NATIONAL QUALITY FORUM

Memo

July 31, 2018

To: NQF Members and the Public

From: NQF Staff

Re: Commenting Draft Report: NQF-endorsed measures for Cardiovascular, Spring 2018

Background

This report reflects the review of measures in the Cardiovascular project. Cardiovascular disease (CVD) is the leading cause of death for men and women in the United States. It kills nearly one in four Americans and costs $312 billion per year, more than 10 percent of annual health expenditures. Considering the toll of cardiovascular disease, measures that assess the performance of clinical care and patient outcomes are critical to reducing the negative impacts of CVD.

The 25-person Cardiovascular Standing Committee reviewed one measure, which was recommended for endorsement.

Recommended Measure

- 0535 30-day all-cause risk-standardized mortality rate following percutaneous coronary intervention (PCI) for patients without ST segment elevation myocardial infarction (STEMI) and without cardiogenic shock (CMS)

NQF Member and Public Commenting

NQF Members and the public are encouraged to provide comments via the online commenting tool on the draft report as a whole, or on the specific measure evaluated by the Cardiovascular Standing Committee.

Please note that commenting concludes on August 29, 2018 at 6:00 pm ET—no exceptions.

Cardiovascular, Spring 2018 Cycle: CDP Report

DRAFT REPORT FOR COMMENT

July 31, 2018

NATIONAL QUALITY FORUM

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Cardiovascular, Spring 2018 Cycle

DRAFT REPORT FOR COMMENT

Executive Summary

Cardiovascular disease (CVD) is the leading cause of death for men and women in the United States. It kills nearly one in four Americans and costs $312 billion per year, and accounts for more than 10 percent of annual health expenditures.[1] Considering the toll of cardiovascular disease, measures that assess clinical care performance and patient outcomes are critical to reducing the negative impacts of CVD.

NQF's cardiovascular portfolio of measures is one of the largest, and it includes primary prevention and screening, coronary artery disease (CAD), ischemic vascular disease (IVD), acute myocardial infarction (AMI), cardiac catheterization, percutaneous catheterization intervention (PCI), heart failure (HF), rhythm disorders, implantable cardioverter-defibrillators (ICDs), cardiac imaging, cardiac rehabilitation, and high blood pressure measures. Despite the large number of endorsed measures, gaps remain in patient-reported outcomes and patient-centric composite measures.

For this project, the Standing Committee evaluated one measure undergoing maintenance review against NQF's standard evaluation criteria. This measure was recommended for endorsement:

- 0535 30-Day All-Cause Risk-Standardized Mortality Rate Following Percutaneous Coronary Intervention (PCI) for Patients Without ST Segment Elevation Myocardial Infarction (STEMI) and Without Cardiogenic Shock

One measure was withdrawn by the developer from endorsement consideration during this cycle before being reviewed by the Committee because the measure was not currently in use, and use is a must-pass criterion for maintenance measures:

- 2473e Hybrid Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) Following Acute Myocardial Infarction (AMI)

A brief summary of the measure currently under review is included in the body of the report; a detailed summary of the Committee's discussion and ratings of the criteria for the measure is in Appendix A.

Introduction

Cardiovascular disease (CVD) is the leading cause of death for men and women in the United States. It kills nearly one in four Americans and costs $312 billion per year, and accounts for more than 10 percent of annual health expenditures.[1] Considering the toll of cardiovascular disease, measures that assess the performance of clinical care and patient outcomes are critical to reducing the negative impacts of CVD.

The measures in the cardiovascular portfolio have been grouped into various conditions, diseases, or procedures related to cardiovascular health topic areas. These topic areas include primary prevention and screening, coronary artery disease (CAD), ischemic vascular disease (IVD), acute myocardial infarction (AMI), cardiac catheterization, percutaneous catheterization intervention (PCI), heart failure (HF), rhythm disorders, implantable cardioverter-defibrillators (ICDs), cardiac imaging, cardiac rehabilitation, and high blood pressure. The spring 2018 cycle of this project addressed the following topic area:

- Percutaneous Coronary Intervention (PCI)

NQF Portfolio of Performance Measures for Cardiovascular Conditions

The Cardiovascular Standing Committee (Appendix C) oversees NQF's portfolio of cardiovascular measures (Appendix B) that includes measures for primary prevention ("specific practices for the prevention of disease or mental disorders in susceptible individuals or populations"); screening ("organized periodic procedures performed on large groups of people for the purpose of detecting disease"); and secondary prevention ("the prevention of recurrences or exacerbations of a disease or complications of its therapy"). This portfolio contains 47 endorsed measures: 23 process/structure measures, 15 outcome measures, five composite measures, and four efficiency measures (see Table 1).

Table 1. NQF Cardiovascular Portfolio of Measures

	Process/Structure	Outcome	Composite	Efficiency
Acute Myocardial Infarction (AMI)	5	4	1	0
Cardiac Catheterization/ Percutaneous Coronary Intervention (PCI)	0	6	1	1
Coronary Artery Disease (CAD)/Ischemic Vascular Disease (IVD)	6	1	1	0
Cardiac Imaging	0	0	0	3
Heart Failure	9	2	0	0
Hyperlipidemia	1	0	0	0
Hypertension	0	1	0	0
Implantable Cardiovascular Devices (ICDs)	1	0	2	0
Rhythm Disorders	1	1	0	0
Total	23	15	5	4

The remaining measures have been assigned to other portfolios. These include readmission measures for AMI and HF (readmissions project), measures for coronary artery bypass graft (CABG) (surgery project), and primary prevention measures (prevention and population health project).

Cardiovascular Measure Evaluation

On June 22, 2018, the Cardiovascular Standing Committee evaluated one measure undergoing maintenance review against NQF's standard evaluation criteria.

Table 2. Cardiovascular Measure Evaluation Summary

	Maintenance	New	Total
Measures under consideration	2	0	2
Measures recommended for endorsement	1	0	1
Measures withdrawn from consideration	1	0	1
Reasons for not recommending	Importance – 0 Scientific Acceptability – 0 Use – 0 Overall Suitability – 0 Competing Measure – 0	Importance – 0 Scientific Acceptability – 0 Overall Suitability – 0 Competing Measure – 0	

Comments Received Prior to Committee Evaluation

NQF solicits comments on endorsed measures on an ongoing basis through the Quality Positioning System (QPS). In addition, NQF solicits comments for a continuous 16-week period during each evaluation cycle via an online tool located on the project webpage. For this evaluation cycle, the commenting period opened on May 1, 2018 and will close on August 29, 2018. As of June 12, 2018, no comments were submitted.

Summary of Measure Evaluation

The following brief summary of the measure evaluation highlights the major issues that the Committee considered. Details of the Committee's discussion and ratings of the criteria for the measure are included in Appendix A.

Percutaneous Coronary Intervention (PCI)

0535 30-Day All-Cause Risk-Standardized Mortality Rate Following Percutaneous Coronary Intervention (PCI) for Patients Without ST Segment Elevation Myocardial Infarction (STEMI) and Without Cardiogenic Shock (American College of Cardiology): Not Recommended

Description: This measure estimates hospital risk-standardized 30-day all-cause mortality rate following percutaneous coronary intervention (PCI) among patients who are 18 years of age or older without STEMI and without cardiogenic shock at the time of procedure. The measure uses clinical data available in the National Cardiovascular Data Registry (NCDR) CathPCI Registry for risk adjustment. For the

purpose of development and testing, the measure used a Medicare fee-for-service (FFS) population of patients 65 years of age or older with a PCI. For the purpose of maintenance, we tested the performance of the measure in a cohort of patients whose vital status was determined from the National Death Index. As such it reflects an all-payor sample as opposed to only the Medicare population. This is consistent with the measure's intent to be applicable to the full population of PCI patients; **Measure Type**: Outcome; **Level of Analysis**: Facility, Other; **Setting of Care**: Inpatient/Hospital; **Data Source**: Claims, Other, Registry Data

Overall, the Standing Committee recommended this outcome measure for continued endorsement. The Standing Committee expressed no concerns about the methodological soundness of this measure, and stated that it met current NQF criteria. However, the Committee discussed several concerns regarding performance gap, feasibility, use, and usability. The timeliness of obtaining the National Death Index (NDI) data to calculate mortality was of concern for performance gap and feasibility. The Committee, however, recognized the time lapse needed to obtain and analyze the NDI data. In addition, similar to NQF #0536 *30-Day All-Cause Risk-Standardized Mortality Rate following Percutaneous Coronary Intervention (PCI) for Patients with ST Segment Elevation Myocardial Infarction (STEMI) or Cardiogenic Shock*, stewardship of this measure transitioned to the American College of Cardiology (ACC) in 2014, and ACC had limited control over the public use of the measure until then. ACC has made a significant effort to ensure that this measure will be publicly reported, as well as used in an accountability program. Due to the developer's efforts, the Committee voted to pass this measure on the Use criterion, even though the measure has not been publicly reported, or used in an accountability program within six years since its initial endorsement. Lastly, the Committee noted the possible unintended consequence of case avoidance between states with and without public reporting, as well suboptimal measure performance due to possible changes in the risk-adjustment schema based on the data. However, the Committee acknowledged that these concerns are speculative given that the measure is not yet in use. The Committee supported the measure and recommended it for continued endorsement.

Measures Withdrawn from Consideration

Five measures previously endorsed by NQF have not been re-submitted for maintenance of endorsement or have been withdrawn during the endorsement evaluation process before Committee review including measure #2473e. Endorsement for these measures will be removed.

Table 3. Measures Withdrawn from Consideration

Measure	Reason for withdrawal
2473e Hybrid Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) Following Acute Myocardial Infarction (AMI)	Developer withdrew the measure because it is currently not in use, and use is a must-pass criterion for maintenance measures
0545 Adherence to Statins for Individuals with Diabetes Mellitus	Developer is no longer maintaining this measure
2379 Adherence to Antiplatelet Therapy after Stent Implantation	Developer is no longer maintaining this measure
2411 Percutaneous Coronary Intervention (PCI): Comprehensive Documentation of Indications for PCI	Developer is no longer maintaining this measure

Measure	Reason for withdrawal
2452 Percutaneous Coronary Intervention (PCI): Post-procedural Optimal Medical Therapy	Developer is no longer maintaining this measure

References

[1] Agency for Healthcare Research and Quality (AHRQ). *2015 National Healthcare Quality and Disparities Report and 5th Anniversary Update on the National Quality Strategy.* Rockville, MD: AHRQ; 2016. http://www.ahrq.gov/research/findings/nhqrdr/nhqdr15/index.html. Last accessed March 2018.

Appendix A: Details of Measure Evaluation

Rating Scale: H=High; **M**=Moderate; **L**=Low; **I**=Insufficient; **NA**=Not Applicable

Measures Recommended

0535 30-Day All-Cause Risk-Standardized Mortality Rate Following Percutaneous Coronary Intervention (PCI) for Patients Without ST Segment Elevation Myocardial Infarction (STEMI) and Without Cardiogenic Shock

Submission | Specifications

Description: This measure estimates hospital risk-standardized 30-day all-cause mortality rate following percutaneous coronary intervention (PCI) among patients who are 18 years of age or older without STEMI and without cardiogenic shock at the time of procedure. The measure uses clinical data available in the National Cardiovascular Data Registry (NCDR) CathPCI Registry for risk adjustment. For the purpose of development and testing, the measure used a Medicare fee-for-service (FFS) population of patients 65 years of age or older with a PCI. For the purpose of maintenance, we tested the performance of the measure in a cohort of patients whose vital status was determined from the National Death Index. As such it reflects an all-payor sample as opposed to only the Medicare population. This is consistent with the measure's intent to be applicable to the full population of PCI patients.

Numerator Statement: The outcome for this measure is all–cause death within 30 days following a PCI procedure in patients without STEMI and without cardiogenic shock at the time of the procedure.

Denominator Statement: The target population for this measure includes inpatient and outpatient hospital stays with a PCI procedure for patients at least 18 years of age, without STEMI and without cardiogenic shock at the time of procedure.

Exclusions: Hospital stays are excluded from the cohort if they meet any of the following criteria:

(1) PCIs that follow a prior PCI in the same admission (either at the same hospital or a PCI performed at another hospital prior to transfer).

This exclusion is applied in order to avoid assigning the death to two separate admissions.

(2) For patients with inconsistent or unknown vital status or other unreliable data (e.g. date of death precedes date of PCI);

(3) Subsequent PCIs within 30-days. The 30-day outcome period for patients with more than one PCI may overlap. In order to avoid attributing the same death to more than one PCI (i.e. double counting a single patient death), additional PCI procedures within 30 days of the death are not counted as new index procedures.

(4) PCIs for patients with more than 10 days between date of admission and date of PCI. Patients who have a PCI after having been in the hospital for a prolonged period of time are rare and represent a distinct population that likely has risk factors related to the hospitalization that are not well quantified in the registry.

Adjustment/Stratification: Statistical risk model. Results of this measure will not be stratified.

Level of Analysis: Facility, Other

Setting of Care: Inpatient/Hospital

Type of Measure: Outcome

Data Source: Claims, Other, Registry Data

Measure Steward: American College of Cardiology

STANDING COMMITTEE MEETING 06/22/2018

1. Importance to Measure and Report: The measure meets the Importance criteria

(1a. Evidence, 1b. Performance Gap)

1a. Evidence: **Accepted Prior Evaluation**; 1b. Performance Gap: **H-0; M-14; L-3; I-0**

Rationale:

- The developer referenced literature supporting an association with improved survival and the use of preprocedural clopidogrel and glycoprotein 2b/3a inhibitors; the volume of iodinated contrast; and participation in continuous quality improvement programs. The Committee agreed that the evidence behind the outcome is clear and accepted the prior maintenance evaluation without further discussion.
- The developer provided all payer and all ages (>18 years) performance data from the National Cardiovascular Data Registry (NCDR) CathPCI data linked with National Death Index (NDI) for 1,365 hospitals and 1,127,423 admissions from 2011-2014 demonstrating a variation in risk-standardized mortality rates with a mean of 1.07% and a range from 0.51% to 2.70%. The Committee noted that the interquartile range of the risk standardized mortality rate for the above data was very narrow (0.91 – 1.29 for the 2013-14 data). However, while narrow, this is clinically significant and represents a substantial number of deaths.
- The Committee discussed the performance gap data presented and expressed concern that recent data were presented. The developer explained that the time lapse needed to obtain and analyze the data made it difficult to get more recent data. The Committee acknowledged this challenge and agreed that there was a performance gap, despite the dated information.

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2. Scientific Acceptability of Measure Properties: The measure meets the Scientific Acceptability criteria

(2a. Reliability - precise specifications, testing; 2b. Validity - testing, threats to validity)

2a. Reliability: **Accepted Prior Evaluation**; 2b. Validity: **Accepted Prior Evaluation**;

Rationale:

- The developer used a "test-retest" approach using Medicare FFS patients aged 65 and older by combining index admissions from two years (2010 and 2011) into a single dataset. The agreement between the two RSMRRs for each hospital was 0.256.
- Data element validity testing was done on the specified measure by comparing data elements with variables in the ACC audit program. In the audit that assessed cases submitted in 2005, the median agreement between submitted and audited values was 92%. The developer noted consistency across sites, with agreement in the lowest and highest deciles of hospitals ranging from 90% to 95%.
- This measure was not adjusted for social risk factors.
- The Committee accepted the prior reliability and validity evaluation without further discussion.

3. Feasibility: H-1; M-14; L-0; I-0

(3a. Clinical data generated during care delivery; 3b. Electronic sources; 3c.Susceptibility to inaccuracies/ unintended consequences identified; 3d. Data collection strategy can be implemented)

Rationale:

- The developer stated that for clinical measures, the required data elements are routinely generated and collected during provision of care (e.g., blood pressure, lab value, diagnosis, medication order, depression score). The data are abstracted from a record by an individual other than the individual who obtained the original information (e.g., chart abstraction for quality measure/registry) and obtained from the National Death Index (NDI).
- The Committee was primarily concerned with data timeliness (the most recent data available is over 18 months old) and cost (approximately $100,000) of using National Death Index (NDI) data. The developer acknowledged these challenges and informed the Committee that the cost is borne by the developer and not the individual hospitals.
- The Committee ultimately agreed the measure is feasible despite these implementation challenges.

4. Usability and Use: The maintenance measure meets the Use subcriterion

(Used and useful to the intended audiences for 4a. Accountability and Transparency; 4b. Improvement; and 4c. Benefits outweigh evidence of unintended consequences)

4a. Use**: Pass-14; No Pass-1**; 4b. Usability: **H-0; M-13; L-2; I-0**

Rationale:

- This measure, similar to NQF #0536 *30-Day All-cause Risk-Standardized Mortality Rate following Percutaneous Coronary Intervention (PCI) for Patients with ST Segment Elevation Myocardial Infarction (STEMI) or Cardiogenic Shock*, is not publicly reported because stewardship of this measure transitioned to the American College of Cardiology (ACC) in 2014, and ACC had limited control over the public use of the measure until then. ACC has made significant effort to ensure this measure will be publicly reported, as well as used in an accountability program.
- Due to the developer's noted efforts, the Committee voted to pass this measure on use.
- The Committee noted the possible unintended consequence of case avoidance between states with and without public reporting, as well suboptimal measure performance due to possible changes in the risk-adjustment schema based on the data. However, the Committee agreed this measure is usable, acknowledging that the unintended consequences are speculative given that the measure is not yet in use.

5. Related and Competing Measures

This measure is related to:

- 0229: Hospital 30-day, All-Cause, Risk-Standardized Mortality Rate (RSMR) Following Heart Failure (HF) Hospitalization for Patients 18 and Older
- 0230: Hospital 30-day, All-Cause, Risk-Standardized Mortality Rate (RSMR) Following Acute Myocardial Infarction (AMI) Hospitalization for Patients 18 and Older
- 0536 30-day all-cause risk-standardized mortality rate following Percutaneous Coronary Intervention (PCI) for patients with ST segment elevation myocardial infarction (STEMI) or cardiogenic shock

The Committee discussed these measures during previous phases of the cancer project and no new information warranted further discussion.

Standing Committee Recommendation for Endorsement: **Yes-15**; **No-0**

6. Public and Member Comment

- No comments were received by or during the June 22 measure evaluation web meeting.

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7. Consensus Standards Approval Committee (CSAC) Endorsement Decision: Yes-X; No-X

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8. Appeals

Appendix B: Cardiovascular Portfolio—Use in Federal Programs

Per CMS Measures Inventory Tool as of June 15, 2018

NQF #	Title	Federal Programs
0018	Controlling High Blood Pressure	Medicare Shared Savings Program (MSSP), Merit-Based Incentive Payment System (MIPS) Program , Medicaid Adult Core Set, Qualified Health Plan (QHP) Quality Rating System (QRS)
0028	Preventive Care & Screening: Tobacco Use: Screening & Cessation Intervention	MIPS, MSSP
0066	Coronary Artery Disease (CAD): Angiotensin-Converting Enzyme (ACE) Inhibitor or Angiotensin Receptor Blocker (ARB) Therapy - Diabetes or Left Ventricular Systolic Dysfunction (LVEF < 40%)	Medicare Physician Quality Reporting System (PQRS), MIPS
0067	Chronic Stable Coronary Artery Disease: Antiplatelet Therapy	PQRS, MIPS
0068	Ischemic Vascular Disease (IVD): Use of Aspirin or Another Antithrombotic	MIPS, MSSP
0070/ 0070e	Coronary Artery Disease (CAD): Beta-Blocker Therapy—Prior Myocardial Infarction (MI) or Left Ventricular Systolic Dysfunction (LVEF <40%)	MIPS
0071	Persistence of Beta-Blocker Treatment After a Heart Attack	MIPS
0081/ 0081e	Heart Failure (HF): Angiotensin-Converting Enzyme (ACE) Inhibitor or Angiotensin Receptor Blocker (ARB) Therapy for Left Ventricular Systolic Dysfunction (LVSD)	MIPS
0083/ 0083e	Heart Failure (HF): Beta-Blocker Therapy for Left Ventricular Systolic Dysfunction (LVSD)	MIPS
0114	Risk-Adjusted Post-Operative Renal Failure	PQRS, MIPS
0115	Risk-Adjusted Surgical Re-exploration	PQRS, MIPS
0119	Risk-Adjusted Operative Mortality for CABG	MIPS
0129	Risk-Adjusted Prolonged Intubation (Ventilation)	PQRS, MIPS
0130	Risk-Adjusted Deep Sternal Wound Infection Rate	PQRS, MIPS
0131	Risk-Adjusted Stroke/Cerebrovascular Accident	PQRS, MIPS
0134	Use of Internal Mammary Artery (IMA) in Coronary Artery Bypass Graft (CABG)	PQRS, MIPS
0142	Aspirin Prescribed at Discharge for AMI	Hospital Inpatient Quality Reporting (IQR)
0229	Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) Following Heart Failure (HF) Hospitalization for Patients 18 and Older	IQR, Hospital Value-Based Purchasing (VBP)
0230	Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) Following Acute Myocardial Infarction (AMI) Hospitalization for Patients 18 and Older	IQR, VBP

NQF #	Title	Federal Programs
0277	Congestive Heart Failure Admission Rate (PQI 8)	Medicaid Adult Core Set
0290	Median Time to Transfer to Another Facility for Acute Coronary Intervention	Hospital Outpatient Quality Reporting (OQR)
0330	Hospital 30-Day, All-Cause, Risk-Standardized Readmission Rate (RSSR) Following Heart Failure Hospitalization	Hospital Readmission Reduction Program (HRRP)
0505	Hospital 30-Day All-Cause, Risk-Standardized Readmission Rate (RSSR) Following Acute Myocardial Infarction (AMI) Hospitalization	IQR, HRRP
0643	Cardiac Rehabilitation Patient Referral from an Outpatient Setting	PQRS, MIPS
0669	Cardiac Imaging for Preoperative Risk Assessment for Non-Cardiac, Low Risk Surgery	OQR
0670	Cardiac Stress Imaging Not Meeting Appropriate Use Criteria: Preoperative Evaluation in Low Risk Surgery Patients	PQRS, MIPS
0671	Cardiac Stress Imaging Not Meeting Appropriate Use Criteria: Routine Testing After Percutaneous Coronary Intervention (PCI)	PQRS, MIPS
0672	Cardiac Stress Imaging Not Meeting Appropriate Use Criteria: Testing in Asymptomatic, Low Risk Patients	PQRS, MIPS
1525	Atrial Fibrillation and Atrial Flutter: Chronic Anticoagulation Therapy	PQRS, MIPS
2474	Cardiac Tamponade and/or Pericardiocentesis Following Atrial Fibrillation Ablation	PQRS, MIPS

Appendix C: Cardiovascular Standing Committee and NQF Staff

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Appendix D: Measure Specifications

0535 30-Day All-Cause Risk-Standardized Mortality Rate Following Percutaneous Coronary Intervention (PCI) for Patients Without ST Segment Elevation Myocardial Infarction (STEMI) and Without Cardiogenic Shock

STEWARD

American College of Cardiology

DESCRIPTION

This measure estimates hospital risk-standardized 30-day all-cause mortality rate following percutaneous coronary intervention (PCI) among patients who are 18 years of age or older without STEMI and without cardiogenic shock at the time of procedure. The measure uses clinical data available in the National Cardiovascular Data Registry (NCDR) CathPCI Registry for risk adjustment. For the purpose of development and testing, the measure used a Medicare fee-for-service (FFS) population of patients 65 years of age or older with a PCI. For the purpose of maintenance, we tested the performance of the measure in a cohort of patients whose vital status was determined from the National Death Index. As such it reflects an all-payor sample as opposed to only the Medicare population. This is consistent with the measure's intent to be applicable to the full population of PCI patients.

TYPE

Outcome

DATA SOURCE

Claims, Other, Registry Data Data sources:

NCDR CatchPCI Registry

Vital Status Source:

National Death Index, Death Masterfile, Medicare enrollment database, or equivalent

LEVEL

Facility, Other

SETTING

Inpatient/Hospital

NUMERATOR STATEMENT

The outcome for this measure is all–cause death within 30 days following a PCI procedure in patients without STEMI and without cardiogenic shock at the time of the procedure.

NUMERATOR DETAILS

Deaths can be identified using an external source of vital status, such as the Social Security Administration's Death Master File (DMF) or the Centers for Disease Control and Prevention's National Death Index (NDI). For the purpose of development and reassessment of the measure, we used a Medicare FFS population age 65 and over. We linked CathPCI registry with

corresponding Medicare data and identified: a) in-hospital deaths using the discharge disposition indicator in the Standard Analytic File (SAF) and identified) post-discharge deaths using the Enrollment Database (EDB). For the purpose of maintenance, the measure used a cohort of patients whose vital status was determined from the National Death Index. This data sample reflects a more comprehensive data set including a broader age range (>18 years) and an all-payer model compared to the Medicare data set (>65 years) used for initial measure testing.

DENOMINATOR STATEMENT

The target population for this measure includes inpatient and outpatient hospital stays with a PCI procedure for patients at least 18 years of age, without STEMI and without cardiogenic shock at the time of procedure.

DENOMINATOR DETAILS

The time window can be specified from one or more years. This measure was developed with Medicare claims and CathPCI Registry data from one calendar year.

The measure cohort is patients undergoing PCI who do NOT have STEMI and do NOT have cardiogenic shock. STEMI or cardiogenic shock is defined as present in Version 4.4 of the CathPCI registry as follows:

Admissions with PCI are identified by field 5305 (PCI=yes);

STEMI or shock is identified by:

(1) Symptoms present on admission = ACS:STEMI (field 5000 = 6) with Time Period Symptom Onset to Admission within 24 hours (field 5005 = 5006, 5007, 5008) or Acute PCI = Yes (field 7035);

OR

(2) Cardiogenic shock = Yes (field 5060=1)

EXCLUSIONS

Hospital stays are excluded from the cohort if they meet any of the following criteria:

(1) PCIs that follow a prior PCI in the same admission (either at the same hospital or a PCI performed at another hospital prior to transfer).

This exclusion is applied in order to avoid assigning the death to two separate admissions.

(2) For patients with inconsistent or unknown vital status or other unreliable data (e.g. date of death precedes date of PCI);

(3) Subsequent PCIs within 30-days. The 30-day outcome period for patients with more than one PCI may overlap. In order to avoid attributing the same death to more than one PCI (i.e. double counting a single patient death), additional PCI procedures within 30 days of the death are not counted as new index procedures.

(4) PCIs for patients with more than 10 days between date of admission and date of PCI. Patients who have a PCI after having been in the hospital for a prolonged period of time are rare and represent a distinct population that likely has risk factors related to the hospitalization that are not well quantified in the registry.

EXCLUSION DETAILS

Excluded hospital stays are identified as follows:

(1) PCIs that follow a prior PCI in the same admission or occur during a transfer-in admission (PCI to PCI). For the purposes of development we used Medicare data to define transfers as two admissions that occur within 1 day of each other and identified patients in this cohort who had a PCI during both admissions. This can also be identified in the registry data. (Note: For purposes of maintenance, we used CathPCI registry data to identify patients transferred in who had a prior PCI at the transferring hospital)

(2) Patients with inconsistent or unknown vital status or other unreliable data (e.g. date of death precedes date of PCI). The specific data fields will depend on the data source used.

(3) Not the first hospital stay with a PCI in the 30 days prior to a patient death. These stays are identified by procedure date in the CathPCI Registry and death date in the vital status data source.

(4) PCIs for patients with more than 10 days between date of admission and date of PCI. We determine length of stay by subtracting the admission date from the procedure date in the CathPCI Registry.

RISK ADJUSTMENT

Statistical risk model

STRATIFICATION

Results of this measure will not be stratified.

TYPE SCORE

Rate/proportion better quality = lower score

ALGORITHM

The measure score is calculated based on the following steps:

1. Patient cohort is identified based on the inclusion and exclusion criteria (see questions S.7, S.8, S.9, S.10, S.11);

2. Data elements for risk adjustment are collected using the first collected value, as detailed below;

3. Outcome is ascertained from an outside data source, such as the Medicare Enrollment Database (see questions S.4, S.5, S.6)

4. Measure score is calculated with aggregated data across all included sites, as described below.

Risk-adjustment variables

The measure is adjusted for the variables listed below:

1. Age (10 year increments)

2. Body Mass Index (5 kg/m^2 increments)

3. History of congestive heart failure

4. History of cerebrovascular disease

5. History of peripheral vascular disease

6. History of chronic lung disease

7. Diabetes

8. Glomerular Filtration Rate (GFR) (derived)

9. Previous PCI

10. Heart Failure - current status

11. New York Hospital Association

12. Symptom onset

13. Ejection Fraction percent (EF)

14. PCI status

15. Highest risk lesion – coronary artery segment category

16. Highest risk lesion: Society for Cardiovascular Angiography and Interventions (SCAI)

Measure Score Calculation

The RSMR is calculated as the ratio of the number of "predicted" to the number of "expected" deaths, multiplied by the national unadjusted mortality rate. For each hospital, the predicted hospital outcome (the numerator) 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 (better quality) and a higher ratio indicates higher-than-expected mortality (worse quality).

The predicted hospital outcome (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, 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, we re-estimate the model coefficients using the years of data in that period.

Please see attachments for more details on the calculation algorithm and the value sets for the risk-adjustment variables.

References:

Normand S-LT, Shahian DM. 2007. Statistical and Clinical Aspects of Hospital Outcomes Profiling. Stat Sci 22 (2): 206-226. 135684| 144800| 143448| 146487| 142910| 141015

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N/A

Appendix E1: Related and Competing Measures (tabular format)

Comparison of NQF #0535, NQF #0536, NQF #0229, and NQF #0230

	0535 30-Day All-Cause Risk-Standardized Mortality Rate Following Percutaneous Coronary Intervention (PCI) for Patients Without ST Segment Elevation Myocardial Infarction (STEMI) and Without Cardiogenic Shock	0536 30-Day All-Cause Risk-Standardized Mortality Rate Following Percutaneous Coronary Intervention (PCI) for Patients with ST Segment Elevation Myocardial Infarction (STEMI) or Cardiogenic Shock	0229 Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) Following Heart Failure (HF) Hospitalization	0230 Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) Following Acute Myocardial Infarction (AMI) Hospitalization for Patients 18 and Older
Steward	American College of Cardiology	American College of Cardiology	Centers for Medicare and Medicaid Services (CMS)	Centers for Medicare and Medicaid Services (CMS)
Description	This measure estimates hospital risk-standardized 30-day all-cause mortality rate following percutaneous coronary intervention (PCI) among patients who are 18 years of age or older without STEMI and without cardiogenic shock at the time of procedure. The measure uses clinical data available in the National Cardiovascular Data Registry (NCDR) CathPCI Registry for risk adjustment. For the purpose of development and testing, the measure used a Medicare fee-for-service (FFS) population of patients 65 years of age or older with a PCI. For the purpose of maintenance, we tested the performance of the measure in a cohort of patients whose vital status was determined from the National Death Index. As such it reflects an all-payor sample as opposed to only the Medicare population. This is consistent with the measure's intent to be applicable to the full population of PCI patients.	This measure estimates hospital risk-standardized 30-day all-cause mortality rate following percutaneous coronary intervention (PCI) among patients who are 18 years of age or older with STEMI or cardiogenic shock at the time of procedure. The measure uses clinical data available in the National Cardiovascular Data Registry (NCDR) CathPCI Registry for risk adjustment. For the purpose of development and testing, the measure cohort was derived in a Medicare fee-for-service (FFS) population of patients 65 years of age or older with a PCI. For the purpose of maintenance, the measure used a cohort of patients whose vital status was determined from the National Death Index (which reflects an all-payor sample as opposed to only the Medicare population). This is consistent with the measure's intent to be applicable to the full population of PCI patients.	The measure estimates a hospital-level 30-day risk-standardized mortality rate (RSMR). Mortality is defined as death for any cause within 30 days after the admission date for the index admission, for patients 18 and older discharged from the hospital with a principal diagnosis of heart failure (HF). The Centers for Medicare & Medicaid Services (CMS) annually reports the measure for patients who are 65 years or older and are either Medicare fee-for-service (FFS) beneficiaries and hospitalized in non-federal hospitals or patients hospitalized in Veterans Health Administration (VA) facilities.	This measure estimates a hospital-level, 30-day risk-standardized mortality rate (RSMR) for patients discharged from the hospital with a principal diagnosis of acute myocardial infarction (AMI). Mortality is defined as death from any cause within 30 days after the index admission date. The Centers for Medicare & Medicaid Services (CMS) annually reports the measure for patients who are 65 years and older and are Medicare fee-for-service (FFS) beneficiaries hospitalized in non-federal hospitals.
Type	Outcome	Outcome	Outcome	Outcome
Data Source	Claims, Other, Registry Data Data sources: NCDR CatchPCI Registry Vital Status Source: National Death Index, Death Masterfile, Medicare enrollment database, or equivalent	Claims, Other, Registry Data Data sources: NCDR CatchPCI Registry Vital Status Source: National Death Index, Death Masterfile, Medicare enrollment database, or equivalent	Claims, Paper Medical Records, Other	Claims, Paper Medical Records, Other
Level	Facility, Other	Facility, Other	Facility	Facility
Setting	Inpatient/Hospital	Inpatient/Hospital	Inpatient/Hospital, Other – Acute Care Facility	Inpatient/Hospital
Numerator Statement	The outcome for this measure is all–cause death within 30 days following a PCI procedure in patients without STEMI and without cardiogenic shock at the time of the procedure.	The outcome for this measure is all-cause death within 30 days following a PCI procedure in patients with STEMI or cardiogenic shock at the time of the procedure.	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 65 and older discharged from the hospital with a principal diagnosis of HF.	The outcome for this measure is 30-day all-cause mortality. We define mortality as death from any cause within 30 days from the date of admission for patients discharged from the hospital with a principal diagnosis of AMI.
Numerator Details	Deaths can be identified using an external source of vital status, such as the Social Security Administration's Death Master File (DMF) or the Centers for Disease Control and Prevention's National Death Index (NDI). For the purpose of development and reassessment of the measure, we used a Medicare FFS population age 65 and over. We linked CathPCI registry with corresponding Medicare data and identified: a) in-hospital deaths using the discharge disposition indicator in the Standard Analytic File (SAF) and identified) post-discharge deaths using the Enrollment Database (EDB). For the purpose of maintenance, the measure used a cohort of patients whose vital status was determined from the National Death Index. This data sample reflects a more comprehensive data set including a broader age range (>18 years) and an all-payer model compared to the Medicare data set (>65 years) used for initial measure testing.	Deaths can be identified using an external source of vital status, such as the Social Security Administration's Death Master File (DMF) or the Centers for Disease Control and Prevention's National Death Index (NDI). For the purpose of development and testing of the measure, we used a Medicare FFS population age 65 and over. We linked CathPCI registry with corresponding Medicare data and identified: a) in-hospital deaths using the discharge disposition indicator in the Standard Analytic File (SAF) and identified) post-discharge deaths using the Enrollment Database (EDB). For the purpose of maintenance, the measure used a cohort of patients whose vital status was determined from the National Death Index. This data sample reflects a more comprehensive data set including a broader age range (>18 years) and an all-payer model compared to the Medicare data set (>65 years) used for initial measure testing.	The measure counts deaths for any cause within 30 days of the date of admission of the index HF hospitalization. Rationale: From a patient perspective, death is a critical outcome regardless of cause. Outcomes occurring within 30 days of the start of the admission can be influenced by hospital care and early transition to the non-acute care setting. The 30-day time frame is a clinically meaningful period for hospitals to collaborate with their communities to reduce mortality (Simoes et al., 2017; Dharmarajan et al., 2015). Identifying deaths in the FFS measure As currently reported, we identify deaths for FFS Medicare patients 65 years and older in the Medicare Enrollment Database (EDB). Identifying deaths in the all-payer measure For the purposes of development of an all-payer measure, deaths	This measure counts death from any cause within 30 days after the index admission date. Rationale: From a patient perspective, death is the most critical outcome regardless of cause. Outcomes occurring within 30 days of admission can be influenced by hospital care and early transition to the non-acute care setting. The 30-day time frame is a clinically meaningful period for hospitals to collaborate with their communities to reduce mortality. (Simoes et al., 2017; Dharmarajan et al., 2015). Identifying deaths in the Medicare FFS population As currently reported, we identify deaths for FFS Medicare patients 65 years and older in the Medicare Enrollment Database (EDB). Identifying deaths in the all-payer population For the purposes of development of an all-payer measure, deaths were identified using the California vital statistics data file.

	0535 30-Day All-Cause Risk-Standardized Mortality Rate Following Percutaneous Coronary Intervention (PCI) for Patients Without ST Segment Elevation Myocardial Infarction (STEMI) and Without Cardiogenic Shock	0536 30-Day All-Cause Risk-Standardized Mortality Rate Following Percutaneous Coronary Intervention (PCI) for Patients with ST Segment Elevation Myocardial Infarction (STEMI) or Cardiogenic Shock	0229 Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) Following Heart Failure (HF) Hospitalization	0230 Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) Following Acute Myocardial Infarction (AMI) Hospitalization for Patients 18 and Older
			were identified using the California vital statistics data file. Nationally, post-discharge deaths can be identified using an external source of vital status, such as the Social Security Administration's Death Master File (DMF) or the Centers for Disease Control and Prevention's National Death Index (NDI).	Nationally, post-discharge deaths can be identified using an external source of vital status, such as the Social Security Administration's Death Master File (DMF) or the Centers for Disease Control and Prevention's National Death Index (NDI).
Denominator Statement	The target population for this measure includes inpatient and outpatient hospital stays with a PCI procedure for patients at least 18 years of age, without STEMI and without cardiogenic shock at the time of procedure.	The target population for this measure includes inpatient and outpatient hospital stays with a PCI procedure for patients at least 18 years of age, with STEMI or cardiogenic shock at the time of procedure, including outpatient and observation stay patients who have undergone PCI but have not been admitted. It is unlikely that patients in this cohort would not be admitted to the hospital, but we keep this criterion to be consistent with the complementary non-STEMI, non-cardiogenic shock PCI cohort.	The cohort for the publically reported measure includes admissions for patients aged 65 years and older discharged from the hospital with a principal discharge diagnosis of HF and with a complete claims history for the 12 months prior to admission. The measure is currently publicly reported by CMS for those patients 65 years and older who are either Medicare FFS beneficiaries admitted to non-federal hospitals or patients admitted to VA hospitals.	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. We have tested the measure in both age groups. The cohort includes admissions for patients discharged from the hospital with a principal discharge diagnosis of AMI and with a complete claims history for the 12 months prior to admission. The measure is currently publicly reported by CMS for those patients 65 years and older who are Medicare FFS beneficiaries admitted to non-federal hospitals.
Denominator Details	The time window can be specified from one or more years. This measure was developed with Medicare claims and CathPCI Registry data from one calendar year. The measure cohort is patients undergoing PCI who do NOT have STEMI and do NOT have cardiogenic shock. STEMI or cardiogenic shock is defined as present in Version 4.4 of the CathPCI registry as follows: Admissions with PCI are identified by field 5305 (PCI=yes); STEMI or shock is identified by: (1) Symptoms present on admission = ACS:STEMI (field 5000 = 6) with Time Period Symptom Onset to Admission within 24 hours (field 5005 = 5006, 5007, 5008) or Acute PCI = Yes (field 7035); OR (2) Cardiogenic shock = Yes (field 5060=1)	The time window can be specified from one or more years. This measure was developed with Medicare claims and CathPCI Registry data from one calendar year. The measure cohort is patients undergoing PCI who have STEMI or cardiogenic shock. STEMI or cardiogenic shock is defined as present in Version 4.4 of the CathPCI registry as follows: Admissions with PCI are identified by field 5305 (PCI=yes); STEMI or shock is identified by: (1) Symptoms present on admission = ACS:STEMI (field 5000 = 6) with Time Period Symptom Onset to Admission within 24 hours (field 5005 = 5006, 5007, 5008) or Acute PCI = Yes (field 7035); OR (2) Cardiogenic shock = Yes (field 5060=1)	To be included in the HF measure cohort used in public reporting, patients must meet the following additional inclusion criteria: 1. Have a principal discharge diagnosis of heart failure (HF); 2. Enrolled in Medicare Fee-For-Service (FFS)Part A and Part B for the 12 months prior to the date of the index admission and Part A during the index admission, or those who are VA beneficiaries (in the cases of the AMI, HF, and pneumonia measures); 3. Aged 65 or over; and, 4. Not transferred from another acute care facility. VA beneficiaries are eligible for inclusion in the AMI, HF, and pneumonia measure cohorts regardless of Medicare FFS enrollment or whether they were hospitalized in a VA or non-VA short-term acute care hospital. This measure can also be used for an all-payer population aged 18 years and older. We have explicitly tested the measure in both patients aged 18+ years and those aged 65+ years. ICD-9 and ICD-10 cohort codes are included in the attached Data Dictionary.	To be included in the measure cohort used in public reporting, patients must meet the following additional inclusion criteria: 1. Having a principal discharge diagnosis of AMI; 2. Enrolled in Medicare FFS Part A and Part B for the first 12 months prior to the date of admission, and enrolled in Part A during the index admission; 3. Aged 65 or over; and 4. Not transferred from another acute care facility. ICD-9 and ICD-10 cohort codes are included in the attached Data Dictionary.
Exclusions	Hospital stays are excluded from the cohort if they meet any of the following criteria: (1) PCIs that follow a prior PCI in the same admission (either at the same hospital or a PCI performed at another hospital prior to transfer). This exclusion is applied in order to avoid assigning the death to two separate admissions. (2) For patients with inconsistent or unknown vital status or other unreliable data (e.g. date of death precedes date of PCI); (3) Subsequent PCIs within 30-days. The 30-day outcome period for patients with more than one PCI may overlap. In order to avoid attributing the same death to more than one PCI (i.e. double counting a single patient death), additional PCI procedures within	Hospital stays are excluded from the cohort if they meet any of the following criteria: (1) PCIs that follow a prior PCI in the same admission (either at the same hospital or a PCI performed at another hospital prior to transfer). This exclusion is applied in order to avoid assigning the death to two separate admissions. (2) For patients with inconsistent or unknown vital status or other unreliable data (e.g. date of death precedes date of PCI); (3) Subsequent PCIs within 30-days. The 30-day outcome period for patients with more than one PCI may overlap. In order to avoid attributing the same death to more than one PCI (i.e. double counting a single patient death), additional PCI procedures within	The HF mortality measure excludes index hospitalizations that meet any of the following exclusion criteria: 1. With inconsistent or unknown vital status or other unreliable demographic (age and gender) data; 2. Enrolled in the Medicare hospice program or used VA hospice services any time in the 12 months prior to the index admission, including the first day of the index admission; or, 3. Discharged against medical advice. 4. Discharged alive on the day of admission or the following day who were not transferred to another acute care facility; or 5. With a procedure code for LVAD implantation or heart transplantation either during the	The mortality measure excludes index hospitalizations that meet any of the following exclusion criteria: 1. Discharged alive on the day of admission or the following day who were not transferred to another acute care facility; 2. Inconsistent or unknown vital status or other unreliable demographic (age and gender) data; 3. Enrolled in the Medicare hospice program any time in the 12 months prior to the index admission, including the first day of the index admission; or 4. Discharged against medical advice (AMA). For patients with more than one admission for a given condition in a given year, only one index admission for that condition is

	0535 30-Day All-Cause Risk-Standardized Mortality Rate Following Percutaneous Coronary Intervention (PCI) for Patients Without ST Segment Elevation Myocardial Infarction (STEMI) and Without Cardiogenic Shock	0536 30-Day All-Cause Risk-Standardized Mortality Rate Following Percutaneous Coronary Intervention (PCI) for Patients with ST Segment Elevation Myocardial Infarction (STEMI) or Cardiogenic Shock	0229 Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) Following Heart Failure (HF) Hospitalization	0230 Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) Following Acute Myocardial Infarction (AMI) Hospitalization for Patients 18 and Older
	30 days of the death are not counted as new index procedures. (4) PCIs for patients with more than 10 days between date of admission and date of PCI. Patients who have a PCI after having been in the hospital for a prolonged period of time are rare and represent a distinct population that likely has risk factors related to the hospitalization that are not well quantified in the registry.	30 days of the death are not counted as new index procedures. (4) PCIs for patients with more than 10 days between date of admission and date of PCI. Patients who have a PCI after having been in the hospital for a prolonged period of time are rare and represent a distinct population that likely has risk factors related to the hospitalization that are not well quantified in the registry.	index admission or in the 12 months prior to the index admission. For patients with more than one admission for a given condition in a given year, only one index admission for that condition is randomly selected for inclusion in the cohort.	randomly selected for inclusion in the cohort. Similarly, for the three-year combined data, when index admissions occur during the transition between measure reporting periods (June and July of each year) and both are randomly selected for inclusion in the measure, the measure includes only the June admission. The July admissions are excluded to avoid assigning a single death to two admissions.
Exclusion Details	Excluded hospital stays are identified as follows: (1) PCIs that follow a prior PCI in the same admission or occur during a transfer-in admission (PCI to PCI). For the purposes of development we used Medicare data to define transfers as two admissions that occur within 1 day of each other and identified patients in this cohort who had a PCI during both admissions. This can also be identified in the registry data. (Note: For purposes of maintenance, we used CathPCI registry data to identify patients transferred in who had a prior PCI at the transferring hospital) (2) Patients with inconsistent or unknown vital status or other unreliable data (e.g. date of death precedes date of PCI). The specific data fields will depend on the data source used. (3) Not the first hospital stay with a PCI in the 30 days prior to a patient death. These stays are identified by procedure date in the CathPCI Registry and death date in the vital status data source. (4) PCIs for patients with more than 10 days between date of admission and date of PCI. We determine length of stay by subtracting the admission date from the procedure date in the CathPCI Registry.	Excluded hospital stays are identified as follows: (1) PCIs that follow a prior PCI in the same admission or occur during a transfer-in admission (PCI to PCI). For the purposes of development we used Medicare data to define transfers as two admissions that occur within 1 day of each other and identified patients in this cohort who had a PCI during both admissions. This can also be identified in the registry data. (Note: For purposes of maintenance, we used NDI and CathPCI registry data) (2) Patients with inconsistent or unknown vital status or other unreliable data (e.g. date of death precedes date of PCI). The specific data fields will depend on the data source used. (3) Not the first hospital stay with a PCI in the 30 days prior to a patient death. These stays are identified by procedure date in the CathPCI Registry and death date in the vital status data source. (4) PCIs for patients with more than 10 days between date of admission and date of PCI. We determine length of stay by subtracting the admission date from the procedure date in the CathPCI Registry	1. Inconsistent or unknown vital status or other unreliable demographic data Inconsistent vital status or unreliable data are identified if any of the following conditions are met 1) the patient's age is greater than 115 years: 2) if the discharge date for a hospitalization is before the admission date; 3) if the patient has a sex other than 'male' Rationale: We do not include stays for patients where the age is greater than 115, where the gender is neither male nor female, where the admission date is after the date of death in the Medicare Enrollment Database, or where the date of death occurs before the date of discharge but the patient was discharged alive. 2. Enrolled in the Medicare hospice program any time in the 12 months prior to the index admission, including the first day of the index admission Rationale: Hospice enrollment in the 12 months prior to or on the index admission is identified using hospice data and the Inpatient standard analytic file (SAF). This exclusion applies when the measure is used in Medicare FFS patients only. Rationale: These patients are likely continuing to seek comfort measures only; thus, mortality is not necessarily an adverse outcome or signal of poor quality care. 3. Discharged against medical advice Discharges against medical advice are identified using the discharge disposition indicator. Rationale: Providers did not have the opportunity to deliver full care and prepare the patient for discharge. 4. Discharged alive on the day of admission or the following day who were not transferred to another acute care facility. The discharge disposition indicator is used to identify patients alive at discharge. Transfers are identified in the claims when a patient with a qualifying admission is discharged from an acute care hospital and admitted to another acute care hospital on the same day or next day. Rationale: It is unlikely that these patients had clinically significant HF. 5. With a procedure code for LVAD implantation or heart transplantation either during the index admission or in the 12	1. Discharged alive on the day of admission or the following day who were not transferred to another acute care facility Rationale: It is unlikely that these patients had clinically significant AMI. 2. Inconsistent or unknown vital status or other unreliable demographic data Rationale: We do not include stays for patients where the age is greater than 115, where the gender is neither male nor female, where the admission date is after the date of death in the Medicare Enrollment Database, or where the date of death occurs before the date of discharge but the patient was discharged alive because these data are likely erroneous. 3. Enrolled in the Medicare hospice program any time in the 12 months prior to the index admission, including the first day of the index admission Rationale: These patients are likely continuing to seek comfort measures only, so mortality is not necessarily an adverse outcome or signal of poor quality care. 4. Discharged against medical advice Rationale: Providers did not have the opportunity to deliver full care and prepare the patient for discharge. After exclusions #1-4 are applied, the measure randomly selects one index admission per patient per year for inclusion in the cohort so that each episode of care is mutually independent with the same probability of the outcome. Additional admissions within that year are excluded. For each patient, the probability of death increases with each subsequent admission and therefore the episodes of care are not mutually independent. For the three-year combined data, when index admissions occur during the transition between measure reporting periods (June and July of each year) and both are randomly selected for inclusion in the measure, the measure includes only the June admission. July admissions are excluded to avoid assigning a single death to two admissions.

	0535 30-Day All-Cause Risk-Standardized Mortality Rate Following Percutaneous Coronary Intervention (PCI) for Patients Without ST Segment Elevation Myocardial Infarction (STEMI) and Without Cardiogenic Shock	0536 30-Day All-Cause Risk-Standardized Mortality Rate Following Percutaneous Coronary Intervention (PCI) for Patients with ST Segment Elevation Myocardial Infarction (STEMI) or Cardiogenic Shock	0229 Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) Following Heart Failure (HF) Hospitalization	0230 Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) Following Acute Myocardial Infarction (AMI) Hospitalization for Patients 18 and Older
			months prior to the index admission Patients with LVAD implantation or heart transplantation during an index admission or in the previous 12 months are identified by the corresponding codes for these procedures included in claims data. Rationale: These patients represent a clinically distinct group (ICD-10-PCS code list). The data sources for these analyses are Medicare administrative claims and enrollment information for patients with hospitalizations between July 1, 2013 and June 30, 2016. After exclusions #1-5 are applied, the measure randomly selects one index admission per patient per year for inclusion in the cohort so that each episode of care is mutually independent with the same probability of the outcome. Additional admissions within that year are excluded. For each patient, the probability of death increases with each subsequent admission and therefore the episodes of care are not mutually independent. For the three-year combined data, when index admissions occur during the transition between measure reporting periods (June and July of each year) and both are randomly selected for inclusion in the measure, the measure includes only the June admission. The July admissions are excluded to avoid assigning a single death to two admissions.	
Risk Adjustment	Statistical risk model	Statistical risk model	Statistical Risk Model	Statistical Risk Model
Stratification	Results of this measure will not be stratified.	Results of this measure will not be stratified.	N/A	N/A
Type Score	Rate/proportion	Rate/proportion	Rate/ proportion	Rate/ proportion
Algorithm	The measure score is calculated based on the following steps: 1. Patient cohort is identified based on the inclusion and exclusion criteria (see questions S.7, S.8, S.9, S.10, S.11); 2. Data elements for risk adjustment are collected using the first collected value, as detailed below; 3. Outcome is ascertained from an outside data source, such as the Medicare Enrollment Database (see questions S.4, S.5, S.6) 4. Measure score is calculated with aggregated data across all included sites, as described below. Risk-adjustment variables The measure is adjusted for the variables listed below: 1. Age (10 year increments) 2. Body Mass Index (5 kg/m^2 increments) 3. History of congestive heart failure 4. History of cerebrovascular disease 5. History of peripheral vascular disease 6. History of chronic lung disease 7. Diabetes 8. Glomerular Filtration Rate (GFR) (derived)	The measure score is calculated based on the following steps: 1. Patient cohort is identified based on the inclusion and exclusion criteria (see questions S.6, S.7, S.8, S.9, S.10); 2. Data elements for risk adjustment are collected using the first collected value, as detailed below; 3. Outcome is ascertained from an outside data source, such as the Medicare Enrollment Database (see questions S.4, S.5, S.6) 4. Measure score is calculated with aggregated data across all included sites, as described below. Risk-adjustment variables The measure is adjusted for the variables listed below: 1. Age (10 year increments) 2. Body Mass Index (5 kg/m^2 increments) 3. History of cerebrovascular disease 4. History of chronic lung disease 5. Glomerular Filtration Rate (GFR) (derived) 6. Previous PCI 7. Heart Failure - current status 8. Cardiogenic shock on admission	The measure estimates hospital-level 30-day all-cause RSMRs following hospitalization for HF using hierarchical logistic regression models. In brief, the approach simultaneously models data at the patient and hospital levels to account for variance in patient outcomes within and between hospitals (Normand and Shahian, 2007). At the patient level, it models the log-odds of mortality within 30 days of index admission using age, sex, selected clinical covariates, and a hospital-specific intercept. At the hospital level, it models the hospital-specific intercepts as arising from a normal distribution. The hospital intercept represents the underlying risk of a mortality at the hospital, after accounting for patient risk. The hospital-specific intercepts are given a distribution 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. The RSMR is calculated as the ratio of the number of “predicted” to the number of “expected” deaths at a given hospital, multiplied by the	The measure estimates hospital-level 30-day all-cause RSMRs following hospitalization for AMI using hierarchical logistic regression models. In brief, the approach simultaneously models data at the patient and hospital levels to account for variance in patient outcomes within and between hospitals (Normand and Shahian, 2007). At the patient level, it models the log-odds of mortality within 30 days of discharge using age, sex, selected clinical covariates, and a hospital-specific intercept. At the hospital level, it models the hospital-specific intercepts as arising from a normal distribution. The hospital intercept represents the underlying risk of mortality at the hospital, after accounting for patient risk. The hospital-specific intercepts are given a distribution 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. The RSMR is calculated as the ratio of the number of “predicted” to the number of “expected” deaths, multiplied by the national unadjusted mortality

	0535 30-Day All-Cause Risk-Standardized Mortality Rate Following Percutaneous Coronary Intervention (PCI) for Patients Without ST Segment Elevation Myocardial Infarction (STEMI) and Without Cardiogenic Shock	0536 30-Day All-Cause Risk-Standardized Mortality Rate Following Percutaneous Coronary Intervention (PCI) for Patients with ST Segment Elevation Myocardial Infarction (STEMI) or Cardiogenic Shock	0229 Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) Following Heart Failure (HF) Hospitalization	0230 Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) Following Acute Myocardial Infarction (AMI) Hospitalization for Patients 18 and Older
	9. Previous PCI 10. Heart Failure - current status 11. New York Hospital Association 12. Symptom onset 13. Ejection Fraction percent (EF) 14. PCI status 15. Highest risk lesion – coronary artery segment category 16. Highest risk lesion: Society for Cardiovascular Angiography and Interventions (SCAI) Measure Score Calculation The RSMR is calculated as the ratio of the number of "predicted" to the number of "expected" deaths, multiplied by the national unadjusted mortality rate. For each hospital, the predicted hospital outcome (the numerator) 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 (better quality) and a higher ratio indicates higher-than-expected mortality (worse quality). The predicted hospital outcome (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, 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, we re-estimate the model coefficients using the years of data in that period. Please see attachments for more details on the calculation algorithm and the value sets for the risk-adjustment variables. References: Normand S-LT, Shahian DM. 2007. Statistical and Clinical Aspects of Hospital Outcomes Profiling. Stat Sci 22 (2): 206-226. 135684| 144800| 143448| 146487| 142910| 141015	9. Symptom onset 10. Ejection Fraction percent (EF) 11. PCI status 12. Highest risk lesion – coronary artery segment category 13. Highest risk lesion: Society for Cardiovascular Angiography and Interventions (SCAI) Measure Score Calculation The RSMR is calculated as the ratio of the number of "predicted" to the number of "expected" deaths, multiplied by the national unadjusted mortality rate. For each hospital, the predicted hospital outcome (the numerator) 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 (better quality) and a higher ratio indicates higher-than-expected mortality (worse quality). The predicted hospital outcome (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, 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, we re-estimate the model coefficients using the years of data in that period. Please see attachments for more details on the calculation algorithm and the value sets for the risk-adjustment variables. References: Normand S-LT, Shahian DM. 2007. Statistical and Clinical Aspects of Hospital Outcomes Profiling. Stat Sci 22 (2): 206-226.	national observed 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 based on 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 rates or better quality, and a higher ratio indicates higher-than-expected mortality rates or worse quality. The "predicted" number of deaths (the numerator) is calculated by using the coefficients estimated by regressing the risk factors and the hospital-specific intercept on the risk of mortality. The estimated hospital-specific effect is added to the sum of the estimated regression coefficients multiplied by the patient characteristics. The results are log transformed and summed over all patients attributed to a hospital to get a predicted value. The "expected" number of deaths (the denominator) is obtained in the same manner, but a common intercept using all hospitals in our sample is added in place of the hospital-specific intercept. The results are log transformed and summed over all patients in the hospital to get an expected value. To assess hospital performance for each reporting period, we re-estimate the model coefficients using the years of data in that period. This calculation transforms the ratio of predicted over expected into a rate that is compared to the national observed mortality rate. The hierarchical logistic regression models are described fully in the original methodology report (Krumholz et al., 2005).	rate. For each hospital, the numerator of the ratio ("predicted") 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 ("expected") 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 "predicted" number of deaths (the numerator) is calculated by using the coefficients estimated by regressing the risk factors and the hospital-specific intercept on the risk of mortality. The estimated hospital-specific effect is added to the sum of the estimated regression coefficients multiplied by the patient characteristics. The results are log transformed and summed over all patients attributed to a hospital to get a predicted value. The "expected" number of deaths (the denominator) is obtained in the same manner, but a common intercept using all hospitals in our sample is added in place of the hospital specific intercept. The results are log transformed and summed over all patients in the hospital to get an expected value. To assess hospital performance for each reporting period, we re-estimate the model coefficients using the years of data in that period. This calculation transforms the ratio of predicted over expected into a rate that is compared to the national observed readmission rate. The hierarchical logistic regression models are described fully in the original methodology report (Krumholz et al., 2005).

Appendix E2: Related and Competing Measures (narrative format)

Comparison of NQF #0535, NQF #0536, NQF #0229, and NQF #0230

0535 30-Day All-Cause Risk-Standardized Mortality Rate Following Percutaneous Coronary Intervention (PCI) for Patients Without ST Segment Elevation Myocardial Infarction (STEMI) and Without Cardiogenic Shock
0536 30-Day All-Cause Risk-Standardized Mortality Rate Following Percutaneous Coronary Intervention (PCI) for Patients with ST Segment Elevation Myocardial Infarction (STEMI) or Cardiogenic Shock
0229 Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) Following Heart Failure (HF) Hospitalization
0230 Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) Following Acute Myocardial Infarction (AMI) Hospitalization for Patients 18 and Older

Steward

0535 30-Day All-Cause Risk-Standardized Mortality Rate Following Percutaneous Coronary Intervention (PCI) for Patients Without ST Segment Elevation Myocardial Infarction (STEMI) and Without Cardiogenic Shock

American College of Cardiology

0536 30-Day All-Cause Risk-Standardized Mortality Rate Following Percutaneous Coronary Intervention (PCI) for Patients with ST Segment Elevation Myocardial Infarction (STEMI) or Cardiogenic Shock

American College of Cardiology

0229 Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) Following Heart Failure (HF) Hospitalization

Centers for Medicare and Medicaid Services (CMS)

0230 Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) Following Acute Myocardial Infarction (AMI) Hospitalization for Patients 18 and Older

Centers for Medicare and Medicaid Services (CMS)

Description

0535 30-Day All-Cause Risk-Standardized Mortality Rate Following Percutaneous Coronary Intervention (PCI) for Patients Without ST Segment Elevation Myocardial Infarction (STEMI) and Without Cardiogenic Shock

This measure estimates hospital risk-standardized 30-day all-cause mortality rate following percutaneous coronary intervention (PCI) among patients who are 18 years of age or older without STEMI and without cardiogenic shock at the time of procedure. The measure uses clinical data available in the National Cardiovascular Data Registry (NCDR) CathPCI Registry for risk adjustment. For the purpose of development and testing, the measure used a Medicare fee-for-service (FFS) population of patients 65 years of age or older with a PCI. For the purpose of maintenance, we tested the performance of the measure in a cohort of patients whose vital status was determined from the National Death Index. As such it reflects an all-payor sample as opposed to only the Medicare population. This is consistent with the measure's intent to be applicable to the full population of PCI patients.

0536 30-Day All-Cause Risk-Standardized Mortality Rate Following Percutaneous Coronary Intervention (PCI) for Patients with ST Segment Elevation Myocardial Infarction (STEMI) or Cardiogenic Shock

This measure estimates hospital risk-standardized 30-day all-cause mortality rate following percutaneous coronary intervention (PCI) among patients who are 18 years of age or older with STEMI or cardiogenic shock at the time of procedure. The measure uses clinical data available in the National Cardiovascular Data Registry (NCDR) CathPCI Registry for risk adjustment. For the purpose of development and testing, the measure cohort was derived in a Medicare fee-for-service (FFS) population of patients 65 years of age or older with a PCI. For the purpose of maintenance, the measure used a cohort of patients whose vital status was determined from the National Death Index (which reflects an all-payor sample as opposed to only the Medicare population). This is consistent with the measure's intent to be applicable to the full population of PCI patients.

0229 Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) Following Heart Failure (HF) Hospitalization

The measure estimates a hospital-level 30-day risk-standardized mortality rate (RSMR). Mortality is defined as death for any cause within 30 days after the admission date for the index admission, for patients 18 and older discharged from the hospital with a principal diagnosis of heart failure (HF). The Centers for Medicare & Medicaid Services (CMS) annually reports the measure for patients who are 65 years or older and are either Medicare fee-for-service (FFS) beneficiaries and hospitalized in non-federal hospitals or patients hospitalized in Veterans Health Administration (VA) facilities.

0230 Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) Following Acute Myocardial Infarction (AMI) Hospitalization for Patients 18 and Older

This measure estimates a hospital-level, 30-day risk-standardized mortality rate (RSMR) for patients discharged from the hospital with a principal diagnosis of acute myocardial infarction (AMI). Mortality is defined as death from any cause within 30 days after the index admission date. The Centers for Medicare & Medicaid Services (CMS) annually reports the measure for patients who are 65 years and older and are Medicare fee-for-service (FFS) beneficiaries hospitalized in non-federal hospitals.

Type

0535 30-Day All-Cause Risk-Standardized Mortality Rate Following Percutaneous Coronary Intervention (PCI) for Patients Without ST Segment Elevation Myocardial Infarction (STEMI) and Without Cardiogenic Shock

Outcome

0536 30-Day All-Cause Risk-Standardized Mortality Rate Following Percutaneous Coronary Intervention (PCI) for Patients with ST Segment Elevation Myocardial Infarction (STEMI) or Cardiogenic Shock

Outcome

0229 Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) Following Heart Failure (HF) Hospitalization

Outcome

0230 Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) Following Acute Myocardial Infarction (AMI) Hospitalization for Patients 18 and Older

Outcome

Data Source

0535 30-Day All-Cause Risk-Standardized Mortality Rate Following Percutaneous Coronary Intervention (PCI) for Patients Without ST Segment Elevation Myocardial Infarction (STEMI) and Without Cardiogenic Shock

Claims, Other, Registry Data Data sources:

NCDR CatchPCI Registry

Vital Status Source:

National Death Index, Death Masterfile, Medicare enrollment database, or equivalent

0536 30-Day All-Cause Risk-Standardized Mortality Rate Following Percutaneous Coronary Intervention (PCI) for Patients with ST Segment Elevation Myocardial Infarction (STEMI) or Cardiogenic Shock

Claims, Other, Registry Data Data sources:

NCDR CatchPCI Registry

Vital Status Source:

National Death Index, Death Masterfile, Medicare enrollment database, or equivalent

0229 Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) Following Heart Failure (HF) Hospitalization

Claims, Paper Medical Records, Other

0230 Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) Following Acute Myocardial Infarction (AMI) Hospitalization for Patients 18 and Older

Claims, Paper Medical Records, Other

Level

0535 30-Day All-Cause Risk-Standardized Mortality Rate Following Percutaneous Coronary Intervention (PCI) for Patients Without ST Segment Elevation Myocardial Infarction (STEMI) and Without Cardiogenic Shock

Facility, Other

0536 30-Day All-Cause Risk-Standardized Mortality Rate Following Percutaneous Coronary Intervention (PCI) for Patients with ST Segment Elevation Myocardial Infarction (STEMI) or Cardiogenic Shock

Facility, Other

0229 Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) Following Heart Failure (HF) Hospitalization

Facility

0230 Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) Following Acute Myocardial Infarction (AMI) Hospitalization for Patients 18 and Older

Facility

Setting

0535 30-Day All-Cause Risk-Standardized Mortality Rate Following Percutaneous Coronary Intervention (PCI) for Patients Without ST Segment Elevation Myocardial Infarction (STEMI) and Without Cardiogenic Shock

Inpatient/Hospital

0536 30-Day All-Cause Risk-Standardized Mortality Rate Following Percutaneous Coronary Intervention (PCI) for Patients with ST Segment Elevation Myocardial Infarction (STEMI) or Cardiogenic Shock

Inpatient/Hospital

0229 Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) Following Heart Failure (HF) Hospitalization

Inpatient/Hospital, Other – Acute Care Facility

0230 Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) Following Acute Myocardial Infarction (AMI) Hospitalization for Patients 18 and Older

Inpatient/Hospital

Numerator Statement

0535 30-Day All-Cause Risk-Standardized Mortality Rate Following Percutaneous Coronary Intervention (PCI) for Patients Without ST Segment Elevation Myocardial Infarction (STEMI) and Without Cardiogenic Shock

The outcome for this measure is all–cause death within 30 days following a PCI procedure in patients without STEMI and without cardiogenic shock at the time of the procedure.

0536 30-Day All-Cause Risk-Standardized Mortality Rate Following Percutaneous Coronary Intervention (PCI) for Patients with ST Segment Elevation Myocardial Infarction (STEMI) or Cardiogenic Shock

The outcome for this measure is all-cause death within 30 days following a PCI procedure in patients with STEMI or cardiogenic shock at the time of the procedure.

0229 Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) Following Heart Failure (HF) Hospitalization

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 65 and older discharged from the hospital with a principal diagnosis of HF.

0230 Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) Following Acute Myocardial Infarction (AMI) Hospitalization for Patients 18 and Older

The outcome for this measure is 30-day all-cause mortality. We define mortality as death from any cause within 30 days from the date of admission for patients discharged from the hospital with a principal diagnosis of AMI.

Numerator Details

0535 30-Day All-Cause Risk-Standardized Mortality Rate Following Percutaneous Coronary Intervention (PCI) for Patients Without ST Segment Elevation Myocardial Infarction (STEMI) and Without Cardiogenic Shock

Deaths can be identified using an external source of vital status, such as the Social Security Administration's Death Master File (DMF) or the Centers for Disease Control and Prevention's National Death Index (NDI). For the purpose of development and reassessment of the measure, we used a Medicare FFS population age 65 and over. We linked CathPCI registry with corresponding Medicare data and identified: a) in-hospital deaths using the discharge disposition indicator in the Standard Analytic File (SAF) and identified) post-discharge deaths using the Enrollment Database (EDB). For the purpose of maintenance, the measure used a cohort of patients whose vital status was determined from the National Death Index. This data sample reflects a more comprehensive data set including a broader age range (>18 years) and an all-payer model compared to the Medicare data set (>65 years) used for initial measure testing.

0536 30-Day All-Cause Risk-Standardized Mortality Rate Following Percutaneous Coronary Intervention (PCI) for Patients with ST Segment Elevation Myocardial Infarction (STEMI) or Cardiogenic Shock

Deaths can be identified using an external source of vital status, such as the Social Security Administration's Death Master File (DMF) or the Centers for Disease Control and Prevention's National Death Index (NDI). For the purpose of development and testing of the measure, we used a Medicare FFS population age 65 and over. We linked CathPCI registry with corresponding Medicare data and identified: a) in-hospital deaths using the discharge disposition indicator in the Standard Analytic File (SAF) and identified) post-discharge deaths using the Enrollment Database (EDB). For the purpose of maintenance, the measure used a cohort of patients whose vital status was determined from the National Death Index. This data sample reflects a more comprehensive data set including a broader age range (>18 years) and an all-payer model compared to the Medicare data set (>65 years) used for initial measure testing.

0229 Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) Following Heart Failure (HF) Hospitalization

The measure counts deaths for any cause within 30 days of the date of admission of the index HF hospitalization.

Rationale: From a patient perspective, death is a critical outcome regardless of cause. Outcomes occurring within 30 days of the start of the admission can be influenced by hospital care and early transition to the non-acute care setting. The 30-day time frame is a clinically meaningful period for hospitals to collaborate with their communities to reduce mortality (Simoes et al., 2017; Dharmarajan et al., 2015).

Identifying deaths in the FFS measure

As currently reported, we identify deaths for FFS Medicare patients 65 years and older in the Medicare Enrollment Database (EDB).

Identifying deaths in the all-payer measure

For the purposes of development of an all-payer measure, deaths were identified using the California vital statistics data file. Nationally, post-discharge deaths can be identified using

an external source of vital status, such as the Social Security Administration's Death Master File (DMF) or the Centers for Disease Control and Prevention's National Death Index (NDI).

0230 Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) Following Acute Myocardial Infarction (AMI) Hospitalization for Patients 18 and Older

This measure counts death from any cause within 30 days after the index admission date.

Rationale: From a patient perspective, death is the most critical outcome regardless of cause. Outcomes occurring within 30 days of admission can be influenced by hospital care and early transition to the non-acute care setting. The 30-day time frame is a clinically meaningful period for hospitals to collaborate with their communities to reduce mortality. (Simoes et al., 2017; Dharmarajan et al., 2015).

Identifying deaths in the Medicare FFS population

As currently reported, we identify deaths for FFS Medicare patients 65 years and older in the Medicare Enrollment Database (EDB).

Identifying deaths in the all-payer population

For the purposes of development of an all-payer measure, deaths were identified using the California vital statistics data file. Nationally, post-discharge deaths can be identified using an external source of vital status, such as the Social Security Administration's Death Master File (DMF) or the Centers for Disease Control and Prevention's National Death Index (NDI).

Denominator Statement

0535 30-Day All-Cause Risk-Standardized Mortality Rate Following Percutaneous Coronary Intervention (PCI) for Patients Without ST Segment Elevation Myocardial Infarction (STEMI) and Without Cardiogenic Shock

The target population for this measure includes inpatient and outpatient hospital stays with a PCI procedure for patients at least 18 years of age, without STEMI and without cardiogenic shock at the time of procedure.

0536 30-Day All-Cause Risk-Standardized Mortality Rate Following Percutaneous Coronary Intervention (PCI) for Patients with ST Segment Elevation Myocardial Infarction (STEMI) or Cardiogenic Shock

The target population for this measure includes inpatient and outpatient hospital stays with a PCI procedure for patients at least 18 years of age, with STEMI or cardiogenic shock at the time of procedure, including outpatient and observation stay patients who have undergone PCI but have not been admitted. It is unlikely that patients in this cohort would not be admitted to the hospital, but we keep this criterion to be consistent with the complementary non-STEMI, non-cardiogenic shock PCI cohort.

0229 Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) Following Heart Failure (HF) Hospitalization

The cohort for the publically reported measure includes admissions for patients aged 65 years and older discharged from the hospital with a principal discharge diagnosis of HF and with a complete claims history for the 12 months prior to admission. The measure is currently publicly reported by CMS for those patients 65 years and older who are either Medicare FFS beneficiaries admitted to non-federal hospitals or patients admitted to VA hospitals.

0230 Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) Following Acute Myocardial Infarction (AMI) Hospitalization for Patients 18 and Older

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. We have tested the measure in both age groups.

The cohort includes admissions for patients discharged from the hospital with a principal discharge diagnosis of AMI and with a complete claims history for the 12 months prior to admission.

The measure is currently publicly reported by CMS for those patients 65 years and older who are Medicare FFS beneficiaries admitted to non-federal hospitals.

Denominator Details

0535 30-Day All-Cause Risk-Standardized Mortality Rate Following Percutaneous Coronary Intervention (PCI) for Patients Without ST Segment Elevation Myocardial Infarction (STEMI) and Without Cardiogenic Shock

The time window can be specified from one or more years. This measure was developed with Medicare claims and CathPCI Registry data from one calendar year.

The measure cohort is patients undergoing PCI who do NOT have STEMI and do NOT have cardiogenic shock. STEMI or cardiogenic shock is defined as present in Version 4.4 of the CathPCI registry as follows:

Admissions with PCI are identified by field 5305 (PCI=yes);

STEMI or shock is identified by:

(1) Symptoms present on admission = ACS:STEMI (field 5000 = 6) with Time Period Symptom Onset to Admission within 24 hours (field 5005 = 5006, 5007, 5008) or Acute PCI = Yes (field 7035);

OR

(2) Cardiogenic shock = Yes (field 5060=1)

0536 30-Day All-Cause Risk-Standardized Mortality Rate Following Percutaneous Coronary Intervention (PCI) for Patients with ST Segment Elevation Myocardial Infarction (STEMI) or Cardiogenic Shock

The time window can be specified from one or more years. This measure was developed with Medicare claims and CathPCI Registry data from one calendar year.

The measure cohort is patients undergoing PCI who have STEMI or cardiogenic shock. STEMI or cardiogenic shock is defined as present in Version 4.4 of the CathPCI registry as follows:

Admissions with PCI are identified by field 5305 (PCI=yes);

STEMI or shock is identified by:

(1) Symptoms present on admission = ACS:STEMI (field 5000 = 6) with Time Period Symptom Onset to Admission within 24 hours (field 5005 = 5006, 5007, 5008) or Acute PCI = Yes (field 7035);

OR

(2) Cardiogenic shock = Yes (field 5060=1)

0229 Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) Following Heart Failure (HF) Hospitalization

To be included in the HF measure cohort used in public reporting, patients must meet the following additional inclusion criteria:

1. Have a principal discharge diagnosis of heart failure (HF);

2. Enrolled in Medicare Fee-For-Service (FFS)Part A and Part B for the 12 months prior to the date of the index admission and Part A during the index admission, or those who are VA beneficiaries (in the cases of the AMI, HF, and pneumonia measures);

3. Aged 65 or over; and,

4. Not transferred from another acute care facility.

VA beneficiaries are eligible for inclusion in the AMI, HF, and pneumonia measure cohorts regardless of Medicare FFS enrollment or whether they were hospitalized in a VA or non-VA short-term acute care hospital.

This measure can also be used for an all-payer population aged 18 years and older. We have explicitly tested the measure in both patients aged 18+ years and those aged 65+ years.

ICD-9 and ICD-10 cohort codes are included in the attached Data Dictionary.

0230 Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) Following Acute Myocardial Infarction (AMI) Hospitalization for Patients 18 and Older

To be included in the measure cohort used in public reporting, patients must meet the following additional inclusion criteria:

1. Having a principal discharge diagnosis of AMI;

2. Enrolled in Medicare FFS Part A and Part B for the first 12 months prior to the date of admission, and enrolled in Part A during the index admission;

3. Aged 65 or over; and

4. Not transferred from another acute care facility.

ICD-9 and ICD-10 cohort codes are included in the attached Data Dictionary.

Exclusions

0535 30-Day All-Cause Risk-Standardized Mortality Rate Following Percutaneous Coronary Intervention (PCI) for Patients Without ST Segment Elevation Myocardial Infarction (STEMI) and Without Cardiogenic Shock

Hospital stays are excluded from the cohort if they meet any of the following criteria:

(1) PCIs that follow a prior PCI in the same admission (either at the same hospital or a PCI performed at another hospital prior to transfer).

This exclusion is applied in order to avoid assigning the death to two separate admissions.

(2) For patients with inconsistent or unknown vital status or other unreliable data (e.g. date of death precedes date of PCI);

(3) Subsequent PCIs within 30-days. The 30-day outcome period for patients with more than one PCI may overlap. In order to avoid attributing the same death to more than one PCI (i.e. double counting a single patient death), additional PCI procedures within 30 days of the death are not counted as new index procedures.

(4) PCIs for patients with more than 10 days between date of admission and date of PCI. Patients who have a PCI after having been in the hospital for a prolonged period of time are rare and represent a distinct population that likely has risk factors related to the hospitalization that are not well quantified in the registry.

0536 30-Day All-Cause Risk-Standardized Mortality Rate Following Percutaneous Coronary Intervention (PCI) for Patients with ST Segment Elevation Myocardial Infarction (STEMI) or Cardiogenic Shock

Hospital stays are excluded from the cohort if they meet any of the following criteria:

(1) PCIs that follow a prior PCI in the same admission (either at the same hospital or a PCI performed at another hospital prior to transfer).

This exclusion is applied in order to avoid assigning the death to two separate admissions.

(2) For patients with inconsistent or unknown vital status or other unreliable data (e.g. date of death precedes date of PCI);

(3) Subsequent PCIs within 30-days. The 30-day outcome period for patients with more than one PCI may overlap. In order to avoid attributing the same death to more than one PCI (i.e. double counting a single patient death), additional PCI procedures within 30 days of the death are not counted as new index procedures.

(4) PCIs for patients with more than 10 days between date of admission and date of PCI. Patients who have a PCI after having been in the hospital for a prolonged period of time are rare and represent a distinct population that likely has risk factors related to the hospitalization that are not well quantified in the registry.

0229 Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) Following Heart Failure (HF) Hospitalization

The HF mortality measure excludes index hospitalizations that meet any of the following exclusion criteria:

1. With inconsistent or unknown vital status or other unreliable demographic (age and gender) data;

2. Enrolled in the Medicare hospice program or used VA hospice services any time in the 12 months prior to the index admission, including the first day of the index admission; or,

3. Discharged against medical advice.

4. Discharged alive on the day of admission or the following day who were not transferred to another acute care facility; or

5. With a procedure code for LVAD implantation or heart transplantation either during the index admission or in the 12 months prior to the index admission.

For patients with more than one admission for a given condition in a given year, only one index admission for that condition is randomly selected for inclusion in the cohort.

0230 Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) Following Acute Myocardial Infarction (AMI) Hospitalization for Patients 18 and Older

The mortality measure excludes index hospitalizations that meet any of the following exclusion criteria:

1. Discharged alive on the day of admission or the following day who were not transferred to another acute care facility;

2. Inconsistent or unknown vital status or other unreliable demographic (age and gender) data;

3. Enrolled in the Medicare hospice program any time in the 12 months prior to the index admission, including the first day of the index admission; or

4. Discharged against medical advice (AMA).

For patients with more than one admission for a given condition in a given year, only one index admission for that condition is randomly selected for inclusion in the cohort. Similarly, for the three-year combined data, when index admissions occur during the transition between measure reporting periods (June and July of each year) and both are randomly selected for inclusion in the measure, the measure includes only the June admission. The July admissions are excluded to avoid assigning a single death to two admissions.

Exclusion Details

0535 30-Day All-Cause Risk-Standardized Mortality Rate Following Percutaneous Coronary Intervention (PCI) for Patients Without ST Segment Elevation Myocardial Infarction (STEMI) and Without Cardiogenic Shock

Excluded hospital stays are identified as follows:

(1) PCIs that follow a prior PCI in the same admission or occur during a transfer-in admission (PCI to PCI). For the purposes of development we used Medicare data to define transfers as two admissions that occur within 1 day of each other and identified patients in this cohort who had a PCI during both admissions. This can also be identified in the registry data. (Note: For purposes of maintenance, we used CathPCI registry data to identify patients transferred in who had a prior PCI at the transferring hospital)

(2) Patients with inconsistent or unknown vital status or other unreliable data (e.g. date of death precedes date of PCI). The specific data fields will depend on the data source used.

(3) Not the first hospital stay with a PCI in the 30 days prior to a patient death. These stays are identified by procedure date in the CathPCI Registry and death date in the vital status data source.

(4) PCIs for patients with more than 10 days between date of admission and date of PCI. We determine length of stay by subtracting the admission date from the procedure date in the CathPCI Registry.

0536 30-Day All-Cause Risk-Standardized Mortality Rate Following Percutaneous Coronary Intervention (PCI) for Patients with ST Segment Elevation Myocardial Infarction (STEMI) or Cardiogenic Shock

Excluded hospital stays are identified as follows:

(1) PCIs that follow a prior PCI in the same admission or occur during a transfer-in admission (PCI to PCI). For the purposes of development we used Medicare data to define transfers as two admissions that occur within 1 day of each other and identified patients in this cohort who had a PCI during both admissions. This can also be identified in the registry data. (Note: For purposes of maintenance, we used NDI and CathPCI registry data)

(2) Patients with inconsistent or unknown vital status or other unreliable data (e.g. date of death precedes date of PCI). The specific data fields will depend on the data source used.

(3) Not the first hospital stay with a PCI in the 30 days prior to a patient death. These stays are identified by procedure date in the CathPCI Registry and death date in the vital status data source.

(4) PCIs for patients with more than 10 days between date of admission and date of PCI. We determine length of stay by subtracting the admission date from the procedure date in the CathPCI Registry

0229 Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) Following Heart Failure (HF) Hospitalization

1. Inconsistent or unknown vital status or other unreliable demographic data

Inconsistent vital status or unreliable data are identified if any of the following conditions are met 1) the patient's age is greater than 115 years: 2) if the discharge date for a hospitalization is before the admission date; 3) if the patient has a sex other than 'male'

Rationale: We do not include stays for patients where the age is greater than 115, where the gender is neither male nor female, where the admission date is after the date of death in the Medicare Enrollment Database, or where the date of death occurs before the date of discharge but the patient was discharged alive.

2. Enrolled in the Medicare hospice program any time in the 12 months prior to the index admission, including the first day of the index admission

Rationale: Hospice enrollment in the 12 months prior to or on the index admission is identified using hospice data and the Inpatient standard analytic file (SAF). This exclusion applies when the measure is used in Medicare FFS patients only.

Rationale: These patients are likely continuing to seek comfort measures only; thus, mortality is not necessarily an adverse outcome or signal of poor quality care.

3. Discharged against medical advice

Discharges against medical advice are identified using the discharge disposition indicator.

Rationale: Providers did not have the opportunity to deliver full care and prepare the patient for discharge.

4. Discharged alive on the day of admission or the following day who were not transferred to another acute care facility. The discharge disposition indicator is used to identify patients alive at discharge. Transfers are identified in the claims when a patient with a qualifying admission is discharged from an acute care hospital and admitted to another acute care hospital on the same day or next day.

Rationale: It is unlikely that these patients had clinically significant HF.

5. With a procedure code for LVAD implantation or heart transplantation either during the index admission or in the 12 months prior to the index admission

Patients with LVAD implantation or heart transplantation during an index admission or in the previous 12 months are identified by the corresponding codes for these procedures included in claims data.

Rationale: These patients represent a clinically distinct group (ICD-10-PCS code list).

The data sources for these analyses are Medicare administrative claims and enrollment information for patients with hospitalizations between July 1, 2013 and June 30, 2016.

After exclusions #1-5 are applied, the measure randomly selects one index admission per patient per year for inclusion in the cohort so that each episode of care is mutually independent with the same probability of the outcome. Additional admissions within that

year are excluded. For each patient, the probability of death increases with each subsequent admission and therefore the episodes of care are not mutually independent. For the three-year combined data, when index admissions occur during the transition between measure reporting periods (June and July of each year) and both are randomly selected for inclusion in the measure, the measure includes only the June admission. The July admissions are excluded to avoid assigning a single death to two admissions.

0230 Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) Following Acute Myocardial Infarction (AMI) Hospitalization for Patients 18 and Older

1. Discharged alive on the day of admission or the following day who were not transferred to another acute care facility

Rationale: It is unlikely that these patients had clinically significant AMI.

2. Inconsistent or unknown vital status or other unreliable demographic data

Rationale: We do not include stays for patients where the age is greater than 115, where the gender is neither male nor female, where the admission date is after the date of death in the Medicare Enrollment Database, or where the date of death occurs before the date of discharge but the patient was discharged alive because these data are likely erroneous.

3. Enrolled in the Medicare hospice program any time in the 12 months prior to the index admission, including the first day of the index admission

Rationale: These patients are likely continuing to seek comfort measures only, so mortality is not necessarily an adverse outcome or signal of poor quality care.

4. Discharged against medical advice

Rationale: Providers did not have the opportunity to deliver full care and prepare the patient for discharge.

After exclusions #1-4 are applied, the measure randomly selects one index admission per patient per year for inclusion in the cohort so that each episode of care is mutually independent with the same probability of the outcome. Additional admissions within that year are excluded. For each patient, the probability of death increases with each subsequent admission and therefore the episodes of care are not mutually independent.

For the three-year combined data, when index admissions occur during the transition between measure reporting periods (June and July of each year) and both are randomly selected for inclusion in the measure, the measure includes only the June admission. July admissions are excluded to avoid assigning a single death to two admissions.

Risk Adjustment

0535 30-Day All-Cause Risk-Standardized Mortality Rate Following Percutaneous Coronary Intervention (PCI) for Patients Without ST Segment Elevation Myocardial Infarction (STEMI) and Without Cardiogenic Shock

Statistical risk model

0536 30-Day All-Cause Risk-Standardized Mortality Rate Following Percutaneous Coronary Intervention (PCI) for Patients with ST Segment Elevation Myocardial Infarction (STEMI) or Cardiogenic Shock

Statistical risk model

0229 Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) Following Heart Failure (HF) Hospitalization

Statistical Risk Model

0230 Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) Following Acute Myocardial Infarction (AMI) Hospitalization for Patients 18 and Older

Statistical Risk Model

Stratification

0535 30-Day All-Cause Risk-Standardized Mortality Rate Following Percutaneous Coronary Intervention (PCI) for Patients Without ST Segment Elevation Myocardial Infarction (STEMI) and Without Cardiogenic Shock

Results of this measure will not be stratified.

0536 30-Day All-Cause Risk-Standardized Mortality Rate Following Percutaneous Coronary Intervention (PCI) for Patients with ST Segment Elevation Myocardial Infarction (STEMI) or Cardiogenic Shock

Results of this measure will not be stratified.

0229 Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) Following Heart Failure (HF) Hospitalization

N/A

0230 Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) Following Acute Myocardial Infarction (AMI) Hospitalization for Patients 18 and Older

N/A

Type Score

0535 30-Day All-Cause Risk-Standardized Mortality Rate Following Percutaneous Coronary Intervention (PCI) for Patients Without ST Segment Elevation Myocardial Infarction (STEMI) and Without Cardiogenic Shock

Rate/proportion

0536 30-Day All-Cause Risk-Standardized Mortality Rate Following Percutaneous Coronary Intervention (PCI) for Patients with ST Segment Elevation Myocardial Infarction (STEMI) or Cardiogenic Shock

Rate/proportion

0229 Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) Following Heart Failure (HF) Hospitalization

Rate/ proportion

0230 Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) Following Acute Myocardial Infarction (AMI) Hospitalization for Patients 18 and Older

Rate/ proportion

Algorithm

0535 30-Day All-Cause Risk-Standardized Mortality Rate Following Percutaneous Coronary Intervention (PCI) for Patients Without ST Segment Elevation Myocardial Infarction (STEMI) and Without Cardiogenic Shock

The measure score is calculated based on the following steps:

1. Patient cohort is identified based on the inclusion and exclusion criteria (see questions S.7, S.8, S.9, S.10, S.11);

2. Data elements for risk adjustment are collected using the first collected value, as detailed below;

3. Outcome is ascertained from an outside data source, such as the Medicare Enrollment Database (see questions S.4, S.5, S.6)

4. Measure score is calculated with aggregated data across all included sites, as described below.

Risk-adjustment variables

The measure is adjusted for the variables listed below:

1. Age (10 year increments)

2. Body Mass Index (5 kg/m^2 increments)

3. History of congestive heart failure

4. History of cerebrovascular disease

5. History of peripheral vascular disease

6. History of chronic lung disease

7. Diabetes

8. Glomerular Filtration Rate (GFR) (derived)

9. Previous PCI

10. Heart Failure - current status

11. New York Hospital Association

12. Symptom onset

13. Ejection Fraction percent (EF)

14. PCI status

15. Highest risk lesion – coronary artery segment category

16. Highest risk lesion: Society for Cardiovascular Angiography and Interventions (SCAI)

Measure Score Calculation

The RSMR is calculated as the ratio of the number of “predicted” to the number of “expected” deaths, multiplied by the national unadjusted mortality rate. For each hospital, the predicted hospital outcome (the numerator) 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 (better quality) and a higher ratio indicates higher-than-expected mortality (worse quality).

The predicted hospital outcome (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, 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, we re-estimate the model coefficients using the years of data in that period.

Please see attachments for more details on the calculation algorithm and the value sets for the risk-adjustment variables.

References:

Normand S-LT, Shahian DM. 2007. Statistical and Clinical Aspects of Hospital Outcomes Profiling. Stat Sci 22 (2): 206-226. 135684| 144800| 143448| 146487| 142910| 141015

0536 30-Day All-Cause Risk-Standardized Mortality Rate Following Percutaneous Coronary Intervention (PCI) for Patients with ST Segment Elevation Myocardial Infarction (STEMI) or Cardiogenic Shock

The measure score is calculated based on the following steps:

1. Patient cohort is identified based on the inclusion and exclusion criteria (see questions S.6, S.7, S.8, S.9, S.10);

2. Data elements for risk adjustment are collected using the first collected value, as detailed below;

3. Outcome is ascertained from an outside data source, such as the Medicare Enrollment Database (see questions S.4, S.5, S.6)

4. Measure score is calculated with aggregated data across all included sites, as described below.

Risk-adjustment variables

The measure is adjusted for the variables listed below:

1. Age (10 year increments)

2. Body Mass Index (5 kg/m^2 increments)

3. History of cerebrovascular disease

4. History of chronic lung disease

5. Glomerular Filtration Rate (GFR) (derived)

6. Previous PCI

7. Heart Failure - current status

8. Cardiogenic shock on admission

9. Symptom onset

10. Ejection Fraction percent (EF)

11. PCI status

12. Highest risk lesion – coronary artery segment category

13. Highest risk lesion: Society for Cardiovascular Angiography and Interventions (SCAI)

Measure Score Calculation

The RSMR is calculated as the ratio of the number of "predicted" to the number of "expected" deaths, multiplied by the national unadjusted mortality rate. For each hospital, the predicted hospital outcome (the numerator) 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 (better quality) and a higher ratio indicates higher-than-expected mortality (worse quality).

The predicted hospital outcome (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, 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, we re-estimate the model coefficients using the years of data in that period.

Please see attachments for more details on the calculation algorithm and the value sets for the risk-adjustment variables.

References:

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

0229 Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) Following Heart Failure (HF) Hospitalization

The measure estimates hospital-level 30-day all-cause RSMRs following hospitalization for HF using hierarchical logistic regression models. In brief, the approach simultaneously models data at the patient and hospital levels to account for variance in patient outcomes within and between hospitals (Normand and Shahian, 2007). At the patient level, it models the log-odds of mortality within 30 days of index admission using age, sex, selected clinical covariates, and a hospital-specific intercept. At the hospital level, it models the hospital-specific intercepts as arising from a normal distribution. The hospital intercept represents the underlying risk of a mortality at the hospital, after accounting for patient risk. The hospital-specific intercepts are given a distribution 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.

The RSMR is calculated as the ratio of the number of "predicted" to the number of "expected" deaths at a given hospital, multiplied by the national observed 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 based on 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 rates or better quality, and a higher ratio indicates higher-than-expected mortality rates or worse quality.

The "predicted" number of deaths (the numerator) is calculated by using the coefficients estimated by regressing the risk factors and the hospital-specific intercept on the risk of mortality. The estimated hospital-specific effect is added to the sum of the estimated regression coefficients multiplied by the patient characteristics. The results are log transformed and summed over all patients attributed to a hospital to get a predicted value. The "expected" number of deaths (the denominator) is obtained in the same manner, but a common intercept using all hospitals in our sample is added in place of the hospital-specific intercept. The results are log transformed and summed over all patients in the hospital to get an expected value. To assess hospital performance for each reporting period, we re-estimate the model coefficients using the years of data in that period.

This calculation transforms the ratio of predicted over expected into a rate that is compared to the national observed mortality rate. The hierarchical logistic regression models are described fully in the original methodology report (Krumholz et al., 2005).

0230 Hospital 30-Day, All-Cause, Risk-Standardized Mortality Rate (RSMR) Following Acute Myocardial Infarction (AMI) Hospitalization for Patients 18 and Older

The measure estimates hospital-level 30-day all-cause RSMRs following hospitalization for AMI using hierarchical logistic regression models. In brief, the approach simultaneously models data at the patient and hospital levels to account for variance in patient outcomes within and between hospitals (Normand and Shahian, 2007). At the patient level, it models the log-odds of mortality within 30 days of discharge using age, sex, selected clinical covariates, and a hospital-specific intercept. At the hospital level, it models the hospital-specific intercepts as arising from a normal distribution. The hospital intercept represents the underlying risk of mortality at the hospital, after accounting for patient risk. The hospital-specific intercepts are given a distribution 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.

The RSMR is calculated as the ratio of the number of "predicted" to the number of "expected" deaths, multiplied by the national unadjusted mortality rate. For each hospital, the numerator of the ratio ("predicted") 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 ("expected") 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 “predicted” number of deaths (the numerator) is calculated by using the coefficients estimated by regressing the risk factors and the hospital-specific intercept on the risk of mortality. The estimated hospital-specific effect is added to the sum of the estimated regression coefficients multiplied by the patient characteristics. The results are log transformed and summed over all patients attributed to a hospital to get a predicted value. The “expected” number of deaths (the denominator) is obtained in the same manner, but a common intercept using all hospitals in our sample is added in place of the hospital specific intercept. The results are log transformed and summed over all patients in the hospital to get an expected value. To assess hospital performance for each reporting period, we re-estimate the model coefficients using the years of data in that period.

This calculation transforms the ratio of predicted over expected into a rate that is compared to the national observed readmission rate. The hierarchical logistic regression models are described fully in the original methodology report (Krumholz et al., 2005).

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