs life. The intent of a mortality rate is not to convey that all deaths are the result of poor care. The goal is not to have zero deaths. The premise is that there are preventable deaths. Knowledge of how an institution performs compared with what might be expected given their case mix is helpful in encouraging efforts to improve outcomes.

Some stakeholders have expressed concerns that our measure cannot adequately exclude patients who choose comfort measures or palliative care during their index hospitalization. Stakeholders are concerned that this could lead to unintended consequences, such as prolonging lives against patient wishes. To address these issues CMS has taken the following steps when applying the measure to the Medicare FFS population aged 65 years or older:

(1) CMS added an exclusion for patients who are enrolled in the Medicare hospice program prior to, or on the day of, admission.
(2) CMS chose not to exclude patients who are discharged to hospice or seek a palliative care consult during admission to account for the fact that the choice of palliative/comfort care may be the result of poor care.
(3) To account for risk factors associated with the end of life, CMS included markers of frailty within our risk-adjustment variables, including: protein-calorie malnutrition, dementia or senility, and hemiplegia, paraplegia, paralysis and functional disability.
(4) CMS is looking into the possibility of adding POA codes to the palliative care consult ICD-9 code (v.66.7) to gather more information, but would need to give further consideration to the clinical and measurement implications before instituting any changes to the measure using this code.
(5) Although CMS is confident in the current model, CMS will further consider clinical and measurement issues for patients for whom survival is not an objective as it maintains this mortality measure.

1c.8 Citations for Evidence (*other than guidelines***):** N/A

1c.9 Quote the Specific guideline recommendation (*including guideline number and/or page number***):** N/A

1c.10 Clinical Practice Guideline Citation: N/A
1c.11 National Guideline Clearinghouse or other URL: N/A

Comment [k6]: 3 The strength of the body of evidence for the specific measure focus should be systematically assessed and rated (e.g., USPSTF grading system http://www.ahrq.gov/clinic/uspstf07/methods/benefit.htm). If the USPSTF grading system was not used, the grading system is explained including how it relates to the USPSTF grades or why it does not. However, evidence is not limited to quantitative studies and the best type of evidence depends upon the question being studied (e.g., randomized controlled trials appropriate for studying drug efficacy are not well suited for complex system changes). When qualitative studies are used, appropriate qualitative research criteria are used to judge the strength of the evidence.

1c.12 **Rating of strength of recommendation** (*also provide narrative description of the rating and by whom*)**:** N/A 1c.13 **Method for rating strength of recommendation** (*If different from USPSTF system, also describe rating and how it relates to USPSTF*)**:** N/A 1c.14 **Rationale for using this guideline over others:** N/A	
TAP/Workgroup: What are the strengths and weaknesses in relation to the subcriteria for *Importance to Measure and Report?*	**1**
Steering Committee: Was the threshold criterion, *Importance to Measure and Report*, **met?** **Rationale:**	**1** **Y☐** **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. (evaluation criteria)	**Eval Rating**
2a. MEASURE SPECIFICATIONS	
S.1 **Do you have a web page where current detailed measure specifications can be obtained?** S.2 **If yes, provide web page URL:** **2a. Precisely Specified**	
2a.1 **Numerator Statement (***Brief, text description of the numerator - what is being measured about the target population, e.g. target condition, event, or outcome***):** This outcome measure does not have a traditional numerator and denominator like a core process measure (e.g., percentage of adult patients with diabetes aged 18-75 years receiving one or more hemoglobin A1c tests per year); thus, we are using this field to define the outcome. The outcome for this measure is 30-day all-cause mortality. We define mortality as death from any cause within 30 days of the index admission date for patients 18 and older discharged from the hospital with a principal diagnosis of AMI. 2a.2 **Numerator Time Window (***The time period in which cases are eligible for inclusion in the numerator***):** Patients who die within 30 days of the index admission date. 2a.3 **Numerator Details (***All information required to collect/calculate the numerator, including all codes, logic, and definitions***):** Measure includes deaths from any cause within 30 days from admission date of index hospitalization.	
2a.4 **Denominator Statement (***Brief, text description of the denominator - target population being measured***):** Note: This outcome measure does not have a traditional numerator and denominator like a core process measure; thus, we are using this field to define the patient cohort. This claims-based measure can be used in either of two patient cohorts: (1) patients aged 65 years or older or (2) patients aged 18 years or older. While the measure can be applied to populations aged 18 years or older, national data are often only available for patients aged 65 years or older. We have explicitly tested the measure in both age groups. The cohorts include admissions for patients discharged from the hospital with a principal diagnosis of AMI (ICD-9-CM codes 410.xx except for 410.x2) and with a complete claims history for the 12 months prior to admission. Patients who are transferred from one acute care facility to another must have a principal	**2a-specs** **C☐** **P☐** **M☐** **N☐**

Comment [k7]: USPSTF grading system **http://www.ahrq.gov/clinic/uspstf/grades.htm**: **A -** The USPSTF recommends the service. There is high certainty that the net benefit is substantial. **B -** The USPSTF recommends the service. There is high certainty that the net benefit is moderate or there is moderate certainty that the net benefit is moderate to substantial. **C -** The USPSTF recommends against routinely providing the service. There may be considerations that support providing the service in an individual patient. There is at least moderate certainty that the net benefit is small. Offer or provide this service only if other considerations support the offering or providing the service in an individual patient. **D -** The USPSTF recommends against the service. There is moderate or high certainty that the service has no net benefit or that the harms outweigh the benefits. **I -** The USPSTF concludes that the current evidence is insufficient to assess the balance of benefits and harms of the service. Evidence is lacking, of poor quality, or conflicting, and the balance of benefits and harms cannot be determined.

Comment [KP8]: 2a. The measure is well defined and precisely specified so that it can be implemented consistently within and across organizations and allow for comparability. The required data elements are of high quality as defined by NQF's Health Information Technology Expert Panel (HITEP) .

discharge diagnosis of AMI at both hospitals. The initial hospital for a transferred patient is designated as the responsible institution for the episode.

If a patient has more than one AMI admission in a year, one hospitalization is randomly selected for inclusion in the measure.

2a.5 Target population gender: Female, Male
2a.6 Target population age range: The target population is age 18 years or older

2a.7 Denominator Time Window (*The time period in which cases are eligible for inclusion in the denominator***):**
This measure was developed with 12 months of data. Currently, the measure is publicly reported with three years of index hospitalizations.

2a.8 Denominator Details (*All information required to collect/calculate the denominator - the target population being measured - including all codes, logic, and definitions***):**
The denominator includes patients aged 18 and older admitted to non-federal acute care hospitals for an AMI defined by a principal discharge diagnosis of ICD-9-CM code 410.xx, excluding those with 410.x2 (AMI, subsequent episode of care), and with a complete claims history for the 12 months prior to admission.

ICD-9-CM codes that define the patient cohort:

410.00 AMI (anterolateral wall) – episode of care unspecified
410.01 AMI (anterolateral wall) – initial episode of care
410.10 AMI (other anterior wall) – episode of care unspecified
410.11 AMI (other anterior wall) – initial episode of care
410.20 AMI (inferolateral wall) – episode of care unspecified
410.21 AMI (inferolateral wall) – initial episode of care
410.30 AMI (inferoposterior wall) – episode of care unspecified
410.31 AMI (inferoposterior wall) – initial episode of care
410.40 AMI (other inferior wall) – episode of care unspecified
410.41 AMI (other inferior wall) – initial episode of care
410.50 AMI (other lateral wall) – episode of care unspecified
410.51 AMI (other lateral wall) – initial episode of care
410.60 AMI (true posterior wall) – episode of care unspecified
410.61 AMI (true posterior wall) – initial episode of care
410.70 AMI (subendocardial) – episode of care unspecified
410.71 AMI (subendocardial) – initial episode of care
410.80 AMI (other specified site) – episode of care unspecified
410.81 AMI (other specified site) – initial episode of care
410.90 AMI (unspecified site) – episode of care unspecified
410.91 AMI (unspecified site) – initial episode of care

Note: We do not include 410.x2 (AMI, subsequent episode of care)

2a.9 Denominator Exclusions (*Brief text description of exclusions from the target population***):** For all cohorts, the measure excludes admissions for patients:
• who were discharged on the day of admission or the following day and did not die or get transferred (because it is less likely they had a significant AMI).
• who were transferred from another acute care hospital (because the death is attributed to the hospital where the patient was initially admitted).
• with inconsistent or unknown mortality status or other unreliable data (e.g. date of death precedes admission date).
• who were discharged alive and against medical advice (AMA) (because providers did not have the opportunity to deliver full care and prepare the patient for discharge).
• that were not the first hospitalization in the 30 days prior to a patient's death. We use this criterion to prevent attribution of a death to two admissions.

For Medicare FFS patients, the measure additionally excludes admissions for patients:

Comment [k9]: 11 Risk factors that influence outcomes should not be specified as exclusions.
12 Patient preference is not a clinical exception to eligibility and can be influenced by provider interventions.

• enrolled in the Medicare Hospice program any time in the 12 months prior to the index hospitalization including the first day of the index admission (since it is likely these patients are continuing to seek comfort measures only). Although this exclusion currently applies to Medicare FFS patients, it could be expanded to include all payer data if an acceptable method for identifying hospice patients outside of Medicare becomes available.

2a.10 Denominator Exclusion Details (*All information required to collect exclusions to the denominator, including all codes, logic, and definitions***):**
See "Denominator Exclusions" section.

2a.11 Stratification Details/Variables (*All information required to stratify the measure including the stratification variables, all codes, logic, and definitions***):**
Results of this measure will not be stratified.

2a.12-13 Risk Adjustment Type: Risk-adjustment devised specifically for this measure/condition

2a.14 Risk Adjustment Methodology/Variables (*List risk adjustment variables and describe conceptual models, statistical models, or other aspects of model or method***):**
Our approach to risk adjustment was tailored to and appropriate for a publicly reported outcome measure, as articulated in the American Heart Association (AHA) Scientific Statement, "Standards for Statistical Models Used for Public Reporting of Health Outcomes" (Krumholz et al. 2006).

The measure employs a hierarchical logistic regression model (a form of hierarchical generalized linear model [HGLM]) to create a hospital level 30-day RSMR. This approach to modeling appropriately accounts for the structure of the data (patients clustered within hospitals), the underlying risk due to patients' comorbidities, and sample size at a given hospital when estimating hospital mortality rates. In brief, the approach simultaneously models two levels (patient and hospital) to account for the variance in patient outcomes within and between hospitals (Normand and Shahnian et al. 2007). At the patient level, each model adjusts the log-odds of mortality within 30 days of admission for age, sex, selected clinical covariates and a hospital specific intercept. The second level models the hospital-specific intercepts as arising from a normal distribution. The hospital intercept, or hospital specific effect, represents the hospital contribution to the risk of mortality, after accounting for patient risk and sample size, and can be inferred as a measure of quality. The hospital-specific intercepts are given a distribution in order to account for the clustering (non-independence) of patients within the same hospital. If there were no differences among hospitals, then after adjusting for patient risk, the hospital intercepts should be identical across all hospitals.

Candidate and Final Risk-adjustment Variables: The measure was developed using Medicare FFS claims data. Candidate variables were patient-level risk-adjustors that are expected to be predictive of mortality, based on empirical analysis, prior literature, and clinical judgment, including demographic factors (age, sex) and indicators of comorbidity and disease severity. For each patient, covariates were obtained from Medicare claims extending 12 months prior to and including the index admission. The model adjusted for case differences based on the clinical status of the patient at the time of admission. We used condition categories (CCs), which are clinically meaningful groupings of more than 15,000 ICD-9-CM diagnosis codes. We did not risk-adjust for CCs that were possible adverse events of care and that were only recorded in the index admission. In addition, only comorbidities that conveyed information about the patient at that time or in the 12 months prior, and not complications that arose during the course of the hospitalization were included in the risk-adjustment.
The final set of risk-adjustment variables is:

Demographic

- Age-65 (years above 65, continuous) for 65 and over cohorts; or Age (years, continuous) for 18 and over cohorts.
- Male

Cardiovascular

- History of PTCA
- History of CABG

- Congestive heart failure
- History of AMI
- Unstable angina
- Anterior myocardial infarction
- Other location of myocardial infarction
- Chronic atherosclerosis
- Cardio-respiratory failure and shock
- Valvular and rheumatic heart disease

Comorbidity

- Hypertension
- Stroke
- Cerebrovascular disease
- Renal failure
- Chronic Obstructive Pulmonary Disease
- Pneumonia
- Diabetes and DM complications
- Protein-calorie malnutrition
- Dementia and senility
- Hemiplegia, paraplegia, paralysis, functional disability
- Peripheral vascular disease
- Metastatic cancer, acute leukemia and other severe cancers
- Trauma in the last year
- Major psychiatric disorders
- Chronic liver disease

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References:
Krumholz HM, Brindis RG, Brush JE, et al. 2006. Standards for Statistical Models Used for Public Reporting of Health Outcomes: An American Heart Association Scientific Statement From the Quality of Care and Outcomes Research Interdisciplinary Writing Group: Cosponsored by the Council on Epidemiology and Prevention and the Stroke Council Endorsed by the American College of Cardiology Foundation. Circulation 113: 456-462.

Normand S-LT, Shahian DM. 2007. Statistical and Clinical Aspects of Hospital Outcomes Profiling. Stat Sci 22 (2): 206-226.

2a.15-17 Detailed risk model available Web page URL or attachment: URL N/A
http://www.qualitynet.org/dcs/ContentServer?c=Page&pagename=QnetPublic%2FPage%2FQnetTier3&cid=1163010421830

2a.18-19 Type of Score: Rate/proportion
2a.20 Interpretation of Score: Better quality = Lower score
2a.21 Calculation Algorithm (*Describe the calculation of the measure as a flowchart or series of steps***):**
The RSMR is calculated as the ratio of the number of "adjusted actual" deaths (also known as "predicted") to the number of "expected" deaths at a given hospital, multiplied by the national unadjusted mortality rate. For each hospital, the "numerator" of the ratio is the number of deaths within 30 days predicted on the basis of the hospital's performance with its observed case mix, and the "denominator" is the number of deaths expected on the basis of the nation's performance with that hospital's case mix. This approach is analogous to a ratio of "observed" to "expected" used in other types of statistical analyses. It conceptually allows for a comparison of a particular hospital's performance given its case-mix to an average hospital's performance with the same case-mix. Thus a lower ratio indicates lower-than-expected mortality or better quality and a higher ratio indicates higher-than-expected mortality or worse quality.

The "adjusted actual" deaths (the numerator) is calculated by regressing the risk factors and the hospital-specific intercept on the risk of mortality, multiplying the estimated regression coefficients by the patient characteristics in the hospital, transforming, and then summing over all patients attributed to the hospital to get a value. The expected number of deaths (the denominator) is obtained by regressing the risk factors and

a common intercept on the mortality outcome using all hospitals in our sample, multiplying the subsequent estimated regression coefficients by the patient characteristics observed in the hospital, transforming, and then summing over all patients in the hospital to get a value.

To assess hospital performance in any reporting period, the model coefficients are re-estimated using the years of data in that period.

2a.22 Describe the method for discriminating performance *(e.g., significance testing)***:**
CMS currently estimates an interval estimate for each risk-standardized rate to characterize the amount of uncertainty associated with the rate, compares the interval estimate to the national crude rate for the outcome, and categorizes hospitals as "better than," "worse than," or "no different than" the US national rate.

2a.23 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 –This measure is not based on a sample or survey.

2a.24 Data Source (*Check the source(s) for which the measure is specified and tested)*
Administrative claims, Other

2a.25 Data source/data collection instrument (*Identify the specific data source/data collection instrument, e.g. name of database, clinical registry, collection instrument, etc.***):**
Two data sources were used to create the measure:
1. Medicare Part A inpatient and outpatient and Part B outpatient claims: This database contains claims data for fee-for-service inpatient and outpatient services, including Medicare inpatient hospital care, outpatient hospital services, skilled nursing facility care, some home health agency services, and hospice care, as well as inpatient and outpatient claims for the 12 months prior to an index admission.

2. Medicare Enrollment Database (EDB): This database contains Medicare beneficiary demographic, benefit/coverage, and vital status information. This dataset was used to obtain information on several inclusion/exclusion indicators such as Medicare status on admission as well as vital status. These data have previously been shown to accurately reflect patient vital status (Fleming et al. 1992).

The measure was originally developed with claims data from 1998. The models have been maintained and re-evaluated each year since public reporting of the measure began in 2007. For details, see measure methodology and measure maintenance reports posted at http://qualitynet.org/dcs/ContentServer?c=Page&pagename=QnetPublic%2FPage%2FQnetTier3&cid=1219069855841.

The measure was subsequently applied to California Patient Discharge Data, a large, linked all-payer database of patient hospital admissions. Records are linked by a unique patient identification number, allowing us to determine patient history from previous hospitalizations. In addition, the unique patient ID number is used to link with state vital statistics records to assess 30-day mortality.

To apply the measure to Medicare data, Medicare Part A inpatient and outpatient and Part B outpatient claims are used. To apply the measure to a non-Medicare population, inpatient claims data are used.

Fleming C, Fisher ES, Chang CH, Bubolz D, Malenda J. Studying outcomes and hospital utilization in the elderly: The advantages of a merged data base for Medicare and Veterans Affairs Hospitals. Medical Care. 1992; 30(5): 377-91.

2a.26-28 Data source/data collection instrument reference web page URL or attachment: URL N/A
http://qualitynet.org/dcs/ContentServer?c=Page&pagename=QnetPublic%2FPage%2FQnetTier3&cid=1219069855841

2a.29-31 Data dictionary/code table web page URL or attachment: URL N/A Condition Category/ICD-9 Code Map available at:
(http://www.qualitynet.org/dcs/ContentServer?c=Page&pagename=QnetPublic%2FPage%2FQnetTier3&cid=1182785083979)

2a.32-35 Level of Measurement/Analysis (*Check the level(s) for which the measure is specified and tested)*
Facility

2a.36-37 Care Settings (*Check the setting(s) for which the measure is specified and tested)*
Hospital/Acute Care Facility

2a.38-41 Clinical Services (*Healthcare services being measured, check all that apply*)

TESTING/ANALYSIS

2b. Reliability testing

2b.1 Data/sample *(description of data/sample and size)*: The model was developed in a randomly selected 50% of Medicare FFS patients aged 65+ in the initial one-year cohort and tested in the other 50% of patients in the initial one-year cohort. In each subsequent year of measure maintenance we recreated the cohorts in the same way or with very little modification. The developmental cohort consisted of 134,661 cases discharged from 4,646 hospitals. The validation sample consisted of 199,978 cases discharged from 4,668 hospitals. Further validation was conducted in additional years.

Reference:
Krumholz HM, Normand S-LT, Galusha DH, Mattera JA, Rich AS, Wang Y-F, Wang Y. Risk-Adjustment Models for AMI and HF: 30-Day Mortality: Report prepared for the Centers for Medicare & Medicaid Services; 2005. Available at: http://www.qualitynet.org/

2b.2 Analytic Method *(type of reliability & rationale, method for testing)*:
In measure development and testing, for all cohorts, we computed diagnostics that describe their respective performance in terms of discriminative ability, overall fit, model coefficients, and generated hospital RSMRs and corresponding interval estimates for the cohort. With all this information, we can compare the changes over time as well as the performance with the model in the development cohort.

2b.3 Testing Results *(reliability statistics, assessment of adequacy in the context of norms for the test conducted)*:
See results under "Risk-Adjustment Strategy" Section 2e.3 below.

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2c. Validity testing

2c.1 Data/sample *(description of data/sample and size)*: Measure development and testing included medical-record validation. For the derivation of the chart-based model, we used cases identified through the Health Care Financing Administration (now CMS) Cooperative Cardiovascular Project (CCP) initiative, which included more than 200,000 admissions to non-governmental, acute care hospitals in the United States and Puerto Rico. In the CCP study, CMS sampled all claims from fee-for-service Medicare patients during an approximately 8-month period (varying by state) in 1994 and 1995 who were discharged with a principal diagnosis of AMI (ICD-9-CM code 410, excluding 410.x2). These patients were matched to the Medicare enrollment database to determine survival and, where applicable, the date of death. Corresponding medical records were abstracted by 2 clinical data abstraction centers (DynKePRO [York, PA] and FMAS Corporation [Rockville, MD]), and the clinical data used to confirm the diagnosis of AMI.

2c.2 Analytic Method *(type of validity & rationale, method for testing)*:
Medical-record validation: We developed a medical record measure to compare with the administrative measure. We defined the measure cohort for the medical record model using the same inclusion/exclusion criteria consistent with the claims-based administrative measure but using chart-based risk adjusters, such as blood pressure, not available in the claims data. We then matched a sample of the same patients in the administrative data for comparison. The sample included 181,032 patients. Lastly, we examined the model performance and produced the hospital RSMR based on both models for comparison.

2c.3 Testing Results *(statistical results, assessment of adequacy in the context of norms for the test conducted)*:
The mortality medical record model had a c-statistic of 0.77 as compared with 0.69 for the claims model.

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Comment [KP10]: 2b. Reliability testing demonstrates the measure results are repeatable, producing the same results a high proportion of the time when assessed in the same population in the same time period.

Comment [k11]: 8 Examples of reliability testing include, but are not limited to: inter-rater/abstractor or intra-rater/abstractor studies; internal consistency for multi-item scales; test-retest for survey items. Reliability testing may address the data items or final measure score.

Comment [KP12]: 2c. Validity testing demonstrates that the measure reflects the quality of care provided, adequately distinguishing good and poor quality. If face validity is the only validity addressed, it is systematically assessed.

Comment [k13]: 9 Examples of validity testing include, but are not limited to: determining if measure scores adequately distinguish between providers known to have good or poor quality assessed by another valid method; correlation of measure scores with another valid indicator of quality for the specific topic; ability of measure scores to predict scores on some other related valid measure; content validity for multi-item scales/tests. Face validity is a subjective assessment by experts of whether the measure reflects the quality of care (e.g., whether the proportion of patients with BP < 140/90 is a marker of quality). If face validity is the only validity addressed, it is systematically assessed (e.g., ratings by relevant stakeholders) and the measure is judged to represent quality care for the specific topic and that the measure focus is the most important aspect of quality for the specific topic.

The correlation coefficient between hospital RSMR from medical record model and hospital RSMR from claims model was 0.90, indicating good consistency of the two models.

References:
Krumholz HM, Normand S-LT, Galusha DH, Mattera JA, Rich AS, Wang Y-F, Wang Y. Risk-Adjustment Models for AMI and HF: 30-Day Mortality: Report prepared for the Centers for Medicare & Medicaid Services; 2005. Available at: http://www.qualitynet.org/

Krumholz HM, Wang Y, Mattera JA, Wang Y-F, Han L, Ingber M, Roman S, Normand S-LT, An Administrative Claims Model Suitable for Profiling Hospital Performance Based on 30-day Mortality Rate among Patients with an Acute Myocardial Infarction. Circulation 2006;113:1683-1692.

2d. Exclusions Justified

2d.1 Summary of Evidence supporting exclusion(s):
Rationale for exclusions described in "Denominator Exclusions"

2d.2 Citations for Evidence:
See "Denominator Exclusions"

2d.3 Data/sample *(description of data/sample and size)*: N/A

2d.4 Analytic Method *(type analysis & rationale)*:
N/A

2d.5 Testing Results *(e.g., frequency, variability, sensitivity analyses)*:
N/A

2d
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NA☐

2e. Risk Adjustment for Outcomes/ Resource Use Measures

2e.1 Data/sample *(description of data/sample and size)*: When applied to Medicare FFS beneficiaries, the prior year of Medicare Part A inpatient and outpatient data and Part B outpatient data are used to identify variables for risk-adjustment. Specifically, Medicare Part A inpatient data are used to identify variables for risk adjustment in the index admission. Part A and B outpatient data are used to identify variables for risk adjustment in the 12-month period preceding the index date of admission.

Application to Medicare FFS Beneficiaries Using Inpatient Data Only for Risk Adjustment
As part of testing the model in all-payer data, we also applied the model to CMS data for Medicare FFS 65+ patients in California hospitals using only inpatient data for risk adjustment. California is a diverse state, and, with more than 37 million residents, California represents 12% of the US population. Specifically, we created a 2006 measure cohort with complete one-year history data and 30-day follow-up data (N= 11,418).

Application to Patients Aged 18 and Older
We also applied the model to all-payer data from California. The analytic sample included 39,481 cases aged 18 and older in the 2006 California Patient Discharge Data. When used in all-payer data, only admission claims data are used for risk adjustment, as the hospital discharge databases do not have outpatient claims. Therefore, the measure can be applied to all payer data for patients 18 and older

The cohorts are as described above in Reliability Testing Data Sample.

2e.2 Analytic Method *(type of risk adjustment, analysis, & rationale)*:
This measure is fully risk-adjusted using a hierarchical logistic regression model to calculate hospital RSMRs. (See "risk adjustment methodology" for additional details.)

Approach to assessing model performance:
During measure development, we computed five summary statistics for assessing model performance (Harrell and Shih, 2001) for the development and validation cohort:
(1) over-fitting indices (over-fitting refers to the phenomenon in which a model accurately describes the relationship between predictive variables and outcome in the development dataset but fails to provide valid

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Comment [KP14]: 2d. Clinically necessary measure exclusions are identified and must be:
•supported by evidence of sufficient frequency of occurrence so that results are distorted without the exclusion;
AND
•a clinically appropriate exception (e.g., contraindication) to eligibility for the measure focus;
AND
•precisely defined and specified:
–if there is substantial variability in exclusions across providers, the measure is specified so that exclusions are computable and the effect on the measure is transparent (i.e., impact clearly delineated, such as number of cases excluded, exclusion rates by type of exclusion);
if patient preference (e.g., informed decision-making) is a basis for exclusion, there must be evidence that it strongly impacts performance on the measure and the measure must be specified so that the information about patient preference and the effect on the measure is transparent (e.g., numerator category computed separately, denominator exclusion category computed separately).

Comment [k15]: 10 Examples of evidence that an exclusion distorts measure results include, but are not limited to: frequency of occurrence, sensitivity analyses with and without the exclusion, and variability of exclusions across providers.

Comment [KP16]: 2e. For outcome measures and other measures (e.g., resource use) when indicated:
•an evidence-based risk-adjustment strategy (e.g., risk models, risk stratification) is specified and is based on patient clinical factors that influence the measured outcome (but not disparities in care) and are present at start of care;[Error! Bookmark not defined.] OR
rationale/data support no risk adjustment.

Comment [k17]: 13 Risk models should not obscure disparities in care for populations by including factors that are associated with differences/inequalities in care such as race, socioeconomic status, gender (e.g., poorer treatment outcomes of African American men with prostate cancer, inequalities in treatment for CVD risk factors between men and women). It is preferable to stratify measures by race and socioeconomic status rather than adjusting out differences.

predictions in new patients)
(2) predictive ability
(3) area under the receiver operating characteristic (ROC) curve
(4) distribution of residuals
(5) model chi-square (a test of statistical significance usually employed for categorical data to determine whether there is a good fit between the observed data and expected values; i.e., whether the differences between observed and expected values are attributable to true differences in characteristics or instead the result of chance variation).

Application to Medicare FFS Beneficiaries Using Inpatient Data Only for Risk Adjustment
To help determine whether the measure could be applied to Medicare FFS 65+ patients using only Medicare Part A data, we performed analyses to assess how the model performs when using only admission claims data for risk adjustment, as all-payer hospital discharge databases do not have outpatient claims. To assess the validity of using only admission claims data for risk adjustment, we fit the model separately using the full data and using only admission claims data and (a) compared the odds ratios (ORs) for the various risk factors; (b) conducted a reclassification analysis to compare risk prediction at the patient level; (c) compared model performance in terms of the c-statistic (discrimination); and (d) compared hospital-level risk-standardized rates (scatterplot, correlation coefficient, and R2) to assess whether the model with only admission claims data is different from the current model in profiling hospital rates.

Application to Patients Aged 18 and Older
To help determine whether the measure could be applied to an population of patients aged 18+, we examined the interaction terms between age (18-64 vs. 65+) and each of the other risk factors. Specifically, we fit the model in all patients 18+ with and without interaction terms and (a) conducted a reclassification analysis to compare risk prediction at the patient level; (b) compared the c-statistic; and (c) compared hospital-level risk-standardized rates (scatterplot, correlation coefficient, and R2) to assess whether the model with interactions is different from the current model in profiling hospital rates.

Reference: Harrell FE, Shih YCT. Using full probability models to compute probabilities of actual interest to decision makers. Int J Technol Assess Health Care. 2001;17:17–26.

2e.3 Testing Results *(risk model performance metrics)*:
During measure development, using Medicare FFS beneficiaries age 65 and over, we tested the performance of the model developed in a randomly selected half of the 1998 hospitalizations for AMI (representing 199,978 cases discharged from 4,668 hospitals) with hospitalizations from the other half. The performance was not substantively different in the validation sample (ROC area = 0.70) compared with the development cohort (ROC area = 0.71). Further validation was done in additional years of data and these results were consistent with the development cohort.

For the development cohort, the model performance results are summarized below:

Residuals lack of fit: <-2 = 0.00%; [-2, 0) = 81.92%; [0, 2) = 10.21%; [2+ = 7.84%
Model Chi-square [# of covariates]: 9370 [27]
Predictive ability (lowest decile %, highest decile %): (4.0, 40.0)
Area under the ROC curve = 0.71

For the validation cohort, the results are summarized below:
Residuals lack of fit: <-2 = 0.00%; [-2, 0) = 81.92%; [0, 2) = 10.22%; [2+ = 7.85%
Model Chi-square [# of covariates]: 9125 [27]
Predictive ability (lowest decile %, highest decile %): (4.2, 40.1)
Area under the ROC curve = 0.70

During the subsequent years of annual maintenance, including the 2010 maintenance update, to test for reliability, we looked at the distributions of comorbid conditions, hospital volume, crude rates, hospital RSMR, risk-adjusted odds ratios and 95% confidence intervals, and between-hospital variance over different time periods during yearly maintenance updates and the parameters were consistent. For example, for the 2006-2008 calendar year dataset, we reported each individual year results as well as the 3-year combined results. Model performance was stable over all time periods; ROC=0.72 across all times periods.

Model Performance in Medicare FFS Beneficiaries Using Inpatient Data Only for Risk Adjustment Using CMS data for Medicare FFS 65+ beneficiaries in California hospitals: (a) the magnitude of odds ratios for most risk factors was similar when comparing the model using full data and using only admission claims data; (b) when comparing the model with full data and with only admission claims data, the reclassification analysis demonstrated good patient-level risk prediction; (c) the c-statistic was similar (0.713 vs. 0.725); and (d) hospital-level risk-standardized rates were highly correlated (r=0.985).

Model Perfomance in Patients Aged 18 and Older
When the model was applied to all patients 18 and over (18+), overall discrimination was good (c-statistic=0.765). In addition, there was good discrimination and predictive ability in both those aged 18-64 and those aged 65+. Moreover, the distribution of Pearson residuals was comparable across the patient subgroups. When comparing the model with and without interaction terms, (a) the reclassification analysis demonstrated good patient-level risk prediction (1.1% to 34.8% vs. 1.5% to 34.7%, respectively, from the bottom decile to the top decile of the prediction values); (b) the c-statistic was nearly identical (0.767 vs. 0.765); and (c) hospital-level risk-standardized rates were highly correlated (r=0.999). Thus, the inclusion of the interactions did not substantively affect either patient-level model performance or hospital-level results.

Therefore, the measure can be applied to all payer data for patients 18 and older.

References:
Krumholz HM, Normand S-LT, Galusha DH, Mattera JA, Rich AS, Wang YF, Wang Y. Risk-Adjustment Models for AMI and HF: 30-Day Mortality: Report prepared for the Centers for Medicare & Medicaid Services; 2005. Available at: http://www.qualitynet.org/

Bernheim SM, et al. 2010 Measures Maintenance Technical Report: Acute Myocardial Infarction, Heart Failure and Pneumonia 30-day Risk Standardized Mortality Rate. 2010 Available at: http://www.qualitynet.org/dcs/ContentServer?c=Page&pagename=QnetPublic/Page/QnetTier3&cid=1163010421830

2e.4 **If outcome or resource use measure is not risk adjusted, provide rationale:** N/A—The measure is risk-adjusted

2f. Identification of Meaningful Differences in Performance

2f.1 **Data/sample from Testing or Current Use** *(description of data/sample and size)*: The data below are based on RSMRs calculated for AMI hospitalizations among Medicare FFS patients aged 65+ from July 1, 2006-June 30, 2009, and includes 558,665 hospitalizations from 4,569 hospitals. The index hospitalizations are those included in the measure and reported in the 2010 update to Hospital Compare.

2f.2 **Methods to identify statistically significant and practically/meaningfully differences in performance** *(type of analysis & rationale)*:
For each RSMR, CMS characterizes the uncertainty associated with the RSMR by estimating the 95% interval estimate. This is similar to a 95% confidence interval but is calculated differently. If the RSMR's interval estimate does not include the national crude mortality rate (is lower or higher than the rate), then CMS is confident that the hospital's RSMR is different from the national rate, and describes the hospital on the Hospital Compare Web site as "better than the U.S. national rate" or "worse than the U.S. national rate." If the interval includes the national rate, then CMS describes the hospital's RSMR as "no different than the U.S. national rate" or "the difference is uncertain." CMS does not classify performance for hospitals that have fewer than 25 AMI cases in the three-year period.

2f.3 **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)*:
Recent analyses of Medicare FFS data show substantial variation in RSMRs among hospitals. For the most recently reported three years of data (7/2006-6/2009) the mean hospital RSMR was 15.9% with a range of 10.3% to 24.6%. The 5th percentile was 13.2% and the 95th percentile was 18.4%. The interquartile range was 15.0% to 16.8%.

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Comment [KP18]: 2f. Data analysis demonstrates that methods for scoring and analysis of the specified measure allow for identification of statistically significant and practically/clinically meaningful differences in performance.

Comment [k19]: 14 With large enough sample sizes, small differences that are statistically significant may or may not be practically or clinically meaningful. The substantive question may be, for example, whether a statistically significant difference of one percentage point in the percentage of patients who received smoking cessation counseling (e.g., 74% v. 75%) is clinically meaningful; or whether a statistically significant difference of $25 in cost for an episode of care (e.g., $5,000 v. $5,025) is practically meaningful. Measures with overall poor performance may not demonstrate much variability across providers.

These results also demonstrated ongoing geographic variation in hospital RSMRs for AMI. Reference: Bernheim SM, Grady JN, Lin Z, Wang Y, Wang Y-F, Savage SV, Bhat KR, Ross JS, Desai MM, Merrill AR, Han LF, Rapp MT, Drye EE, Normand SL, Krumholz HM. National patterns of risk-standardized mortality and readmission for acute myocardial infarction and heart failure. Update on publicly reported outcomes measures based on the 2010 release. Circ Cardiovasc Qual Outcomes. 2010 Sep 1;3(5):459-67. Epub 2010 Aug 24.	
2g. Comparability of Multiple Data Sources/Methods 2g.1 **Data/sample** *(description of data/sample and size)*: The measure performs well in both Medicare FFS data and all-payer data. 2g.2 **Analytic Method** *(type of analysis & rationale)*: See above 2g.3 **Testing Results** *(e.g., correlation statistics, comparison of rankings)*: See above	**2g** C☐ P☐ M☐ N☐ NA ☐
2h. Disparities in Care 2h.**1 If measure is stratified, provide stratified results** *(scores by stratified categories/cohorts)*: N/A – Measure is not stratified 2h.2 **If disparities have been reported/identified, but measure is not specified to detect disparities, provide follow-up plans:** Disparities in race and socioeconomic status (SES) have been reported at the patient level but our analyses indicate little hospital-level disparities.	**2h** C☐ P☐ M☐ N☐ NA ☐
TAP/Workgroup: What are the strengths and weaknesses in relation to the subcriteria for *Scientific Acceptability of Measure Properties?*	**2**
Steering Committee: Overall, to what extent was the criterion, *Scientific Acceptability of Measure Properties*, **met?** **Rationale:**	*2* C☐ P☐ M☐ 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. (evaluation criteria)	**Eval Rating**
3a. Meaningful, Understandable, and Useful Information 3a.1 **Current Use:** In use 3a.2 **Use in a public reporting initiative (disclosure of performance results to the public at large)** (*If used in a public reporting initiative, provide name of initiative(s), locations, Web page URL(s). If not publicly reported, state the plans to achieve public reporting within 3 years*): The measure has been publicly reported on Hospital Compare (www.hospitalcompare.hhs.gov) since June 2007 and is used in CMS's Hospital Inpatient Quality Reporting Program (formerly RHQDAPU). 3a.3 **If used in other programs/initiatives (***If used in quality improvement or other programs/initiatives, name of initiative(s), locations, Web page URL(s). If not used for QI, state the plans to achieve use for QI within 3 years*): **Testing of Interpretability** (*Testing that demonstrates the results are understood by the potential users for public reporting and quality improvement*) 3a.4 **Data/sample** *(description of data/sample and size)*:	**3a** C☐ P☐ M☐ N☐

Comment [KP20]: 2g. If multiple data sources/methods are allowed, there is demonstration they produce comparable results.

Comment [KP21]: 2h. If disparities in care have been identified, measure specifications, scoring, and analysis allow for identification of disparities through stratification of results (e.g., by race, ethnicity, socioeconomic status, gender);OR rationale/data justifies why stratification is not necessary or not feasible.

Comment [KP22]: 3a. Demonstration that information produced by the measure is meaningful, understandable, and useful to the intended audience(s) for both public reporting (e.g., focus group, cognitive testing) and informing quality improvement (e.g., quality improvement initiatives). An important outcome that may not have an identified improvement strategy still can be useful for informing quality improvement by identifying the need for and stimulating new approaches to improvement.

3a.5 Methods *(e.g., focus group, survey, QI project)*: This measure is NQF endorsed. Prior to public reporting in 2007, CMS conducted a dry run in December 2006 to provide hospitals and the public with an opportunity to preview the measure methodology, proposed information for public reporting, and hospital-specific information. Additionally, CMS has also conducted consumer testing of the language on Hospital Compare to ensure clarity and ease of interpretation of the information to be posted publicly. **3a.6 Results** *(qualitative and/or quantitative results and conclusions)*:	
3b/3c. Relation to other NQF-endorsed measures **3b.1 NQF # and Title of similar or related measures:**	
(for NQF staff use) **Notes on similar/related endorsed or submitted measures:**	
3b. Harmonization If this measure is related to measure(s) already endorsed by NQF (e.g., same topic, but different target population/setting/data source or different topic but same target population): **3b.2 Are the measure specifications harmonized? If not, why?** Yes, they use a similar risk-adjustment strategy.	**3b** C☐ P☐ M☐ N☐ NA ☐
3c. Distinctive or Additive Value **3c.1 Describe the distinctive, improved, or additive value this measure provides to existing NQF-endorsed measures:** This measure looks at a different condition for the mortality outcome, AMI, from the two other related mortality measures. **5.1 If this measure is similar to measure(s) already endorsed by NQF (i.e., on the same topic and the same target population), Describe why it is a more valid or efficient way to measure quality:** AHRQ inpatient AMI mortality measure. Inpatient mortality rates can be influenced by hospital length of stay, thus 30-day measures that establish a standard follow-up period are more appropriate for profiling a diverse group of hospitals.	**3c** C☐ P☐ M☐ N☐ NA ☐
TAP/Workgroup: What are the strengths and weaknesses in relation to the subcriteria for *Usability*?	**3**
Steering Committee: Overall, to what extent was the criterion, *Usability*, **met?** **Rationale:**	**3** C☐ P☐ M☐ N☐
4. FEASIBILITY	
Extent to which the required data are readily available, retrievable without undue burden, and can be implemented for performance measurement. (evaluation criteria)	**Eval Rating**
4a. Data Generated as a Byproduct of Care Processes **4a.1-2 How are the data elements that are needed to compute measure scores generated?** Coding/abstraction performed by someone other than person obtaining original information (E.g., DRG, ICD-9 codes on claims, chart abstraction for quality measure or registry)	**4a** C☐ P☐ M☐ N☐
4b. Electronic Sources **4b.1 Are all 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*) Yes	**4b** C☐ P☐ M☐ N☐

Comment [KP23]: 3b. The measure specifications are harmonized with other measures, and are applicable to multiple levels and settings.

Comment [k24]: 16 Measure harmonization refers to the standardization of specifications for similar measures on the same topic (e.g., *influenza immunization* of patients in hospitals or nursing homes), or related measures for the same target population (e.g., eye exam and HbA1c for *patients with diabetes*), or definitions applicable to many measures (e.g., age designation for children) so that they are uniform or compatible, unless differences are dictated by the evidence. The dimensions of harmonization can include numerator, denominator, exclusions, and data source and collection instructions. The extent of harmonization depends on the relationship of the measures, the evidence for the specific measure focus, and differences in data sources.

Comment [KP25]: 3c. Review of existing endorsed measures and measure sets demonstrates that the measure provides a distinctive or additive value to existing NQF-endorsed measures (e.g., provides a more complete picture of quality for a particular condition or aspect of healthcare, is a more valid or efficient way to measure).

Comment [KP26]: 4a. For clinical measures, required data elements are routinely generated concurrent with and as a byproduct of care processes during care delivery. (e.g., BP recorded in the electronic record, not abstracted from the record later by other personnel; patient self-assessment tools, e.g., depression scale; lab values, meds, etc.)

Comment [KP27]: 4b. The required data elements are available in electronic sources. If the required data are not in existing electronic sources, a credible, near-term path to electronic collection by most providers is specified and clinical data elements are specified for transition to the electronic health record.

4b.2 If not, specify the near-term path to achieve electronic capture by most providers.	
4c. Exclusions **4c.1 Do the specified exclusions require additional data sources beyond what is required for the numerator and denominator specifications?** No **4c.2 If yes, provide justification.**	**4c** C☐ P☐ M☐ N☐ **NA** ☐
4d. Susceptibility to Inaccuracies, Errors, or Unintended Consequences **4d.1 Identify susceptibility to inaccuracies, errors, or unintended consequences of the measure and describe how these potential problems could be audited. If audited, provide results.** Using administrative claims variables for risk adjustment: This measure uses variables from claims data submitted by hospitals for payment as clinical risk adjusters. Our analyses have demonstrated that administrative claims data can be used to develop a risk-adjusted outcome measure for mortality following admission for AMI and that the model produced estimates of RSMRs that are very similar to rates estimated by models based on chart data. This high level of agreement in the results based on the two different approaches supports the use of the claims-based model for public reporting. The model has also demonstrated consistent performance across years of claims data. The approach to gathering risk factors for patients also mitigates the potential limitations of claims data. Because not every diagnosis is coded at every visit, we use inpatient, outpatient, and physician claims data for the year prior to admission, and diagnosis codes during the index admission, for risk adjustment when the measure is used in Medicare FFS data. When the measure is used in all-payer data, only admission claims data (from the index hospitalization and prior year) are used for risk adjustment; however, model testing demonstrated both strong patient-level model performance and consistent hospital-level results when using only admission claims data. The 1-year time frame provides a more comprehensive view of patients' medical histories than is provided by the secondary diagnosis codes from the index hospitalization alone. If a diagnosis appears in some visits and not others, it is included, minimizing the effect of incomplete coding. We were careful, however, to include information about each patient's status at admission and not to adjust for possible complications of the admission. Although some codes, by definition, represent conditions that are present before admission (e.g. cancer), other codes and conditions cannot be differentiated from complications during the hospitalization (e.g. infection or shock). If these are secondary diagnoses from the index admission, then they are not adjusted for in the analysis.	**4d** C☐ P☐ M☐ N☐
4e. Data Collection Strategy/Implementation **4e.1 Describe what you have learned/modified as a result of testing and/or operational use of the measure regarding data collection, availability of data/missing data, timing/frequency of data collection, patient confidentiality, time/cost of data collection, other feasibility/ implementation issues:** N/A **4e.2 Costs to implement the measure** (*costs of data collection, fees associated with proprietary measures*)**:** The measure is developed using administrative claims data and does not necessitate any additional cost/burden on hospitals. **4e.3 Evidence for costs:** N/A **4e.4 Business case documentation:** N/A	**4e** C☐ P☐ M☐ N☐
TAP/Workgroup: What are the strengths and weaknesses in relation to the subcriteria for *Feasibility?*	**4**
Steering Committee: Overall, to what extent was the criterion, *Feasibility*, **met?** **Rationale:**	**4** C☐

Comment [KP28]: 4c. Exclusions should not require additional data sources beyond what is required for scoring the measure (e.g., numerator and denominator) unless justified as supporting measure validity.

Comment [KP29]: 4d. Susceptibility to inaccuracies, errors, or unintended consequences and the ability to audit the data items to detect such problems are identified.

Comment [KP30]: 4e. Demonstration that the data collection strategy (e.g., source, timing, frequency, sampling, patient confidentiality, etc.) can be implemented (e.g., already in operational use, or testing demonstrates that it is ready to put into operational use).

	P☐ M☐ N☐
RECOMMENDATION	
(for NQF staff use) **Check if measure is untested and only eligible for time-limited endorsement.**	Time-limited ☐
Steering Committee: Do you recommend for endorsement? **Comments:**	Y☐ N☐ A☐

CONTACT INFORMATION

Co.1 **Measure Steward (Intellectual Property Owner)**
Co.1 **Organization**
Centers for Medicare & Medicaid Services (CMS), 7500 Security Boulevard , Mail Stop S3-02-01, Baltimore, Maryland, 21244-9045

Co.2 **Point of Contact**
Lein, Han, PhD, Government Task Leader, lein.han@cms.hhs.gov, 410-786-0205-

Measure Developer If different from Measure Steward
Co.3 **Organization**
Yale New Haven Health Services Corporation (YNHHSC), 1 Church Street, Suite 200, New Haven, Connecticut, 06510

Co.4 **Point of Contact**
Susannah, Bernheim, MD, MHS, susannah.bernheim@yale.edu, 203-764-3271-

Co.5 **Submitter If different from Measure Steward POC**
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Co.6 **Additional organizations that sponsored/participated in measure development**
MPR-Mathematica Policy Research; RTI-Research Triangle Institute

ADDITIONAL INFORMATION

Workgroup/Expert Panel involved in measure development
Ad.1 **Provide a list of sponsoring organizations and workgroup/panel members' names and organizations. Describe the members' role in measure development.**
The working group involved in the initial measure development is detailed in the original technical report available at www.qualitynet.org

Ad.2 **If adapted, provide name of original measure:** Acute Myocardial Infarction 30-day Mortality
Ad.3-5 **If adapted, provide original specifications URL or attachment** URL www.qualitynet.org

Measure Developer/Steward Updates and Ongoing Maintenance
Ad.6 **Year the measure was first released:** 2007
Ad.7 **Month and Year of most recent revision:** 04, 2011
Ad.8 **What is your frequency for review/update of this measure?** Yearly
Ad.9 **When is the next scheduled review/update for this measure?** 08, 2011

Ad.10 **Copyright statement/disclaimers:** N/A

Ad.11 -13 **Additional Information web page URL or attachment:** URL N/A www.qualitynet.org for Measure Methodology report and Maintenance reports

Date of Submission (*MM/DD/YY*)**:** 10/28/2010

NATIONAL QUALITY FORUM

Measure Evaluation 4.1
December 2009

This form contains the measure information submitted by stewards. Blank fields indicate no information was provided. Attachments also may have been submitted and are provided to reviewers. The subcriteria and most of the footnotes from the evaluation criteria are provided in Word comments within the form and will appear if your cursor is over the highlighted area. Hyperlinks to the evaluation criteria and ratings are provided in each section.

TAP/Workgroup (if utilized)**:** Complete all yellow highlighted areas of the form. Evaluate the extent to which each subcriterion is met. Based on your evaluation, summarize the strengths and weaknesses in each section.

Note: *If there is no TAP or workgroup, the SC also evaluates the subcriteria (yellow highlighted areas).*

Steering Committee: Complete all pink highlighted areas of the form. Review the workgroup/TAP assessment of the subcriteria, noting any areas of disagreement; then evaluate the extent to which each major criterion is met; and finally, indicate your recommendation for the endorsement. Provide the rationale for your ratings.

Evaluation ratings of the extent to which the criteria are met
C = Completely (unquestionably demonstrated to meet the criterion)
P = Partially (demonstrated to partially meet the criterion)
M = Minimally (addressed BUT demonstrated to only minimally meet the criterion)
N = Not at all (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 #:** 0330 **NQF Project:** Cardiovascular Endorsement Maintenance 2010

MEASURE DESCRIPTIVE INFORMATION
De.1 **Measure Title:** Hospital 30-day, all-cause, risk-standardized readmission rate following heart failure hospitalization for patients 18 and older
De.2 **Brief description of measure**: The measure estimates a hospital 30-day risk-standardized readmission rate (RSRR), defined as readmission for any cause within 30 days after the date of discharge of the index admission for patients 18 and older discharged from the hospital with a principal diagnosis of heart failure (HF).
1.1-2 **Type of Measure:** Outcome De.3 **If included in a composite or paired with another measure, please identify composite or paired measure** This measure is paired with a measure of hospital-level, all-cause, 30-day, risk-standardized mortality rate (RSMR) following an HF hospitalization.
De.4 **National Priority Partners Priority Area:** Patient and family engagement, Care coordination, Safety De.5 **IOM Quality Domain**: Effectiveness, Patient-centered, Efficiency, Safety De.6 **Consumer Care Need:** Getting better, Staying healthy

CONDITIONS FOR CONSIDERATION BY NQF	NQF Staff
Four conditions must be met before proposed measures may be considered and evaluated for suitability as voluntary consensus standards:	
A. The measure is in the public domain or an intellectual property (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.* A.1 **Do you attest that the measure steward holds intellectual property rights to the measure and the right to use aspects of the measure owned by another entity (e.g., risk model, code set)?** Yes A.2 **Indicate if Proprietary Measure** (*as defined in measure steward agreement*)**:** A.3 **Measure Steward Agreement:** Government entity and in the public domain - no agreement necessary A.4 **Measure Steward Agreement attached:**	**A** **Y**☐ **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, information provided in contact section	**B** Y☐ N☐
C. The intended use of the measure includes both public reporting and quality improvement. ►**Purpose:** Public Reporting, Quality Improvement with Benchmarking (external benchmarking to multiple organizations)	**C** Y☐ 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 12 months of endorsement. D.1**Testing:** Yes, fully developed and tested D.2 **Have NQF-endorsed measures been reviewed to identify if there are similar or related measures?** Yes	**D** Y☐ N☐
(for NQF staff use**) Have all conditions for consideration been met?** **Staff Notes to Steward** (*if submission returned*)**:**	**Met** Y☐ N☐
Staff Notes to Reviewers (*issues or questions regarding any criteria*)**:**	
Staff Reviewer Name(s):	

TAP/Workgroup Reviewer Name:	
Steering Committee Reviewer Name:	
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 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.* (evaluation criteria) **1a. High Impact**	**Eval Rating**
(for NQF staff use) **Specific NPP goal**:	
1a.1 **Demonstrated High Impact Aspect of Healthcare:** Affects large numbers, Leading cause of morbidity/mortality, High resource use, Severity of illness, Patient/societal consequences of poor quality 1a.2 1a.3 **Summary of Evidence of High Impact:** The Medicare Payment Advisory Commission (MedPAC) has called for hospital-specific public reporting of readmission rates, identifying HF as a priority condition (MedPAC, 2007). MedPAC finds that readmissions are common, costly, and often preventable. Based on 2005 Medicare data, MedPAC estimates that about 12.5% of Medicare HF admissions were followed by a readmission within 15 days, accounting for more than 90,000 admissions at a cost of $590 million. HF is the most common principal discharge diagnosis among older adults and the third highest for hospital reimbursements in 2005 (CMS/OIS, 2006), and the leading cause of readmission among Medicare beneficiaries, with nearly half of HF patients expected to return to the hospital within 6 months of discharge. (Jencks 2009, Krumholz 1997) All-cause 30-day readmission rates per thousand patients discharged with HF increased by 11 percent between 1992 and 2001 (CMS/MPR/MQMS, 2003). HF readmission is a costly event and represents an undesirable outcome of care from the patient's perspective, and highly disparate HF readmission rates among hospitals suggest there is room for improvement. (MedPAC 2007, Bernheim 2010) 1a.4 **Citations for Evidence of High Impact:** Report to the Congress: Promoting Greater Efficiency in	**1a** C☐ P☐ M☐ N☐

Comment [KP1]: 1a. The measure focus addresses:
- a specific national health goal/priority identified by NQF's National Priorities Partners; OR
- a demonstrated high impact aspect of healthcare (e.g., affects large numbers, leading cause of morbidity/mortality, high resource use (current and/or future), severity of illness, and patient/societal consequences of poor quality).

Medicare. Washington, DC: Medicare Payment Advisory Commission, 2007.

Centers for Medicare & Medicaid Services, Office of Information Services (OIS). Available at http://www.cms.hhs.gov/MedicareFeeforSvcPartsAB/Downloads/SSDischarges0405.pdf , accessed October 21, 2006.

Jencks SF, Williams MV, Coleman EA. Rehospitalizations among patients in the Medicare fee-for-service program. N Engl J Med. 2009 Apr 2;360(14):1418-28.

Krumholz HM, Parent EM, Tu N, Vaccarino V, Wang Y, Radford MJ, Hennen J. Readmission after hospitalization for congestive heart failure among Medicare beneficiaries. Arch Intern Med. 1997;157:99 –104.

Centers for Medicare & Medicaid Services, Mathematica Policy Research, Medicare Quality Monitoring System (MQMS) Report: Heart Failure, 1992-2001. Available at: http://www.mathematica-mpr.com/publications/PDFs/mqmsheart.pdf. accessed December 06, 2010

Report to the Congress: Promoting Greater Efficiency in Medicare. Washington, DC: Medicare Payment Advisory Commission, 2007.

Bernheim SM, Grady JN, Lin Z, Wang Y, Wang Y, Savage SV, Bhat KR, Ross JS, Desai MM, Merrill AR, Han LF, Rapp MT, Drye EE, Normand SL, Krumholz HM. National patterns of risk-standardized mortality and readmission for acute myocardial infarction and heart failure. Update on publicly reported outcomes measures based on the 2010 release. Circ Cardiovasc Qual Outcomes. 2010 Sep 1;3(5):459-67.

1b. Opportunity for Improvement

1b.1 Benefits (improvements in quality) envisioned by use of this measure: The goal of this measure is to improve patient outcomes by providing patients, physicians, and hospitals with information about hospital-level, risk-standardized readmission rates following hospitalization for HF. Measurement of patient outcomes allows for a broad view of quality of care that encompasses more than what can be captured by individual process-of-care measures. Complex and critical aspects of care, such as communication between providers, prevention of, and response to, complications, patient safety and coordinated transitions to the outpatient environment, all contribute to patient outcomes but are difficult to measure by individual process measures. The goal of outcomes measurement is to risk-adjust for patients' conditions at the time of hospital admission and then evaluate patient outcomes. This measure was developed to identify institutions, whose performance is better or worse than would be expected based on their patient case-mix, and therefore promote hospital quality improvement and better inform consumers about care quality.

1b.2 Summary of data demonstrating performance gap (variation or overall poor performance) across providers:
Our recent analyses of Medicare FFS data show substantial variation in RSRRs among hospitals. For the most recently reported three years of data (7/2006-6/2009) the mean hospital RSRR was 24.6% with a range of 17.3% to 32.4%. The 5th percentile was 21.4% and the 95th was 28.1%. The interquartile range was 23.4% to 25.8%.

We have also demonstrated ongoing geographic variation in hospital RSRRs for HF.

Reference:

Bernheim SM, Grady JN, Lin Z, Wang Y, Wang Y-F, Savage SV, Bhat KR, Ross JS, Desai MM, Merrill AR, Han LF, Rapp MT, Drye EE, Normand SL, Krumholz HM. National patterns of risk-standardized mortality and readmission for acute myocardial infarction and heart failure. Update on publicly reported outcomes measures based on the 2010 release. Circ Cardiovasc Qual Outcomes. 2010 Sep 1;3(5):459-67. Epub 2010 Aug 24.

1b.3 Citations for data on performance gap:
The information on the performance gap is based on RSRRs calculated for HF hospitalizations among Medicare FFS patients aged 65 and over (65+) from July 1, 2006- June 30, 2009 and includes 1,319,065 hospitalizations from 4759 hospitals. The index hospitalizations are those included in the measure and

1b
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P ☐
M ☐
N ☐

Comment [KP2]: 1b. Demonstration of quality problems and opportunity for improvement, i.e., data demonstrating considerable variation, or overall poor performance, in the quality of care across providers and/or population groups (disparities in care).

Comment [k3]: 1 Examples of data on opportunity for improvement include, but are not limited to: prior studies, epidemiologic data, measure data from pilot testing or implementation. If data are not available, the measure focus is systematically assessed (e.g., expert panel rating) and judged to be a quality problem.

reported in the 2010 update to hospital compare.

1b.4 Summary of Data on disparities by population group:
The measure is a hospital-level measure and therefore CMS assessed evidence of disparities by examining hospital performance based on the proportion of African-American patients served or the proportion of low-income patients served by the hospital.

The analyses examining the proportion of Medicare FFS patients that a hospital served who are African-American show slightly higher RSRRs for hospitals with higher proportions of African-American patients compared with lower proportions, but the range of performance across all levels is similar. We divided hospitals into deciles based on the proportion of their patients that were African-American and looked at hospital performance on the measure across deciles. The combined lowest 5 deciles include hospitals with fewer than 5% African-American patients and have a median HF RSRR of 24.3% (range 18.2% -33.2%) in comparison hospitals in the highest decile with greater than 25% African American patients have a median HF RSRR of 26.0% (range 20.6% - 32.8%). Although this demonstrates slightly worse performance of hospitals with a large proportion of African-American patients, these analyses also show wide variation in performance of hospitals regardless of the proportion of African-American patients and suggest that hospitals with large proportions of African American patients are not consistently performing at a lower or higher level than other hospitals.

Similar analyses were completed to evaluate hospital differences in performance on RSRR based on the socioeconomic status (SES) of their patients. These analyses suggest a slightly higher median HF RSRR at the hospitals in the lowest quartile based on the SES of their patients (as measured by the median of the patient's ZIP-code level median income). The lowest quartile hospitals have a median RSRR of 25.0% compared to a median RSRR of 24.4% for hospitals in highest quartile. However, the range for the two groups is largely overlapping (19.0% - 33.2 % vs. 18.8% - 31.0%, respectively) demonstrating that substantial numbers of hospitals serving low SES patients perform well on the measure.

1b.5 Citations for data on Disparities:
The sample for the above analyses is from a similar 3-year cohort of Medicare FFS hospitalizations as the data for the performance gap analysis above (January 2006- December 2008) but limited to hospitals with at least 25 HF cases over the 3-year period, a total of 4,260 hospitals.

1c. Outcome or Evidence to Support Measure Focus

1c.1 Relationship to Outcomes (*For non-outcome measures, briefly describe the relationship to desired outcome. For outcomes, describe why it is relevant to the target population*)**:** This measure calculates hospital-level, 30-day all-cause readmission rates after hospitalization for HF. The goal is to directly affect patient outcomes by measuring risk-standardized rates of readmission.

1c.2-3. Type of Evidence: Systematic synthesis of research

1c.4 Summary of Evidence (*as described in the criteria; for outcomes, summarize any evidence that healthcare services/care processes influence the outcome*)**:**
Studies have shown that interventions during and after a hospitalization can be effective in reducing readmission rates in geriatric populations (Benbassat and Taragin, 2000; Naylor et al. 1999; Coleman et al. 2006) and for elderly HF patients particularly (Phillips et al. 2004; Naylor et al. 2004; Koelling et al. 2005; Krumholz et al. 2002). Such interventions can be cost saving (Coleman et al. 2006; Krumholz et al. 2002; Naylor et al. 2004; Koelling et al. 2005; Phillips et al. 2004).

References:

Benbassat J, Taragin M. Hospital readmissions as a measure of quality of health care: advantages and limitations. Arch Intern Med. 2000 Apr 24;160(8):1074-81.

Naylor MD, Brooten D, Campbell R, et al. Comprehensive discharge planning and home follow-up of hospitalized elders: a randomized clinical trial. JAMA. 1999 Feb 17;281(7):613-20.

1c
C☐
P☐
M☐
N☐

Comment [k4]: 1c. The measure focus is:
•an outcome (e.g., morbidity, mortality, function, health-related quality of life) that is relevant to, or associated with, a national health goal/priority, the condition, population, and/or care being addressed;
OR
•if an intermediate outcome, process, structure, etc., there is **evidence** that supports the specific measure focus as follows:
oIntermediate outcome – evidence that the measured intermediate outcome (e.g., blood pressure, Hba1c) leads to improved health/avoidance of harm or cost/benefit.
oProcess – evidence that the measured clinical or administrative process leads to improved health/avoidance of harm and
if the measure focus is on one step in a multi-step care process, it measures the step that has the greatest effect on improving the specified desired outcome(s).
oStructure – evidence that the measured structure supports the consistent delivery of effective processes or access that lead to improved health/avoidance of harm or cost/benefit.
oPatient experience – evidence that an association exists between the measure of patient experience of health care and the outcomes, values and preferences of individuals/ the public.
oAccess – evidence that an association exists between access to a health service and the outcomes of, or experience with, care.
oEfficiency – demonstration of an association between the measured resource use and level of performance with respect to one or more of the other five IOM aims of quality.

Comment [k5]: 4 Clinical care processes typically include multiple steps: assess → identify problem/potential problem → choose/plan intervention (with patient input) → provide intervention → evaluate impact on health status. If the measure focus is one step in such a multi-step process, the step with the greatest effect on the desired outcome should be selected as the focus of measurement. For example, although assessment of immunization status and recommending immunization are necessary steps, they are not sufficient to achieve the desired impact on health status – patients must be vaccinated to achieve immunity. This does not preclude consideration of measures of preventive screening interventions where there is a strong link with desired outcomes (e.g., mammography) or measures for multiple care processes that affect a single outcome.

Coleman EA, Parry C, Chalmers S, Min SJ. The care transitions intervention:results of a randomized controlled trial. Arch Intern Med. 2006 Sep 25;166(17):1822-8.

Phillips CO, Wright SM, Kern DE, et al. Comprehensive discharge planning with postdischarge support for older patients with congestive heart failure: a meta-analysis. JAMA. 2004 Mar 17;291(11):1358-67.

Naylor MD, Brooten DA, et al. Transitional care of older adults hospitalized with heart failure: a randomized, controlled trial. J Am Geriatr Soc. 2004 May;52(5):675-84.

Koelling TM, Johnson ML, Cody RJ, Aaronson KD. Discharge education improves clinical outcomes in patients with chronic heart failure. Circulation. 2005 Jan 18;111(2):179-85.

Krumholz HM, Amatruda J, Smith GL, et al. Randomized trial of an education and support intervention to prevent readmission of patients with heart failure. J Am Coll Cardiol. 2002 Jan 2;39(1):83-9.

1c.5 Rating of strength/quality of evidence (*also provide narrative description of the rating and by whom*): N/A (outcomes measure)

1c.6 Method for rating evidence: N/A (outcomes measure)

1c.7 Summary of Controversy/Contradictory Evidence: All-cause Readmission
This measure calculates a 30-day all-cause readmission rate. CMS measures all-cause readmission for rather than readmission due to certain conditions (e.g. heart failure readmissions) for a number of reasons. First, a narrow focus on specific causes of readmission may simply provide an incentive to shift patients away from those codes. Second, within the chain of events that lead to a patient being readmitted to the hospital there is often some aspect of care that could be improved, thereby reducing the risk of readmission. This is not to suggest that all readmissions are preventable, but the goal of the measure is to encourage broad approaches to quality improvement which will thereby lower all patients' risk of readmission. More narrowly defining readmission measures to those that are disease specific may incentivize a limited focus on improvements in care as opposed to thinking comprehensively about the patient's full medical and social needs at discharge. Factors which may influence readmission rates include medication reconciliation, patient education, follow-up care and communication between inpatient and outpatient providers. The goal is not to reduce the readmission rate to zero but to reduce overall readmission rates to what is achievable by the best hospitals.

Use of Hierarchical Generalized Linear Modeling
Hierarchical modeling is the appropriate statistical approach for hospital outcomes measures given the structure of the data and the underlying assumption of such measures, which is that hospital quality of care influences 30-day readmission rates. However, CMS frequently receives comments and questions about this approach, so we are concisely reiterating the rationale for and merits of using hierarchiacal logistic regression. Patients are clustered within hospitals and, as such, have a shared exposure to the hospital quality and processes. The use of hierarchical modeling accounts for the clustering of patients within hospitals. Second, hierarchical models distinguish within-hospital variation and between-hospital variation to estimate the hospital's contribution to the risk of readmission. This allows for an estimation of the hospital's influence on patient outcomes. Finally, within hierarchical models we can account for both differences in case mix and sample size to fairly profile hospital performance. If we did not use hierarchical modeling we could overestimate variation and potentially misclassify hospitals' performance. Accurately estimating variation is an important objective for models used in public reporting and potentially used in value-based purchasing programs.

1c.8 Citations for Evidence (*other than guidelines*):

1c.9 Quote the Specific guideline recommendation (*including guideline number and/or page number*): N/A

1c.10 Clinical Practice Guideline Citation: N/A
1c.11 National Guideline Clearinghouse or other URL: N/A

Comment [k6]: 3 The strength of the body of evidence for the specific measure focus should be systematically assessed and rated (e.g., USPSTF grading system http://www.ahrq.gov/clinic/uspstf07/methods/benefit.htm). If the USPSTF grading system was not used, the grading system is explained including how it relates to the USPSTF grades or why it does not. However, evidence is not limited to quantitative studies and the best type of evidence depends upon the question being studied (e.g., randomized controlled trials appropriate for studying drug efficacy are not well suited for complex system changes). When qualitative studies are used, appropriate qualitative research criteria are used to judge the strength of the evidence.

1c.12 Rating of strength of recommendation (*also provide narrative description of the rating and by whom***):** N/A **1c.13 Method for rating strength of recommendation** (*If different from USPSTF system, also describe rating and how it relates to USPSTF)***:** N/A **1c.14 Rationale for using this guideline over others:** N/A	
TAP/Workgroup: What are the strengths and weaknesses in relation to the subcriteria for *Importance to Measure and Report?*	**1**
Steering Committee: Was the threshold criterion, *Importance to Measure and Report***, met?** **Rationale:**	**1** **Y☐** **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. (evaluation criteria)	**Eval Rating**
2a. MEASURE SPECIFICATIONS	
S.1 Do you have a web page where current detailed measure specifications can be obtained? **S.2 If yes, provide web page URL:** **2a. Precisely Specified**	
2a.1 Numerator Statement (*Brief, text description of the numerator - what is being measured about the target population, e.g. target condition, event, or outcome***):** This outcome measure does not have a traditional numerator and denominator like a core process measure (e.g., percentage of adult patients with diabetes aged 18-75 years receiving one or more hemoglobin A1c tests per year); thus, we are using this field to define the outcome. The outcome for this measure is 30 day all-cause readmission. We define this as readmission for any cause within 30 days from the date of discharge of the index HF admission for paients 18 and older. In addition, if a patient has one or more admissions within 30 days of discharge from the index admission, only one was counted as a readmission. **2a.2 Numerator Time Window (***The time period in which cases are eligible for inclusion in the numerator***):** Defined as readmission for any cause within 30 days from the date of discharge of the index admission. **2a.3 Numerator Details (***All information required to collect/calculate the numerator, including all codes, logic, and definitions***):** Measure includes readmissions to any acute care hospital for any cause within 30 days of the index HF admission discharge date.	
2a.4 Denominator Statement (*Brief, text description of the denominator - target population being measured***):** Note: This outcome measure does not have a traditional numerator and denominator like a core process measure; thus, we are using this field to define the patient cohort and to define the patient cohort. This claims-based measure can be used in either of two patient cohorts: (1) patients aged 65 years or older or (2) patients aged 18 years or older. While the measure can be applied to populations aged 18 years or older, nationally data are often only available for patients aged 65 years or older. We have explicitly tested the measure in both age groups.	**2a-specs** **C☐** **P☐** **M☐** **N☐**

Comment [k7]: USPSTF grading system **http://www.ahrq.gov/clinic/uspstf/grades.htm**: **A -** The USPSTF recommends the service. There is high certainty that the net benefit is substantial. **B -** The USPSTF recommends the service. There is high certainty that the net benefit is moderate or there is moderate certainty that the net benefit is moderate to substantial. **C -** The USPSTF recommends against routinely providing the service. There may be considerations that support providing the service in an individual patient. There is at least moderate certainty that the net benefit is small. Offer or provide this service only if other considerations support the offering or providing the service in an individual patient. **D -** The USPSTF recommends against the service. There is moderate or high certainty that the service has no net benefit or that the harms outweigh the benefits. **I -** The USPSTF concludes that the current evidence is insufficient to assess the balance of benefits and harms of the service. Evidence is lacking, of poor quality, or conflicting, and the balance of benefits and harms cannot be determined.

Comment [KP8]: 2a. The measure is well defined and precisely specified so that it can be implemented consistently within and across organizations and allow for comparability. The required data elements are of high quality as defined by NQF's Health Information Technology Expert Panel (HITEP) .

The cohort includes admissions for patients discharged from the hospital with a principal diagnosis of HF (ICD-9-CM codes 402.01, 402.11, 402.91, 404.01, 404.03, 404.11, 404.13, 404.91, 404.93, and 428.xx) and with a complete claims history for the 12 months prior to admission.

2a.5 **Target population gender:** Female, Male
2a.6 **Target population age range:** The target population is age 18 years or older

2a.7 **Denominator Time Window (***The time period in which cases are eligible for inclusion in the denominator***):**
This measure was developed with 12 months of data. Currently the measure is publicly-reported with three years of index hospitalizations.

2a.8 **Denominator Details (***All information required to collect/calculate the denominator - the target population being measured - including all codes, logic, and definitions***):**
The denominator includes patients aged 18 and older admitted to non-federal acute care hospitals for HF defined by a principal discharge diagnosis of the following (ICD-9-CM codes 402.01, 402.11, 402.91, 404.01, 404.03, 404.11, 404.13, 404.91, 404.93, and 428.xx) and with a complete claims history for the 12 months prior to admission.

ICD-9-CM codes that define the patient cohort:
402.01 Hypertensive heart disease, malignant, with heart failure
402.11 Hypertensive heart disease, benign, with heart failure
402.91 Hypertensive heart disease, unspecified, with heart failure
404.01 Hypertensive heart and chronic kidney disease, malignant, with heart failure and with chronic kidney disease stage I through stage IV, or unspecified
404.03 Hypertensive heart and chronic kidney disease, malignant, with heart failure and with chronic kidney disease stage V or end stage renal disease
404.11 Hypertensive heart and chronic kidney disease, benign, with heart failure and with chronic kidney disease stage I through stage IV, or unspecified
404.13 Hypertensive heart and chronic kidney disease, benign, with heart failure and chronic kidney disease stage V or end stage renal disease
404.91 Hypertensive heart and chronic kidney disease, unspecified, with heart failure and with chronic kidney disease stage I through stage IV, or unspecified
404.93 Hypertensive heart and chronic kidney disease, unspecified, with heart failure and chronic kidney disease stage V or end stage renal disease
428.0 Congestive heart failure, unspecified
428.1 Left heart failure
428.20 Unspecified systolic heart failure
428.21 Acute systolic heart failure
428.22 Chronic systolic heart failure
428.23 Acute on chronic systolic heart failure
428.30 Unspecified diastolic heart failure
428.31 Acute diastolic heart failure
428.32 Chronic diastolic heart failure
428.33 Acute on chronic diastolic heart failure
428.40 Unspecified combined systolic and diastolic heart failure
428.41 Acute combined systolic and diastolic heart failure
428.42 Chronic combined systolic and diastolic heart failure
428.43 Acute on chronic combined systolic and diastolic heart failure
428.9 Heart Failure, unspecified

2a.9 **Denominator Exclusions (***Brief text description of exclusions from the target population***):** For all cohorts, the measure excludes admissions for patients:

- with an in-hospital death (because they are not eligible for readmission);

- without at least 30 days post-discharge enrollment in Medicare FFS (because the 30-day readmission outcome cannot be assessed in this group);

Comment [k9]: 11 Risk factors that influence outcomes should not be specified as exclusions.
12 Patient preference is not a clinical exception to eligibility and can be influenced by provider interventions.

- transferred to another acute care facility (When a patient is transferred from one acute care hospital to another, these multiple contiguous hospitalizations are considered one episode of care. Readmissions for transferred patients are attributed to the hospital that ultimately discharges the patient to a non-acute care setting.);

- discharged against medical advice (AMA) (because providers did not have the opportunity to deliver full care and prepare the patient for discharge);

- admitted with HF within 30 days of discharge from an index admission (Admissions within 30 days of discharge of an index admission will be considered readmissions. No admission is counted as a readmission and an index admission. The next eligible admission after the 30-day time period following an index admission will be considered another index admission.)

2a.10 Denominator Exclusion Details (*All information required to collect exclusions to the denominator, including all codes, logic, and definitions***):**
See "Denominator Exclusions" section.

2a.11 Stratification Details/Variables (*All information required to stratify the measure including the stratification variables, all codes, logic, and definitions***):**
Results of this measure will not be stratified.

2a.12-13 Risk Adjustment Type: Risk-adjustment devised specifically for this measure/condition

2a.14 Risk Adjustment Methodology/Variables (*List risk adjustment variables and describe conceptual models, statistical models, or other aspects of model or method***):**
Our approach to risk adjustment was tailored to and appropriate for a publicly reported outcome measure, as articulated in the American Heart Association (AHA) Scientific Statement, "Standards for Statistical Models Used for Public Reporting of Health Outcomes" (Krumholz et al. 2006).

The measure employs a hierarchical logistic regression model (a form of hierarchical generalized linear model [HGLM]) to create a hospital level 30-day RSRR. This approach to modeling appropriately accounts for the structure of the data (patients clustered within hospitals), the underlying risk due to patients' comorbidities, and sample size at a given hospital when estimating hospital readmission rates. In brief, the approach simultaneously models two levels (patient and hospital) to account for the variance in patient outcomes within and between hospitals (Normand and Shahian et al. 2007). At the patient level, each model adjusts the log-odds of readmission within 30-days of admission for age, sex, selected clinical covariates and a hospital-specific intercept. The second level models the hospital-specific intercepts as arising from a normal distribution. The hospital intercept, or hospital specific effect, represents the hospital contribution to the risk of readmission, after accounting for patient risk and sample size, and can be inferred as a measure of quality. The hospital-specific intercepts are given a distribution in order to account for the clustering (non-independence) of patients within the same hospital. If there were no differences among hospitals, then after adjusting for patient risk, the hospital intercepts should be identical across all hospitals.

Candidate and Final Risk-adjustment Variables: The measure was developed using Medicare FFS claims data. Candidate variables were patient-level risk-adjustors that are expected to be predictive of readmission, based on empirical analysis, prior literature, and clinical judgment, including demographic factors (age, sex) and indicators of comorbidity and disease severity. For each patient, covariates were obtained from Medicare claims extending 12 months prior to and including the index admission. The model adjusted for case differences based on the clinical status of the patient at the time of admission. We used condition categories (CCs), which are clinically meaningful groupings of more than 15,000 ICD-9-CM diagnosis codes. In addition, only comorbidities that conveyed information about the patient at that time or in the 12-months prior, and not complications that arose during the course of the hospitalization were included in the risk-adjustment. We did not risk-adjust for CCs that were possible adverse events of care and that were only recorded in the index admission,

The final set of risk-adjustment variables is:

Demographic

• Age-65 (years above 65, continuous) for 65 and over cohorts; or Age (years, continuous) for 18 and over cohorts.
• Male

Cardiovascular

• History of CABG
• Cardio-respiratory failure or shock
• Congestive heart failure
• Acute coronary syndrome
• Coronary atherosclerosis or angina
• Valvular or rheumatic heart disease
• Specified arrhythmias
• Other or unspecified heart disease
• Vascular or circulatory disease

Comorbidity

• Metastatic cancer or acute leukemia
• Cancer
• Diabetes or DM complications
• Protein-calorie malnutrition
• Disorders of fluid, electrolyte, acid-base
• Liver or biliary disease
• Peptic ulcer, hemorrhage, other specified gastrointestinal disorders
• Other gastrointestinal disorders
• Severe hematological disorders
• Iron deficiency or other anemias and blood disease
• Dementia or other specified brain disorders
• Drug/alcohol abuse/dependence/psychosis
• Major psychiatric disorders
• Depression
• Other psychiatric disorders
• Hemiplegia, paraplegia, paralysis, functional disability
• Stroke
• Chronic obstructive pulmonary disease
• Fibrosis of lung or other chronic lung disorders
• Asthma
• Pneumonia
• End stage renal disease or dialysis
• Renal failure
• Nephritis
• Other urinary tract disorders
• Decubitus ulcer or chronic skin ulcer

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References:
Krumholz HM, Brindis RG, Brush JE, et al. 2006. Standards for Statistical Models Used for Public Reporting of Health Outcomes: An American Heart Association Scientific Statement From the Quality of Care and Outcomes Research Interdisciplinary Writing Group: Cosponsored by the Council on Epidemiology and Prevention and the Stroke Council Endorsed by the American College of Cardiology Foundation. Circulation 113: 456-462.

Normand S-LT, Shahian DM. 2007. Statistical and Clinical Aspects of Hospital Outcomes Profiling. Stat Sci 22 (2): 206-226.

2a.15-17 Detailed risk model available Web page URL or attachment: URL N/A
http://qualitynet.org/dcs/ContentServer?c=Page&pagename=QnetPublic%2FPage%2FQnetTier3&cid=1219069855841

2a.18-19 Type of Score: Rate/proportion
2a.20 Interpretation of Score: Better quality = Lower score
2a.21 Calculation Algorithm (*Describe the calculation of the measure as a flowchart or series of steps***):**
The RSRR is calculated as the ratio of the number of "adjusted-actual" readmissions (also referred to as "predicted')to the number of "expected" readmissions at a given hospital, multiplied by the national unadjusted readmission rate. For each hospital, the "numerator" of the ratio is the number of readmissions within 30 days predicted on the basis of the hospital's performance with its observed case mix, and the "denominator" is the number of readmissions expected on the basis of the nation's performance with that hospital's case mix. This approach is analogous to a ratio of "observed" to "expected" used in other types of statistical analyses. It conceptually allows for a comparison of a particular hospital's performance given its case-mix to an average hospital's performance with the same case-mix. Thus a lower ratio indicates lower-than-expected readmission or better quality and a higher ratio indicates higher-than-expected readmission or worse quality.

The "adjusted actual" readmissions (the numerator) is calculated by regressing the risk factors and the hospital-specific intercept on the risk of readmission, multiplying the estimated regression coefficients by the patient characteristics in the hospital, transforming, and then summing over all patients attributed to the hospital to get a value. The expected number of readmissions (the denominator) is obtained by regressing the risk factors and a common intercept on the readmission outcome using all hospitals in our sample, multiplying the subsequent estimated regression coefficients by the patient characteristics observed in the hospital, transforming, and then summing over all patients in the hospital to get a value.

To assess hospital performance in any reporting period, the model coefficients are re-estimated using the years of data in that period.

2a.22 Describe the method for discriminating performance *(e.g., significance testing)***:**
CMS currently estimates an interval estimate for each risk-standardized rate to characterize the amount of uncertainty associated with the rate, compares the interval estimate to the national crude rate for the outcome, and categorizes hospitals as "better than," "worse than," or "no different than" the US national rate.

2a.23 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 –This measure is not based on a sample or survey.

2a.24 Data Source (*Check the source(s) for which the measure is specified and tested)*
Administrative claims, Other

2a.25 Data source/data collection instrument (*Identify the specific data source/data collection instrument, e.g. name of database, clinical registry, collection instrument, etc.***):**
Two data sources were used to create the measure:
1. Medicare Part A Inpatient and Outpatient and Part B outpatient claims: This database contains claims data for fee-for service inpatient and outpatient services including: Medicare inpatient hospital care, outpatient hospital services, skilled nursing facility care, some home health agency services, and hospice care, as well as inpatient and outpatient claims for the 12 months prior to an index admission.

2. Medicare Enrollment Database (EDB): This database contains Medicare beneficiary demographic, benefit/coverage, and vital status information. This dataset was used to obtain information on several inclusion/exclusion indicators such as Medicare status on admission as well as vital status. These data have previously been shown to accurately reflect patient vital status (Fleming Fisher et al. 1992).

The measure was originally developed with claims data from a 2004 sample of 283,919 cases from 4,669 hospitals. The models have been maintained and re-evaluated each year since public reporting of the measures began in 2009. For details, see measure methodology and measure maintenance reports posted at www.qualitynet.org .

The measure was subsequently applied to California Patient Discharge Data, a large, linked all-payer database of patient hospital admissions. Records are linked by a unique patient identification number, allowing us to determine patient history from previous hospitalizations as well as risk of readmission within 30 days.

To apply the measure to Medicare data, Medicare Part A inpatient and outpatient and Part B outpatient claims are used. To apply the measure to a non-Medicare population, inpatient claims data are used.

Fleming C., Fisher ES, Chang CH, Bubolz D, Malenda J. Studying outcomes and hospital utilization in the elderly: The advantages of a merged data base for Medicare and Veterans Affairs Hospitals. Medical Care. 1992; 30(5): 377-91.

2a.26-28 **Data source/data collection instrument reference web page URL or attachment:** URL N/A
http://qualitynet.org/dcs/ContentServer?c=Page&pagename=QnetPublic%2FPage%2FQnetTier3&cid=1219069855841

2a.29-31 **Data dictionary/code table web page URL or attachment:** URL N/A
http://www.qualitynet.org/dcs/ContentServer?c=Page&pagename=QnetPublic%2FPage%2FQnetTier3&cid=1182785083979

2a.32-35 **Level of Measurement/Analysis** (*Check the level(s) for which the measure is specified and tested)*
Facility

2a.36-37 **Care Settings (***Check the setting(s) for which the measure is specified and tested)*
Hospital/Acute Care Facility

2a.38-41 **Clinical Services** (*Healthcare services being measured, check all that apply*)

TESTING/ANALYSIS

2b. Reliability testing

2b.1 **Data/sample** *(description of data/sample and size)*: The reliability of the model was tested by randomly selecting 50% of Medicare FFS patients aged 65+ in the initial one-year cohort and developing a risk-adjusted model for this group. We then developed a second model for the remaining 50% of patients. Furthermore, in each subsequent year of measure maintenance we have re-fit the model and compared the frequencies of comorbidities and model fit across 3 years.

2b.2 **Analytic Method** *(type of reliability & rationale, method for testing)*:
In measure development and testing, for all cohorts, we computed diagnostics that describe their respective performance in terms of discriminant ability, overall fit, and generated hospital-level RSRRs and corresponding interval estimates for the development sample.

2b.3 **Testing Results** *(reliability statistics, assessment of adequacy in the context of norms for the test conducted)*:
See results under "Risk-Adjustment Strategy" below.

2b
C ☐
P ☐
M ☐
N ☐

2c. Validity testing

2c.1 **Data/sample** *(description of data/sample and size)*: Measure development and testing included medical record validation. For the derivation of the chart-based model, we used cases identified through a Health Care Financing Administration (now CMS) quality initiative, which sampled admissions from fee-for-service Medicare beneficiaries for several clinical conditions, including HF. Cases were identified over between April 1998 and March 1999 or between July 2000 and June 2001. Based on the principal discharge diagnosis, approximately 800 HF discharges per state were identified, and the corresponding medical records were abstracted by data central data abstraction center. In states with fewer than 800 HF discharges, all cases were used. The abstractors first grouped the claims by state, then sorted the universe of eligible claims by age, race, sex, and treating hospital, and then systematically sampled cases from a random starting point.

2c
C ☐
P ☐
M ☐
N ☐

Comment [KP10]: 2b. Reliability testing demonstrates the measure results are repeatable, producing the same results a high proportion of the time when assessed in the same population in the same time period.

Comment [k11]: 8 Examples of reliability testing include, but are not limited to: inter-rater/abstractor or intra-rater/abstractor studies; internal consistency for multi-item scales; test-retest for survey items. Reliability testing may address the data items or final measure score.

Comment [KP12]: 2c. Validity testing demonstrates that the measure reflects the quality of care provided, adequately distinguishing good and poor quality. If face validity is the only validity addressed, it is systematically assessed.

Patients must have been enrolled in fee-for-service Medicare, resulting in a dataset of 78,882 records.

2c.2 Analytic Method *(type of validity & rationale, method for testing)*:
Medical-record validation: We developed a medical record measure to compare with the administrative measure. We defined a measure cohort with the medical record data using the inclusion/exclusion criteria that was consistent with the claims-based administrative measure but using chart-based risk adjusters, such as blood pressure, not available in the claims data. We then matched a sample of the same patients in the administrative data for comparison. The matched sample included 64,329 patients. We compared the output of the two measures, that is, the state performance results, in the same group of patients.

2c.3 Testing Results *(statistical results, assessment of adequacy in the context of norms for the test conducted)*:
The results of the medical-record validation were produced at the state level. The mortality medical record model had a c-statistic of 0.58 as compared with 0.60 for the claims based measure. The correlation coefficient for the results of the administrative model compared with the medical-record model was very high, at 0.97 showing excellent consistency of the two models.

Reference:
Keenan PS, Normand SL, Lin Z, Drye EE, Bhat KR, Ross JS, Schuur JD, Stauffer BD, Bernheim SM, Epstein AJ, Wang Y, Herrin J, Chen J, Federer JJ, Mattera JA,Wang Y, Krumholz HM. An administrative claims measure suitable for profiling hospital performance on the basis of 30-day all-cause readmission rates among patients with heart failure. Circ Cardiovasc Qual Outcomes. 2008 Sep;1(1):29-37.

2d. Exclusions Justified

2d.1 Summary of Evidence supporting exclusion(s):
Rationale for exclusions described in "Denominator Exclusions"

2d.2 Citations for Evidence:
See "Denominator Exclusions"

2d.3 Data/sample *(description of data/sample and size)*: N/A

2d.4 Analytic Method *(type analysis & rationale)*:
N/A

2d.5 Testing Results *(e.g., frequency, variability, sensitivity analyses)*:
N/A

2d
C☐
P☐
M☐
N☐
NA☐

2e. Risk Adjustment for Outcomes/ Resource Use Measures

2e.1 Data/sample *(description of data/sample and size)*: When applied to Medicare FFS beneficiaries, the prior year of Medicare Part A inpatient and outpatient data and Part B outpatient data are used to identify variables for risk-adjustment.

Application to Medicare FFS Beneficiaries Using Inpatient Data Only for Risk Adjustment
As part of testing the model in all-payer data, we also applied the model to CMS data for Medicare FFS 65+ patients in California hospitals using only inpatient data for risk adjustment. California is a diverse state, and, with more than 37 million residents, California represents 12% of the US population. Specifically, we created a 2006 measure cohort with complete one-year history data and 30-day follow-up data (N= 29,169).

Application to Patients Aged 18 and Older
We also applied the model to all-payer data from California. The analytic sample included 76,536 cases aged 18 and older in the 2006 California Patient Discharge Data. When used in all-payer data, only admission claims data are used for risk adjustment, as the hospital discharge databases do not have outpatient claims.

2e.2 Analytic Method *(type of risk adjustment, analysis, & rationale)*:
This measure is fully risk-adjusted using a hierarchical logistic regression model to calculate hospital RSRRs accounting for differences in hospital case-mix. (See "risk adjustment methodology" for additional details.)

2e
C☐
P☐
M☐
N☐
NA☐

Comment [k13]: 9 Examples of validity testing include, but are not limited to: determining if measure scores adequately distinguish between providers known to have good or poor quality assessed by another valid method; correlation of measure scores with another valid indicator of quality for the specific topic; ability of measure scores to predict scores on some other related valid measure; content validity for multi-item scales/tests. Face validity is a subjective assessment by experts of whether the measure reflects the quality of care (e.g., whether the proportion of patients with BP < 140/90 is a marker of quality). If face validity is the only validity addressed, it is systematically assessed (e.g., ratings by relevant stakeholders) and the measure is judged to represent quality care for the specific topic and that the measure focus is the most important aspect of quality for the specific topic.

Comment [KP14]: 2d. Clinically necessary measure exclusions are identified and must be:
•supported by evidence of sufficient frequency of occurrence so that results are distorted without the exclusion;
AND
•a clinically appropriate exception (e.g., contraindication) to eligibility for the measure focus;
AND
•precisely defined and specified:
–if there is substantial variability in exclusions across providers, the measure is specified so that exclusions are computable and the effect on the measure is transparent (i.e., impact clearly delineated, such as number of cases excluded, exclusion rates by type of exclusion);
if patient preference (e.g., informed decision-making) is a basis for exclusion, there must be evidence that it strongly impacts performance on the measure and the measure must be specified so that the information about p... [1]

Comment [k15]: 10 Examples of evidence that an exclusion distorts measure results include, but are not limited to: frequency of occurrence, sensitivity analyses with and without the exclusion, and variability of exclusions across providers.

Comment [KP16]: 2e. For outcome measures and other measures (e.g., resource use) when indicated:
•an evidence-based risk-adjustment strategy (e.g., risk models, risk stratification) is specified and is based on patient clinical factors that influence the measured outcome (but not disparities in care) and are present at start of care;[Error! Bookmark not defined.] OR
rationale/data support no risk adjustment.

Comment [k17]: 13 Risk models should not obscure disparities in care for populations by including factors that are associated with differences/inequalities in care such as race, socioeconomic status, gender (e.g., poorer treatment outcomes of African American men with prostate cancer, inequalities in treatment for CVD risk factors between men and women). It is preferable to stratify measures by race and socioeconomic status rather than adjusting out differences.

Approach to assessing model performance:
During measure development, we computed five summary statistics for assessing model performance (Harrell and Shih, 2001) for the development and validation cohort:
(1) over-fitting indices (over-fitting refers to the phenomenon in which a model accurately describes the relationship between predictive variables and outcome in the development dataset but fails to provide valid predictions in new patients)
(2) predictive ability
(3) area under the receiver operating characteristic (ROC) curve
(4) distribution of residuals
(5) model chi-square (A test of statistical significance usually employed for categorical data to determine whether there is a good fit between the observed data and expected values; i.e., whether the differences between observed and expected values are attributable to true differences in characteristics or instead the result of chance variation).

Application to Medicare FFS Beneficiaries Using Inpatient Data Only for Risk Adjustment
To help determine whether the measure could be applied to Medicare FFS 65+ patients using only Medicare Part A data, we performed analyses to assess how the model performs when using only admission claims data for risk adjustment, as all-payer hospital discharge databases do not have outpatient claims. To assess the validity of using only admission claims data for risk adjustment, we fit the model separately using the full data and using only admission claims data and (a) compared the odds ratios (ORs) for the various risk factors; (b) conducted a reclassification analysis to compare risk prediction at the patient level; (c) compared model performance in terms of the c-statistic (discrimination); and (d) compared hospital-level risk-standardized rates (scatterplot, correlation coefficient, and R2) to assess whether the model with only admission claims data is different from the current model in profiling hospital rates.

Application to Patients Aged 18 and Older
To help determine whether the measure could be applied to an population of patients aged 18+, we examined the interaction terms between age (18-64 vs. 65+) and each of the other risk factors. Specifically, we fit the model in all patients 18+ with and without interaction terms and (a) conducted a reclassification analysis to compare risk prediction at the patient level; (b) compared the c-statistic; and (c) compared hospital-level risk-standardized rates (scatterplot, correlation coefficient, and R2) to assess whether the model with interactions is different from the current model in profiling hospital rates.

Reference: Harrell FE, Shih YCT. Using full probability models to compute probabilities of actual interest to decision makers. Int J Technol Assess Health Care. 2001;17:17–26.

2e.3 Testing Results *(risk model performance metrics)*:
During initial measure development, using Medicare FFS beneficiaries age 65 and over, we tested the performance of the model developed in a random selected half of the 2004 hospitalizations for HF (representing 283,919 cases discharged from 4,669 hospitals) against hospitalizations from the other half(representing 283,528 cases discharged from 4,680 hospitals). The performance was not substantively different in the validation sample (ROC area = 0.60) compared with the development sample (2004). The models appear well calibrated, with the over-fitting indices of (0,089, 1.05).

For the development cohort, the model performance results are summarized below:
Residuals lack of fit {<-2, [-2,0),[0,2),[2+}: {0,76.40,17.62,5.98}
Model Chi-Sq [# of covariates]: 6,462 [37]
Predictive ability (lowest decile %, highest decile %): (15%,37%)
Area under ROC curve: .60

For the validation cohort the results are summarized below:
Residuals lack of fit {<-2, [-2,0),[0,2),[2+}: {0,76.29,17.83,5.88}
Model Chi-Sq [# of covariates]: 6,632 [37]
Predictive ability (lowest decile%, highest decile %): (15%,37%)
Area under ROC curve: .60

In subsequent years, during annual measure maintenance we looked at the distributions of comorbid conditions, hospital volume, crude rates, hospital RSRR, risk-adjusted odds ratios and 95% confidence

intervals, and between-hospital variance over each subsequent year since 2006 and the and the parameters have remained consistent. For example, for the 2006-2008 calendar year dataset, we reported each individual year results as well as the 3-year combined results. Model performance was stable over all time periods.

Model Performance in Medicare FFS Beneficiaries Using Inpatient Data Only for Risk Adjustment Using CMS data for Medicare FFS 65+ beneficiaries in California hospitals: (a) the magnitude of odds ratios for most risk factors was similar when comparing the model using full data and using only admission claims data; (b) when comparing the model with full data and with only admission claims data, the reclassification analysis demonstrated good patient-level risk prediction; (c) the c-statistic was similar (0.610 vs. 0.611); and (d) hospital-level risk-standardized rates were highly correlated (r=0.986).

Model Perfomance in Patients Aged 18 and Older
When the model was applied to all patients 18 and over (18+), overall discrimination was good (c-statistic=0.638). In addition, there was good discrimination and predictive ability in both those aged 18-64 and those aged 65+. Moreover, the distribution of Pearson residuals was comparable across the patient subgroups. When comparing the model with and without interaction terms, (a) the reclassification analysis demonstrated good patient-level risk prediction (12.0% to 44.1% vs. 13.0% to 43.2%, respectively, from the bottom decile to the top decile of the prediction values); (b) the c-statistic was nearly identical (0.640 vs. 0.638); and (c) hospital-level risk-standardized rates were highly correlated (r=0.998). Thus, the inclusion of the interactions did not substantively affect either patient-level model performance or hospital-level results.

Therefore, the measure can be applied to all payer data for patients 18 and older.

References:

Krumholz HM, Normand S-LT, Keenan PS, et al. 2008. Hospital 30-Day Heart Failure Readmission Measure: Methodology. Report prepared for the Centers for Medicare & Medicaid Services.

Bernheim SM, Lin Z, Bhat KR, et al. 2010. 2010 Measures Maintenance Technical Report: Acute Myocardial Infarction, Heart Failure, and Pneumonia 30-Day Risk-Standardized Readmission Measures. Report prepared for the Centers for Medicare & Medicaid Services.

2e.4 If outcome or resource use measure is not risk adjusted, provide rationale: N/A—The measure is risk-adjusted

2f. Identification of Meaningful Differences in Performance

2f.1 Data/sample from Testing or Current Use *(description of data/sample and size)*: The data below are based on RSRRs calculated for HF hospitalizations among Medicare FFS patients aged 65+ from July 1, 2006-June 30, 2009 and includes 1,319,065 hospitalizations from 4,759 hospitals. The index hospitalizations are those included in the measure and reported in the 2010 update to Hospital Compare.

2f.2 Methods to identify statistically significant and practically/meaningfully differences in performance *(type of analysis & rationale)*:
For each RSRR, CMS characterizes the uncertainty associated with the RSRR by estimating the 95% interval estimate. This is similar to a 95% confidence interval but is calculated differently. If the RSRR's interval estimate does not include the national crude readmission rate (is lower or higher than the rate), then CMS is confident that the hospital's RSRR is different from the national rate, and describes the hospital on the Hospital Compare Web site as "better than the U.S. national rate" or "worse than the U.S. national rate." If the interval includes the national rate, then CMS describes the hospital's RSMR as "no different than the U.S. national rate" or "the difference is uncertain." CMS does not classify performance for hospitals that have fewer than 25 HF cases in the three-year period.

2f.3 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)*:
Recent analyses of Medicare FFS data show substantial variation in hospital RSRR's for HF:

2f
C ☐
P ☐
M ☐
N ☐

Comment [KP18]: 2f. Data analysis demonstrates that methods for scoring and analysis of the specified measure allow for identification of statistically significant and practically/clinically meaningful differences in performance.

Comment [k19]: 14 With large enough sample sizes, small differences that are statistically significant may or may not be practically or clinically meaningful. The substantive question may be, for example, whether a statistically significant difference of one percentage point in the percentage of patients who received smoking cessation counseling (e.g., 74% v. 75%) is clinically meaningful; or whether a statistically significant difference of $25 in cost for an episode of care (e.g., $5,000 v. $5,025) is practically meaningful. Measures with overall poor performance may not demonstrate much variability across providers.

Mean: 24.6%
Minimum: 17.3%
5th percentile: 21.4%
25th percentile: 23.4%
Median: 24.5%
75th percentile: 25.8%
95th percentile: 28.1%
Maximum: 32.4%

2g. Comparability of Multiple Data Sources/Methods

2g.1 **Data/sample** *(description of data/sample and size)*: The measure performs well in both Medicare FFS data and all-payer data.

2g.2 **Analytic Method** *(type of analysis & rationale)*:
See above

2g.3 **Testing Results** *(e.g., correlation statistics, comparison of rankings)*:
See above

2g
C☐ P☐ M☐ N☐ NA☐

Comment [KP20]: 2g. If multiple data sources/methods are allowed, there is demonstration they produce comparable results.

2h. Disparities in Care

2h.**1 If measure is stratified, provide stratified results** *(scores by stratified categories/cohorts)*: N/A – Measure is not stratified

2h.2 **If disparities have been reported/identified, but measure is not specified to detect disparities, provide follow-up plans:**
The analyses performed by CMS (described in section 1b) demonstrate that hospitals have largely overlapping performance on the measure regardless of the proportion of patients of low socioeconomic status or of African-American race. Importantly, the analyses show that hospitals with high proportions of low socioeconomic status patients or high proportions of African-American patients are able to perform well on the measure. For this reason CMS does not plan to stratify the measure.

2h
C☐ P☐ M☐ N☐ NA☐

Comment [KP21]: 2h. If disparities in care have been identified, measure specifications, scoring, and analysis allow for identification of disparities through stratification of results (e.g., by race, ethnicity, socioeconomic status, gender);OR rationale/data justifies why stratification is not necessary or not feasible.

TAP/Workgroup: What are the strengths and weaknesses in relation to the subcriteria for *Scientific Acceptability of Measure Properties?*

2

Steering Committee: Overall, to what extent was the criterion, *Scientific Acceptability of Measure Properties*, **met?**
Rationale:

2
C☐ P☐ M☐ 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. (evaluation criteria)

Eval Rating

3a. Meaningful, Understandable, and Useful Information

3a.1 **Current Use:** In use

3a.2 **Use in a public reporting initiative (disclosure of performance results to the public at large)** (*If used in a public reporting initiative, provide name of initiative(s), locations, Web page URL(s). If not publicly reported, state the plans to achieve public reporting within 3 years*):
The measure has been publicly reported on Hospital Compare (www.hospitalcompare.hhs.gov) since July 2009 and is used in CMS's Hospital Inpatient Quality Reporting Program (formerly RHQDAPU).

3a.3 **If used in other programs/initiatives (***If used in quality improvement or other programs/initiatives, name of initiative(s), locations, Web page URL(s). If not used for QI, state the plans to achieve use for QI within 3 years***):**

3a
C☐ P☐ M☐ N☐

Comment [KP22]: 3a. Demonstration that information produced by the measure is meaningful, understandable, and useful to the intended audience(s) for both public reporting (e.g., focus group, cognitive testing) and informing quality improvement (e.g., quality improvement initiatives). An important outcome that may not have an identified improvement strategy still can be useful for informing quality improvement by identifying the need for and stimulating new approaches to improvement.

Testing of Interpretability (*Testing that demonstrates the results are understood by the potential users for public reporting and quality improvement*)

3a.4 **Data/sample** *(description of data/sample and size)*:

3a.5 **Methods** *(e.g., focus group, survey, QI project)*:
This measure was originally NQF endorsed in 2008. Prior to public reporting in 2009, CMS conducted a dry run in 2008 to provide hospitals and the public with an opportunity to preview the measure methodology, proposed information for public reporting and hospital-specific information Additionally, CMS has also conducted consumer testing of the language on Hospital Compare to ensure clarity and ease of interpretation of the information to be posted publicly.

3a.6 **Results** *(qualitative and/or quantitative results and conclusions)*:

3b/3c. Relation to other NQF-endorsed measures

3b.1 **NQF # and Title of similar or related measures:**

(for NQF staff use) **Notes on similar/related endorsed or submitted measures:**

3b. Harmonization
If this measure is related to measure(s) already endorsed by NQF (e.g., same topic, but different target population/setting/data source or different topic but same target population):
3b.2 **Are the measure specifications harmonized? If not, why?**
Yes, they used a similar risk adjustment strategy.

3b
C☐ P☐ M☐ N☐ NA☐

3c. Distinctive or Additive Value
3c.1 **Describe the distinctive, improved, or additive value this measure provides to existing NQF-endorsed measures:**
This measure looks at a different condition for the readmission outcome, HF, from the two other related readmission measures for AMI and pneumonia.

5.1 **If this measure is similar to measure(s) already endorsed by NQF (i.e., on the same topic and the same target population), Describe why it is a more valid or efficient way to measure quality:**

3c
C☐ P☐ M☐ N☐ NA☐

TAP/Workgroup: What are the strengths and weaknesses in relation to the subcriteria for *Usability*?

3

Steering Committee: Overall, to what extent was the criterion, *Usability*, **met?**
Rationale:

3
C☐ P☐ M☐ N☐

4. FEASIBILITY

Extent to which the required data are readily available, retrievable without undue burden, and can be implemented for performance measurement. (evaluation criteria)

Eval Rating

4a. Data Generated as a Byproduct of Care Processes

4a.1-2 **How are the data elements that are needed to compute measure scores generated?**
Coding/abstraction performed by someone other than person obtaining original information (E.g., DRG, ICD-9 codes on claims, chart abstraction for quality measure or registry)

4a
C☐ P☐ M☐ N☐

4b. Electronic Sources

4b.1 **Are all 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*)

4b
C☐ P☐ M☐

Comment [KP23]: 3b. The measure specifications are harmonized with other measures, and are applicable to multiple levels and settings.

Comment [k24]: 16 Measure harmonization refers to the standardization of specifications for similar measures on the same topic (e.g., *influenza immunization* of patients in hospitals or nursing homes), or related measures for the same target population (e.g., eye exam and HbA1c for *patients with diabetes*), or definitions applicable to many measures (e.g., age designation for children) so that they are uniform or compatible, unless differences are dictated by the evidence. The dimensions of harmonization can include numerator, denominator, exclusions, and data source and collection instructions. The extent of harmonization depends on the relationship of the measures, the evidence for the specific measure focus, and differences in data sources.

Comment [KP25]: 3c. Review of existing endorsed measures and measure sets demonstrates that the measure provides a distinctive or additive value to existing NQF-endorsed measures (e.g., provides a more complete picture of quality for a particular condition or aspect of healthcare, is a more valid or efficient way to measure).

Comment [KP26]: 4a. For clinical measures, required data elements are routinely generated concurrent with and as a byproduct of care processes during care delivery. (e.g., BP recorded in the electronic record, not abstracted from the record later by other personnel; patient self-assessment tools, e.g., depression scale; lab values, meds, etc.)

Comment [KP27]: 4b. The required data elements are available in electronic sources. If the required data are not in existing electronic sources, a credible, near-term path to electronic collection by most providers is specified and clinical data elements are specified for transition to the electronic health record.

Yes **4b.2 If not, specify the near-term path to achieve electronic capture by most providers.**	**N**☐
4c. Exclusions **4c.1 Do the specified exclusions require additional data sources beyond what is required for the numerator and denominator specifications?** No **4c.2 If yes, provide justification.**	**4c** **C**☐ **P**☐ **M**☐ **N**☐ **NA** ☐
4d. Susceptibility to Inaccuracies, Errors, or Unintended Consequences **4d.1 Identify susceptibility to inaccuracies, errors, or unintended consequences of the measure and describe how these potential problems could be audited. If audited, provide results.** Using administrative claims variables for risk adjustment: This measure uses variables from claims data submitted by hospitals for payment as clinical risk adjusters. Our analyses have demonstrated that administrative claims data can be used to develop a risk-adjusted outcome measure for readmission following admission for HF and that the model produced estimates of RSRRs that are very similar to rates estimated by models based on chart data. This high level of agreement in the results based on the two different approaches supports the use of the claims-based model for public reporting. The model has also demonstrated consistent performance across years of claims data. The approach to gathering risk factors for patients also mitigates the potential limitations of claims data. Because not every diagnosis is coded at every visit, we use inpatient, outpatient, and physician claims data for the year prior to admission, and diagnosis codes during the index admission, for risk adjustment when the measure is used in Medicare FFS data. When the measure is used in all-payer data, only admission claims data (from the index hospitalization and prior year) are used for risk adjustment; however, model testing demonstrated both strong patient-level model performance and consistent hospital-level results when using only admission claims data. The 1-year time frame provides a more comprehensive view of patients' medical histories than is provided by the secondary diagnosis codes from the index hospitalization alone. If a diagnosis appears in some visits and not others, it is included, minimizing the effect of incomplete coding. We were careful, however, to include information about each patient's status at admission and not to adjust for possible complications of the admission. Although some codes, by definition, represent conditions that are present before admission (e.g. cancer), other codes and conditions cannot be differentiated from complications during the hospitalization (e.g. infection or shock). If these are secondary diagnoses from the index admission, then they are not adjusted for in the analysis.	**4d** **C**☐ **P**☐ **M**☐ **N**☐
4e. Data Collection Strategy/Implementation **4e.1 Describe what you have learned/modified as a result of testing and/or operational use of the measure regarding data collection, availability of data/missing data, timing/frequency of data collection, patient confidentiality, time/cost of data collection, other feasibility/ implementation issues:** N/A **4e.2 Costs to implement the measure** (*costs of data collection, fees associated with proprietary measures*)**:** The measure is developed using administrative claims data and does not necessitate any additional cost/burden on hospitals. **4e.3 Evidence for costs:** N/A **4e.4 Business case documentation:** N/A	**4e** **C**☐ **P**☐ **M**☐ **N**☐
TAP/Workgroup: What are the strengths and weaknesses in relation to the subcriteria for *Feasibility*?	**4**
Steering Committee: Overall, to what extent was the criterion, *Feasibility*, **met?**	**4**

Comment [KP28]: 4c. Exclusions should not require additional data sources beyond what is required for scoring the measure (e.g., numerator and denominator) unless justified as supporting measure validity.

Comment [KP29]: 4d. Susceptibility to inaccuracies, errors, or unintended consequences and the ability to audit the data items to detect such problems are identified.

Comment [KP30]: 4e. Demonstration that the data collection strategy (e.g., source, timing, frequency, sampling, patient confidentiality, etc.) can be implemented (e.g., already in operational use, or testing demonstrates that it is ready to put into operational use).

Rationale:	C☐ P☐ M☐ N☐
RECOMMENDATION	
(for NQF staff use) **Check if measure is untested and only eligible for time-limited endorsement.**	Time-limited ☐
Steering Committee: Do you recommend for endorsement? **Comments:**	Y☐ N☐ A☐

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Co.1 **Organization**
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Measure Developer If different from Measure Steward
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Co.6 **Additional organizations that sponsored/participated in measure development**
MPR- Mathematica Policy Research, RTI- Research Triangle Institute

ADDITIONAL INFORMATION

Workgroup/Expert Panel involved in measure development
Ad.1 **Provide a list of sponsoring organizations and workgroup/panel members' names and organizations. Describe the members' role in measure development.**
The working group involved in the initial measure development is detailed in the original technical report available at www.qualitynet.org

Ad.2 **If adapted, provide name of original measure:** N/A
Ad.3-5 **If adapted, provide original specifications URL or attachment** URL N/A www.qualitynet.org

Measure Developer/Steward Updates and Ongoing Maintenance
Ad.6 **Year the measure was first released:** 2008
Ad.7 **Month and Year of most recent revision:** 04, 2011
Ad.8 **What is your frequency for review/update of this measure?** yearly
Ad.9 **When is the next scheduled review/update for this measure?** 08, 2011

Ad.10 **Copyright statement/disclaimers:** N/A

Ad.11 -13 **Additional Information web page URL or attachment:** URL N/A www.qualitynet.org for Measure Methodology report and Maintenance reports

Date of Submission (*MM/DD/YY*)**:** 12/14/2010

Page 12: [1] Comment [KP14]	Karen Pace	10/5/2009 8:59:00 AM

2d. Clinically necessary measure exclusions are identified and must be:

- supported by evidence of sufficient frequency of occurrence so that results are distorted without the exclusion;

AND

- a clinically appropriate exception (e.g., contraindication) to eligibility for the measure focus;

AND

- precisely defined and specified:
  - if there is substantial variability in exclusions across providers, the measure is specified so that exclusions are computable and the effect on the measure is transparent (i.e., impact clearly delineated, such as number of cases excluded, exclusion rates by type of exclusion);

if patient preference (e.g., informed decision-making) is a basis for exclusion, there must be evidence that it strongly impacts performance on the measure and the measure must be specified so that the information about patient preference and the effect on the measure is transparent (e.g., numerator category computed separately, denominator exclusion category computed separately).

Testing 30-day Risk-Standardized Mortality and Readmission Measures in All-Payer Data

June 17, 2011

Prepared for:

Centers for Medicare & Medicaid Services (CMS)
Contract Number: HHSM-500-2008-0025I/HHSM-500-T0001, Modification No. 000005

For submission to:

The National Quality Forum (NQF) for the Cardiovascular Endorsement Maintenance Project re: Measure #s 230, 229, and 330

Submitted by:

Yale New Haven Health Services Corporation/Center for Outcomes Research and Evaluation (YNHHSC/CORE)

Introduction

The Centers for Medicare & Medicaid Services (CMS) publicly reports six National Quality Forum (NQF)-approved quality measures: hospital 30-day risk-standardized mortality rates (RSMRs) and readmission rates (RSRRs) for patients hospitalized for acute myocardial infarction (AMI), heart failure (HF), and pneumonia. The measures were developed for and are currently applied to Medicare fee-for-service (FFS) beneficiaries aged 65+ years. Three of the measures – AMI mortality, HF mortality, and HF readmission – are currently undergoing NQF endorsement maintenance. As part of the NQF endorsement maintenance process, the measure developers, YNHHSC/CORE, is performing analyses to determine whether CMS' publicly reported measures can be applied to and perform well in an all-payer patient population of adults aged 18 years and older. In this report, we detail our approach to addressing this question and present the findings.

The mortality and readmission measures employ administrative data, and are calculated using hierarchical logistic regression models to account for the clustering of observations within hospitals and differences in the number of admissions across hospitals. For risk adjustment, patient comorbidities are identified through claims data from each index hospitalization and from inpatient and outpatient Medicare claims during the 12 months before the index hospitalization. Reports that detail the original methodology for each measure, as well as subsequent measures maintenance technical reports, are available on the *QualityNet* Web site (http://www.qualitynet.org).The mortality and readmission measure results are posted on the *Hospital Compare* Web site (http://www.hospitalcompare.hhs.gov).

The results support expanding the measure patient population to include all-payer patients aged 18-64 years without changes to current measure specifications. Based on the results presented below, we conclude that the AMI mortality, HF mortality, and HF readmission measures perform well when applied to all-payer data (all patients aged 18+ years). Model testing demonstrated both strong patient-level model performance and consistent hospital-level results.

Methods

Data Source: For our analyses, we used all-payer data from California in addition to CMS data for Medicare FFS 65+ patients in California hospitals. California is a diverse state, and, with more than 37 million residents, California represents 12% of the US population. We used the California Patient Discharge Data, a large, linked database of patient hospital admissions. In 2006, there were approximately 3 million adult discharges from more than 450 hospitals. Records are linked by a unique patient identification number, allowing us to determine patient history from previous hospitalizations and to evaluate rates of both readmission and mortality (via linking with California vital statistics records).

Using all-payer data from California as well as CMS Medicare FFS data for California hospitals, we performed analyses to determine whether the publicly reported measures can be applied to

all adult patients, including not only FFS Medicare patients 65+ but also non-FFS Medicare patients 65+ and younger patients aged 18-64 years. The CMS models use inpatient and outpatient data for risk adjustment and were validated against medical record-based models in a subset of patients aged 65 and over.[1-6] Therefore, showing that the measures can be used in all-payer data requires answering two main questions:

Question 1: Given that outpatient claims are not available in the all-payer data set, how do the current CMS models perform when using only admission claims data (i.e., hospital claims for admitted patients)?

Question 2: When applied to all patients 18+, do the models perform well both at the patient level and at the hospital level? That is, at the patient level, is there good discrimination, predictive ability, and model fit across patient subgroups when we add new patients? In addition, when new patients are added, do potential differences in the effect of risk factors across patient subgroups affect risk prediction at the patient level (reclassification analysis) and risk profiling at the hospital level?

Question 1 analyses: Limiting risk-adjustment data to inpatient claims

To address the question of how the models perform when using only admission claims data, we used CMS data on FFS 65+ patients from California hospitals. Specifically, we created 2006 measure cohorts with complete one-year history data and 30-day follow-up data. For each of the three measures in NQF endorsement maintenance, we:

A. Examined the frequency (prevalence) of risk factors using all Part B, hospital outpatient history, and admission claims (history and current) according to current model specifications vs. using only admission claims data (history and current).
B. Fit the model separately using the full data and using only admission claims data and (a) compared the odds ratios (ORs) for the various risk factors; (b) conducted a reclassification analysis to compare risk prediction at the patient level; (c) compared model performance in terms of the c-statistic (discrimination); and (d) compared hospital-level risk-standardized rates (scatterplot, correlation coefficient, and R^2) to assess whether the model with only admission claims data is different from the current model in profiling hospital rates.

Question 2 analyses: Can the models be used in all-payer patient population of adults 18 years and older?

To address the main question of how well the models perform when applied to all patients 18+, we used the California Patient Discharge Data. Specifically, we created 2006 measure cohorts with up to one year of hospital admission claims history and 30-day follow-up data. For each of the three measures in NQF endorsement maintenance, we:

A. Created the patient cohort using the CMS measure inclusion and exclusion criteria (with the exception of including all patients 18+), and compared the FFS

65+, non-FFS 65+, and 18-64 year-old patient subgroups with respect to the distribution of risk factors and the crude outcome rate.

B. Fit the model in all patients 18+ and (a) examined overall model performance in terms of the c-statistic; (b) compared performance (c-statistic, predictive ability) across the patient subgroups (FFS 65+, non-FFS 65+, all 65+, and all-payer 18-64); and (c) compared the distribution of Pearson residuals (model fit) across the patient subgroups.

C. Fit the model separately in each patient subgroup and compared ORs associated with the risk factors to assess differences in magnitude or direction of ORs between the subgroups.

D. Fit the model in all patients 18+ and tested interaction terms between age and each of the other risk factors.

E. Fit the model in all patients 18+ with interaction terms and compared performance (c-statistic, predictive ability) across the patient subgroups.

F. Fit the model in all patients 18+ with and without interaction terms and (a) conducted a reclassification analysis to compare risk prediction at the patient level; (b) compared the c-statistic; and (c) compared hospital-level risk-standardized rates (scatterplot, correlation coefficient, and R^2) to assess whether the model with interactions is different from the current model in profiling hospital rates.

Results

Question 1 analyses: Limiting risk-adjustment data to inpatient claims

A. The numbers of patients in the AMI mortality, HF mortality, and HF readmission cohorts are presented in **Figures 1a, 1b, and 1c**, respectively. For all three measures, the prevalence of most risk factors was lower when using only admission claims data (**Tables 1a-1c**).

B. However, the magnitude of effect for most risk factors was similar when comparing the model using full data and using only admission claims data (**Tables 2a-2c**). In addition, when comparing the model with full data and with only admission claims data, the reclassification analysis demonstrated good patient-level risk prediction for all three measures (**Tables 3a-3c**), and the c-statistic was similar (0.713 vs. 0.725 for AMI mortality; 0.681 vs. 0.684 for HF mortality; and 0.610 vs. 0.611 for HF readmission) (**Tables 4a-4c**). Moreover, when comparing the model with full data and with only admission claims data, hospital-level risk-standardized rates were highly correlated (r=0.982 and R^2=0.964 for AMI mortality; r=0.993 and R^2=0.987 for HF mortality; and r=0.986 and R^2=0.972 for HF readmission) (**Figures 2a-2c**).

Question 2 analyses: Can the models be used in all-payer patient population of adults 18 years and older?

A. The AMI mortality, HF mortality, and HF readmission cohorts are presented in **Figures 3a, 3b, and 3c**, respectively. As the results in **Tables 5a-5c** show, for each measure, there are some differences in the risk factor profile and crude outcome rate among patient subgroups. For example, across all three measures, patients aged 18-64 were significantly more likely than patients aged 65+ to be men. For AMI mortality (**Table 5a**), the prevalence of risk factors and the crude outcome rate were similar in FFS 65+ and non-FFS 65+ patients; however, values were generally substantially lower in younger patients 18-64 compared with those 65+. For HF mortality (**Table 5b**) and HF readmission (**Table 5c**), a similar pattern was found in terms of FFS 65+ and non-FFS 65+ patients having a comparable risk factor profile and crude outcome rate. In contrast to findings for the AMI mortality measure, though, prevalence estimates for many HF mortality and HF readmission risk factors were more similar between younger and older patients; in fact, prevalence estimates were higher in younger than older patients for some conditions, including diabetes and its complications, psychiatric and substance use disorders, and liver and biliary disease (**Tables 5b and 5c**). Finally, unlike for the two mortality measures, the crude outcome rate for HF readmission was similar in younger and older patients (**Table 5c**).

B. Nevertheless, when the current models were applied to all patients 18+, overall discrimination was good (c-statistic=0.765 for AMI mortality, 0.718 for HF mortality, and 0.638 for HF readmission). In addition, there was good discrimination and predictive ability in all subgroups of patients (**Tables 6a-6c and 7a-7c**). For HF readmission, both discrimination and predictive ability were actually found to be greater in newly added younger patients aged 18-64 than those aged 65+ (**Table 7c**). For the HF mortality measure, the predictive range was narrower among those 18-64, albeit still reasonable given the group's lower mortality rate, compared with those 65+ (**Table 7b**). Moreover, for all three measures, the distribution of Pearson residuals was comparable across the patient subgroups (**Tables 8a-8c**).

C. For all three measures, ORs were generally similar for FFS 65+ and non-FFS 65+ patients. For some risk factors, there were differences in magnitude of effect between younger and older patients (**Tables 9a-9c**).

D. For each measure, few significant age-by-risk-factor interaction terms were found (**Tables 10a-10c**).

E. Nevertheless, inclusion of the interaction terms did not substantively change the level of discrimination and predictive ability across the patient subgroups (**Tables 11a-11c**).

F. In addition, when comparing the model with and without interaction terms, the reclassification analysis demonstrated good patient-level risk prediction across measures (**Tables 12a-12c**), and the c-statistic was nearly identical (0.767 vs. 0.765 for AMI mortality; 0.720 vs. 0.718 for HF mortality; and 0.640 vs. 0.638 for HF readmission) (**Tables 13a-13c**). Finally, when comparing the model with and without interaction terms, hospital-level risk-standardized rates were highly

correlated (r=0.9988 and R^2=0.9976 for AMI mortality; r=0.9997 and R^2=0.9994 for HF mortality; and r=0.9979 and R^2=0.9958 for HF readmission) (**Figures 4a-4c**).

Conclusions

Based on the results presented above, we conclude that the AMI mortality, HF mortality, and HF readmission measures perform well when applied to all-payer data (all patients aged 18+). Although there are some statistically significant age-by-risk-factor interaction terms, we do not recommend changing the model variables (with the exception of the slight modification of changing "age-65" to fully continuous age), as the inclusion of the interactions did not substantively affect either patient-level model performance or hospital-level results. We have demonstrated that the models can be applied to all patients aged 18+ and that they perform well when using only admission claims data to determine patient history. Thus, based on these results, the measure specifications could be modified to include the 18 and over population and to allow for the use of admission claims only for risk adjustment when complete claims history (i.e., outpatient data) is unavailable.

The data set has some limitations. Data on previous admissions and 30-day readmissions are available only from California hospitals; however, it is unlikely that many measure-specific cohort patients sought hospital inpatient care outside the state. In addition, data on 30-day mortality outside the hospital are available only for deaths in California; however, it is unlikely that many measure-specific cohort patients died outside the state within 30 days of their index hospitalization.

In summary, the AMI mortality, HF mortality, and HF readmission measures perform well when used in all-payer data (all patients aged 18+). Model testing demonstrated both strong patient-level model performance and consistent hospital-level results.

References

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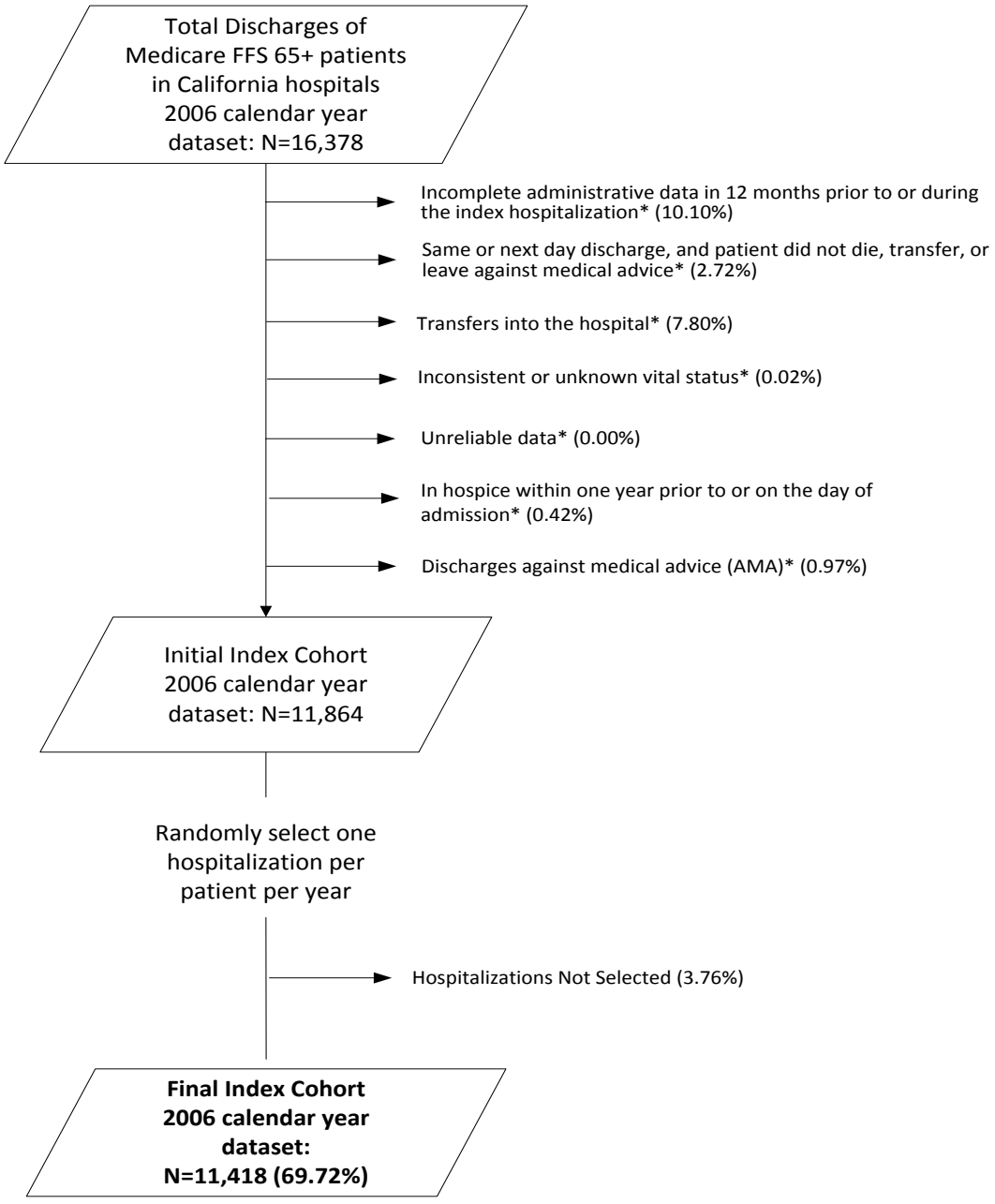
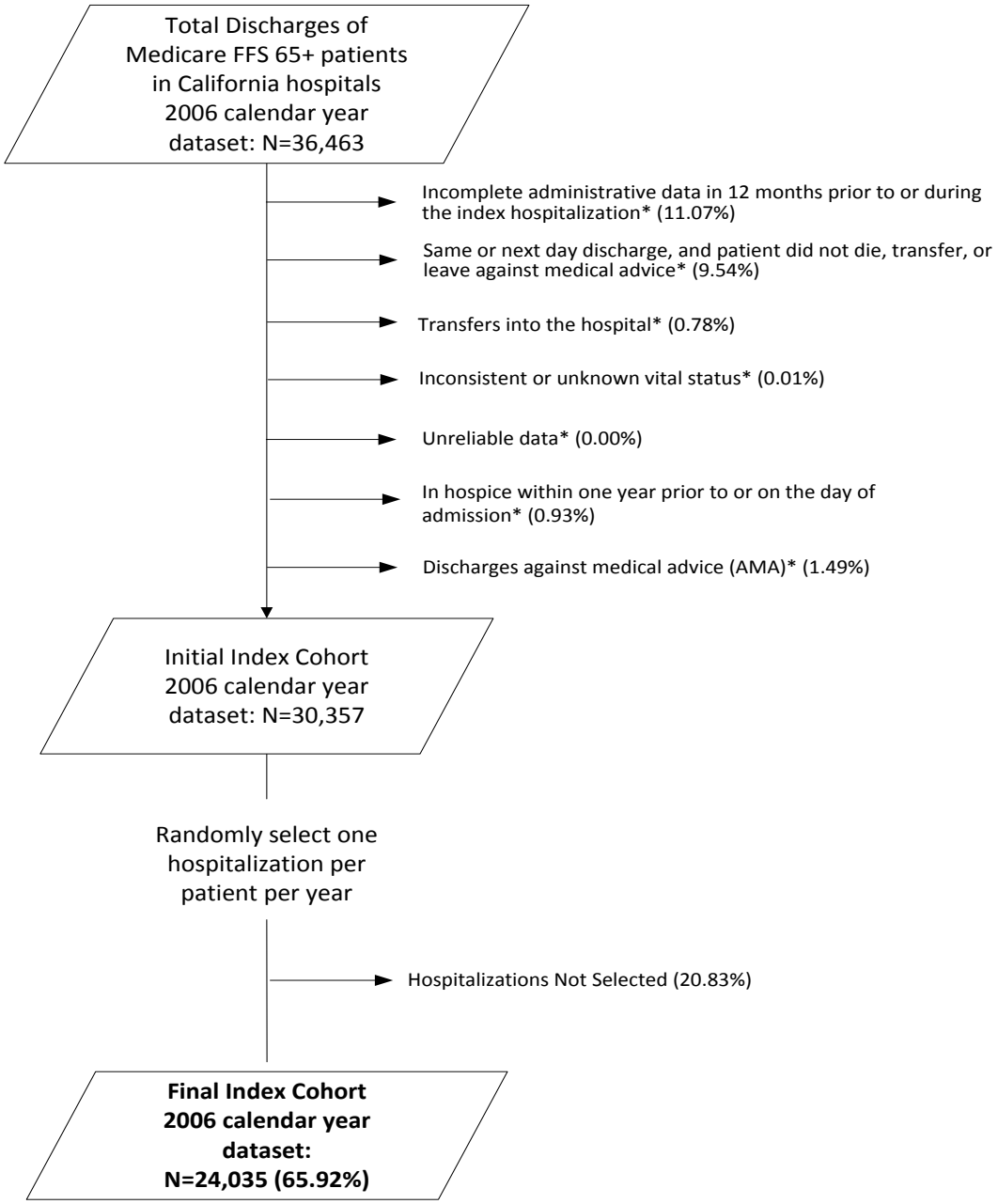
FIGURES AND TABLES

Figure 1a. 2006 AMI Mortality Cohort Using CMS Medicare Claims Data for FFS Patients 65+ Admitted to California Hospitals



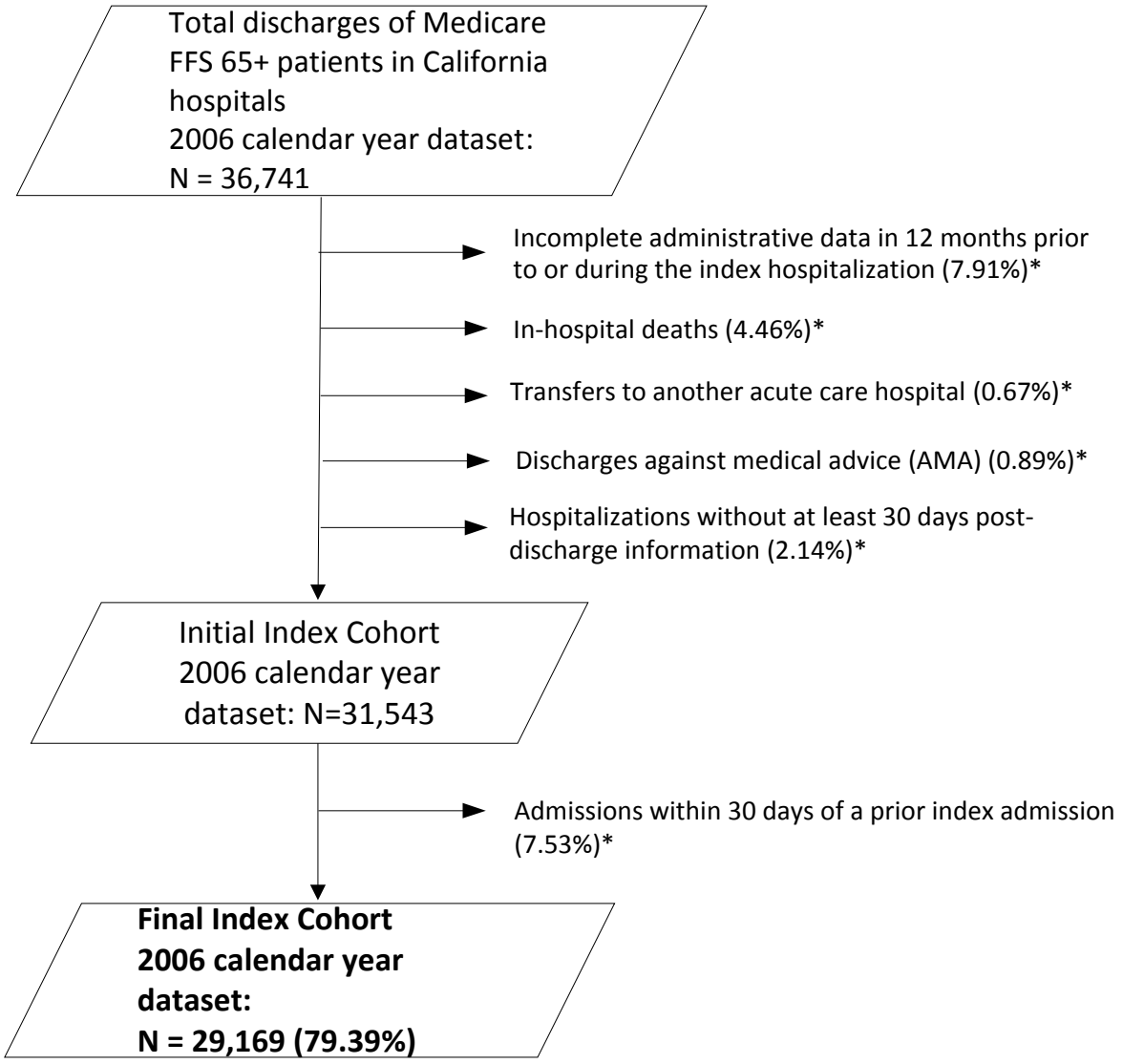
*Categories are not mutually exclusive

Figure 1b. 2006 HF Mortality Cohort Using CMS Medicare Claims Data for FFS Patients 65+ Admitted to California Hospitals



*Categories are not mutually exclusive

Figure 1c. 2006 HF Readmission Cohort Using CMS Medicare Claims Data for FFS Patients 65+ Admitted to California Hospitals



* These categories are not mutually exclusive.

Table 1a. Prevalence of Risk Factors for AMI Mortality Model Using Full Data vs. Using Only Admission Claims Data (N=11,418)
Data Source: 2006 CMS Medicare Claims Data for FFS Patients 65+ Admitted to California Hospitals

Risk Factor	Full data* # (%)	Admission claims data only # (%)
Demographics		
Age: Mean (range)	79.47 (65-110)	79.47 (65-110)
Male	5,676 (50)	5,676 (50)
Cardiovascular		
Percutaneous Transluminal Coronary Angioplasty	851 (7)	851 (7)
Coronary Artery Bypass Graft Surgery	615 (5)	615 (5)
Congestive Heart failure (CC 80)	3,690 (32)	1,922 (17)
Acute Myocardial Infarction (CC 81)	1,391 (12)	720 (6)
Unstable Angina (CC82)	1,744 (15)	458 (4)
Anterior Myocardial Infarction (ICD9 410.00-410.19)	1,567 (14)	1,567 (14)
Other Location of Myocardial Infarction (ICD9 410.20-410.69)	1,823 (16)	1,823 (16)
Chronic atherosclerosis (CC 83 or 84)	8,470 (74)	7,570 (66)
Cardio-respiratory failure and shock (CC 79)	953 (8)	423 (4)
Valvular or Rheumatic Heart Disease (CC 86)	3,500 (31)	2,292 (20)
Comorbidity		
Hypertension (CC 89, 91)	8,809 (77)	6,385 (56)
Stroke (CC 95 or 96)	1,031 (9)	237 (2)
Cerebrovascular Disease (CC 97 to 99, 103)	2,047 (18)	476 (4)
Renal Failure (CC 131)	1,912 (17)	1,229 (11)
Chronic Obstructive Pulmonary Disease (CC 108)	3,393 (30)	2,695 (24)
Pneumonia (CC 111 to 113)	2,831 (25)	1,857 (16)
Diabetes and DM Complications (CC 15 to 20, 120)	4,705 (41)	3,575 (31)
Protein-Calorie Malnutrition (CC 21)	421 (4)	373 (3)
Dementia and Senility (CC 49 or 50)	2,010 (18)	1,334 (12)
Hemiplegia, Paralysis, Functional Disability (CC 67 to 69, 100 to 102, 177, 178)	674 (6)	307 (3)
Vascular or Circulatory Disease (CC 104, 105)	2,493 (22)	780 (7)
Metastatic Cancer and Acute Leukemia (CC 7, 8)	423 (4)	292 (3)
Trauma (CC 154 to 156, 158 to 162)	3,449 (30)	1,010 (9)
Major Psych Disorders (CC 54 to 56)	680 (6)	218 (2)
Liver and Biliary Disease (CC 25 to 27)	156 (1)	106 (1)

* Including Part B, hospital outpatient, and hospital inpatient data.

Table 1b. Prevalence of Risk Factors for HF Mortality Models Using Full Data vs. Using Only Admission Claims Data (N=24,035)
Data Source: 2006 CMS Medicare Claims Data for FFS Patients 65+ Admitted to California Hospitals

Risk Factor	Full data* # (%)	Admission Claims data only # (%)
Demographics		
Age: Mean (range)	80.92 (65-109)	80.92 (65-109)
MALE	10,479 (44)	10,479 (44)
Cardiovascular		
Percutaneous Transluminal Coronary Angioplasty	1,614 (7)	1,614 (7)
Coronary Artery Bypass Graft Surgery	2,552 (11)	2,552 (11)
Congestive Heart failure (CC 80)	17, 563 (73)	11,000 (46)
Acute Myocardial Infarction (CC 81)	2,092 (9)	1,773 (7)
Unstable Angina (CC82)	3,695 (15)	1,082 (5)
Chronic atherosclerosis (CC 83 or 84)	16,590 (69)	12,493 (56)
Cardio-respiratory failure and shock (CC 79)	4,659 (19)	2,300 (10)
Valvular or Rheumatic Heart Disease (CC 86)	11,602 (48)	7,658 (32)
Comorbidity		
Hypertension (CC 89, 91)	19,456 (81)	12,184 (55)
Stroke (CC 95 or 96)	2,634 (11)	672 (3)
Renal Failure (CC 131)	8,024 (33)	5,891 (25)
Chronic Obstructive Pulmonary Disease (CC 108)	11,182 (47)	9.315 (39)
Pneumonia (CC 111 to 113)	10,314 (43)	6,746 (28)
Diabetes and DM Complications (CC 15 to 20, 120)	11,878 (49)	9,635 (40)
Protein-Calorie Malnutrition (CC 21)	1,386 (6)	1,225 (5)
Dementia and Senility (CC 49 or 50)	4,748 (20)	3,100 (13)
Hemiplegia, Paralysis, Functional Disability (CC 67 to 69, 100 to 102, 177, 178)	1,767 (7)	933 (4)
Peripheral vascular disease (CC 104, 105)	7,134 (30)	2,475 (10)
Metastatic Cancer and Acute Leukemia (CC 7, 8)	998 (4)	619 (3)
Trauma (CC 154 to 156, 158 to 162)	8,792 (37)	2,911 (12)
Major Psych Disorders (CC 54 to 56)	1,813 (8)	614 (3)
Liver and Biliary Disease (CC 25 to 27)	683 (3)	522 (2)

* Including Part B, hospital outpatient, and hospital inpatient data.

Table 1c. Prevalence of Risk Factors for HF Readmission Models Using Full Data vs. Using Only Admission Claims Data (N=29,169)
Data Source: 2006 CMS Medicare Claims Data for FFS Patients 65+ Admitted to California Hospitals

Risk Factor	Full data* # (%)	Admission Claims data only # (%)
Demographics		
Age: Mean (range)	80.59 (65-109)	80.59 (65-109)
MALE	12,928 (44)	12,928 (44)
Cardiovascular		
History of CABG	3,460 (12)	3,460 (12)
Cardio-respiratory failure or shock (CC 79)	6,041 (21)	2,955 (10)
Congestive heart failure (CC 80)	22,103 (76)	14,388 (49)
Acute coronary syndrome (CC 81-82)	5,881 (20)	3,319 (11)
Coronary atherosclerosis or angina (CC 83-84)	20,843 (71)	17,162 (59)
Valvular or rheumatic heart disease (CC 86)	14,414 (49)	9,435 (32)
Specified arrhythmias (CC 92-93)	18,029 (62)	10,762 (37)
Other or unspecified heart disease (CC 94)	10,158 (35)	1,206 (4)
Vascular or circulatory disease (CC 104-106)	12,826 (44)	4,820 (17)
Comorbidity		
Metastatic cancer or acute leukemia (CC 7)	659 (2)	445 (2)
Cancer (CC 8-12)	5,698 (20)	2,134 (7)
Diabetes or DM complications (CC 15-20, 119-120)	14,801 (51)	12,185 (42)
Protein-calorie malnutrition (CC 21)	1,582 (5)	1,391 (5)
Disorders of fluid, electrolyte, acid-base (CC 22-23)	11,526 (40)	8,356 (29)
Liver or biliary disease (CC 25-30)	2,747 (9)	1,394 (5)
Peptic ulcer, hemorrhage, other specified gastrointestinal disorders (CC 34)	4,392 (15)	2,485 (9)
Other gastrointestinal disorders (CC 36)	14,040 (48)	7,436 (25)
Severe hematological disorders (CC 44)	1,384 (5)	670 (2)
Iron deficiency or other anemias and blood disease (CC 47)	15,619 (54)	10,914 (37)
Dementia or other specified brain disorders (CC 49-50)	5,586 (19)	3,565 (12)
Drug/alcohol abuse/dependence/psychosis (CC 51-53)	2,597 (9)	2,251 (8)
Major psychiatric disorders (CC 54-56)	2,222 (8)	732 (3)
Depression (CC 58)	3,022 (10)	2,135 (7)
Other psychiatric disorders (CC 60)	2,282 (8)	1,118 (4)
Hemiplegia, paraplegia, paralysis, functional disability (CC 67-69, 100-102, 177-178)	2,168 (7)	1,125 (4)
Stroke (CC 95-96)	3,200 (11)	799 (3)
Chronic obstructive pulmonary disease (CC 108)	13,663 (47)	11,348 (39)
Fibrosis of lung or other chronic lung disorders (CC 109)	3,874 (13)	1,239 (4)
Asthma (CC 110)	3,188 (11)	1,253 (4)
Pneumonia (CC 111-113)	12,572 (43)	7,963 (27)
End stage renal disease or dialysis (CC 129-130)	1,605 (6)	1,228 (4)
Renal failure (CC 131)	10,224 (35)	7,664 (26)
Nephritis (CC 132)	1,219 (4)	789 (3)
Other urinary tract disorders (CC 136)	9,843 (34)	4,867 (17)
Decubitus ulcer or chronic skin ulcer (CC 148-149)	3,441 (12)	1,611 (6)

* Including Part B, hospital outpatient, and hospital inpatient data.

Table 2a. Odds Ratios for Risk Factors in AMI Mortality Models With Full Data and With Only Admission Claims Data -- GLM (N=11,418)
Data Source: 2006 CMS Medicare Claims Data for FFS Patients 65+ Admitted to California Hospitals

	Full data*		Admission claims data only	
Risk Factor	**OR (95% CI)**	**P-value**	**OR (95% CI)**	**P-value**
Intercept		<.0001		<.0001
Demographics				
Age-65 (years above 65, continuous)	1.05 (1.05-1.06)	<.0001	1.05 (1.05-1.06)	<.0001
Male	1.28 (1.15-1.42)	<.0001	1.26 (1.13-1.40)	<.0001
Cardiovascular				
Percutaneous Transluminal Coronary Angioplasty	0.65 (0.50-0.83)	0.0006	0.67 (0.52-0.86)	0.0018
Coronary Artery Bypass Graft Surgery	0.79 (0.61-1.02)	0.0738	0.86 (0.67-1.11)	0.2533
Congestive Heart failure (CC 80)	1.44 (1.27-1.62)	<.0001	1.91 (1.64-2.24)	<.0001
Acute Myocardial Infarction (CC 81)	1.26 (1.07-1.48)	0.0047	1.14 (0.92-1.41)	0.2417
Unstable Angina (CC82)	0.87 (0.74-1.02)	0.0898	1.23 (0.94-1.61)	0.1375
Anterior Myocardial Infarction (ICD9 410.00-410.19)	1.53 (1.32-1.76)	<.0001	1.52 (1.31-1.76)	<.0001
Other Location of Myocardial Infarction (ICD9 410.20-410.69)	1.36 (1.18-1.57)	<.0001	1.38 (1.19-1.59)	<.0001
Chronic atherosclerosis (CC 83 or 84)	0.51 (0.45-0.57)	<.0001	0.46 (0.41-0.51)	<.0001
Cardio-respiratory failure and shock (CC 79)	1.35 (1.13-1.61)	0.0008	1.08 (0.84-1.39)	0.5383
Valvular or Rheumatic Heart Disease (CC 86)	0.95 (0.85-1.06)	0.3578	0.97 (0.86-1.10)	0.6764
Comorbidity				
Hypertension (CC 89, 91)	0.73 (0.65-0.83)	<.0001	0.67 (0.61-0.75)	<.0001
Stroke (CC 95 or 96)	1.10 (0.92-1.31)	0.2881	1.17 (0.83-1.66)	0.3694
Cerebrovascular Disease (CC 97 to 99, 103)	1.18 (1.03-1.35)	0.017	1.44 (1.14-1.82)	0.0019
Renal Failure (CC 131)	1.36 (1.18-1.55)	<.0001	1.26 (1.06-1.50)	0.0075
Chronic Obstructive Pulmonary Disease (CC 108)	1.03 (0.92-1.16)	0.5754	0.99 (0.87-1.11)	0.8096
Pneumonia (CC 111 to 113)	1.36 (1.21-1.53)	<.0001	1.42 (1.25-1.62)	<.0001
Diabetes and DM Complications (CC 15 to 20, 120)	1.19 (1.07-1.33)	0.0014	1.05 (0.93-1.18)	0.4427
Protein-Calorie Malnutrition (CC 21)	1.27 (1.01-1.59)	0.0452	1.18 (0.92-1.51)	0.1837
Dementia and Senility (CC 49 or 50)	1.35 (1.19-1.54)	<.0001	1.48 (1.28-1.71)	<.0001
Hemiplegia, Paralysis, Functional Disability (CC 67 to 69, 100 to 102, 177, 178)	1.47 (1.21-1.79)	0.0001	1.30 (0.96-1.76)	0.0948
Vascular or Circulatory Disease (CC 104, 105)	0.99 (0.87-1.13)	0.8827	0.96 (0.78-1.18)	0.6939
Metastatic Cancer and Acute Leukemia (CC 7, 8)	1.91 (1.52-2.40)	<.0001	2.83 (2.18-3.67)	<.0001
Trauma (CC 154 to 156, 158 to 162)	0.94 (0.84-1.05)	0.2855	0.89 (0.75-1.06)	0.1938
Major Psych Disorders (CC 54 to 56)	1.13 (0.93-1.39)	0.2154	1.35 (0.97-1.90)	0.079
Liver and Biliary Disease (CC 25 to 27)	1.34 (0.90-1.99)	0.1516	1.75 (1.10-2.76)	0.0173

* Including Part B, hospital outpatient, and hospital inpatient data.

Table 2b. Odds Ratios for Risk Factors in HF Mortality Models With Full Data and With Only Admission Claims Data -- GLM (N=24,035)
Data Source: 2006 CMS Medicare Claims Data for FFS Patients 65+ Admitted to California Hospitals

	Full data*		Admission Claims data only	
Risk Factor	**OR (95% CI)**	**P-value**	**OR (95% CI)**	**P-value**
Intercept		<.0001		<.0001
Demographics				
Age-65 (years above 65, continuous)	1.05 (1.04-1.06)	<.0001	1.05 (1.04-1.06)	<.0001
Male	1.24 (1.14-1.35)	<.0001	1.24 (1.14-1.35)	<.0001
Cardiovascular				
Percutaneous Transluminal Coronary Angioplasty	0.61 (0.50-0.75)	<.0001	0.61 (0.49-0.74)	<.0001
Coronary Artery Bypass Graft Surgery	0.72 (0.62-0.85)	<.0001	0.75 (0.64-0.88)	0.0003
Congestive Heart failure (CC 80)	1.19 (1.07-1.32)	0.0013	1.24 (1.12-1.37)	<.0001
Acute Myocardial Infarction (CC 81)	1.53 (1.32-1.77)	<.0001	1.61 (1.39-1.87)	<.0001
Unstable Angina (CC82)	0.95 (0.83-1.08)	0.3934	0.88 (0.71-1.09)	0.2376
Chronic atherosclerosis (CC 83 or 84)	0.86 (0.78-0.95)	0.0016	0.89 (0.81-0.97)	0.0079
Cardio-respiratory failure and shock (CC 79)	1.17 (1.06-1.30)	0.0028	1.11 (0.97-1.27)	0.1412
Valvular or Rheumatic Heart Disease (CC 86)	1.02 (0.94-1.11)	0.5859	1.08 (0.99-1.18)	0.0865
Comorbidity				
Hypertension (CC 89, 91)	0.65 (0.59-0.71)	<.0001	0.68 (0.62-0.74)	<.0001
Stroke (CC 95 or 96)	0.92 (0.81-1.05)	0.2245	1.18 (0.93-1.50)	0.1763
Renal Failure (CC 131)	1.30 (1.19-1.42)	<.0001	1.18 (1.07-1.31)	0.0016
Chronic Obstructive Pulmonary Disease (CC 108)	1.06 (0.98-1.16)	0.1646	1.09 (1.00-1.19)	0.0508
Pneumonia (CC 111 to 113)	1.37 (1.25-1.49)	<.0001	1.36 (1.25-1.49)	<.0001
Diabetes and DM Complications (CC 15 to 20, 120)	0.86 (0.79-0.94)	0.0008	0.82 (0.75-0.89)	<.0001
Protein-Calorie Malnutrition (CC 21)	1.74 (1.51-1.99)	<.0001	1.70 (1.47-1.97)	<.0001
Dementia and Senility (CC 49 or 50)	1.37 (1.24-1.50)	<.0001	1.35 (1.21-1.51)	<.0001
Hemiplegia, Paralysis, Functional Disability (CC 67 to 69, 100 to 102, 177, 178)	1.08 (0.92-1.26)	0.3506	1.10 (0.89-1.36)	0.3955
Peripheral vascular disease (CC 104, 105)	0.95 (0.87-1.04)	0.2747	1.07 (0.94-1.22)	0.3274
Metastatic Cancer and Acute Leukemia (CC 7, 8)	1.96 (1.66-2.31)	<.0001	2.66 (2.20-3.23)	<.0001
Trauma (CC 154 to 156, 158 to 162)	1.06 (0.97-1.15)	0.1941	1.07 (0.95-1.21)	0.2413
Major Psych Disorders (CC 54 to 56)	0.97 (0.84-1.13)	0.7309	0.92 (0.71-1.20)	0.5269
Liver and Biliary Disease (CC 25 to 27)	1.24 (0.99-1.57)	0.0635	1.24 (0.96-1.62)	0.1052

* Including Part B, hospital outpatient, and hospital inpatient data.

Table 2c. Odds Ratios for Risk Factors in HF Readmission Models With Full Data and With Only Admission Claims Data -- GLM (N=24,035)
Data Source: 2006 CMS Medicare Claims Data for FFS Patients 65+ Admitted to California Hospitals

	Full data*		Admission Claims data only	
Risk Factor	**OR (95% CI)**	**P-value**	**OR (95% CI)**	**P-value**
Intercept		<.0001		<.0001
Demographics				
Age-65 (years above 65, continuous)	1.00 (1.00-1.00)	0.9992	1.00 (1.00-1.00)	0.8769
Male	1.01 (0.95-1.07)	0.8044	1.03 (0.97-1.09)	0.3707
Cardiovascular				
History of CABG	0.94 (0.86-1.03)	0.1682	0.95 (0.87-1.04)	0.2746
Cardio-respiratory failure or shock (CC 79)	1.15 (1.07-1.23)	0.0002	1.11 (1.01-1.21)	0.0292
Congestive heart failure (CC 80)	1.14 (1.06-1.23)	0.0007	1.18 (1.09-1.27)	<.0001
Acute coronary syndrome (CC 81-82)	1.07 (1.00-1.15)	0.0531	1.02 (0.93-1.11)	0.7399
Coronary atherosclerosis or angina (CC 83-84)	1.16 (1.08-1.24)	<.0001	1.13 (1.06-1.20)	0.0001
Valvular or rheumatic heart disease (CC 86)	1.07 (1.01-1.13)	0.0302	1.10 (1.03-1.16)	0.0023
Specified arrhythmias (CC 92-93)	1.01 (0.95-1.08)	0.7362	1.06 (0.99-1.13)	0.0886
Other or unspecified heart disease (CC 94)	1.03 (0.97-1.10)	0.2825	0.92 (0.80-1.06)	0.2473
Vascular or circulatory disease (CC 104-106)	1.04 (0.98-1.10)	0.2619	1.09 (1.01-1.18)	0.0236
Comorbidity				
Metastatic cancer or acute leukemia (CC 7)	1.13 (0.94-1.36)	0.1792	1.37 (1.10-1.70)	0.0051
Cancer (CC 8-12)	1.05 (0.98-1.13)	0.1518	1.03 (0.92-1.15)	0.5988
Diabetes or DM complications (CC 15-20, 119-120)	1.10 (1.04-1.17)	0.0014	1.12 (1.06-1.19)	0.0001
Protein-calorie malnutrition (CC 21)	0.98 (0.87-1.10)	0.6993	1.01 (0.89-1.15)	0.8520
Disorders of fluid, electrolyte, acid-base (CC 22-23)	1.16 (1.09-1.24)	<.0001	1.16 (1.08-1.24)	<.0001
Liver or biliary disease (CC 25-30)	1.05 (0.95-1.15)	0.3477	1.06 (0.94-1.20)	0.3741
Peptic ulcer, hemorrhage, other specified gastrointestinal disorders (CC 34)	1.16 (1.07-1.25)	0.0003	1.12 (1.01-1.23)	0.0254
Other gastrointestinal disorders (CC 36)	1.04 (0.98-1.10)	0.2134	1.08 (1.01-1.15)	0.0214
Severe hematological disorders (CC 44)	1.13 (1.00-1.28)	0.0499	1.21 (1.02-1.44)	0.0270
Iron deficiency or other anemias and blood disease (CC 47)	1.04 (0.98-1.11)	0.1994	1.08 (1.01-1.14)	0.0189
Dementia or other specified brain disorders (CC 49-50)	1.03 (0.96-1.11)	0.4364	0.97 (0.89-1.06)	0.4934
Drug/alcohol abuse/dependence/psychosis (CC 51-53)	1.07 (0.97-1.18)	0.1618	1.02 (0.92-1.13)	0.7817
Major psychiatric disorders (CC 54-56)	1.07 (0.97-1.19)	0.1783	1.15 (0.97-1.35)	0.1128
Depression (CC 58)	1.05 (0.95-1.14)	0.3428	1.09 (0.98-1.20)	0.1213
Other psychiatric disorders (CC 60)	1.04 (0.94-1.15)	0.4868	1.09 (0.95-1.25)	0.2303
Hemiplegia, paraplegia, paralysis, functional disability (CC 67-69, 100-102, 177-178)	1.06 (0.95-1.17)	0.3042	1.17 (1.02-1.34)	0.0299
Stroke (CC 95-96)	1.02 (0.94-1.12_	0.6054	1.01 (0.86-1.19)	0.9054
Chronic obstructive pulmonary disease (CC 108)	1.11 (1.05-1.18)	0.0004	1.10 (1.04-1.17)	0.0011
Fibrosis of lung or other chronic lung disorders (CC 109)	1.09 (1.01-1.18)	0.0296	1.05 (0.92-1.20)	0.4591
Asthma (CC 110)	1.07 (0.99-1.17)	0.1064	1.03 (0.90-1.18)	0.6529
Pneumonia (CC 111-113)	1.10 (1.04-1.17)	0.0013	1.10 (1.03-1.17)	0.0048
End stage renal disease or dialysis (CC 129-130)	1.24 (1.10-1.40)	0.0004	1.43 (1.26-1.63)	<.0001
Renal failure (CC 131)	1.20 (1.12-1.29)	<.0001	1.20 (1.12-1.29)	<.0001
Nephritis (CC 132)	0.99 (0.87-1.13)	0.8937	0.91 (0.77-1.07)	0.2314
Other urinary tract disorders (CC 136)	1.09 (1.02-1.16)	0.0068	1.17 (1.09-1.25)	<.0001
Decubitus ulcer or chronic skin ulcer (CC 148-149)	1.18 (1.08-1.28)	0.0001	1.26 (1.13-1.41)	<.0001

* Including Part B, hospital outpatient, and hospital inpatient data.

Table 3a. Reclassification Table of Risk Categories for AMI Mortality Model with Full Data and With Only Admission Claims Data
Data Source: 2006 CMS Medicare Claims Data for FFS Patients 65+ Admitted to California Hospitals

Model with Admissions Claims Only Data	Model with Full Data										
	0 to <5%		5% to <10%		10% to <20%		>=20%		Total		
	#	%	#	%	#	%	#	%	#	%	
Risk Category											
0 to <5%	383	3.35	219	1.92	12	0.11	0	0.00	614	5.38	
5% to <10%	98	0.86	2,143	18.77	811	7.10	27	0.24	3,079	26.97	
10% to <20%	8	0.07	468	4.10	2,825	24.74	709	6.21	4,010	35.12	Same category: 72.80
>=20%	0	0.00	29	0.25	725	6.35	2,961	25.93	3,715	32.54	Similar category: 99.33
Total	489	4.28	2,859	25.04	4,373	38.30	3,697	32.38	11,418	100.00	

Table 3b. Reclassification Table of Risk Categories for HF Mortality Model with Full Data and With Only Admission Claims Data
Data Source: 2006 CMS Medicare Claims Data for FFS Patients 65+ Admitted to California Hospitals

Model with Admissions Claims Only Data	Model with Full Data										
	0 to <5%		5% to <10%		10% to <20%		>=20%		Total		
	#	%	#	%	#	%	#	%	#	%	
Risk Category											
0 to <5%	2,133	8.87	757	3.15	25	0.10	1	0.00	2,916	12.13	
5% to <10%	766	3.19	6,680	27.79	1,545	6.43	30	0.12	9,021	37.53	
10% to <20%	0	0.00	1,580	6.57	6,886	28.65	842	3.50	9,308	38.73	Same category: 73.36
>=20%	0	0.00	1	0.00	856	3.56	1,933	8.04	2,790	11.61	Similar category: 99.76
Total	2,899	12.06	9,018	37.52	9,312	38.74	2,806	11.67	24,035	100.00	

Table 3c. Reclassification Table of Risk Categories for HF Readmission Model with Full Data and With Only Admission Claims Data
Data Source: 2006 CMS Medicare Claims Data for FFS Patients 65+ Admitted to California Hospitals

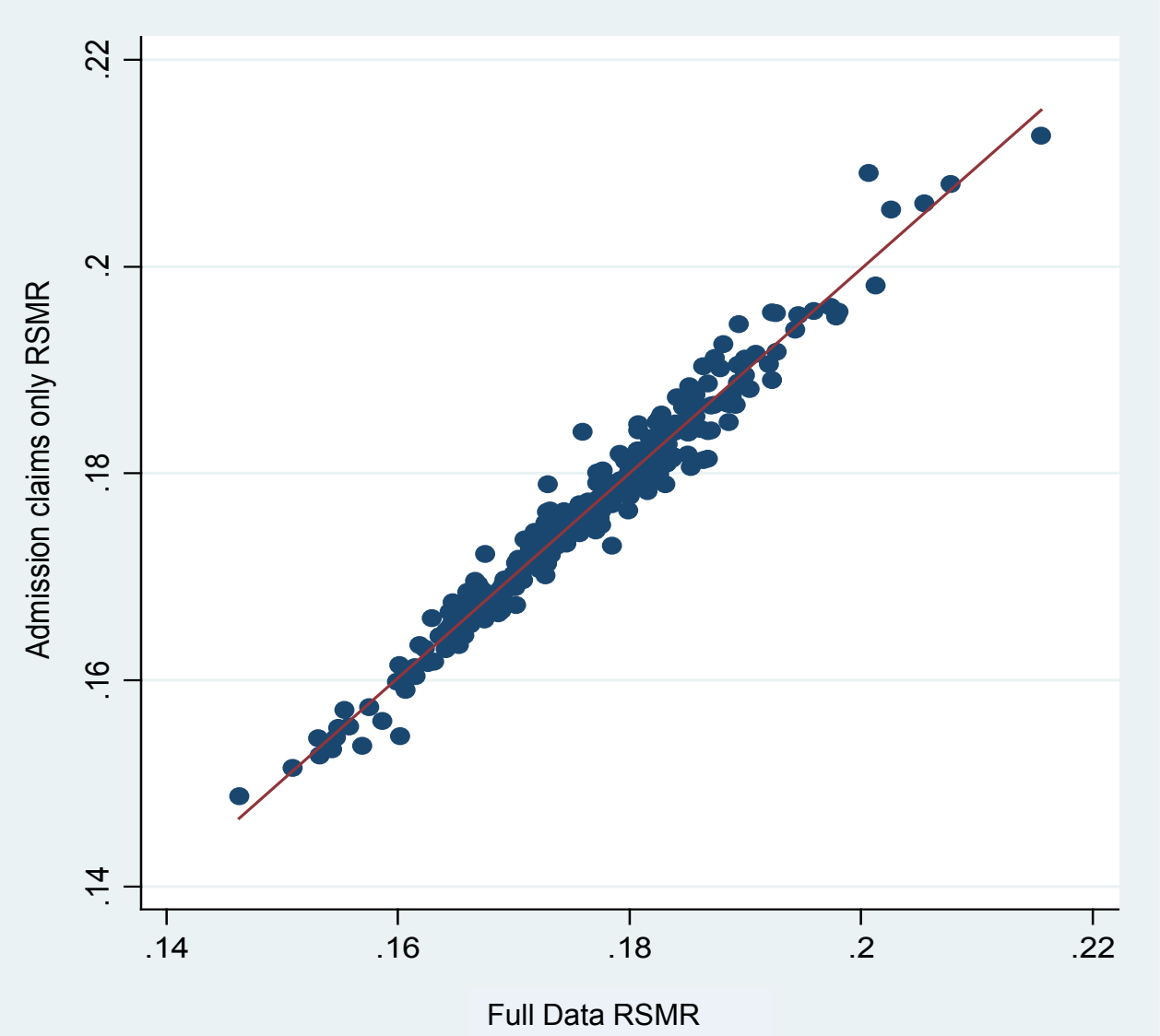
Model with Admissions Claims Only Data	Model with Full Data												
	0 to <15%		15% to <20%		20% to <25%		25% to <30%		>=30%		Total		
	#	%	#	%	#	%	#	%	#	%	#	%	
Risk Category													
0 to <15%	471	1.61	421	1.44	75	0.26	10	0.03	2	0.01	979	3.36	
15% to <20%	1,514	5.19	6,164	21.13	2,306	7.91	463	1.59	96	0.33	10,543	36.14	
20% to <25%	4	0.01	1,782	6.11	3,322	11.39	1,218	4.18	253	0.87	6,579	22.55	
25% to <30%	0	0.00	55	0.19	1,688	5.79	2,376	8.15	1,142	3.92	5,261	18.04	Same category: 57.41
>=30%	0	0.00	0	0.00	103	0.35	1,292	4.43	4,412	15.13	5,807	19.91	Similar category: 96.36
Total	1,989	6.82	8,422	28.87	7,494	25.69	5,359	18.37	5,905	20.24	29,169	100.00	

Table 4a. Performance of AMI Mortality Model With Full Data* and With Only Admission Claims Data
Data Source: 2006 CMS Medicare Claims Data for FFS Patients 65+ Admitted to California Hospitals

	GLM model with full data	GLM model with admission claims data only
C-statistic	0.713	0.725

* Including Part B, hospital outpatient, and hospital inpatient data.

Figure 2a. Scatterplot of AMI 30-day Risk-Standardized Mortality Rates (RSMR30) from Model Using Full Data* and from Model Using Only Admission Claims Data (N=316 Hospitals)
Data Source: 2006 CMS Medicare Claims Data for FFS Patients 65+ Admitted to California Hospitals



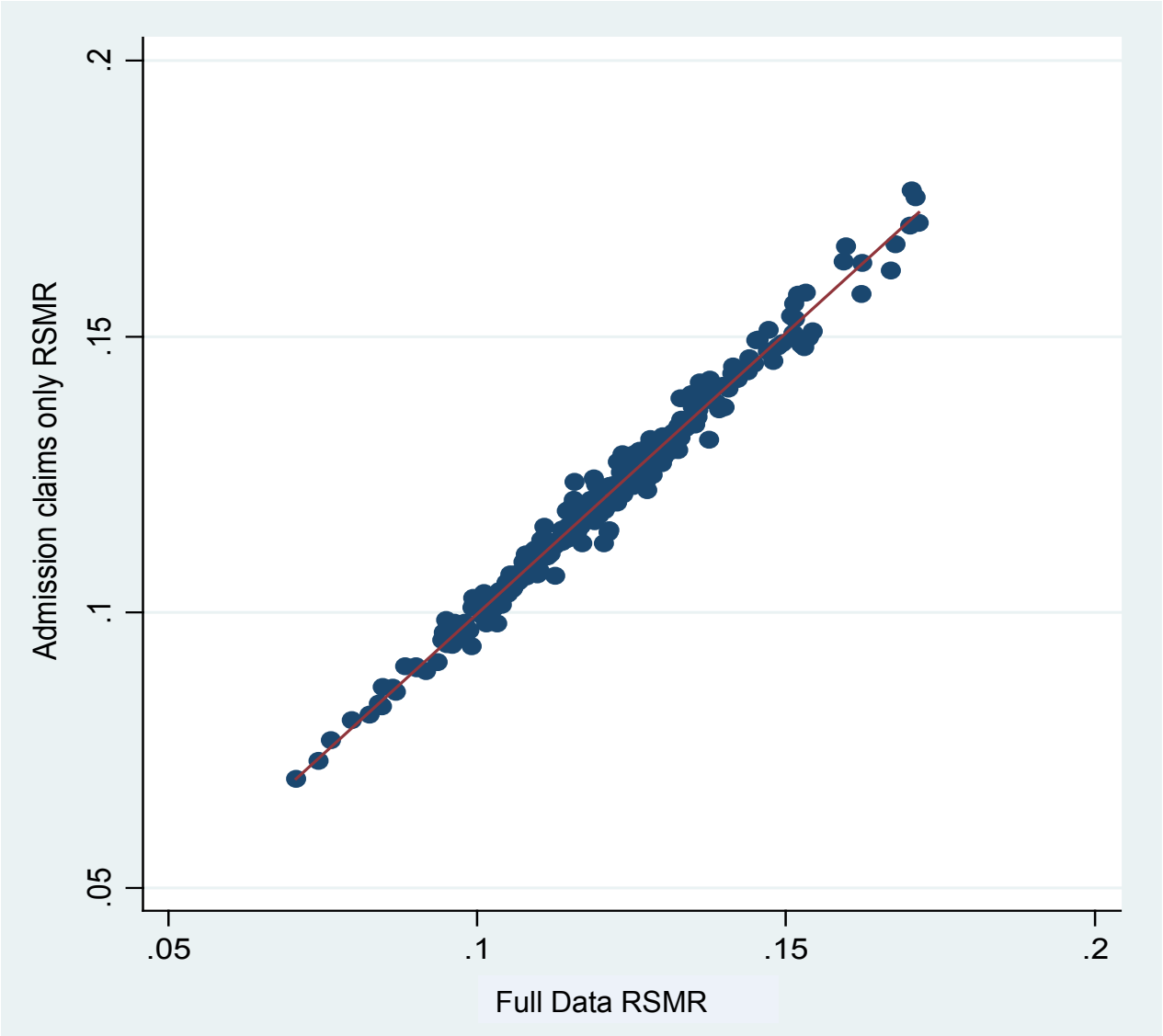
Correlation Coefficients (Weighted by Hospital Volume): 0.985

* Including Part B, hospital outpatient, and hospital inpatient data.

Table 4b. Performance of HF Mortality Models With Full Data* and With Only Admission Claims Data
Data Source: 2006 CMS Medicare Claims Data for FFS Patients 65+ Admitted to California Hospitals

	GLM model with full data	GLM model with admission claims data
C-statistic	0.681	0.684

Figure 2b. Scatterplot of HF 30-day Risk-Standardized Mortality Rates (RSMR30) from Model Using Full Data* and from Model Using Only Admission Claims Data (N=330 Hospitals)
Data Source: 2006 CMS Medicare Claims Data for FFS Patients 65+ Admitted to California Hospitals



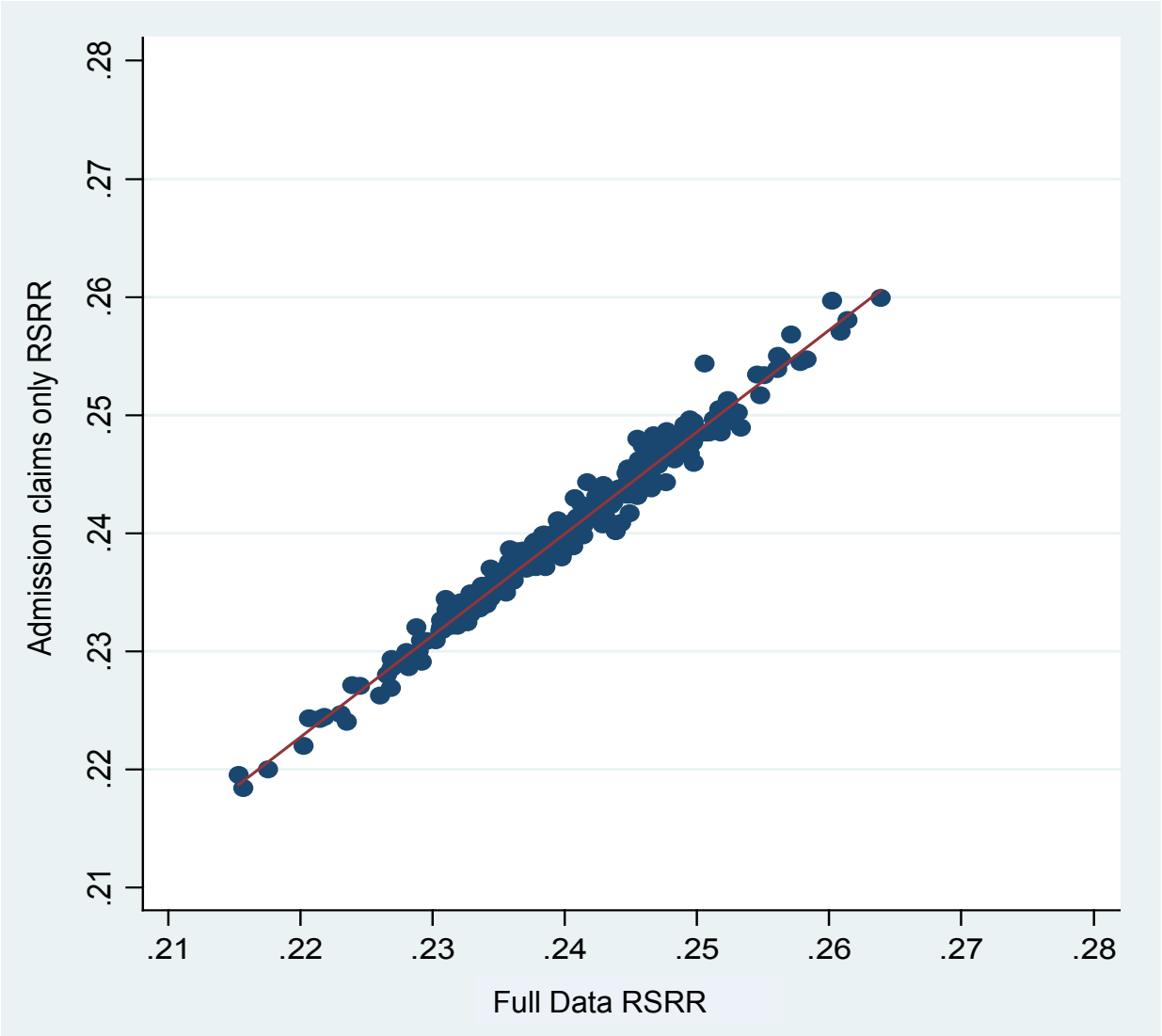
Correlation Coefficients (Weighted by Hospital Volume): 0.993

* Including Part B, hospital outpatient, and hospital inpatient data.

Table 4c.Performance of HF Readmission Models With Full Data* and With Only Admission Claims Data
Data Source: 2006 CMS Medicare Claims Data for FFS Patients 65+ Admitted to California Hospitals

	GLM model with full data	GLM model with admission claims data
C-statistic	0.610	0.611

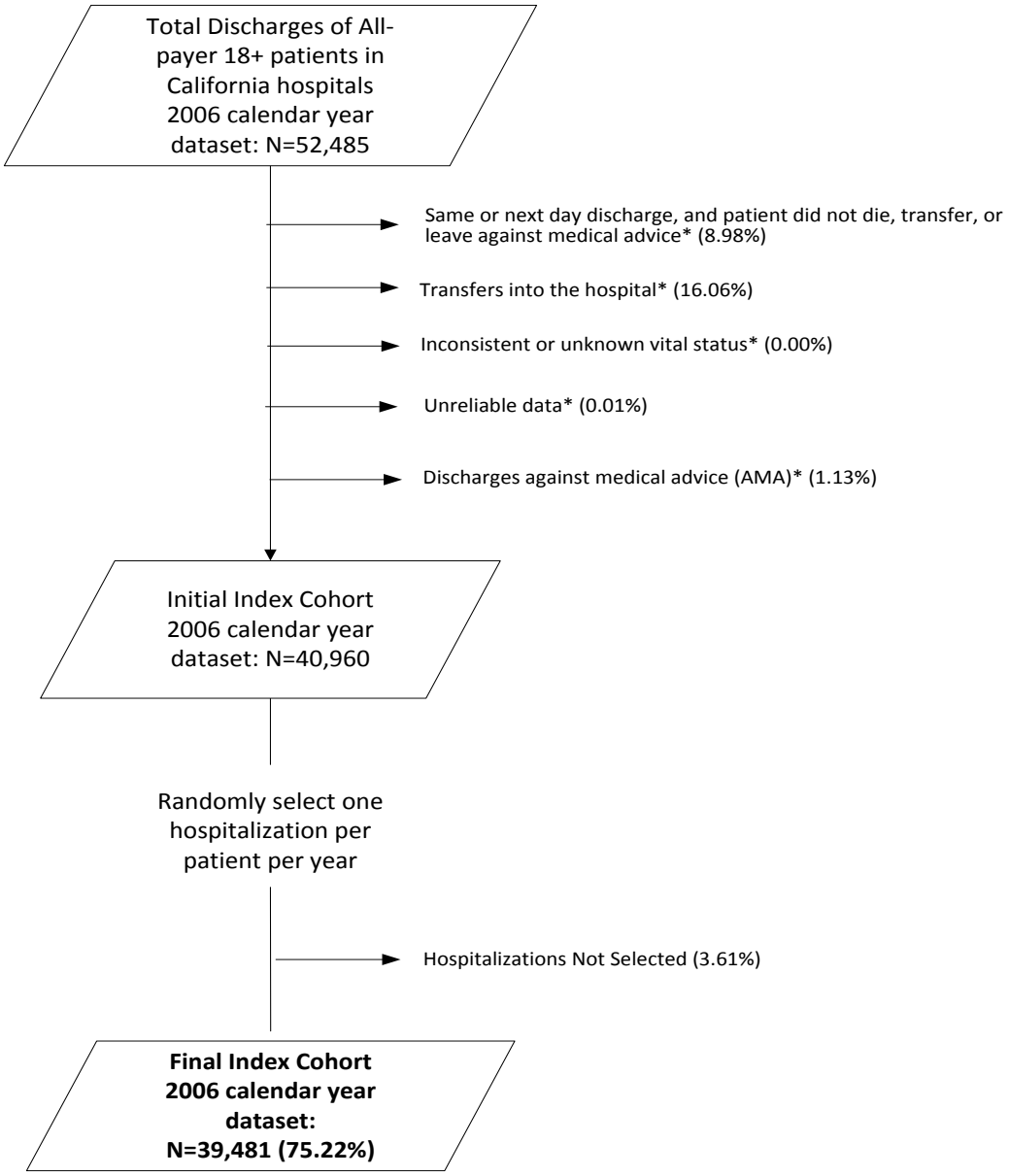
Figure 2c. Scatterplot of HF 30-day Risk-Standardized Readmission Rates (RSRR30) from Model Using Full Data* and from Model Using Only Admission Claims Data (N=335 Hospitals)
Data Source: 2006 CMS Medicare Claims Data for FFS Patients 65+ Admitted to California Hospitals



Correlation Coefficients (Weighted by Hospital Volume): 0.986

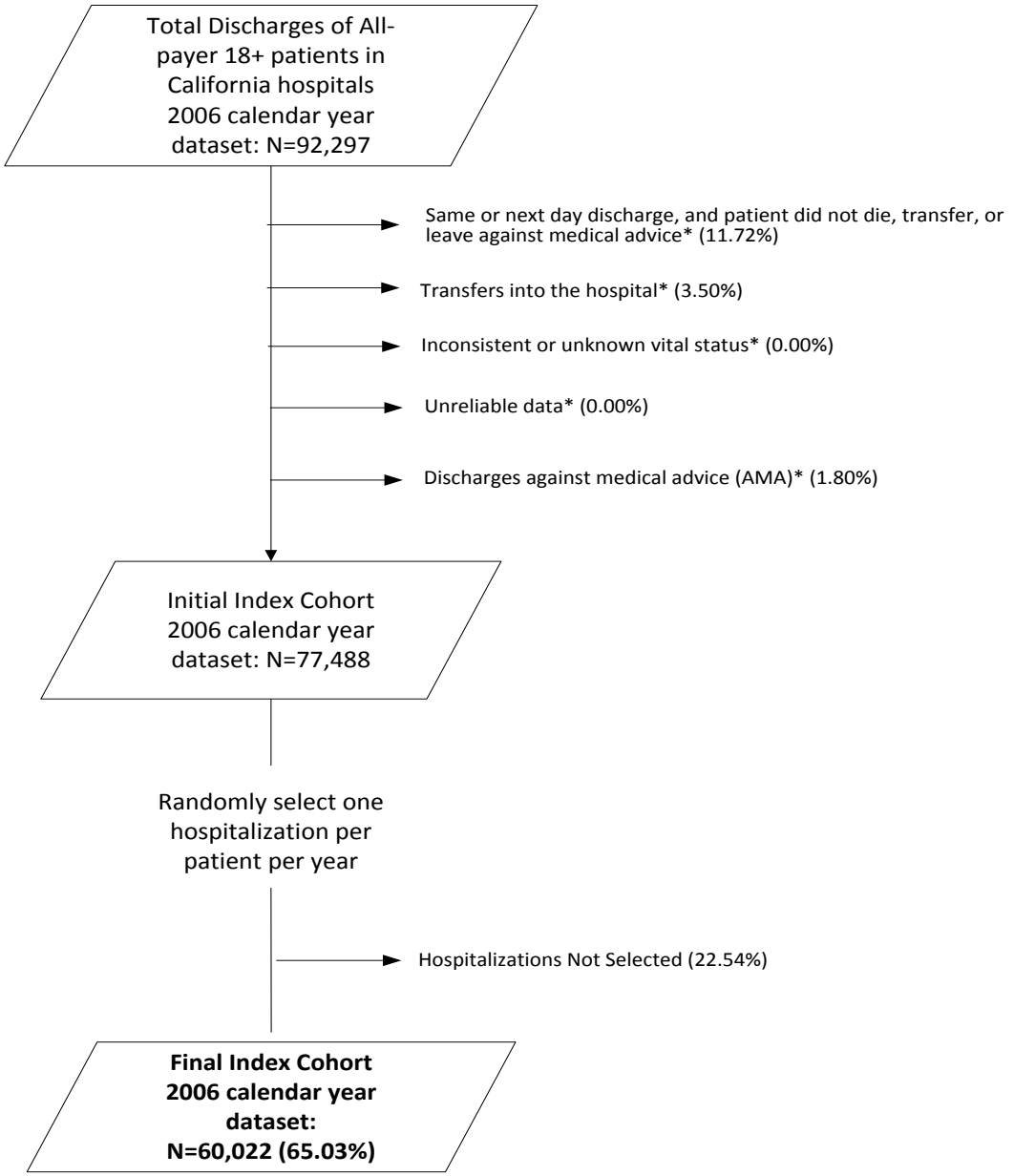
* Including Part B, hospital outpatient, and hospital inpatient data.

Figure 3a. 2006 AMI Mortality Cohort Using California Patient Discharge Data for All-payer Patients 18+ Admitted to California Hospitals



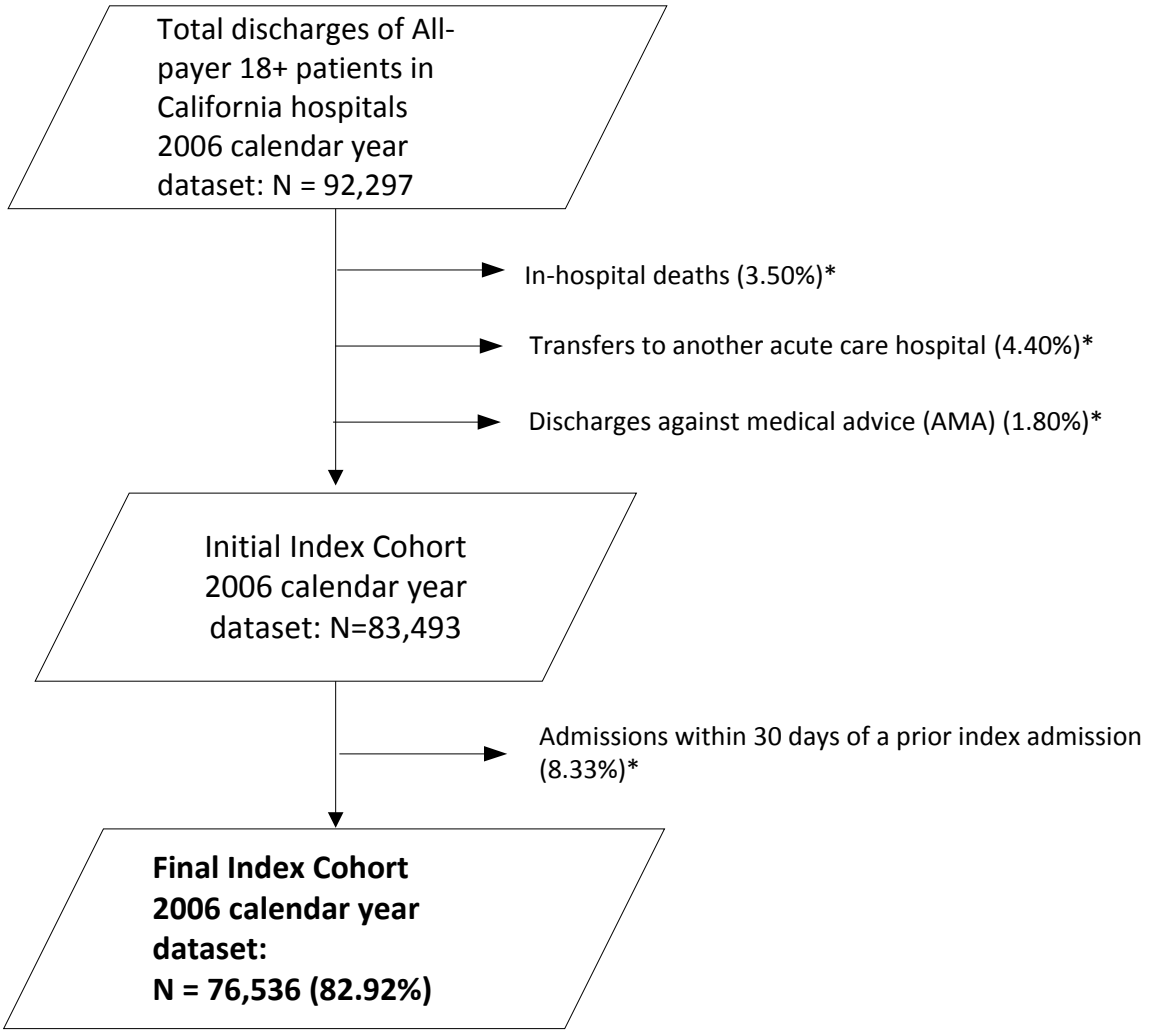
*Categories are not mutually exclusive

Figure 3b. 2006 HF Mortality Cohort Using California Patient Discharge Data for All-payer Patients 18+ Admitted to California Hospitals



*Categories are not mutually exclusive

Figure 3c. 2006 HF Readmission Cohort Using California Patient Discharge Data for All-payer Patients 18+ Admitted to California Hospitals



* These categories are not mutually exclusive.

Table 5a. Prevalence of Risk Factors in AMI Mortality Model for All Patients Aged 18+ Years, FFS 65+ Patients, Non-FFS 65+ Patients, and All 18-64 Years Patients; Data Source: 2006 California Patient Discharge Data for All-payer Patients 18+ Admitted to California Hospitals

Risk Factor	All 18+ (TOTAL) # (%)	FFS 65+ # (%)	Non-FFS 65+ # (%)	All 18-64 # (%)	P-value
All	39,481 (100)	13,347 (100)	11,214 (100)	14,920 (100)	
Demographics					
Age: Mean (SD)	69 (14)	79 (8)	78 (8)	54 (8)	0.0000
Male	23,977 (61)	6,682 (50)	6,099 (54)	11,196 (75)	0.0000
Cardiovascular					
Percutaneous Transluminal Coronary Angioplasty	4,637 (12)	1,594 (12)	1,290 (12)	1,753 (12)	0.5670
Coronary Artery Bypass Graft Surgery	3,490 (9)	1,406 (11)	1,337 (12)	747 (5)	0.0000
Congestive Heart failure (CC 80)	4,829 (12)	2,214 (17)	1,646 (15)	969 (6)	0.0000
Acute Myocardial Infarction (CC 81)	2,084 (5)	797 (6)	739 (7)	548 (4)	0.0000
Unstable Angina (CC82)	1,412 (4)	533 (4)	435 (4)	444 (3)	0.0000
Anterior Myocardial Infarction (ICD9 410.00-410.19)	5,773 (15)	1,800 (13)	1,280 (11)	2,693 (18)	0.0000
Other Location of Myocardial Infarction (ICD9 410.20-410.69)	7,715 (20)	2,111 (16)	1,682 (15)	3,922 (26)	0.0000
Chronic atherosclerosis (CC 83 or 84)	29,221 (74)	10,109 (76)	8,158 (73)	10,954 (73)	0.0000
Cardio-respiratory failure and shock (CC 79)	1,143 (3)	499 (4)	358 (3)	286 (2)	0.0000
Valvular or Rheumatic Heart Disease (CC 86)	5,746 (15)	2,733 (20)	2,014 (18)	999 (7)	0.0000
Comorbidity					
Hypertension (CC 89, 91)	24,388 (62)	8,503 (64)	7,437 (66)	8,448 (57)	0.0000
Stroke (CC 95 or 96)	618 (2)	279 (2)	229 (2)	110 (1)	0.0000
Cerebrovascular Disease (CC 97 to 99, 103)	1,698 (4)	817 (6)	621 (6)	260 (2)	0.0000
Renal Failure (CC 131)	3,378 (9)	1,409 (11)	1,176 (10)	793 (5)	0.0000
Chronic Obstructive Pulmonary Disease (CC 108)	7,181 (18)	3,175 (24)	2,283 (20)	1,723 (12)	0.0000
Pneumonia (CC 111 to 113)	4,865 (12)	2,265 (17)	1,657 (15)	943 (6)	0.0000
Diabetes and DM Complications (CC 15 to 20, 120)	14,462 (37)	5,062 (38)	4,375 (39)	5,025 (34)	0.0000
Protein-Calorie Malnutrition (CC 21)	1,015 (3)	537 (4)	325 (3)	153 (1)	0.0000
Dementia and Senility (CC 49 or 50)	3,641 (9)	2,145 (16)	1,359 (12)	137 (1)	0.0000
Hemiplegia, Paralysis, Functional Disability (CC 67 to 69, 100 to 102, 177, 178)	1,230 (3)	527 (4)	387 (3)	316 (2)	0.0000
Vascular or Circulatory Disease (CC 104, 105)	2,475 (6)	1,102 (8)	849 (8)	524 (4)	0.0000
Metastatic Cancer and Acute Leukemia (CC 7, 8)	775 (2)	367 (3)	265 (2)	143 (1)	0.0000
Trauma (CC 154 to 156, 158 to 162)	1,835 (5)	875 (7)	627 (6)	333 (2)	0.0000
Major Psych Disorders (CC 54 to 56)	1,030 (3)	379 (3)	235 (2)	416 (3)	0.0003
Liver and Biliary Disease (CC 25 to 27)	634 (2)	152 (1)	112 (1)	370 (2)	0.0000
Outcome					
Death within 30-days of admission	4,667 (12)	2,257 (17)	1,736 (15)	674 (5)	0.0000

FFS is defined as payer category=Medicare and payer type of coverage=Traditional.

Table 5b. Prevalence of Risk Factors in HF Mortality Model with All 18+ Years Patients, FFS 65+ Years Patients, Non-FFS 65+ Years Patients, and All 18-64 Years Patients; Data Source: 2006 California Patient Discharge Data for All-payer Patients 18+ Admitted to California Hospitals

Risk Factor	All 18+ (TOTAL) # (%)	FFS 65+ # (%)	Non-FFS 65+ # (%)	All 18-64 # (%)	P-value
All	60,022 (100)	27,977 (100)	16,447 (100)	15,598 (100)	
Demographics					
Age: Mean (SD)	73 (15)	81 (8)	80 (8)	53 (9)	0.0000
Male	29,241 (49)	12,120 (43)	7,640 (46)	9,481 (61)	0.0000
Cardiovascular					
Percutaneous Transluminal Coronary Angioplasty	5,720 (10)	2,937 (10)	1,553 (9)	1,230 (8)	0.0000
Coronary Artery Bypass Graft Surgery	10,026 (17)	5,435 (19)	3,105 (19)	1,486 (10)	0.0000
Congestive Heart failure (CC 80)	27,013 (45)	12,826 (46)	7,307 (44)	6,880 (44)	0.0005
Acute Myocardial Infarction (CC 81)	4,546 (8)	2,056 (7)	1,530 (9)	960 (6)	0.0000
Unstable Angina (CC82)	2,829 (5)	1,283 (5)	813 (5)	733 (5)	0.2285
Chronic atherosclerosis (CC 83, 84)	34,945 (58)	17,884 (64)	10,103 (61)	6,958 (45)	0.0000
Cardio-respiratory failure and shock (CC 79)	5,696 (9)	2,680 (10)	1,409 (9)	1,607 (10)	0.0000
Valvular or Rheumatic Heart Disease (CC 86)	17,416 (29)	8,874 (32)	5,252 (32)	3,290 (21)	0.0000
Comorbidity					
Hypertension (CC 89, 91)	36,660 (61)	17,174 (61)	10,485 (64)	9,001 (58)	0.0000
Stroke (CC 95, 96)	1,455 (2)	763 (3)	365 (2)	327 (2)	0.0000
Renal Failure (CC 131)	15,039 (25)	6,835 (24)	4,320 (26)	3,884 (25)	0.0001
Chronic Obstructive Pulmonary Disease (CC 108)	21,633 (36)	10,944 (39)	5,722 (35)	4,967 (32)	0.0000
Pneumonia (CC 111 to 113)	16,146 (27)	7,993 (29)	4,500 (27)	3,653 (23)	0.0000
Diabetes and DM Complications (CC 15 to 20, 120)	28,208 (47)	12,713 (45)	7,511 (46)	7,984 (51)	0.0000
Protein-Calorie Malnutrition (CC 21)	3,043 (5)	1,569 (6)	857 (5)	617 (4)	0.0000
Dementia and Senility (CC 49, 50)	7,463 (12)	4,871 (17)	2,342 (14)	250 (2)	0.0000
Hemiplegia, Paralysis, Functional Disability (CC 67 to 69, 100 to 102, 177, 178)	3,407 (6)	1,619 (6)	826 (5)	962 (6)	0.0000
Vascular or Circulatory Disease (CC 104, 105)	7,843 (13)	3,845 (14)	2,276 (14)	1,722 (11)	0.0000
Metastatic Cancer and Acute Leukemia (CC 7, 8)	1,369 (2)	741 (3)	412 (3)	216 (1)	0.0000
Trauma (CC 154 to 156, 158 to 162)	4,714 (8)	2,573 (9)	1,365 (8)	776 (5)	0.0000
Major Psych Disorders (CC 54 to 56)	2,646 (4)	1,107 (4)	467 (3)	1,072 (7)	0.0000
Liver and Biliary Disease (CC 25 to 27)	2,344 (4)	646 (2)	377 (2)	1,321 (8)	0.0000
Outcome					
Death within 30-days of admission	5,802 (10)	3,176 (11)	2,009 (12)	617 (4)	0.0000

FFS is defined as "Payer category is Medicare and Payer type of coverage is Traditional".

Table 5c. Prevalence of Risk Factors in HF Readmission Model with All 18+ Years Patients, FFS 65+ Years Patients, Non-FFS 65+ Years Patients, and All 18-64 Years Patients; Data Source: 2006 California Patient Discharge Data for All-payer Patients 18+ Admitted to California Hospitals

Risk Factor	All 18+ (TOTAL) # (%)	FFS 65+ # (%)	Non-FFS 65+ # (%)	All 18-64 # (%)	P-value
All	76,536 (100)	33,784 (100)	20,989 (100)	21,763 (100)	
Demographics					
Age: Mean (SD)	72 (15)	80 (8)	80 (8)	53 (9)	0.0000
Male	37,918 (50)	14,833 (44)	9,777 (47)	13,308 (61)	0.0000
Cardiovascular					
Coronary Artery Bypass Graft Surgery	13,314 (17)	6,913 (20)	4,201 (20)	2,200 (10)	0.0000
Congestive Heart failure (CC 80)	37,883 (49)	16,853 (50)	10,029 (48)	11,001 (51)	0.0000
Acute coronary syndrome (CC 81, 82)	8,991 (12)	3,882 (11)	2,743 (13)	2,366 (11)	0.0000
Arrhythmias (CC 92, 93)	25,928 (34)	13,006 (38)	7,603 (36)	5,319 (24)	0.0000
Cardio-respiratory failure and shock (CC 79)	7,985 (10)	3,507 (10)	1,967 (9)	2,511 (12)	0.0000
Valvular or Rheumatic Heart Disease (CC 86)	22,138 (29)	10,905 (32)	6,609 (31)	4,624 (21)	0.0000
Vascular or Circulatory Disease (CC 104, 105, 106)	16,245 (21)	7,459 (22)	4,546 (22)	4,240 (19)	0.0000
Chronic atherosclerosis (CC 83, 84)	45,749 (60)	22,260 (66)	13,229 (63)	10,260 (47)	0.0000
Other and unspecified heart disease (CC 94)	5,633 (7)	2,302 (7)	1,538 (7)	1,793 (8)	0.0000
Comorbidity					
Hemiplegia, Paralysis, Functional Disability (CC 67 to 69, 100 to 102, 177, 178)	4,535 (6)	2,028 (6)	1,099 (5)	1,408 (6)	0.0000
Stroke (CC 95, 96)	1,868 (2)	916 (3)	489 (2)	463 (2)	0.0000
Renal Failure (CC 131)	20,819 (27)	9,066 (27)	5,819 (28)	5,934 (27)	0.0732
Chronic Obstructive Pulmonary Disease (CC 108)	27,939 (37)	13,334 (39)	7,337 (35)	7,268 (33)	0.0000
Diabetes and DM Complications (CC 15 to 20, 119, 120)	36,663 (48)	15,813 (47)	9,703 (46)	11,147 (51)	0.0000
Disorders of fluid/electrolyte/acid-base (CC22, 23)	21,763 (28)	10,090 (30)	5,359 (26)	6,314 (29)	0.0000
Other urinary tract disorders (CC 136)	16,267 (21)	7,823 (23)	4,379 (21)	4,065 (19)	0.0000
Decubitus ulcer or chronic skin ulcer (CC 148, 149)	4,988 (7)	2,035 (6)	1,331 (6)	1,622 (7)	0.0000
Other gastrointestinal disorders (CC 36)	26,683 (35)	12,767 (38)	7,274 (35)	6,642 (31)	0.0000
Peptic ulcer, hemorrhage, other specified gastrointestinal disorders (CC 34)	6,600 (9)	3,286 (10)	1,831 (9)	1,483 (7)	0.0000
Severe hematological disorders (CC 44)	1,325 (2)	648 (2)	328 (2)	349 (2)	0.0019
Nephritis (CC132)	4,955 (6)	1,602 (5)	1,403 (7)	1,950 (9)	0.0000
Dementia and Senility (CC 49, 50)	8,678 (11)	5,519 (16)	2,801 (13)	358 (2)	0.0000
Metastatic Cancer and Acute Leukemia (CC 7)	1,001 (1)	520 (2)	292 (1)	189 (1)	0.0000
Cancer (CC 8 to 12)	5,967 (8)	3,080 (9)	1,850 (9)	1,037 (5)	0.0000
Liver and biliary disease (CC 25 to 30)	6,737 (9)	2,031 (6)	1,235 (6)	3,471 (16)	0.0000
End-stage renal disease or dialysis (CC 129, 130)	3,925 (5)	1,392 (4)	750 (4)	1,783 (8)	0.0000
Asthma (CC 110)	5,423 (7)	1,813 (5)	1,105 (5)	2,505 (12)	0.0000
Iron deficiency and other/unspecified anemias and blood disease (CC 47)	35,339 (46)	16,765 (50)	9,653 (46)	8,921 (41)	0.0000

Table 5c. Prevalence of Risk Factors in HF Readmission Model with All 18+ Years Patients, FFS 65+ Years Patients, Non-FFS 65+ Years Patients, and All 18-64 Years Patients; Data Source: 2006 California Patient Discharge Data for All-payer Patients 18+ Admitted to California Hospitals

Risk Factor	All 18+ (TOTAL) # (%)	FFS 65+ # (%)	Non-FFS 65+ # (%)	All 18-64 # (%)	P-value
Pneumonia (CC 111 to 113)	20,276 (26)	9,390 (28)	5,547 (26)	5,339 (25)	0.0000
Drug/alcohol abuse/dependence/psychosis (CC 51 to 53)	15,223 (20)	3,653 (11)	2,288 (11)	9,282 (43)	0.0000
Major pysch disorders (CC 54 to 56)	3,566 (5)	1,291 (4)	629 (3)	1,646 (8)	0.0000
Depression (CC 58)	10,059 (13)	4,223 (13)	2,535 (12)	3,301 (15)	0.0000
Other psychiatric disorders (CC 60)	5,329 (7)	2,186 (6)	1,278 (6)	1,865 (9)	0.0000
Fibrosis of lung and other chronic lung disorders (CC 109)	2,945 (4)	1,526 (5)	886 (4)	533 (2)	0.0000
Protein-Calorie Malnutrition (CC 21)	3,531 (5)	1,752 (5)	938 (4)	841 (4)	0.0000
Outcome					
Readmission within one month of discharge	17,938 (23)	7,922 (23)	4,668 (22)	5,348 (25)	0.0000

FFS is defined as "Payer category is Medicare and Payer type of coverage is Traditional".

Table 6a. Odds Ratios for Risk Factors in AMI Mortality Measure for All Patients 18+ Years (GLM, N=39,481, C-Statistic=0.765)

Data Source: 2006 California Patient Discharge Data for All-payer Patients 18+ Admitted to California Hospitals

Risk Factor	OR (95% CI)	P-value
Intercept		0.0000
Demographics		
Age	1.05 (1.05-1.06)	0.0000
Male	1.12 (1.05-1.20)	0.0008
Cardiovascular		
Percutaneous Transluminal Coronary Angioplasty	0.81 (0.72-0.92)	0.0007
Coronary Artery Bypass Graft Surgery	1.16 (1.04-1.30)	0.0076
Congestive Heart failure (CC 80)	1.54 (1.38-1.71)	0.0000
Acute Myocardial Infarction (CC 81)	1.08 (0.94-1.24)	0.2920
Unstable Angina (CC82)	0.76 (0.63-0.92)	0.0042
Anterior Myocardial Infarction (ICD9 410.00-410.19)	1.74 (1.59-1.91)	0.0000
Other Location of Myocardial Infarction (ICD9 410.20-410.69)	1.42 (1.30-1.56)	0.0000
Chronic atherosclerosis (CC 83 or 84)	0.57 (0.53-0.61)	0.0000
Cardio-respiratory failure and shock (CC 79)	0.88 (0.74-1.04)	0.1322
Valvular or Rheumatic Heart Disease (CC 86)	1.18 (1.09-1.28)	0.0001
Comorbidity		
Hypertension (CC 89, 91)	0.70 (0.66-0.75)	0.0000
Stroke (CC 95 or 96)	1.26 (1.01-1.57)	0.0382
Cerebrovascular Disease (CC 97 to 99, 103)	1.24 (1.09-1.42)	0.0016
Renal Failure (CC 131)	1.19 (1.06-1.34)	0.0027
Chronic Obstructive Pulmonary Disease (CC 108)	1.10 (1.02-1.20)	0.0155
Pneumonia (CC 111 to 113)	1.60 (1.47-1.74)	0.0000
Diabetes and DM Complications (CC 15 to 20, 120)	1.27 (1.18-1.36)	0.0000
Protein-Calorie Malnutrition (CC 21)	1.60 (1.38-1.86)	0.0000
Dementia and Senility (CC 49 or 50)	1.51 (1.38-1.65)	0.0000
Hemiplegia, Paralysis, Functional Disability (CC 67 to 69, 100 to 102, 177, 178)	1.25 (1.06-1.48)	0.0084
Vascular or Circulatory Disease (CC 104, 105)	1.12 (0.99-1.27)	0.0733
Metastatic Cancer and Acute Leukemia (CC 7, 8)	3.08 (2.61-3.62)	0.0000
Trauma (CC 154 to 156, 158 to 162)	1.12 (0.98-1.27)	0.0872
Major Psych Disorders (CC 54 to 56)	1.09 (0.90-1.31)	0.3774
Liver and Biliary Disease (CC 25 to 27)	2.25 (1.81-2.80)	0.0000

Table 6b. Odds Ratios of Risk Factors in HF Mortality Measure for All Patients 18+ Years (GLM, N=60,022, C-Statistic=0.718)
Data Source: 2006 California Patient Discharge Data for All-payer Patients 18+ Admitted to California Hospitals

Risk Factor	OR (95% CI)	P-value
Intercept		0.0000
Demographics		
Age	1.04 (1.04-1.05)	0.0000
Male	1.27 (1.20-1.35)	0.0000
Cardiovascular		
Percutaneous Transluminal Coronary Angioplasty	0.72 (0.64-0.80)	0.0000
Coronary Artery Bypass Graft Surgery	0.91 (0.84-0.98)	0.0168
Congestive Heart failure (CC 80)	1.31 (1.22-1.40)	0.0000
Acute Myocardial Infarction (CC 81)	1.34 (1.21-1.48)	0.0000
Unstable Angina (CC82)	0.81 (0.70-0.93)	0.0028
Chronic atherosclerosis (CC 83, 84)	1.03 (0.96-1.10)	0.4432
Cardio-respiratory failure and shock (CC 79)	1.05 (0.96-1.16)	0.2778
Valvular or Rheumatic Heart Disease (CC 86)	1.17 (1.10-1.24)	0.0000
Comorbidity		
Hypertension (CC 89, 91)	0.70 (0.66-0.75)	0.0000
Stroke (CC 95, 96)	1.14 (0.97-1.35)	0.1150
Renal Failure (CC 131)	1.11 (1.03-1.19)	0.0061
Chronic Obstructive Pulmonary Disease (CC 108)	1.12 (1.06-1.19)	0.0001
Pneumonia (CC 111 to 113)	1.30 (1.22-1.38)	0.0000
Diabetes and DM Complications (CC 15 to 20, 120)	0.89 (0.84-0.95)	0.0002
Protein-Calorie Malnutrition (CC 21)	1.90 (1.72-2.09)	0.0000
Dementia and Senility (CC 49, 50)	1.53 (1.42-1.64)	0.0000
Hemiplegia, Paralysis, Functional Disability (CC 67 to 69, 100 to 102, 177, 178)	1.04 (0.92-1.18)	0.4939
Vascular or Circulatory Disease (CC 104, 105)	1.07 (0.98-1.16)	0.1323
Metastatic Cancer and Acute Leukemia (CC 7, 8)	2.84 (2.49-3.25)	0.0000
Trauma (CC 154 to 156, 158 to 162)	1.29 (1.18-1.41)	0.0000
Major Psych Disorders (CC 54 to 56)	0.93 (0.81-1.07)	0.3259
Liver and Biliary Disease (CC 25 to 27)	1.44 (1.25-1.66)	0.0000

Table 6c. Odds Ratios of Risk Factors in HF Readmission Measure for All Patients 18+ Years (GLM, N=76,536, C-Statistic=0.638)
Data Source: 2006 California Patient Discharge Data for All-payer Patients 18+ Admitted to California Hospitals

Risk Factor	OR (95% CI)	P-value
Intercept		0.0000
Demographics		
Age	1.00 (1.00-1.00)	0.0372
Male	1.02 (0.99-1.06)	0.1943
Cardiovascular		
Coronary Artery Bypass Graft Surgery	0.97 (0.92-1.01)	0.1613
Congestive Heart failure (CC 80)	1.22 (1.16-1.27)	0.0000
Acute coronary syndrome (CC 81, 82)	1.04 (0.99-1.10)	0.1150
Arrhythmias (CC 92, 93)	1.09 (1.05-1.14)	0.0000
Cardio-respiratory failure and shock (CC 79)	1.10 (1.04-1.16)	0.0007
Valvular or Rheumatic Heart Disease (CC 86)	1.08 (1.04-1.12)	0.0001
Vascular or Circulatory Disease (CC 104, 105, 106)	1.06 (1.01-1.11)	0.0177
Chronic atherosclerosis (CC 83, 84)	1.14 (1.10-1.19)	0.0000
Other and unspecified heart disease (CC 94)	1.03 (0.97-1.10)	0.3223
Comorbidity		
Hemiplegia, Paralysis, Functional Disability (CC 67 to 69, 100 to 102, 177, 178)	1.07 (1.00-1.15)	0.0594
Stroke (CC 95, 96)	1.05 (0.94-1.16)	0.4159
Renal Failure (CC 131)	1.13 (1.08-1.18)	0.0000
Chronic Obstructive Pulmonary Disease (CC 108)	1.13 (1.09-1.18)	0.0000
Diabetes and DM Complications (CC 15 to 20, 119, 120)	1.12 (1.08-1.16)	0.0000
Disorders of fluid/electrolyte/acid-base (CC22, 23)	1.20 (1.15-1.25)	0.0000
Other urinary tract disorders (CC 136)	1.15 (1.10-1.20)	0.0000
Decubitus ulcer or chronic skin ulcer (CC 148, 149)	1.12 (1.05-1.20)	0.0006
Other gastrointestinal disorders (CC 36)	1.10 (1.06-1.14)	0.0000
Peptic ulcer, hemorrhage, other specified gastrointestinal disorders (CC 34)	1.02 (0.96-1.08)	0.5994
Severe hematological disorders (CC 44)	1.23 (1.09-1.39)	0.0007
Nephritis (CC132)	0.99 (0.93-1.07)	0.8744
Dementia and Senility (CC 49, 50)	0.97 (0.92-1.03)	0.3283
Metastatic Cancer and Acute Leukemia (CC 7)	1.16 (1.00-1.35)	0.0482
Cancer (CC 8 to 12)	1.02 (0.96-1.09)	0.5434
Liver and biliary disease (CC 25 to 30)	1.20 (1.13-1.27)	0.0000
End-stage renal disease or dialysis (CC 129, 130)	1.39 (1.29-1.50)	0.0000
Asthma (CC 110)	1.05 (0.98-1.12)	0.1539
Iron deficiency and other/unspecified anemias and blood disease (CC 47)	1.18 (1.13-1.23)	0.0000
Pneumonia (CC 111 to 113)	1.06 (1.02-1.11)	0.0027
Drug/alcohol abuse/dependence/psychosis (CC 51 to 53)	1.12 (1.07-1.17)	0.0000
Major pysch disorders (CC 54 to 56)	1.28 (1.18-1.38)	0.0000
Depression (CC 58)	1.06 (1.01-1.11)	0.0237
Other psychiatric disorders (CC 60)	1.18 (1.10-1.25)	0.0000
Fibrosis of lung and other chronic lung disorders (CC 109)	1.13 (1.04-1.23)	0.0047
Protein-Calorie Malnutrition (CC 21)	1.04 (0.96-1.13)	0.2912

Table 7a. AMI Mortality Model Performance for Models with All 18+ Patients and by Subgroups of Patients*
Data Source: 2006 California Patient Discharge Data for All-payer Patients 18+ Admitted to California Hospitals

Model with	N	C-statistic	SE	Lower	Upper	Predictive ability, % (lowest decile – highest decile)
All 65+	24,561	0.714	0.004	0.705	0.722	(0.00%, 34.77%)
FFS, 65+	13,347	0.712	0.006	0.701	0.723	(0.00%, 35.20%)
Non-FFS, 65+	11,214	0.715	0.007	0.702	0.728	(0.00%, 34.11%)
All 18-64	14,920	0.728	0.01	0.708	0.748	(1.47%, 31.15%)
All 18+ (overall)	**39,481**	**0.765**	**0.004**	**0.758**	**0.772**	**(1.47%, 34.71%)**

*Note that a single overall model for all 18+ is applied to the subgroups of patients

Table 7b. HF Mortality Model Performance for Models with All 18+ Patients and with Subgroups of Patients*
Data Source: 2006 California Patient Discharge Data for All-payer Patients 18+ Admitted to California Hospitals

Model with	N	C-statistic	SE	Lower	Upper	Predictive ability[#], % (lowest decile – highest decile)
All 65+	44,424	0.690	0.004	0.683	0.698	(2.31%, 25.26%)
FFS, 65+	27,977	0.690	0.005	0.681	0.700	(0.00%, 24.17%)
Non-FFS, 65+	16,447	0.693	0.006	0.680	0.705	(5.17%, 27.41%)
All 18-64	15,598	0.663	0.011	0.641	0.685	(1.96%, 14.06%)
All 18+ (overall)	**60,022**	**0.718**	**0.003**	**0.712**	**0.725**	**(1.97%, 25.14%)**

*Note that a single overall model for all 18+ is applied to the subgroups of patients

[#]Mean observation mortality in the lowest and the highest decile of the predicted mortality.

Table 7c. HF Readmission Model Performance for Models with All 18+ Patients and with Subgroups of Patients*
Data Source: 2006 California Patient Discharge Data for All-payer Patients 18+ Admitted to California Hospitals

Model with	N	C-statistic	SE	Lower	Upper	Predictive ability[#], % (lowest decile – highest decile)
All 65+	54,773	0.616	0.003	0.610	0.622	(13.89%, 39.14%)
FFS, 65+	33,784	0.617	0.004	0.610	0.624	(14.15%, 39.42%)
Non-FFS, 65+	20,989	0.614	0.005	0.604	0.623	(13.53%, 38.58%)
All 18-64	21,763	0.687	0.004	0.679	0.695	(9.93%, 49.41%)
All 18+ (overall)	**76,536**	**0.638**	**0.002**	**0.633**	**0.642**	**(13.03%, 43.20%)**

*Note that a single overall model for all 18+ is applied to the subgroups of patients

[#]Mean observation mortality in the lowest and the highest decile of the predicted mortality.

Table 8a. Distribution of Pearson Chi-Square Residuals for AMI Mortality Model by Patient Subgroups
Data Source: 2006 California Patient Discharge Data for All-payer Patients 18+ Admitted to California Hospitals

	All 18+ (TOTAL)	All 65+	FFS 65+	Non-FFS 65+	All 18-64
N	39,481	24,561	13,347	11,214	14,920
Mean	-0.005	-0.002	-0.004	-0.001	-0.009
Std Deviation	0.978	0.994	0.994	0.995	0.950
100% Max	9.705	6.159	5.454	6.159	9.705
99%	4.088	3.512	3.418	3.566	5.062
95%	2.334	2.415	2.407	2.428	-0.089
90%	1.365	1.761	1.759	1.762	-0.122
75% Q3	-0.174	-0.245	-0.245	-0.244	-0.154
50% Median	-0.260	-0.335	-0.341	-0.329	-0.190
25% Q1	-0.379	-0.453	-0.464	-0.436	-0.231
10%	-0.527	-0.601	-0.617	-0.580	-0.282
5%	-0.640	-0.718	-0.739	-0.692	-0.321
1%	-0.902	-0.990	-1.025	-0.934	-0.446
0% Min	-2.385	-2.385	-2.385	-2.088	-1.683
Residual < -2	2 (0.01%)	2 (0.01%)	1 (0.01%)	1 (0.01%)	0 (0.00%)
-2 <= Residual < 0	34,812 (88.17%)	20,566 (83.73%)	11,809 (83.08%)	9,477 (84.51%)	14,246 (95.48%)
0 <= Residual < 2	2,089 (5.29%)	2,054 (8.36%)	1,219 (9.13%)	835 (7.45%)	35 (0.23%)
Residual >= 2	2,578 (6.53%)	1,939 (7.89%)	1,038 (7.78%)	901 (9.03%)	639 (4.28%)

Table 8b. Distribution of Pearson Chi-Square Residual for HF Mortality Models by Patient Subgroups
Data Source: 2006 California Patient Discharge Data for All-payer Patients 18+ Admitted to California Hospitals

	All 18+ (TOTAL)	All 65+	FFS 65+	Non-FFS 65+	All 18-64
N	60,022	44,424	27,977	16,447	15,598
Mean	-0.0016	-0.0051	-0.0209	0.0219	0.0082
Std Deviation	0.9949	0.9844	0.9646	1.0168	1.0242
100% Max	13.3990	6.7464	5.9748	6.7464	13.3990
99%	4.2042	3.7393	3.6917	3.8302	5.7434
95%	2.5427	2.6158	2.5493	2.7077	-0.0954
90%	-0.0974	1.7596	1.6668	1.8785	-0.1183
75% Q3	-0.1880	-0.2410	-0.2427	-0.2370	-0.1478
50% Median	-0.2686	-0.3066	-0.3102	-0.3015	-0.1780
25% Q1	-0.3559	-0.3860	-0.3914	-0.3762	-0.2138
10%	-0.4508	-0.4796	-0.4870	-0.4656	-0.2593
5%	-0.5206	-0.5508	-0.5582	-0.5368	-0.2962
1%	-0.7020	-0.7395	-0.7493	-0.7223	-0.4051
0% Min	-1.6798	-1.6798	-1.6798	-1.6685	-0.7087
Residual < -2	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
-2 <= Residual < 0	54,220 (90.33%)	39,239 (88.33%)	24,801 (88.65%)	14,438 (87.79%)	14,981 (96.04%)
0 <= Residual < 2	1,275 (2.12%)	1,269 (2.86%)	811 (2.90%)	458 (2.78%)	6 (0.04%)
Residual >= 2	4,527 (7.54%)	3,916 (8.82%)	2,365 (8.45%)	1,551 (9.43%)	611 (3.92%)

Table 8c. Distribution of Pearson Chi-Square Residual for HF Readmission Models by Patient Subgroups
Data Source: 2006 California Patient Discharge Data for All-payer Patients 18+ Admitted to California Hospitals

	All 18+ (TOTAL)	All 65+	FFS 65+	Non-FFS 65+	All 18-64
N	76,536	54,773	33,784	20,989	21,763
Mean	0.0000	0.0022	0.0065	-0.0047	-0.0055
Std Deviation	1.0000	1.0085	1.0112	1.0042	0.9782
100% Max	2.7554	2.7554	2.7554	2.7469	2.6472
99%	2.5027	2.5181	2.5123	2.5260	2.4500
95%	2.1716	2.1958	2.1894	2.2098	2.0945
90%	1.8238	1.8582	1.8512	1.8707	1.7320
75% Q3	-0.3777	-0.3769	-0.3755	-0.3792	-0.3798
50% Median	-0.4541	-0.4552	-0.4569	-0.4520	-0.4512
25% Q1	-0.5695	-0.5695	-0.5738	-0.5627	-0.5696
10%	-0.6948	-0.6883	-0.6936	-0.6778	-0.7128
5%	-0.7727	-0.7613	-0.7683	-0.7497	-0.8072
1%	-0.9336	-0.9071	-0.9132	-0.8979	-0.9902
0% Min	-1.5081	-1.4771	-1.2495	-1.4771	-1.5081
Residual < -2	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
-2 <= Residual < 0	58,598 (76.56%)	42,183 (77.01%)	25,862 (76.55%)	16,321 (77.76%)	16,415 (75.43%)
0 <= Residual < 2	12,263 (16.02%)	8,266 (15.09%)	5,323 (15.76%)	2,943 (14.02%)	3,997 (18.37%)
Residual >= 2	5,675 (7.41%)	4,324 (7.89%)	2,599 (7.69%)	1,725 (8.22%)	1,351 (6.21%)

Table 9a. Odds Ratios for Risk Factors in AMI Mortality Measure -- Stratified Results for FFS 65+ Patients, Non-FFS 65+ Patients, All 65+ Patients, and All 18-64 Patients
Data Source: 2006 California Patient Discharge Data for All-payer Patients 18+ Admitted to California Hospitals

Risk Factor	All 65+ (N=24,561, C-Statistic=0.714)		FFS 65+ (N=13,347, C-statistic=0.713)		Non-FFS 65+ (N= 11,214, C-statistic=0.719)		All 18-64 (N=14,920, C-Statistic=0.753)	
	OR (95% CI)	P-value	OR (95% CI)	P-value	OR (95% CI)	P-value	OR (95% CI)	P-value
Intercept		0.000		0.000		0.000		0.000
Demographics								
Age	1.06 (1.05-1.06)	0.000	1.06 (1.05-1.06)	0.000	1.06 (1.05-1.07)	0.000	1.04 (1.02-1.05)	0.000
Male	1.16 (1.08-1.25)	0.000	1.17 (1.06-1.29)	0.002	1.16 (1.04-1.30)	0.008	1.06 (0.88-1.27)	0.560
Cardiovascular								
Percutaneous Transluminal Coronary Angioplasty	0.80 (0.70-0.91)	0.001	0.77 (0.65-0.92)	0.004	0.82 (0.68-1.00)	0.055	0.86 (0.65-1.15)	0.310
Coronary Artery Bypass Graft Surgery	1.15 (1.03-1.30)	0.016	1.24 (1.06-1.45)	0.007	1.05 (0.88-1.26)	0.556	1.16 (0.82-1.65)	0.402
Congestive Heart failure (CC 80)	1.58 (1.41-1.77)	0.000	1.70 (1.46-1.96)	0.000	1.42 (1.19-1.70)	0.000	1.24 (0.90-1.71)	0.186
Acute Myocardial Infarction (CC 81)	1.04 (0.89-1.21)	0.613	1.00 (0.81-1.23)	0.971	1.09 (0.87-1.36)	0.458	1.37 (0.94-2.01)	0.104
Unstable Angina (CC82)	0.79 (0.65-0.97)	0.024	0.90 (0.70-1.17)	0.449	0.67 (0.49-0.93)	0.015	0.63 (0.39-1.03)	0.068
Anterior Myocardial Infarction (ICD9 410.00-410.19)	1.71 (1.54-1.90)	0.000	1.67 (1.46-1.92)	0.000	1.81 (1.54-2.12)	0.000	1.96 (1.59-2.41)	0.000
Other Location of Myocardial Infarction (ICD9 410.20-410.69)	1.50 (1.36-1.66)	0.000	1.53 (1.34-1.76)	0.000	1.47 (1.26-1.72)	0.000	1.29 (1.05-1.59)	0.017
Chronic atherosclerosis (CC 83 or 84)	0.60 (0.55-0.65)	0.000	0.54 (0.49-0.61)	0.000	0.68 (0.60-0.77)	0.000	0.44 (0.37-0.53)	0.000
Cardio-respiratory failure and shock (CC 79)	0.86 (0.71-1.04)	0.110	0.89 (0.69-1.13)	0.330	0.83 (0.62-1.12)	0.219	0.92 (0.61-1.40)	0.695
Valvular or Rheumatic Heart Disease (CC 86)	1.12 (1.03-1.23)	0.009	1.01 (0.90-1.14)	0.826	1.29 (1.13-1.48)	0.000	1.79 (1.39-2.29)	0.000
Comorbidity								
Hypertension (CC 89, 91)	0.71 (0.65-0.76)	0.000	0.69 (0.63-0.76)	0.000	0.72 (0.65-0.81)	0.000	0.71 (0.60-0.84)	0.000
Stroke (CC 95 or 96)	1.31 (1.04-1.65)	0.021	1.08 (0.78-1.49)	0.641	1.63 (1.16-2.28)	0.005	0.91 (0.45-1.85)	0.787
Cerebrovascular Disease (CC 97 to 99, 103)	1.27 (1.11-1.47)	0.001	1.39 (1.16-1.67)	0.000	1.13 (0.91-1.42)	0.269	1.12 (0.69-1.80)	0.646
Renal Failure (CC 131)	1.11 (0.98-1.25)	0.106	1.20 (1.02-1.41)	0.032	0.99 (0.82-1.20)	0.954	1.70 (1.23-2.35)	0.001
Chronic Obstructive Pulmonary Disease (CC 108)	1.10 (1.01-1.20)	0.031	1.05 (0.94-1.18)	0.376	1.15 (1.01-1.32)	0.034	1.17 (0.93-1.46)	0.182
Pneumonia (CC 111 to 113)	1.53 (1.39-1.68)	0.000	1.54 (1.37-1.74)	0.000	1.52 (1.32-1.75)	0.000	2.08 (1.63-2.66)	0.000
Diabetes and DM Complications (CC 15 to 20, 120)	1.19 (1.10-1.28)	0.000	1.24 (1.12-1.37)	0.000	1.14 (1.02-1.28)	0.025	1.73 (1.46-2.06)	0.000
Protein-Calorie Malnutrition (CC 21)	1.53 (1.31-1.80)	0.000	1.28 (1.04-1.57)	0.022	2.05 (1.59-2.65)	0.000	2.05 (1.32-3.17)	0.001
Dementia and Senility (CC 49 or 50)	1.51 (1.38-1.66)	0.000	1.43 (1.27-1.62)	0.000	1.64 (1.42-1.89)	0.000	1.63 (0.94-2.84)	0.082
Hemiplegia, Paralysis, Functional Disability (CC 67 to 69, 100 to 102, 177, 178)	1.23 (1.03-1.48)	0.023	1.21 (0.95-1.54)	0.116	1.26 (0.96-1.67)	0.101	1.06 (0.70-1.62)	0.771
Vascular or Circulatory Disease (CC 104, 105)	1.07(0.94-1.22)	0.325	0.97 (0.81-1.16)	0.721	1.24 (1.01-1.52)	0.043	1.47 (1.04-2.08)	0.027
Metastatic Cancer and Acute Leukemia (CC 7, 8)	3.06 (2.56-3.64)	0.000	3.04 (2.41-3.84)	0.000	3.11 (2.37-4.08)	0.000	3.27 (2.09-5.10)	0.000
Trauma (CC 154 to 156, 158 to 162)	1.07 (0.93-1.22)	0.351	0.94 (0.78-1.12)	0.492	1.26 (1.03-1.54)	0.026	1.63 (1.12-2.38)	0.012
Major Psych Disorders (CC 54 to 56)	1.03 (0.84-1.28)	0.761	1.11 (0.85-1.46)	0.432	0.93 (0.65-1.32)	0.691	1.13 (0.76-1.67)	0.547
Liver and Biliary Disease (CC 25 to 27)	1.65 (1.22-2.23)	0.001	1.92 (1.31-2.82)	0.001	1.31 (0.80-2.15)	0.291	2.68 (1.94-3.69)	0.000

Table 9b. Odds Ratios for Risk Factors in HF Mortality Measure -- Stratified Results for FFS 65+ Patients, Non-FFS 65+ Patients, All 65+ Patients, and All 18-64 Patients
Data Source: 2006 California Patient Discharge Data for All-payer Patients 18+ Admitted to California Hospitals

Risk Factor	All 65+ (N=44,424, C-statistic=0.690)		FFS 65+ (N=27,977, C-statistic=0.691)		Non-FFS 65+ (N= 16,447, C-statistic=0.694)		All 18-64 (N=15,598, C-Statistic=0.687)	
	OR (95% CI)	P-value	OR (95% CI)	P-value	OR (95% CI)	P-value	OR (95% CI)	P-value
Intercept		0.0000		0.0000		0.0000		0.0000
Demographics								
Age	1.05 (1.04-1.05)	0.0000	1.05 (1.05-1.06)	0.0000	1.04 (1.04-1.05)	0.0000	1.02 (1.01-1.03)	0.0024
Male	1.32 (1.24-1.40)	0.0000	1.26 (1.17-1.37)	0.0000	1.39 (1.26-1.53)	0.0000	1.04 (0.88-1.23)	0.6533
Cardiovascular								
Percutaneous Transluminal Coronary Angioplasty	0.69 (0.62-0.78)	0.0000	0.67 (0.58-0.78)	0.0000	0.74 (0.62-0.90)	0.0023	0.96 (0.71-1.31)	0.8185
Coronary Artery Bypass Graft Surgery	0.92 (0.84-1.00)	0.0436	0.92 (0.82-1.02)	0.1071	0.93 (0.81-1.06)	0.2815	0.87 (0.66-1.16)	0.3408
Congestive Heart failure (CC 80)	1.26 (1.17-1.36)	0.0000	1.18 (1.07-1.29)	0.0006	1.43 (1.27-1.61)	0.0000	1.70 (1.38-2.09)	0.0000
Acute Myocardial Infarction (CC 81)	1.34 (1.20-1.49)	0.0000	1.43 (1.25-1.65)	0.0000	1.16 (0.99-1.38)	0.0739	1.35 (1.01-1.81)	0.0442
Unstable Angina (CC82)	0.80 (0.69-0.93)	0.0046	0.77 (0.63-0.94)	0.0119	0.84 (0.66-1.07)	0.1563	0.84 (0.58-1.22)	0.3553
Chronic atherosclerosis (CC 83, 84)	1.04 (0.97-1.11)	0.3230	1.04 (0.95-1.13)	0.4485	1.05 (0.93-1.18)	0.4192	1.01 (0.83-1.22)	0.9518
Cardio-respiratory failure and shock (CC 79)	1.03 (0.93-1.14)	0.5366	1.03 (0.91-1.17)	0.6248	1.06 (0.89-1.25)	0.5123	1.21 (0.96-1.54)	0.1124
Valvular or Rheumatic Heart Disease (CC 86)	1.15 (1.08-1.23)	0.0000	1.13 (1.05-1.23)	0.0023	1.18 (1.06-1.30)	0.0017	1.38 (1.15-1.66)	0.0005
Comorbidity								
Hypertension (CC 89, 91)	0.72 (0.67-0.76)	0.0000	0.73 (0.67-0.79)	0.0000	0.68 (0.62-0.76)	0.0000	0.64 (0.54-0.76)	0.0000
Stroke (CC 95, 96)	1.15 (0.96-1.38)	0.1249	1.26 (1.01-1.58)	0.0385	0.96 (0.69-1.32)	0.7871	1.23 (0.80-1.90)	0.3530
Renal Failure (CC 131)	1.11 (1.03-1.20)	0.0059	1.07 (0.97-1.18)	0.1768	1.16 (1.02-1.31)	0.0229	1.06 (0.86-1.31)	0.5594
Chronic Obstructive Pulmonary Disease (CC 108)	1.14 (1.07-1.21)	0.0000	1.18 (1.09-1.28)	0.0001	1.11 (1.00-1.23)	0.0524	1.09 (0.91-1.31)	0.3389
Pneumonia (CC 111 to 113)	1.33 (1.24-1.42)	0.0000	1.41 (1.30-1.54)	0.0000	1.20 (1.08-1.34)	0.0009	1.01 (0.83-1.22)	0.9522
Diabetes and DM Complications (CC 15 to 20, 120)	0.90 (0.84-0.96)	0.0010	0.90 (0.83-0.98)	0.0116	0.90 (0.81-1.00)	0.0445	1.03 (0.86-1.24)	0.7143
Protein-Calorie Malnutrition (CC 21)	1.91 (1.72-2.12)	0.0000	1.84 (1.62-2.10)	0.0000	2.03 (1.71-2.40)	0.0000	1.80 (1.35-2.41)	0.0001
Dementia and Senility (CC 49, 50)	1.52 (1.42-1.64)	0.0000	1.47 (1.35-1.62)	0.0000	1.65 (1.46-1.86)	0.0000	0.97 (0.59-1.62)	0.9201
Hemiplegia, Paralysis, Functional Disability (CC 67 to 69, 100 to 102, 177, 178)	0.94 (0.82-1.08)	0.3602	0.95 (0.80-1.13)	0.5482	0.92 (0.74-1.16)	0.4968	1.67 (1.27-2.21)	0.0003
Vascular or Circulatory Disease (CC 104, 105)	1.05 (0.96-1.15)	0.2817	1.03 (0.92-1.15)	0.6411	1.09 (0.94-1.25)	0.2589	1.17 (0.92-1.49)	0.1884
Metastatic Cancer and Acute Leukemia (CC 7, 8)	2.79 (2.42-3.21)	0.0000	2.80 (2.34-3.34)	0.0000	2.85 (2.26-3.59)	0.0000	3.96 (2.66-5.90)	0.0000
Trauma (CC 154 to 156, 158 to 162)	1.30 (1.19-1.43)	0.0000	1.30 (1.16-1.46)	0.0000	1.31 (1.12-1.53)	0.0006	1.12 (0.82-1.53)	0.4862
Major Psych Disorders (CC 54 to 56)	0.92 (0.78-1.07)	0.2718	0.99 (0.82-1.19)	0.9220	0.78 (0.58-1.05)	0.1007	0.96 (0.72-1.30)	0.8140
Liver and Biliary Disease (CC 25 to 27)	1.31 (1.09-1.58)	0.0042	1.24 (0.98-1.58)	0.0774	1.47 (1.10-1.98)	0.0096	1.71 (1.35-2.15)	0.0000

Table 9c. Odds Ratios for Risk Factors in HF Readmission Measure -- Stratified Results for FFS 65+ Patients, Non-FFS 65+ Patients, All 65+ Patients, and All 18-64 Patients

Data Source: 2006 California Patient Discharge Data for All-payer Patients 18+ Admitted to California Hospitals

Risk Factor	All 65+ (N=54,773, C-statistic=0.617)		FFS 65+ (N=33,784, C-Statistic=0.619)		Non-FFS 65+ (N=20,989, C-Statistic=0.617)		All 18-64 (N=21,763, C-Statistic=0.689)	
	OR (95% CI)	P-value	OR (95% CI)	P-value	OR (95% CI)	P-value	OR (95% CI)	P-value
Intercept		0.0000		0.0000		0.0000		0.0000
Demographics								
Age	1.00 (1.00-1.00)	0.8059	1.00 (1.00-1.00)	0.8997	1.00 (1.00-1.01)	0.8947	0.99 (0.99-1.00)	0.0007
Male	1.03 (0.99-1.08)	0.1615	1.01 (0.96-1.07)	0.7059	1.07 (1.00-1.15)	0.0627	1.02 (0.95-1.10)	0.5663
Cardiovascular								
Coronary Artery Bypass Graft Surgery	0.98 (0.93-1.03)	0.3807	0.96 (0.89-1.02)	0.2055	1.01 (0.92-1.10)	0.8365	0.94 (0.84-1.05)	0.2486
Congestive Heart failure (CC 80)	1.18 (1.11-1.24)	0.0000	1.19 (1.11-1.28)	0.0000	1.16 (1.06-1.27)	0.0013	1.31 (1.21-1.43)	0.0000
Acute coronary syndrome (CC 81, 82)	1.03 (0.97-1.10)	0.3025	0.99 (0.91-1.07)	0.8301	1.11 (1.00-1.22)	0.0468	1.09 (0.99-1.21)	0.0948
Arrhythmias (CC 92, 93)	1.05 (1.00-1.11)	0.0375	1.05 (0.98-1.12)	0.1507	1.06 (0.98-1.15)	0.1434	1.24 (1.14-1.35)	0.0000
Cardio-respiratory failure and shock (CC 79)	1.08 (1.01-1.16)	0.0218	1.04 (0.95-1.13)	0.3941	1.17 (1.04-1.30)	0.0075	1.13 (1.02-1.25)	0.0174
Valvular or Rheumatic Heart Disease (CC 86)	1.09 (1.04-1.13)	0.0003	1.08 (1.02-1.14)	0.0051	1.09 (1.01-1.17)	0.0196	1.06 (0.98-1.15)	0.1376
Vascular or Circulatory Disease (CC 104, 105, 106)	1.02 (0.97-1.08)	0.3845	1.04 (0.97-1.11)	0.2402	1.00 (0.91-1.09)	0.9450	1.18 (1.08-1.29)	0.0003
Chronic atherosclerosis (CC 83, 84)	1.11 (1.06-1.17)	0.0000	1.15 (1.08-1.22)	0.0000	1.04 (0.96-1.13)	0.3077	1.21 (1.12-1.31)	0.0000
Other and unspecified heart disease (CC 94)	1.02 (0.95-1.11)	0.5560	1.02 (0.93-1.13)	0.6405	1.02 (0.90-1.16)	0.7306	1.02 (0.91-1.14)	0.7295
Comorbidity								
Hemiplegia, Paralysis, Functional Disability (CC 67 to 69, 100 to 102, 177, 178)	1.13 (1.03-1.23)	0.0072	1.16 (1.05-1.30)	0.0052	1.06 (0.91-1.22)	0.4667	0.95 (0.84-1.09)	0.4903
Stroke (CC 95, 96)	1.04 (0.92-1.18)	0.4979	1.00 (0.85-1.17)	0.9737	1.13 (0.92-1.40)	0.2455	1.04 (0.85-1.29)	0.6887
Renal Failure (CC 131)	1.16 (1.10-1.23)	0.0000	1.17 (1.09-1.25)	0.0000	1.14 (1.04-1.25)	0.0046	1.09 (0.99-1.20)	0.0668
Chronic Obstructive Pulmonary Disease (CC 108)	1.12 (1.07-1.17)	0.0000	1.11 (1.05-1.18)	0.0002	1.12 (1.04-1.20)	0.0034	1.19 (1.11-1.29)	0.0000
Diabetes and DM Complications (CC 15 to 20, 119, 120)	1.16 (1.11-1.21)	0.0000	1.13 (1.07-1.19)	0.0000	1.20 (1.11-1.29)	0.0000	1.07 (0.99-1.15)	0.0764
Disorders of fluid/electrolyte/acid-base (CC22, 23)	1.16 (1.10-1.22)	0.0000	1.14 (1.07-1.22)	0.0000	1.17 (1.07-1.27)	0.0005	1.30 (1.19-1.41)	0.0000
Other urinary tract disorders (CC 136)	1.17 (1.11-1.22)	0.0000	1.18 (1.11-1.26)	0.0000	1.14 (1.05-1.24)	0.0018	1.10 (1.01-1.19)	0.0305
Decubitus ulcer or chronic skin ulcer (CC 148, 149)	1.17 (1.08-1.26)	0.0002	1.18 (1.07-1.31)	0.0015	1.14 (1.00-1.30)	0.0489	1.02 (0.90-1.15)	0.7965
Other gastrointestinal disorders (CC 36)	1.06 (1.02-1.11)	0.0077	1.07 (1.01-1.13)	0.0182	1.05 (0.97-1.13)	0.2193	1.21 (1.13-1.31)	0.0000
Peptic ulcer, hemorrhage, other specified gastrointestinal disorders (CC 34)	1.02 (0.95-1.09)	0.6025	1.11 (1.01-1.20)	0.0214	0.88 (0.78-0.99)	0.0311	1.08 (0.96-1.22)	0.2189

Table 9c. Odds Ratios for Risk Factors in HF Readmission Measure -- Stratified Results for FFS 65+ Patients, Non-FFS 65+ Patients, All 65+ Patients, and All 18-64 Patients

Data Source: 2006 California Patient Discharge Data for All-payer Patients 18+ Admitted to California Hospitals

Risk Factor	All 65+ (N=54,773, C-statistic=0.617)		FFS 65+ (N=33,784, C-Statistic=0.619)		Non-FFS 65+ (N=20,989, C-Statistic=0.617)		All 18-64 (N=21,763, C-Statistic=0.689)	
	OR (95% CI)	P-value	OR (95% CI)	P-value	OR (95% CI)	P-value	OR (95% CI)	P-value
Severe hematological disorders (CC 44)	1.25 (1.09-1.44)	0.0016	1.16 (0.98-1.39)	0.0868	1.44 (1.13-1.83)	0.0028	1.17 (0.93-1.48)	0.1849
Nephritis (CC132)	1.00 (0.91-1.09)	0.9597	0.98 (0.88-1.11)	0.7869	1.03 (0.91-1.18)	0.6085	0.97 (0.86-1.09)	0.5911
Dementia and Senility (CC 49, 50)	1.00 (0.94-1.06)	0.9592	1.00 (0.93-1.07)	0.9984	0.99 (0.90-1.10)	0.9089	0.78 (0.61-0.99)	0.0382
Metastatic Cancer and Acute Leukemia (CC 7)	1.15 (0.98-1.36)	0.0961	1.22 (1.00-1.50)	0.0541	1.03 (0.78-1.37)	0.8211	1.31 (0.93-1.84)	0.1287
Cancer (CC 8 to 12)	1.05 (0.98-1.13)	0.1617	1.00 (0.91-1.09)	0.9424	1.16 (1.03-1.30)	0.0141	0.95 (0.81-1.10)	0.4834
Liver and biliary disease (CC 25 to 30)	1.12 (1.03-1.21)	0.0064	1.07 (0.97-1.19)	0.1909	1.20 (1.06-1.37)	0.0058	1.22 (1.12-1.33)	0.0000
End-stage renal disease or dialysis (CC 129, 130)	1.40 (1.27-1.54)	0.0000	1.45 (1.28-1.63)	0.0000	1.32 (1.11-1.56)	0.0013	1.27 (1.12-1.44)	0.0001
Asthma (CC 110)	0.98 (0.90-1.07)	0.6641	0.97 (0.87-1.08)	0.5890	1.00 (0.86-1.16)	0.9926	1.07 (0.97-1.18)	0.1917
Iron deficiency and other/unspecified anemias and blood disease (CC 47)	1.15 (1.09-1.20)	0.0000	1.12 (1.06-1.19)	0.0001	1.18 (1.10-1.28)	0.0000	1.28 (1.19-1.38)	0.0000
Pneumonia (CC 111 to 113)	1.06 (1.01-1.11)	0.0226	1.05 (0.99-1.12)	0.0833	1.07 (0.98-1.15)	0.1142	1.07 (0.99-1.15)	0.1033
Drug/alcohol abuse/dependence/psychosis (CC 51 to 53)	1.05 (0.99-1.13)	0.1182	1.06 (0.97-1.15)	0.1944	1.05 (0.94-1.17)	0.4079	1.13 (1.05-1.22)	0.0010
Major pysch disorders (CC 54 to 56)	1.09 (0.98-1.21)	0.1173	1.13 (0.99-1.28)	0.0605	1.00 (0.83-1.21)	0.9722	1.48 (1.32-1.65)	0.0000
Depression (CC 58)	1.03 (0.97-1.10)	0.2727	1.06 (0.98-1.15)	0.1318	1.00 (0.90-1.10)	0.9662	1.08 (0.98-1.18)	0.1088
Other psychiatric disorders (CC 60)	1.14 (1.06-1.24)	0.0010	1.11 (1.00-1.23)	0.0407	1.19 (1.05-1.36)	0.0086	1.21 (1.08-1.35)	0.0006
Fibrosis of lung and other chronic lung disorders (CC 109)	1.14 (1.03-1.25)	0.0077	1.11 (0.99-1.25)	0.0802	1.18 (1.01-1.37)	0.0421	1.16 (0.95-1.40)	0.1399
Protein-Calorie Malnutrition (CC 21)	1.02 (0.93-1.12)	0.6763	1.04 (0.93-1.16)	0.4801	0.98 (0.84-1.15)	0.8365	1.14 (0.98-1.33)	0.1011

Table 10a. AMI Mortality Model with Interaction Terms -- GLM (N=39,481, C-Statistic=0.767)
Data Source: 2006 California Patient Discharge Data for All-payer Patients 18+ Admitted to California Hospitals

Risk Factor	Estimate	Standard Error	Wald Chi-Square	P-value	OR	LOR	UOR
Intercept	-6.047	0.173	1221.388	0.0000			
Demographics							
Age	0.053	0.002	529.957	0.0000	1.05	1.05	1.06
Male	0.067	0.093	0.521	0.4704	1.07	0.89	1.28
Cardiovascular							
Percutaneous Transluminal Coronary Angioplasty	-0.155	0.145	1.135	0.2868	0.86	0.64	1.14
Coronary Artery Bypass Graft Surgery	0.123	0.178	0.477	0.4899	1.13	0.80	1.60
Congestive Heart failure (CC 80)	0.226	0.163	1.906	0.1674	1.25	0.91	1.73
Acute Myocardial Infarction (CC 81)	0.328	0.195	2.817	0.0933	1.39	0.95	2.04
Unstable Angina (CC82)	-0.445	0.250	3.170	0.0750	0.64	0.39	1.05
Anterior Myocardial Infarction (ICD9 410.00-410.19)	0.686	0.106	41.646	0.0000	1.99	1.61	2.44
Other Location of Myocardial Infarction (ICD9 410.20-410.69)	0.263	0.106	6.107	0.0135	1.30	1.06	1.60
Chronic atherosclerosis (CC 83 or 84)	-0.834	0.090	86.492	0.0000	0.43	0.36	0.52
Cardio-respiratory failure and shock (CC 79)	-0.086	0.213	0.162	0.6873	0.92	0.60	1.39
Valvular or Rheumatic Heart Disease (CC 86)	0.574	0.128	20.239	0.0000	1.78	1.38	2.28
Comorbidity							
Hypertension (CC 89, 91)	-0.360	0.084	18.156	0.0000	0.70	0.59	0.82
Stroke (CC 95 or 96)	-0.092	0.363	0.064	0.8007	0.91	0.45	1.86
Cerebrovascular Disease (CC 97 to 99, 103)	0.097	0.243	0.160	0.6894	1.10	0.68	1.77
Renal Failure (CC 131)	0.535	0.165	10.574	0.0011	1.71	1.24	2.36
Chronic Obstructive Pulmonary Disease (CC 108)	0.125	0.114	1.187	0.2759	1.13	0.91	1.42
Pneumonia (CC 111 to 113)	0.731	0.126	33.862	0.0000	2.08	1.62	2.66
Diabetes and DM Complications (CC 15 to 20, 120)	0.538	0.089	36.653	0.0000	1.71	1.44	2.04
Protein-Calorie Malnutrition (CC 21)	0.725	0.224	10.449	0.0012	2.06	1.33	3.20
Dementia and Senility (CC 49 or 50)	0.479	0.283	2.863	0.0907	1.61	0.93	2.81
Hemiplegia, Paralysis, Functional Disability (CC 67 to 69, 100 to 102, 177, 178)	0.065	0.215	0.090	0.7642	1.07	0.70	1.63
Vascular or Circulatory Disease (CC 104, 105)	0.377	0.176	4.598	0.0320	1.46	1.03	2.06
Metastatic Cancer and Acute Leukemia (CC 7, 8)	1.140	0.227	25.247	0.0000	3.13	2.00	4.88
Trauma (CC 154 to 156, 158 to 162)	0.496	0.194	6.552	0.0105	1.64	1.12	2.40
Major Psych Disorders (CC 54 to 56)	0.137	0.202	0.459	0.4979	1.15	0.77	1.70
Liver and Biliary Disease (CC 25 to 27)	1.007	0.164	37.763	0.0000	2.74	1.99	3.78
Older (Age>=65)	0.105	0.143	0.543	0.4611	1.11	0.84	1.47
Interactions							

Table 10a. AMI Mortality Model with Interaction Terms -- GLM (N=39,481, C-Statistic=0.767)
Data Source: 2006 California Patient Discharge Data for All-payer Patients 18+ Admitted to California Hospitals

Risk Factor	Estimate	Standard Error	Wald Chi-Square	P-value	OR	LOR	UOR
Older and Male	0.076	0.100	0.577	0.4474	1.08	0.89	1.31
Cardiovascular							
Older and Percutaneous Transluminal Coronary Angioplasty	-0.074	0.160	0.213	0.6441	0.93	0.68	1.27
Older and Coronary Artery Bypass Graft Surgery	0.021	0.188	0.012	0.9129	1.02	0.71	1.47
Older and Congestive Heart failure (CC 80)	0.234	0.173	1.821	0.1772	1.26	0.90	1.77
Older and Acute Myocardial Infarction (CC 81)	-0.286	0.210	1.860	0.1726	0.75	0.50	1.13
Older and Unstable Angina (CC82)	0.213	0.270	0.623	0.4298	1.24	0.73	2.10
Older and Anterior Myocardial Infarction (ICD9 410.00-410.19)	-0.150	0.119	1.599	0.2061	0.86	0.68	1.09
Older and Other Location of Myocardial Infarction (ICD9 410.20-410.69)	0.139	0.118	1.372	0.2415	1.15	0.91	1.45
Older and Chronic atherosclerosis (CC 83 or 84)	0.323	0.099	10.642	0.0011	1.38	1.14	1.68
Older and Cardio-respiratory failure and shock (CC 79)	-0.071	0.234	0.093	0.7601	0.93	0.59	1.47
Older and Valvular or Rheumatic Heart Disease (CC 86)	-0.452	0.135	11.206	0.0008	0.64	0.49	0.83
Comorbidity							
Older and Hypertension (CC 89, 91)	0.011	0.092	0.014	0.9068	1.01	0.84	1.21
Older and Stroke (CC 95 or 96)	0.363	0.382	0.904	0.3416	1.44	0.68	3.04
Older and Cerebrovascular Disease (CC 97 to 99, 103)	0.144	0.253	0.323	0.5696	1.15	0.70	1.90
Older and 'Renal Failure (CC 131)	-0.433	0.176	6.049	0.0139	0.65	0.46	0.92
Older and Chronic Obstructive Pulmonary Disease (CC 108)	-0.032	0.123	0.068	0.7936	0.97	0.76	1.23
Older and Pneumonia (CC 111 to 113)	-0.304	0.134	5.149	0.0233	0.74	0.57	0.96
Older and Diabetes and DM Complications (CC 15 to 20, 120)	-0.372	0.097	14.681	0.0001	0.69	0.57	0.83
Older and Protein-Calorie Malnutrition (CC 21)	-0.295	0.239	1.528	0.2165	0.74	0.47	1.19
Older and Dementia and Senility (CC 49 or 50)	-0.055	0.287	0.037	0.8472	0.95	0.54	1.66
Older and Hemiplegia, Paralysis, Functional Disability (CC 67 to 69, 100 to 102, 177, 178)	0.141	0.234	0.363	0.5471	1.15	0.73	1.82
Older and Vascular or Circulatory Disease (CC 104, 105)	-0.311	0.189	2.711	0.0997	0.73	0.51	1.06
Older and Metastatic Cancer and Acute Leukemia (CC 7, 8)	-0.028	0.244	0.013	0.9093	0.97	0.60	1.57
Older and Trauma (CC 154 to 156, 158 to 162)	-0.428	0.205	4.342	0.0372	0.65	0.44	0.97
Older and Major Psych Disorders (CC 54 to 56)	-0.108	0.229	0.222	0.6376	0.90	0.57	1.41
Older and Liver and Biliary Disease (CC 25 to 27)	-0.516	0.225	5.278	0.0216	0.60	0.38	0.93

Table 10b. HF Mortality Model with Interaction Terms -- GLM (N=60,022, C-statistic= 0.720)
Data Source: 2006 California Patient Discharge Data for All-payer Patients 18+ Admitted to California Hospitals

Risk Factor	Estimate	Standard Error	Wald Chi-Square	P-value	OR	LOR	UOR
Intercept	-5.9558	0.1520	1534.4593	0.0000			
Demographics							
Age	0.0435	0.0020	480.4268	0.0000	1.0445	1.0404	1.0485
Male	0.0601	0.0869	0.4792	0.4888	1.0620	0.8957	1.2591
Cardiovascular							
Percutaneous Transluminal Coronary Angioplasty	-0.0488	0.1568	0.0970	0.7554	0.9523	0.7003	1.2950
Coronary Artery Bypass Graft Surgery	-0.1931	0.1445	1.7846	0.1816	0.8244	0.6211	1.0944
Congestive Heart failure (CC 80)	0.5665	0.1063	28.3788	0.0000	1.7621	1.4306	2.1704
Acute Myocardial Infarction (CC 81)	0.3000	0.1501	3.9979	0.0456	1.3499	1.0059	1.8114
Unstable Angina (CC82)	-0.1612	0.1902	0.7188	0.3965	0.8511	0.5863	1.2355
Chronic atherosclerosis (CC 83, 84)	-0.0734	0.0992	0.5473	0.4594	0.9292	0.7650	1.1287
Cardio-respiratory failure and shock (CC 79)	0.2067	0.1222	2.8626	0.0907	1.2297	0.9678	1.5624
Valvular or Rheumatic Heart Disease (CC 86)	0.3309	0.0936	12.5054	0.0004	1.3922	1.1589	1.6724
Comorbidity							
Hypertension (CC 89, 91)	-0.4502	0.0881	26.1116	0.0000	0.6375	0.5364	0.7576
Stroke (CC 95, 96)	0.2355	0.2226	1.1196	0.2900	1.2655	0.8181	1.9576
Renal Failure (CC 131)	0.0505	0.1064	0.2249	0.6353	1.0518	0.8538	1.2957
Chronic Obstructive Pulmonary Disease (CC 108)	0.0319	0.0916	0.1214	0.7275	1.0324	0.8628	1.2354
Pneumonia (CC 111 to 113)	0.0122	0.0995	0.0151	0.9023	1.0123	0.8330	1.2302
Diabetes and DM Complications (CC 15 to 20, 120)	-0.0300	0.0915	0.1077	0.7428	0.9704	0.8110	1.1611
Protein-Calorie Malnutrition (CC 21)	0.5761	0.1478	15.1888	0.0001	1.7791	1.3316	2.3769
Dementia and Senility (CC 49, 50)	-0.0752	0.2597	0.0840	0.7720	0.9275	0.5576	1.5429
Hemiplegia, Paralysis, Functional Disability (CC 67 to 69, 100 to 102, 177, 178)	0.5119	0.1413	13.1290	0.0003	1.6685	1.2649	2.2008
Vascular or Circulatory Disease (CC 104, 105)	0.1623	0.1219	1.7733	0.1830	1.1762	0.9263	1.4936
Metastatic Cancer and Acute Leukemia (CC 7, 8)	1.3165	0.2035	41.8623	0.0000	3.7303	2.5035	5.5583
Trauma (CC 154 to 156, 158 to 162)	0.1049	0.1593	0.4332	0.5104	1.1106	0.8127	1.5176
Major Psych Disorders (CC 54 to 56)	-0.0053	0.1526	0.0012	0.9722	0.9947	0.7375	1.3415
Liver and Biliary Disease (CC 25 to 27)	0.5438	0.1185	21.0493	0.0000	1.7225	1.3654	2.1729
Old (Age>=65)	-0.0298	0.1316	0.0513	0.8208	0.9706	0.7499	1.2563
Interactions							
Male	0.2092	0.0924	5.1235	0.0236	1.2326	1.0284	1.4774
Cardiovascular							
Percutaneous Transluminal Coronary Angioplasty	-0.3218	0.1677	3.6799	0.0551	0.7249	0.5218	1.0070
Coronary Artery Bypass Graft Surgery	0.1028	0.1508	0.4646	0.4955	1.1082	0.8247	1.4892
Congestive Heart failure (CC 80)	-0.3318	0.1128	8.6452	0.0033	0.7176	0.5752	0.8953

Table 10b. HF Mortality Model with Interaction Terms -- GLM (N=60,022, C-statistic= 0.720)
Data Source: 2006 California Patient Discharge Data for All-payer Patients 18+ Admitted to California Hospitals

Risk Factor	Estimate	Standard Error	Wald Chi-Square	P-value	OR	LOR	UOR
Acute Myocardial Infarction (CC 81)	-0.0077	0.1596	0.0023	0.9615	0.9923	0.7257	1.3568
Unstable Angina (CC82)	-0.0629	0.2056	0.0934	0.7599	0.9391	0.6276	1.4052
Chronic atherosclerosis (CC 83, 84)	0.1093	0.1055	1.0734	0.3002	1.1155	0.9071	1.3718
Cardio-respiratory failure and shock (CC 79)	-0.1801	0.1328	1.8397	0.1750	0.8352	0.6438	1.0835
Valvular or Rheumatic Heart Disease (CC 86)	-0.1870	0.0990	3.5715	0.0588	0.8294	0.6832	1.0070
Comorbidity							
Hypertension (CC 89, 91)	0.1163	0.0938	1.5380	0.2149	1.1233	0.9347	1.3499
Stroke (CC 95, 96)	-0.0937	0.2412	0.1509	0.6977	0.9106	0.5676	1.4608
Renal Failure (CC 131)	0.0558	0.1135	0.2416	0.6230	1.0574	0.8465	1.3208
Chronic Obstructive Pulmonary Disease (CC 108)	0.0948	0.0972	0.9531	0.3289	1.0995	0.9089	1.3301
Pneumonia (CC 111 to 113)	0.2758	0.1050	6.8964	0.0086	1.3176	1.0725	1.6188
Diabetes and DM Complications (CC 15 to 20, 120)	-0.0927	0.0976	0.9018	0.3423	0.9115	0.7528	1.1036
Protein-Calorie Malnutrition (CC 21)	0.0707	0.1570	0.2028	0.6525	1.0733	0.7890	1.4599
Dementia and Senility (CC 49, 50)	0.5109	0.2622	3.7963	0.0514	1.6668	0.9970	2.7865
Hemiplegia, Paralysis, Functional Disability (CC 67 to 69, 100 to 102, 177, 178)	-0.5810	0.1574	13.6173	0.0002	0.5594	0.4109	0.7616
Vascular or Circulatory Disease (CC 104, 105)	-0.1159	0.1300	0.7942	0.3728	0.8906	0.6902	1.1491
Metastatic Cancer and Acute Leukemia (CC 7, 8)	-0.2986	0.2158	1.9160	0.1663	0.7418	0.4860	1.1323
Trauma (CC 154 to 156, 158 to 162)	0.1628	0.1662	0.9596	0.3273	1.1768	0.8497	1.6298
Major Psych Disorders (CC 54 to 56)	-0.0924	0.1725	0.2869	0.5922	0.9117	0.6502	1.2785
Liver and Biliary Disease (CC 25 to 27)	-0.2872	0.1518	3.5810	0.0584	0.7504	0.5573	1.0103

Table 10c. HF Readmission Model with Interaction Terms -- GLM (N=76,536, C-statistic= 0.640)
Data Source: 2006 California Patient Discharge Data for All-payer Patients 18+ Admitted to California Hospitals

Risk Factor	Estimate	Standard Error	Wald Chi-Square	P-value	OR	LOR	UOR
Intercept	-2.029	0.075	727.902	0.000			
Demographics							
Age	-0.002	0.001	3.039	0.081	0.998	0.996	1.000
Male	0.024	0.036	0.449	0.503	1.024	0.955	1.099
Cardiovascular							
Coronary Artery Bypass Graft Surgery	-0.077	0.057	1.849	0.174	0.926	0.828	1.035
Congestive Heart failure (CC 80)	0.281	0.044	41.753	0.000	1.325	1.216	1.443
Acute coronary syndrome (CC 81, 82)	0.087	0.052	2.801	0.094	1.091	0.985	1.208
Arrhythmias (CC 92, 93)	0.210	0.042	25.509	0.000	1.234	1.137	1.338
Cardio-respiratory failure and shock (CC 79)	0.122	0.051	5.808	0.016	1.130	1.023	1.248
Valvular or Rheumatic Heart Disease (CC 86)	0.060	0.040	2.235	0.135	1.062	0.981	1.149
Vascular or Circulatory Disease (CC 104, 105, 106)	0.163	0.045	12.966	0.000	1.177	1.077	1.286
Chronic atherosclerosis (CC 83, 84)	0.173	0.039	20.197	0.000	1.189	1.103	1.283
Other and unspecified heart disease (CC 94)	0.024	0.058	0.174	0.676	1.024	0.915	1.147
Comorbidity							
Hemiplegia, Paralysis, Functional Disability (CC 67 to 69, 100 to 102, 177, 178)	-0.049	0.067	0.531	0.466	0.953	0.836	1.086
Stroke (CC 95, 96)	0.048	0.107	0.202	0.653	1.049	0.851	1.293
Renal Failure (CC 131)	0.084	0.048	3.065	0.080	1.088	0.990	1.196
Chronic Obstructive Pulmonary Disease (CC 108)	0.161	0.038	18.062	0.000	1.175	1.091	1.265
Diabetes and DM Complications (CC 15 to 20, 119, 120)	0.053	0.037	2.095	0.148	1.055	0.981	1.134
Disorders of fluid/electrolyte/acid-base (CC22, 23)	0.265	0.042	38.953	0.000	1.304	1.199	1.417
Other urinary tract disorders (CC 136)	0.093	0.042	4.810	0.028	1.097	1.010	1.193
Decubitus ulcer or chronic skin ulcer (CC 148, 149)	0.013	0.062	0.046	0.830	1.013	0.897	1.145
Other gastrointestinal disorders (CC 36)	0.193	0.038	25.226	0.000	1.213	1.125	1.307
Peptic ulcer, hemorrhage, other specified gastrointestinal disorders (CC 34)	0.073	0.062	1.376	0.241	1.075	0.952	1.214
Severe hematological disorders (CC 44)	0.157	0.119	1.741	0.187	1.169	0.927	1.476
Nephritis (CC132)	-0.026	0.059	0.200	0.655	0.974	0.867	1.094
Dementia and Senility (CC 49, 50)	-0.268	0.121	4.885	0.027	0.765	0.603	0.970
Metastatic Cancer and Acute Leukemia (CC 7)	0.264	0.176	2.264	0.132	1.303	0.923	1.838
Cancer (CC 8 to 12)	-0.069	0.078	0.786	0.375	0.933	0.800	1.088
Liver and biliary disease (CC 25 to 30)	0.197	0.044	19.762	0.000	1.218	1.117	1.329
End-stage renal disease or dialysis (CC 129, 130)	0.251	0.063	16.009	0.000	1.286	1.137	1.454
Asthma (CC 110)	0.080	0.050	2.532	0.112	1.083	0.982	1.196
Iron deficiency and other/unspecified anemias and blood disease (CC 47)	0.244	0.039	39.542	0.000	1.277	1.183	1.378
Pneumonia (CC 111 to 113)	0.066	0.040	2.781	0.095	1.068	0.988	1.155

Table 10c. HF Readmission Model with Interaction Terms -- GLM (N=76,536, C-statistic= 0.640)
Data Source: 2006 California Patient Discharge Data for All-payer Patients 18+ Admitted to California Hospitals

Risk Factor	Estimate	Standard Error	Wald Chi-Square	P-value	OR	LOR	UOR
Drug/alcohol abuse/dependence/psychosis (CC 51 to 53)	0.137	0.037	13.797	0.000	1.147	1.067	1.234
Major pysch disorders (CC 54 to 56)	0.392	0.058	45.414	0.000	1.479	1.320	1.658
Depression (CC 58)	0.074	0.046	2.622	0.105	1.077	0.984	1.179
Other psychiatric disorders (CC 60)	0.194	0.056	12.155	0.000	1.214	1.089	1.354
Fibrosis of lung and other chronic lung disorders (CC 109)	0.145	0.099	2.175	0.140	1.157	0.953	1.403
Protein-Calorie Malnutrition (CC 21)	0.126	0.078	2.602	0.107	1.135	0.973	1.323
Old (Age>=65)	0.321	0.063	25.644	0.000	1.379	1.218	1.562
Interactions							
Old and Male	0.003	0.042	0.006	0.937	1.003	0.924	1.090
Cardiovascular							
Old and Coronary Artery Bypass Graft Surgery	0.051	0.063	0.664	0.415	1.053	0.930	1.191
Old and Congestive Heart failure (CC 80)	-0.118	0.052	5.175	0.023	0.889	0.803	0.984
Old and Acute coronary syndrome (CC 81, 82)	-0.055	0.061	0.806	0.369	0.947	0.840	1.067
Old and Arrhythmias (CC 92, 93)	-0.155	0.049	10.071	0.002	0.857	0.779	0.943
Old and Cardio-respiratory failure and shock (CC 79)	-0.046	0.061	0.573	0.449	0.955	0.847	1.076
Old and Valvular or Rheumatic Heart Disease (CC 86)	0.024	0.046	0.268	0.605	1.024	0.936	1.121
Old and Vascular or Circulatory Disease (CC 104, 105, 106)	-0.140	0.053	6.971	0.008	0.870	0.784	0.965
Old and Chronic atherosclerosis (CC 83, 84)	-0.069	0.046	2.243	0.134	0.933	0.853	1.022
Old and Other and unspecified heart disease (CC 94)	-0.002	0.070	0.001	0.982	0.998	0.871	1.145
Comorbidity							
Old and Hemiplegia, Paralysis, Functional Disability (CC 67 to 69, 100 to 102, 177, 178)	0.164	0.080	4.208	0.040	1.178	1.007	1.378
Old and Stroke (CC 95, 96)	-0.005	0.124	0.001	0.970	0.995	0.780	1.270
Old and Renal Failure (CC 131)	0.063	0.056	1.253	0.263	1.065	0.954	1.188
Old and Chronic Obstructive Pulmonary Disease (CC 108)	-0.053	0.044	1.426	0.232	0.949	0.870	1.034
Old and Diabetes and DM Complications (CC 15 to 20, 119, 120)	0.083	0.043	3.642	0.056	1.086	0.998	1.183
Old and Disorders of fluid/electrolyte/acid-base (CC22, 23)	-0.121	0.050	5.879	0.015	0.886	0.804	0.977
Old and Other urinary tract disorders (CC 136)	0.062	0.049	1.587	0.208	1.064	0.966	1.172
Old and Decubitus ulcer or chronic skin ulcer (CC 148, 149)	0.139	0.075	3.481	0.062	1.149	0.993	1.331
Old and Other gastrointestinal disorders (CC 36)	-0.130	0.045	8.441	0.004	0.878	0.804	0.959
Old and Peptic ulcer, hemorrhage, other specified gastrointestinal disorders (CC 34)	-0.055	0.071	0.590	0.442	0.947	0.823	1.089
Old and Severe hematological disorders (CC 44)	0.070	0.139	0.253	0.615	1.072	0.817	1.407
Old and Nephritis (CC132)	0.019	0.074	0.067	0.795	1.019	0.882	1.178
Old and Dementia and Senility (CC 49, 50)	0.280	0.125	5.048	0.025	1.324	1.036	1.691

Table 10c. HF Readmission Model with Interaction Terms -- GLM (N=76,536, C-statistic= 0.640)
Data Source: 2006 California Patient Discharge Data for All-payer Patients 18+ Admitted to California Hospitals

Risk Factor	Estimate	Standard Error	Wald Chi-Square	P-value	OR	LOR	UOR
Old and 'Metastatic Cancer and Acute Leukemia (CC 7)	-0.127	0.195	0.423	0.515	0.881	0.601	1.291
Old and Cancer (CC 8 to 12)	0.121	0.087	1.953	0.162	1.129	0.952	1.338
Old and Liver and biliary disease (CC 25 to 30)	-0.089	0.061	2.142	0.143	0.915	0.812	1.031
Old and End-stage renal disease or dialysis (CC 129, 130)	0.078	0.080	0.935	0.334	1.081	0.923	1.265
Old and Asthma (CC 110)	-0.102	0.068	2.292	0.130	0.903	0.790	1.031
Old and Iron deficiency and other/unspecified anemias and blood disease (CC 47)	-0.107	0.045	5.553	0.018	0.899	0.822	0.982
Old and 'Pneumonia (CC 111 to 113)	-0.008	0.047	0.033	0.855	0.992	0.905	1.086
Old and Drug/alcohol abuse/dependence/psychosis (CC 51 to 53)	-0.095	0.050	3.678	0.055	0.909	0.825	1.002
Old and Major pysch disorders (CC 54 to 56)	-0.312	0.079	15.554	0.000	0.732	0.627	0.855
Old and Depression (CC 58)	-0.042	0.056	0.578	0.447	0.959	0.860	1.069
Old and Other psychiatric disorders (CC 60)	-0.062	0.069	0.807	0.369	0.940	0.821	1.076
Old and Fibrosis of lung and other chronic lung disorders (CC 109)	-0.017	0.110	0.024	0.878	0.983	0.793	1.219
Old and Protein-Calorie Malnutrition (CC 21)	-0.105	0.091	1.335	0.248	0.900	0.754	1.076

Table 11a. AMI Mortality Model Performance for Models with Interaction Terms by Patient Subgroups
Data Source: 2006 California Patient Discharge Data for All-payer Patients 18+ Admitted to California Hospitals

Model with	N	C-statistic	SE	Lower C-stat	Upper C-stat	Predictive Ability*
All 65+	24,561	0.714	0.004	0.705	0.722	(NA, 35.17%)
FFS, 65+	13,347	0.712	0.006	0.700	0.723	(NA, 35.12%)
Non-FFS, 65+	11,214	0.715	0.007	0.702	0.728	(NA, 35.24%)
All 18-64	14,920	0.750	0.010	0.730	0.769	(1.06%, 26.98%)
All 18+	**39,481**	**0.767**	**0.004**	**0.760**	**0.774**	**(1.06%, 34.78%)**

* Mean observed mortality in the lowest and the highest decile of the predicted mortality.

Table 11b. HF Mortality Model Performance for Models with Interaction by Patient Subgroups
Data Source: 2006 California Patient Discharge Data for All-payer Patients 18+ Admitted to California Hospitals

Model with	N	C-statistic	SE	Lower C-stat	Upper C-stat	Predictive Ability*
All 65+	44,424	0.691	0.004	0.683	0.698	(1.45%, 25.62%)
FFS, 65+	27,977	0.691	0.005	0.681	0.700	(0.00%, 24.63%)
Non-FFS, 65+	16,447	0.692	0.006	0.680	0.704	(3.33%, 27.58%)
All 18-64	15,598	0.681	0.011	0.659	0.703	(1.87%, 17.78%)
All 18+	**60,022**	**0.720**	**0.003**	**0.714**	**0.727**	**(1.87%, 25.44%)**

*Mean observation mortality in the lowest and the highest decile of the predicted mortality.

Table 11c. HF Readmission Model Performance for Models with Interaction by Patient Subgroups
Data Source: 2006 California Patient Discharge Data for All-payer Patients 18+ Admitted to California Hospitals

Model with	N	C-statistic	SE	Lower C-stat	Upper C-stat	Predictive Ability*
All 65+	54,773	0.617	0.003	0.612	0.623	(12.13%, 40.51%)
FFS, 65+	33,784	0.618	0.004	0.611	0.625	(12.58%, 40.66%)
Non-FFS, 65+	20,989	0.615	0.005	0.606	0.624	(11.53%, 40.21%)
All 18-64	21,763	0.689	0.004	0.680	0.697	(11.93%, 47.25%)
All 18+	**76,536**	**0.640**	**0.002**	**0.636**	**0.645**	**(11.99%, 44.07%)**

*Mean observation readmission in the lowest and the highest decile of the predicted readmission.

Table 12a. Reclassification Table of Risk Categories for AMI Mortality Model with and without Interaction Terms
Data Source: 2006 California Patient Discharge Data for All-payer Patients 18+ Admitted to California Hospitals

Model without Interactions	Model with Interactions: 0 to <5%		5% to <10%		10% to <20%		>=20%		Total		
	#	%	#	%	#	%	#	%	#	%	
Among All 18+ Patients											
Risk Category											
0 to <5%	11,400	28.9	697	1.8	9	0.0	0	0.0	12,106	30.7	
5% to <10%	930	2.4	8,797	22.3	1,024	2.6	11	0.0	10,762	27.3	
10% to <20%	0	0.0	223	0.6	9,195	23.3	417	1.1	9,835	24.9	Same category: 90.84
>=20%	0	0.0	0	0.0	303	0.8	6,475	16.4	6,778	17.2	Similar category: 99.95
Total	12,330	31.2	9,717	24.6	10,531	26.7	6,903	17.5	39,481	100.0	
In All 65+ Patients											
Risk Category											
0 to <5%	1,156	4.7	277	1.1	0	0.0	0	0.0	1,433	5.8	
5% to <10%	17	0.1	6,678	27.2	590	2.4	0	0.0	7,285	29.7	
10% to <20%	0	0.0	164	0.7	8,791	35.8	239	1.0	9,194	37.4	Same category: 93.54
>=20%	0	0.0	0	0.0	300	1.2	6,349	25.9	6,649	27.1	Similar category: 100.00
Total	1,173	4.8	7,119	29.0	9,681	39.4	6,588	26.8	24,561	100.0	
In FFS 65+ Patients											
Risk Category											
0 to <5%	573	4.3	137	1.0	0	0.0	0	0.0	710	5.3	
5% to <10%	10	0.1	3,408	25.5	314	2.4	0	0.0	3,732	28.0	
10% to <20%	0	0.0	87	0.7	4,761	35.7	140	1.1	4,988	37.4	Same category: 93.55
>=20%	0	0.0	0	0.0	172	1.3	3,745	28.1	3,917	29.4	Similar category: 99.99
Total	583	4.4	3,632	27.2	5,247	39.3	3,885	29.1	13,347	100.0	
InNon-FFS 65+ Patients											
Risk Category											
0 to <5%	583	5.2	140	1.3	0	0.0	0	0.0	723	6.5	
5% to <10%	7	0.1	3,270	29.2	276	2.5	0	0.0	3,553	31.7	
10% to <20%	0	0.0	77	0.7	4,030	35.9	99	0.9	4,206	37.5	Same category: 93.52
>=20%	0	0.0	0	0.0	128	1.1	2,604	23.2	2,732	24.4	Similar category: 100.00
Total	590	5.3	3,487	31.1	4,434	39.5	2,703	24.1	11,214	100.0	
In All 18-64 Patients											
Risk Category											
0 to <5%	10,244	68.7	420	2.8	9	0.1	0	0.0	10,673	71.5	
5% to <10%	913	6.1	2,119	14.2	434	2.9	11	0.1	3,477	23.3	
10% to <20%	0	0.0	59	0.4	404	2.7	178	1.2	641	4.3	Same category: 86.41
>=20%	0	0.0	0	0.0	3	0.0	126	0.8	129	0.9	Similar category: 99.87
Total	11,157	74.8	2,598	17.4	850	5.7	315	2.1	14,920	100.0	

Table 12b. Reclassification Table of Risk Categories for HF Mortality Model with and without Interaction Terms
Data Source: 2006 California Patient Discharge Data for All-payer Patients 18+ Admitted to California Hospitals

Model without Interaction	Model With Interaction: 0 to <5%		5% to <10%		10% to <20%		>=20%		Total		
	#	%	#	%	#	%	#	%	#	%	
Among All 18+ Patients											
Risk Category											
0 to <5%	16,018	26.69	1,053	1.75	17	0.03	0	0.00	17,088	28.5	
5% to <10%	892	1.49	19,056	31.75	752	1.25	6	0.01	20,706	34.5	
10% to <20%	3	0.00	629	1.05	16,345	27.23	301	0.50	17,278	28.8	Same category: 93.5
>=20%	0	0.00	0	0.00	239	0.40	4,711	7.85	4,950	8.3	Similar category: 100.0
Total	16,913	28.18	20,738	34.55	17,353	28.91	5,018	8.36	60,022	100.0	
In All 65+ Patients											
Risk Category											
0 to <5%	4,422	9.95	126	0.28	0	0.00	0	0.00	4,548	10.2	
5% to <10%	346	0.78	17,404	39.18	395	0.89	0	0.00	18,145	40.9	
10% to <20%	0	0.00	539	1.21	16,056	36.14	233	0.52	16,828	37.9	Same category: 95.8
>=20%	0	0.00	0	0.00	226	0.51	4,677	10.53	4,903	11.0	Similar category: 100.0
Total	4,768	10.73	18,069	40.67	16,677	37.54	4,910	11.05	44,424	100.0	
In FFS 65+ Patients											
Risk Category											
0 to <5%	2,707	9.68	71	0.25	0	0.00	0	0.00	2,778	9.9	
5% to <10%	216	0.77	10,685	38.19	222	0.79	0	0.00	11,123	39.8	
10% to <20%	0	0.00	344	1.23	10,315	36.87	155	0.55	10,814	38.7	Same category: 95.9
>=20%	0	0.00	0	0.00	153	0.55	3,109	11.11	3,262	11.7	Similar category: 100.0
Total	2,923	10.45	11,100	39.67	10,690	38.21	3,264	11.66	27,977	100.0	
In Non-FFS 65+ Patients											
Risk Category											
0 to <5%	1,715	10.43	55	0.33	0	0.00	0	0.00	1,770	10.8	
5% to <10%	130	0.79	6,719	40.85	173	1.05	0	0.00	7,022	42.7	
10% to <20%	0	0.00	195	1.19	5,741	34.91	78	0.47	6,014	36.6	Same category: 95.7
>=20%	0	0.00	0	0.00	73	0.44	1,568	9.53	1,641	10.0	Similar category: 100.0
Total	1,845	11.22	6,969	42.37	5,987	36.40	1,646	10.00	16,447	100.0	
In All 18-64 Patients											
Risk Category											
0 to <5%	11,596	74.34	927	5.94	17	0.11	0	0.00	12,540	80.4	
5% to <10%	546	3.50	1,652	10.59	357	2.29	6	0.04	2,561	16.4	
10% to <20%	3	0.02	90	0.58	289	1.85	68	0.44	450	2.9	Same category: 87.0
>=20%	0	0.00	0	0.00	13	0.08	34	0.22	47	0.3	Similar category: 99.8
Total	12,145	77.86	2,669	17.11	676	4.33	108	0.70	15,598	100.0	

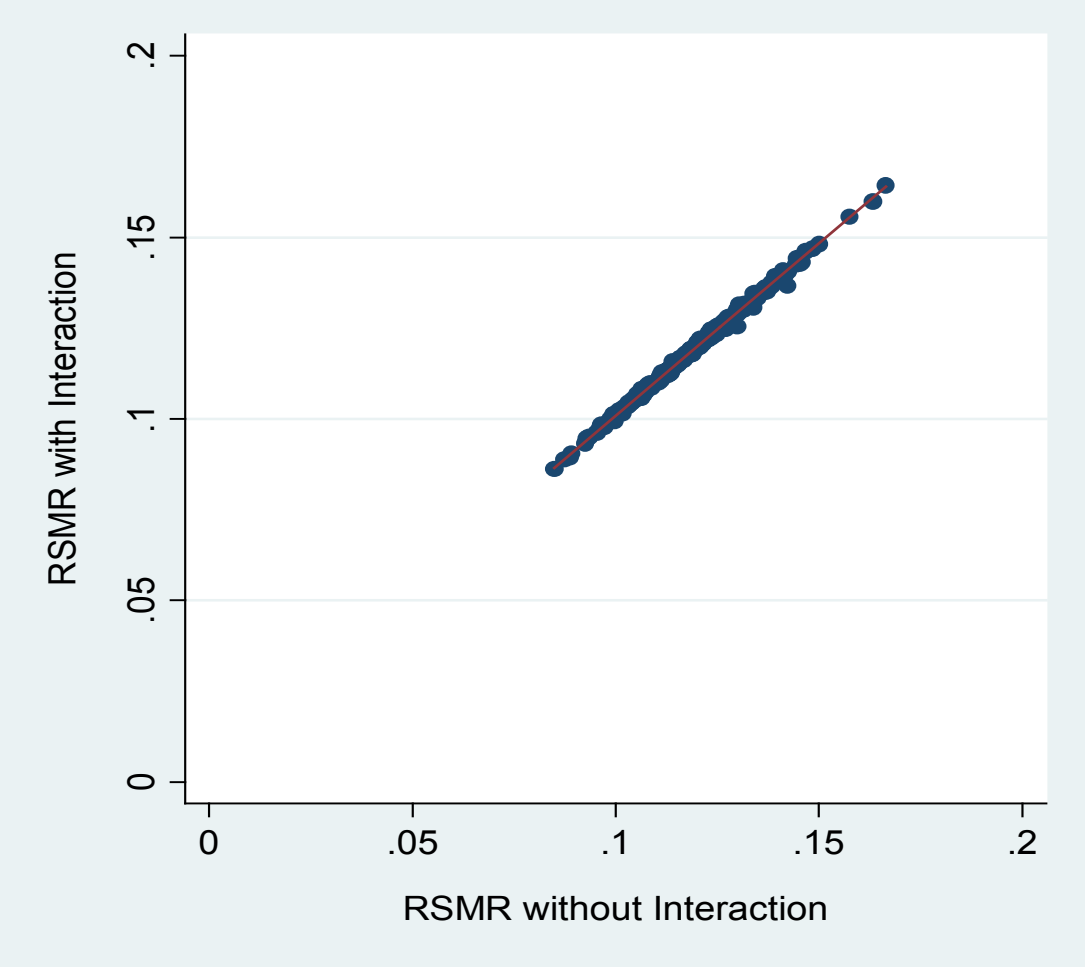
Table 12c. Reclassification Table of Risk Categories for HF Readmission Model with and without Interaction Terms
Data Source: 2006 California Patient Discharge Data for All-payer Patients 18+ Admitted to California Hospitals

Model without Interaction	Model With Interaction												
	0 to <15%		15% to <20%		20% to <25%		25% to <30%		>=30%		Total		
	#	%	#	%	#	%	#	%	#	%	#	%	
Among All 18+ Patients													
Risk Category													
0 to <15%	8,836	11.54	3,793	4.96	0	0.00	0	0.00	0	0.00	12,629	16.5	
15% to <20%	3,236	4.23	17,751	23.19	1,669	2.18	0	0.00	0	0.00	22,656	29.6	
20% to <25%	5	0.01	1,576	2.06	11,226	14.67	1,080	1.41	13	0.02	13,900	18.2	Same category: 79.0
25% to <30%	0	0.00	14	0.02	1,672	2.18	7,731	10.10	1,140	1.49	10,557	13.8	Similar category: 99.9
>=30%	0	0.00	0	0.00	21	0.03	1,848	2.41	14,925	19.50	16,794	21.9	
Total	12,077	15.78	23,134	30.23	14,588	19.06	10,659	13.92	16,078	21.01	76,536	100.0	
In All 65+ Patients													
Risk Category													
0 to <15%	5,451	9.95	3,793	6.92	0	0.00	0	0.00	0	0.00	9,244	16.9	
15% to <20%	32	0.06	14,703	26.84	1,548	2.83	0	0.00	0	0.00	16,283	29.7	
20% to <25%	0	0.00	568	1.04	9,102	16.62	621	1.13	0	0.00	10,291	18.8	Same category: 82.3
25% to <30%	0	0.00	0	0.00	1,264	2.31	6,226	11.37	311	0.57	7,801	14.3	Similar category: 100.0
>=30%	0	0.00	0	0.00	7	0.01	1,580	2.88	9,567	17.47	11,154	20.4	
Total	5,483	10.01	19,064	34.80	11,921	21.77	8,427	15.38	9,878	18.04	54,773	100.0	
In FFS 65+ Patients													
Risk Category													
0 to <15%	3,212	9.51	2,218	6.57	0	0.00	0	0.00	0	0.00	5,430	16.1	
15% to <20%	21	0.06	8,854	26.21	918	2.72	0	0.00	0	0.00	9,793	29.0	
20% to <25%	0	0.00	348	1.03	5,684	16.82	391	1.16	0	0.00	6,423	19.0	Same category: 82.4
25% to <30%	0	0.00	0	0.00	813	2.41	3,896	11.53	198	0.59	4,907	14.5	Similar category: 100.0
>=30%	0	0.00	0	0.00	4	0.01	1,025	3.03	6,202	18.36	7,231	21.4	
Total	3,233	9.57	11,420	33.81	7,419	21.96	5,312	15.72	6,400	18.95	33,784	100.0	
In Non-FFS 65+ Patients													
Risk Category													
0 to <15%	2,239	10.67	1,575	7.50	0	0.00	0	0.00	0	0.00	3,814	18.2	
15% to <20%	11	0.05	5,849	27.87	630	3.00	0	0.00	0	0.00	6,490	30.9	
20% to <25%	0	0.00	220	1.05	3,418	16.28	230	1.10	0	0.00	3,868	18.4	Same category: 82.0
25% to <30%	0	0.00	0	0.00	451	2.15	2,330	11.10	113	0.54	2,894	13.8	Similar category: 100.0
>=30%	0	0.00	0	0.00	3	0.01	555	2.64	3,365	16.03	3,923	18.7	
Total	2,250	10.72	7,644	36.42	4,502	21.44	3,115	14.84	3,478	16.57	20,989	100.0	
In All 18-64 Patients													
Risk Category													
0 to <15%	3,385	15.55	0	0.00	0	0.00	0	0.00	0	0.00	3,385	15.6	
15% to <20%	3,204	14.72	3,048	14.01	121	0.56	0	0.00	0	0.00	6,373	29.3	
20% to <25%	5	0.02	1,008	4.63	2,124	9.76	459	2.11	13	0.06	3,609	16.6	Same category: 70.9
25% to <30%	0	0.00	14	0.06	408	1.87	1,505	6.92	829	3.81	2,756	12.7	Similar category: 99.8
>=30%	0	0.00	0	0.00	14	0.06	268	1.23	5,358	24.62	5,640	25.9	
Total	6,594	30.29	4,070	18.70	2,667	12.25	2,232	10.26	6,200	28.49	21,763	100.0	

Table 13a. AMI Mortality Model Performance for Models With and Without Interaction Terms (N = 39,481)
Data Source: 2006 California Patient Discharge Data for All-payer Patients 18+ Admitted to California Hospitals

AMI Mortality Model	C-statistic	SE	Lower	Upper
With interaction terms	0.767	0.004	0.760	0.774
Without interaction terms	0.765	0.004	0.758	0.772

Figure 4a. Scatterplot of AMI Risk-Standardized Mortality Rates (RSMRs) from Models With and Without Interaction Terms
Data Source: 2006 California Patient Discharge Data for All-payer Patients 18+ Admitted to California Hospitals

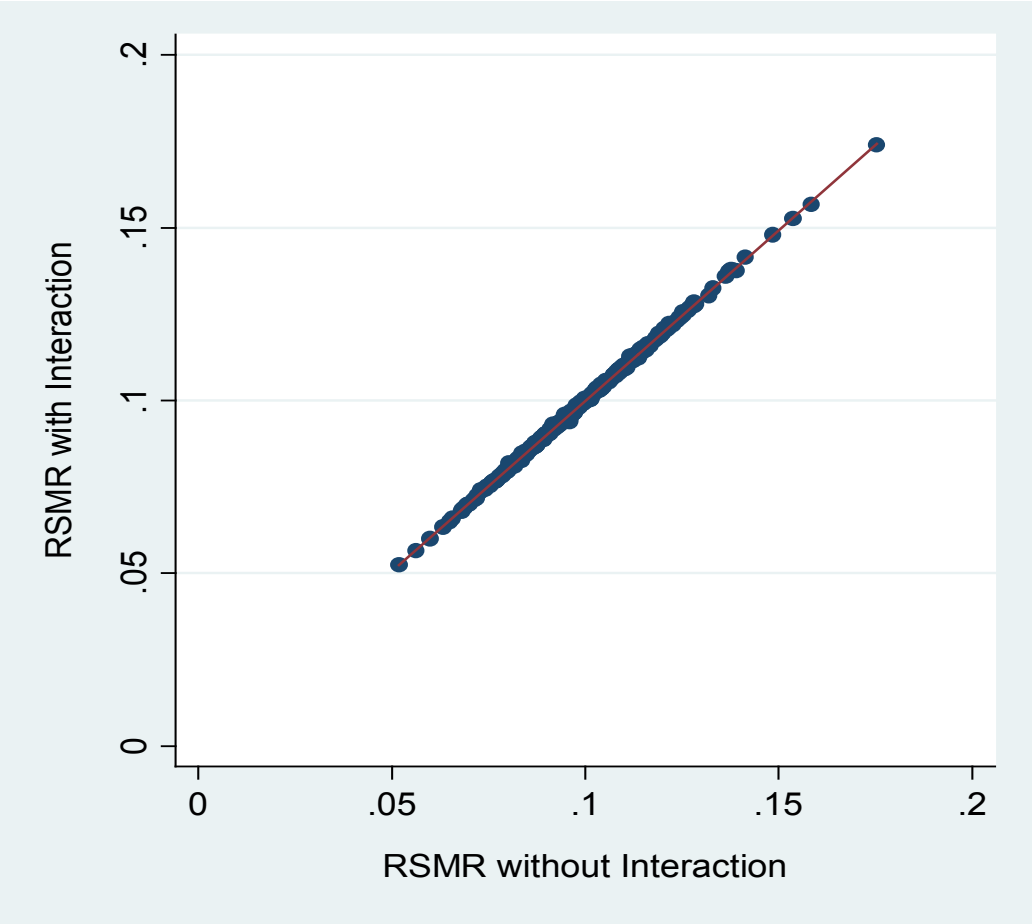


Correlation Coefficients (Weighted by Hospital Volume): 0.99879

Table 13b. HF Mortality Model Performance for Models With and Without Interaction Terms (N = 60,022)
Data Source: 2006 California Patient Discharge Data for All-payer Patients 18+ Admitted to California Hospitals

HF Mortality Model	C-statistic	SE	Lower	Upper
With interaction terms	0.720	0.003	0.714	0.727
Without interaction terms	0.718	0.003	0.712	0.725

Figure 4b. Scatterplot of HF Risk-Standardized Mortality Rates (RSMRs) from Models With and Without Interaction Terms
Data Source: 2006 California Patient Discharge Data for All-payer Patients 18+ Admitted to California Hospitals

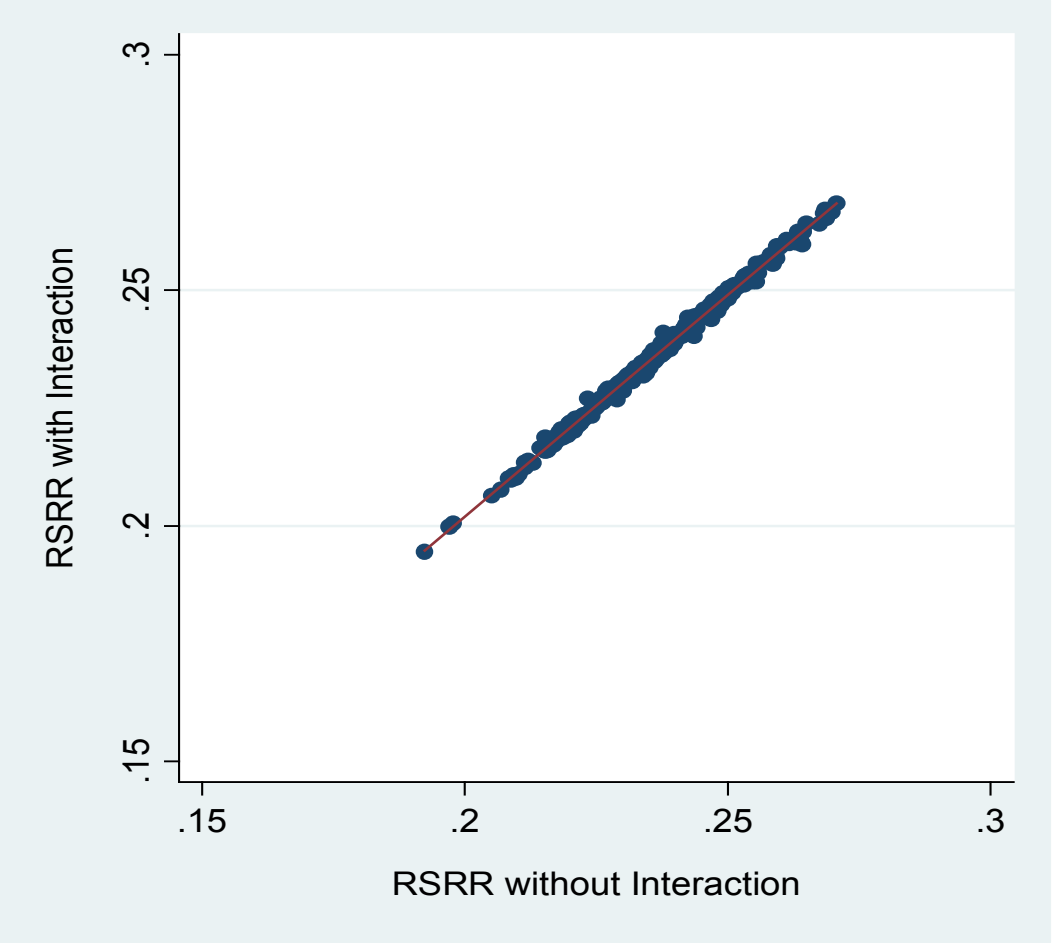


Correlation Coefficients (Weighted by Hospital Volume): 0.99971

Table 13c. HF Readmission Model Performance for Models With and Without Interaction Terms (N = 76,536)
Data Source: 2006 California Patient Discharge Data for All-payer Patients 18+ Admitted to California Hospitals

HF Readmission Model	C-statistic	SE	Lower	Upper
With interaction terms	0.640	0.002	0.636	0.645
Without interaction terms	0.638	0.002	0.633	0.642

Figure 4c. Scatterplot of HF Risk-Standardized Readmission Rates (RSRRs) from Models With and Without Interaction Terms
Data Source: 2006 California Patient Discharge Data for All-payer Patients 18+ Admitted to California Hospitals



Correlation Coefficients (Weighted by Hospital Volume): 0.99787