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Episode-based Resource Use Measures

Acute Myocardial Infarction (AMI) Episode-of-Care for 30 Days Following Onset

This measure was developed by the American Board of Medical Specialties Research and Education Foundation for the High Value Health Care Project: Characterizing Episodes and Costs of Care—funded by the Robert Wood Johnson Foundation under grant 63609.

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Acute Myocardial Infarction (AMI) Episode-of-Care for 30 days following onset

Measure Description

Resource use and costs associated with acute myocardial infarction (AMI) episode-of care in 30 day period following onset of AMI. An index AMI event is identified and all AMI-related services are identified in the 30 day period following the onset of the acute event.

Required Data Elements

Administrative claims data

Calculation

Identify index hospitalization during the measurement year as a hospitalization for an AMI (see Table AMI-A for codes) in which the patient was discharged alive and had a length of stay greater than 1 day. Patients with an admission for AMI in the preceding 30 days from their index event will be excluded. For each patient, all AMI-related resources used during the 30 days from their admission will be identified. A standard price list will be applied to the AMI-related resource use to estimate the costs of the episode of care related to the AMI event. Resources will be defined for the following categories: 1) inpatient facility; 2) evaluation and management; 3) procedures; 4) imaging; 5) tests; 6) DME; 7) other drugs and services; 8) medications; 9) other and 10) outpatient facility. Costs will be risk adjusted for age and selected comorbidities. For inpatient facility costs, the standard cost is based on a per diem cost for a DRG and will be multiplied by the length of stay for the index event. For each of the other resource use categories, standardized prices will be available for each of the unique codes available under the other categories.

Episode Definition

AMI-related care provided in the 30 days following an AMI.

Rationale

The Institute of Medicine and AQA (formerly known as the Ambulatory Care Quality Alliance) have identified AMI as one of 20 conditions that should be considered a priority area in need of quality improvement based on the prevalence of the condition,

its impact on morbidity and mortality, and the opportunity to significantly improve the quality of related care. AMI had also been previously identified as a priority area in other national initiatives including Health Resources and Services Administration's Health Disparities Collaboratives and the Quality Improvement Program at Centers for Medicare and Medicaid Services.¹ In addition, AMI episodes tend to be relatively high-resource use episodes – hospital discharges for AMI cost approximately \$17,500 on average in 2006 for a total of nearly \$12 billion nationwide.² Furthermore, costs per AMI patient can vary dramatically from one provider to the next as well as across regions, in part because of underlying patient risk factors and comorbidities (for which this measure adjusts), but also because of variations in practice patterns.

Importantly, guidelines for the management of AMI differentiate ST-segment elevation myocardial infarction (STEMI) from non-ST-segment elevation myocardial infarction (NSTEMI).^{3,4} A factor contributing to the differentiation is the evidence available around effective treatments for STEMI and NSTEMI. While the evidence base and clinical practice guidelines differ for the two, quality improvement measures group STEMI and NSTEMI events together as many of the interventions are similar between the two and it is not possible to differentiate the events in administrative datasets.⁵ Therefore, this measure includes STEMI and NSTEMI in a single measuring due to the inability to differentiate these in administrative datasets, while acknowledging it may be important to create separate measures when it becomes possible to accurately identify STEMI versus NSTEMI as resource use and quality of care differ between the two.⁶

While AMI is primarily an acute condition, the successful management of patients that are post-AMI also involves need for longer-term treatment and secondary prevention. Additionally, the initial event and resource use around that event will be associated with disproportionate costs than the medical management following the initial event. Therefore, resource use during an AMI episode will be measured in two ways. First, to measure variation in resource use at the hospital following patient presentation and during the post-hospitalization period (so as to capture variability associated with readmissions and the use of post-acute care), this measure begins at admission and follows the patient for the next 30 days. Measuring resource use associated with patient management post-AMI for the following 11 months is reserved for a separate measure. Only initial AMI episodes will be considered for these measures, given that treatment patterns may be different in the care for a patient with a secondary MI, particularly if the secondary MI took place within 30 days of the initial MI.

¹ Priority Areas for National Action: Transforming Health Care Quality. Institute of Medicine. Karen Adams and Janet Corrigan Editors. March 10, 2003.

² Health Care and Utilization Project. AHRQ. <http://hcupnet.ahrq.gov/>. Accessed March 2009.

³ Antman EM, Anbe DT, et al. ACC/AHA guidelines for the management of patients with ST-elevation myocardial infarction; a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. *J Am Coll Cardiol*. 2004;44:e1-e211.

⁴ Anderson JL, Adams CD, et al. ACC/AHA 2007 Guidelines for the Management of Patients with Unstable Angina/Non-ST-Elevation Myocardial Infarction. *J Am Coll Cardiol*. 2007; 50:1-157.

⁵ Chen J, Rathore SS, et al. JCAHO accreditation and quality of care for acute myocardial infarction. *Health Aff (Millwood)*. 2003; 22:243-254.

⁶ Roe MT, Parson LS, et al. Quality of care by classification of myocardial infarction: treatment patterns for ST-segment elevation vs non-ST-segment elevation myocardial infarction. *Arch Intern Med*. 2005; 165(14):1630-1636.

This measure will be attributed at the level of the hospital. It was determined this measure could not be attributed to individual physicians or physician practice groups because AMI patients almost always present in the emergency department where they do not have a choice of provider – their care will be rendered by physicians making rounds or on call. The hospital is believed to have greater control over the patient’s treatment during and immediately following hospitalization under this scenario.

Measures

- AMI-related resource use / costs
 - Inpatient Facility
 - Evaluation and Management
 - Procedures
 - Imaging
 - Tests
 - DME
 - Other drugs and services
 - Exceptions / Unclassified
 - Other
 - Pharmacy
 - Outpatient Facility

Eligible Population

Age	18 to 85 years during the measurement year
Patient Inclusion Criteria	Continuous medical and pharmacy benefit enrollment for at least one year preceding the onset of the AMI episode and for one year following the episode onset, with no more than one gap in enrollment of more than 45 days during each year of continuous enrollment. Patients that die during the year following the event are included in the sample
Event/diagnosis	Admitted to an inpatient setting for an AMI between January 1 and December 31 of the measurement year and no AMI admission in the preceding 30 days with a length of stay > 1 day and discharged alive. Refer to Table AMI-A for codes to identify AMIs.
Exclusion	Hospitalizations excluded with ICD-9 Code 410.x2; Exclude patients with DRG (v24) 123 (MS-DRG 283, 284, 285) at index hospitalization. Persons with any of the following diagnoses in the measurement year or the year prior to measurement are

excluded (see tables AMI-D for codes):
 active cancer; end stage renal disease
 (ESRD); dialysis; renal failure; organ transplant;
 HIV/AIDS

Patients discharged to a skilled nursing facility (SNF)

Table AMI-A: Codes to identify initial AMI episode

Description	ICD-9 Code
AMI	410.xx

Primary diagnosis of AMI 410.xx (excluding 410.x2)

Table AMI-B: Diagnostic codes to identify AMI-related services

Description	ICD-9 Code	DRG v24	DRG v25 (MS-DRG)
AMI	410.xx	121, 122, 535	280, 281, 282, 222, 223
Unstable angina	411.xx, 413.x	140, 143	311, 313
Arrhythmia and ICD / Pacemaker	427.xx, except 427.5	138, 139, 117, 118, 515, 535, 536, 551, 552	308, 309, 310, 260, 261, 262, 258, 259, 226, 227, 222, 223, 224, 225, 242, 243, 244
Cardiac arrest	427.5	129	296, 297, 298
PCI	00.66, 36.01, 36.02, 36.05, 36.06, 36.07	555, 556, 557, 558	248, 249, 246, 247
CABG	36.10-36.16	547, 548, 549, 550	233, 234, 235, 236
Coronary Atherosclerosis	414.0x, 414.8, 414.9		
Heart failure	402.01, 402.11, 402.91, 404.01, 404.03, 404.11, 404.13, 404.91, 404.93, 428.0, 428.00, 428.1, 428.10, 428.90, 428.20, 428.21, 428.22, 428.23, 428.30, 428.31, 428.32, 428.33, 428.40, 428.41, 428.42, 428.43, 428.9		

Codes present in *any* diagnostic field during 30 day measurement period

Tables AMI-C: Other Codes to Identify AMI-related Services

Categories of service are classified according to Berenson-Eggers Type of Services (BETOS) codes which assign CPT and HCPCS codes to the measurement categories.

Table AMI-C1 -Inpatient Facility Codes

Description	CPT
Nonacute inpatient	99301-99313, 99315, 99316, 99318, 99321-99328, 99331-99337
Acute inpatient	99221-99223, 99231-99233, 99238, 99239, 99251-99255, 99261-99263, 99291

Codes present with another code (eg. ICD-9, CPT, HCPCs, DRG) for AMI-related service

Table AMI-C2 -Evaluation and Management Codes

Description	CPT Codes
Office or Other Outpatient Services	99201-99215
Hospital Observation Services	99217-99220, 99358-99360
Hospital Inpatient Services	99221-99239
Consultations	99241-99255, 99261-99263, 99271-99275
Critical Care and Intensive Care Services	99289-99298
Nursing Facility, Domiciliary and Home Services	99301-99350
Case Management Services and Care Plan Oversight Services	99361-99380
Preventive Medicine Services	99385-99390, 99395-99405, 99410-99429
Other E&M Services	99450-99456, 99354-99357

Codes present with another code (eg. ICD-9, CPT, HCPCs, DRG) for AMI-related service

Table AMI-C3 -Surgery and Procedure Codes

Description	ICD-9 Code	CPT	DRG	MS-DRG (v25)
PCI	00.66, 36.01, 36.02, 36.05, 36.06, 36.07	92982-92984, 92995	555, 556, 557, 558	248, 249, 246, 247
CABG	36.10-36.16	33503-33505, 33510-33516, 33517-33519, 33521-33523, 33533-33535	547, 548, 549, 550	233, 234, 235, 236
Coronary thrombolysis	36.04			

Diagnostic cardiac catheterization; coronary arteriography	37.21-37.23, 88.52-88.57	93526-93529, 93536, 93503, 93561-93562, 93555-93556, 93539-93545, 93510-93524		
Insertion; revision; replacement; removal of cardiac pacemaker or cardioverter/defibrillator	00.50-00.57, 37.70-37.83, 37.85-37.87, 37.89, 37.94-37.98	33200-33201, 33206-33208, 33210-33211, 33216-33217, 33212-33213	117, 118, 515, 535, 536, 551, 552	260, 261, 262, 258, 259, 226, 227, 222, 223, 224, 225, 242, 243, 244
Other vascular procedures			553, 554	253, 254
Radiology		71010, 71015, 71020, 71021, 71022, 71030, 71035, 71090, 71250, 71260, 71270, 71275		
EKG		93000, 93005, 93010, 93012, 93014, 93015, 93016, 93017, 93018, 93040, 93041, 93042, 93224, 93225, 93226, 93227, 93230, 93231, 93232, 93233, 93235, 93237		

Table AMI-C4 -Pharmacy

Following classes of medications are included as AMI-related medications:

1. Beta-blockers
2. ACE Inhibitors
3. ARBs
4. Clopidogrel, plavix
5. Lipid lowering medications (statins, niacin, etc.)
6. Nitrates

The following HCPCs codes identify additional AMI-related medications

HCPC	Short Description
C9109	Tirofiban hcl, 6.25 mg
C9121	Injection, argatroban
J0130	Abciximab injection
J0350	Injection anistreplase 30 u
J0365	Aprotonin, 10,000 kiu
J0583	Bivalirudin

J1160	Digoxin injection
J1162	Digoxin immune fab (ovine)
J1245	Dipyridamole injection
J1327	Eptifibatide injection
J1642	Inj heparin sodium per 10 u
J1644	Inj heparin sodium per 1000u
J1645	Dalteparin sodium
J1650	Inj enoxaparin sodium
J1652	Fondaparinux sodium
J1655	Tinzaparin sodium injection
J2993	Retepase injection
J2995	Inj streptokinase /250000 IU
J2997	Alteplase recombinant
J3100	Tenecteplase injection
J3245	Tirofiban hydrochloride
J3246	Tirofiban HCl
J3265	Injection torsemide 10 mg/ml
J3364	Urokinase 5000 IU injection
J3365	Urokinase 250,000 IU inj

Tables AMI-D: Codes to Identify Exclusions

Table AMI-D1-Cancer: Codes to Identify Active Cancer Treatment

Description	ICD-9-CM Diagnosis
Cancer	140-171; 174-184; 187-203; 204.0; 204.2; 204.8; 205-208; 230-239

WITH

Description	CPT	ICD-9-CM Procedure	UB Revenue
Treatment	38230, 38240-38242, 77261-77799, 79000-79999, 96400-96549	41.0, 41.91, 92.2	028x, 033x, 0342, 0344, 0973

Table AMI-D2-ESRD: Codes to Identify ESRD

Description	CPT	HCPCS	ICD-9-CM Diagnosis	ICD-9-CM Procedure	UB Revenue	UB Type of Bill	POS
ESRD (including renal dialysis)	36145, 36800-36821, 36831-36833, 90919-90921, 90923-90925, 90935, 90937, 90939, 90940, 90945, 90947, 90989, 90993, 90997, 90999, 99512	G0257, G0311- G0319, G0321- G0323, G0325- G0327, G0392, G0393, S9339	585.5, 585.6, V42.0, V45.1, V56	38.95, 39.27, 39.42, 39.43, 39.53, 39.93, 39.94, 39.95, 54.98	080x, 082x-085x, 088x	72x	65

Table AMI-D3-Transplant: Codes to Identify Organ Transplant

Description	CPT	HCPCS	ICD-9-CM Procedure	UB Revenue
Organ transplant	32850-32856, 33930-33945, 44132-44137, 44715-44721, 47133-47147, 48160, 48550-48556, 50300-50380	S2152, S2053-S2055, S2060, S2061, S2065	33.5, 33.6, 37.5, 41.94, 46.97, 50.5, 52.8, 55.6	0362, 0367, 0810-0813, 0819

Table AMI-D4-Transplant: Codes to Identify Organ Transplant

Description	ICD-9-CM Diagnosis
HIV	042

Risk Adjustment Method

Comorbid conditions indentified as HCCs in 12 months preceding event date using inpatient and outpatient ICD-9 codes.

Episode Severity / Disease Staging

Two separate stratifications will be created. First, we will stratify patients that are transferred compared to those that are not transferred. Second, patients will be stratified by the presence of heart failure in the year preceding the event. Results will be reported overall and for each of the strata.

Outlier Methodology

All individuals are included in the analysis with costs winsorized at the 2nd and 98th percentile.

Level of Measurement/Analysis

Measurement will take place at the level of the hospital and the provider team within the hospital.

Applicable Care Settings

- Inpatient
- Outpatient
- Post-Acute Care

Technical Appendix

Acute Myocardial Infarction (AMI) Episode-of-Care for 30 Days Following Onset

Appendix Overview

The following document provides step-by-step methods for implementing the Acute Myocardial Infarction (AMI) Episode-of care for 30 Days Following Onset using an administrative, claims, or healthcare encounter database.

There are 9 sections for calculating person-level episode costs:

1. Eligible population identification
2. Identification of related resources
3. Assignment of standardized prices
4. Create episode specific strata
5. Calculation of individual episode costs
6. Calculation of risk-adjusted costs
7. Determination of attributable provider
8. Creation of provider summaries
9. Reporting

Measure Description

Resource use and costs associated with AMI episode during the acute period. The acute period is defined as 30 days following initial hospitalization for an AMI event. An index AMI event is identified and all AMI-related services are identified in the 30 days following the onset of the acute event. Total AMI-related costs are calculated for each patient and summarized at the attributable hospital level. Observed costs are compared to risk-adjusted expected costs at the hospital level.

Required Data Elements

Eligibility and/or enrollment information (both medical and pharmacy)

Administrative claims:

- Inpatient
- Outpatient
- Pharmacy

Required Data Duration and Timeframe

A minimum of 24 months of continuous data is necessary to calculate the measure.

The 24-month period is divided into a 12-month identification period and a 12-month measurement period.

Definitions

Identification year	12-month period used to identify presence of comorbid conditions among patients included in the measure
Measurement year	12-month period over which AMI-related resource use is measured; immediately follows identification year.
Measure population	The collection of patients who meet all measure inclusion criteria and do not meet any measure exclusion criteria. Their resource use will be calculated and included in provider summary reports.
Age	Patient age at the eligible event.
AMI-related¹	Healthcare encounters defined as being related to AMI care
Continuous enrollment	As identified in eligibility or enrollment information, full medical and pharmacy benefit enrollment during both the identification year and the measurement year, with at least 320 total days of coverage during each year ²
Medication dispensing event	Medication dispensing with a positive, non-zero cost.
Inpatient Hospital Event	An acute care overnight hospital stay of ≥ 1 day with positive associated charges

Section I – Eligible Population Identification

The process of identifying patients to be included in the measure is divided into three separate steps, each with multiple sub-steps. The following steps are used for identifying the included population:

Step 1: Identify patients that meet the episode definition inclusion criteria

Step 2: Identify patients that meet eligibility and continuous enrollment criteria

Step 3: Identify patients with exclusion criteria

¹ May refer to services both appropriately and inappropriately rendered in the treatment or management of a patient with an AMI

² This method was derived using HEDIS methods for determining coverage eligibility. HEDIS rules require that each eligible person have no more than 1 gap in coverage of up to 45 days in each year.

Step 4: Combine prior steps to identify measure population

Step 1: Identify patients that meet episode inclusion criteria

1. Identify patients 18 to 85 years during the measurement year
2. Identify patients that meet the following inclusion criteria during the measurement year:
 - i. Admitted to inpatient facility for AMI (See **Table AMI-A**) between January 1 and December 31 of measurement year;
 - ii. No AMI admission in the preceding 30 days;
 - iii. Length of stay > 1 day; AND
 - iv. Discharged alive
3. Identify patients that are transferred between two inpatient facilities. This information is used when reporting the results as findings are stratified by those that were and were not transferred.

Step 2: Identify patients that meet eligibility and continuous enrollment criteria

1. Eligibility
 - a. Identify benefits during both the identification year and the measurement year
 - b. To be included persons must have both of the following benefits in both years
 - i. Medical benefit
 - ii. Pharmacy benefit
2. Continuous enrollment
 - a. Determine enrollment during both the identification and measurement years
 - b. Identify (or estimate³) total days of coverage in each year
 - c. To be eligible, persons must have at least 320 total days of coverage during each year

³ If precise information regarding persons' total days of coverage is not available, it is recommended that measure implementers estimate this information to the best of their ability using available data elements (e.g., monthly enrollment indicators).

Step 3: Identify patients with exclusion criteria

- I. Identify patients that meet any of the following exclusion criteria during either the identification year **OR** the measurement year:
 - a. Hospitalizations excluded with ICD-9 Code 410.x2;
 - b. Exclude patients with DRG (v24) 123 (MS-DRG 283, 284, 285) at index hospitalization;
 - c. Discharged to skilled nursing facility (SNF) from index hospitalization
 - d. Any of the diagnoses appearing in **Tables AMI-D1-4** during the identification or measurement year:
 - i. Active cancer (excluding melanoma, skin, prostate, and CLL)
 - ii. End stage renal disease (ESRD)
 - iii. End stage liver disease (ESLD)
 - iv. HIV/AIDS
 - v. Organ transplant

Step 4: Combine prior steps to identify measure population

1. Identify acute AMI eligible population
2. Exclude those patients not meeting general inclusion criteria (e.g., continuous eligibility)
3. Exclude patients meeting one or more measure exclusion criteria
4. The resulting collection of patients is the measure population

Section 2 – Eligible Event Identification

For each individual in the measure population, identify the following paid claims for services rendered during the measurement period. Claims / encounters will be identified based on the presence of AMI-related diagnosis codes or procedure codes. These events will be used to determine the AMI-related resource use.

Inpatient hospitalization events

Referring to **Table AMI-B**, identify all inpatient hospitalization events with one of the diagnosis codes appearing in the **primary** diagnosis field.

Outpatient events

Referring to **Table AMI-B**, identify all outpatient claims / encounters with an AMI-related diagnostic code appearing in **any** position.

Procedures and laboratory

Referring to **Table AMI-B** and **Tables AMI-C1-3**, identify all claims / encounters with listed CPT, HCPCs, or ICD-9 procedure codes. The procedure codes are used to

identify AMI-related services during the measurement period, regardless of corresponding ICD-9 diagnosis codes. Similarly, all claims with a qualifying ICD-9 code are included regardless of the procedure codes associated with that claim.

Prescription drugs

Referring to **Table AMI-C4**, identify medications in the listed therapeutic classes during the measurement period or with the listed HCPCs codes.

Section 3 – Assignment of standardized prices

Standardized prices are calculated for all of the components of care used to treat or manage the patient's condition to ensure that comparisons can be made solely on the basis of differential practice patterns and resource use. Three separate methodologies are used to derive these standardized prices: for inpatient facility charges, for ambulatory pharmacy charges (i.e., prescriptions dispensed outside the inpatient hospital setting), and for all other charges. These standardized prices are then applied to the claims identified as AMI-related.

Standard Cost Calculation

- Step 1** Identify all claims paid for services rendered during the measurement year and with positive non-zero paid amounts for all patients, regardless as to whether they have been included in the measure population. Categorize these claims as follows (in accordance with the BETOS classification process followed in Step 3 above):
- *Inpatient Facility* (services provided by a facility during an acute inpatient hospital stay, standard price includes room and board and ancillary services)
 - *Ambulatory Pharmacy* (ambulatory prescriptions included in a member's pharmacy benefit)
 - *All other* (E&M, procedures, imaging, tests, DME, other, and exceptions/unclassified)
- Step 2** For each category identified, compute standardized prices. Refer to each service category's instructions (i.e., *Calculating Standard Units of Service and Total Standard Cost*) below.
- Step 3** Combine standardized prices with eligible events (e.g., through a file merge as specified in each service category's instructions).
- Step 4** For each individual claim, multiply standardized price by the number of service units identified on the claim to determine the full cost of the service, hospitalization, or prescription.

Calculating Standard Units of Service and Total Standard Cost: *Inpatient Facility*

For inpatient facility costs, standardized prices are developed at the diagnosis-related group (DRG) level and – for those hospitalizations where DRG-level information is unavailable – at the ADSC level. Each is adjusted for length-of-stay (LOS) so as to more closely mirror the payment systems typically applied among commercial health plans. Both approaches use RRU HEDIS standardized daily price tables developed by NCQA. All inpatient facility costs are considered “acute” for this analysis.

- Step 1** Identify all inpatient stays that occurred during the measurement year. Include stays that may have started before the measurement year or ended after the close of the measurement year. Define a single, unique record describing the member’s inpatient stay.
- Step 2.** Identify the primary discharge DRG. Also identify the DRG version (e.g., CMS-DRG vs. MS-DRG). Care must be taken in using the standardized price tables (specified below) to insure the data and the tables use the same DRG version.
- Step 3** Compute the stay’s total LOS in days, using paid or expected-to-be-paid days only. Include all paid days in the LOS calculation, whether or not they fall outside the measurement year. Also identify the stay’s LOS group based on the stay’s LOS and the information contained in Table AMI-E below.

Table AMI-E: Length of Stay Group

LOS (Days)	LOS GRP
1	A
2	B
3-4	C
5-6	D
7-8	E
9-15	F
16 or more	G

- Step 4** Compute the LOS per diem multiplier. If the inpatient stay falls completely within the measurement year, use the total number of paid days as the per diem multiplier. If the inpatient stay does not fall completely inside the measurement year, count only the days within the measurement year (including the last day of the year) to compute the per diem multiplier.
- Step 5** Download the HEDIS RRU standardized daily price tables from the NCQA website (www.ncqa.org) for the corresponding measurement years. Note that there is a one year lag in the file and data years (i.e. files designated 2007 are based on 2006 data).

Some years may have two sets of tables if there is a significant change in DRG versions.⁴

Step 6 Calculate the DRG-specific per-diem payment rate by adjusting the standard daily prices for inflation to a reference year using the medical care component of the Consumer Price Index (CPI).

Step 7 Combine DRG-specific per-diem payment rates with the dataset containing eligible inpatient hospital events for the measure. For each event, multiply the per-diem payment rate by the event's LOS per diem multiplier to determine the event's total standard cost.

Total standard costs will not be computed using this approach for stays that have not been assigned a DRG, and for DRGs that are not assigned a standard price by HEDIS. These stays will be assigned a standard price using the ADSC method described below.

Example⁵ Assume the calculated DRG-specific per-diem payment rate for DRG XXX for FY 2007 is \$900.17. An eligible member had an inpatient stay with the following characteristics:

- A principal diagnosis with an eligible ICD-9 code
- A DRG of XXX (DRG associated with an eligible inpatient stay for the episode)
- Date of admission of February 2, 2007 and date of discharge of February 9, 2007 (fiscal year 2007)
- A LOS of 8 days, and therefore a LOS per diem multiplier of 8 days

This event has a calculated total standard cost of $\$900.17 \times 8 = \$7,201.36$.

Example Again assume the calculated DRG-specific per-diem payment rate for DRG XXX for FY 2007 is \$900.17. An eligible member had an inpatient stay with the following characteristics:

- A principal diagnosis with an eligible ICD-9 code
- A DRG of XXX (DRG associated with an eligible inpatient stay for the episode)
- Date of admission of December 28, 2006 and date of discharge of January 2, 2007 (fiscal year 2007)
- A LOS of 6 days, and a LOS per diem multiplier of 2 days (January 1-2).

This event has a calculated total standard cost of $\$900.17 \times 2 = \$1,800.34$.

⁴ The project staff worked in collaboration with NCQA in development of this methodology for purposes of testing the initial set of measures. Users of the measures may need to implement their own methodology that does not rely on a price list from NCQA.

⁵ Figures presented in this example are arbitrary and do not reflect any particular dataset or patient. Additionally, the DRG XXX is intended to be used as an illustrative example for calculating inpatient costs. Only DRGs related to the episode should be included in this calculation.

- Step 8** If DRG information is not available for a given inpatient hospitalization a method must be used that assigns prices to those hospitalizations. The methodology used in testing the initial development of the measures was to assign an Aggregate Diagnostic Service Category (ADSC) for the stay using the principal discharge diagnosis. To assign ADSC, download the ADSC Table (Table SPT-INP-ADSC) from the NCQA Web site (www.ncqa.org) and match the principal ICD-9-CM Diagnosis code from the discharge claim to an ADSC. If the claim does not contain a DRG and the primary ICD-9-CM Diagnosis code is invalid or missing, map the inpatient stay to the ADSC Table's MISA category.⁶ An alternative would be to create average prices from the dataset the measures are being implemented for each of the ADSC categories and discharge ICD-9-CM codes and assign those prices to missing hospitalizations.
- Step 9** Determine if the member underwent major surgery during the inpatient stay. If this information is not available within the dataset, this may be determined using the list of codes included in a table from the NCQA Web site (Maj-Surg Table). Flag eligible members if one procedure code in the Maj-Surg-Table is present from any provider during the time period defined by the admission and discharge dates.
- Step 10** Match each ADSC, LOS per diem multiplier, and major surgery flag assignment for the stay to a value in the Table SPT-INP-ADSC to obtain the assigned standard price. For each event, multiply the per-diem payment rate by the event's LOS per diem multiplier to determine the event's total standard cost. As with the DRG method, the ADSC standard prices must be adjusted for inflation to a reference year using the CPI. Between this ADSC methodology and the previously described DRG-based methodology, each inpatient hospital stay should now have an associated standardized price.

Example An eligible member had an inpatient stay with the following characteristics:

- A principal diagnosis for an eligible event assigned to ADSC category Respiratory-C (RESC)
- No available valid DRG information
- Date of admission of February 2, 2007 and date of discharge of February 9, 2007
- A LOS of 8 days, and therefore LOS group E
- A major surgery event during the stay

Using Sample Table SPT-INP-ADSC, we determine this event has a standard per-diem payment rate of \$1,474.00. Therefore, this event has a calculated total standard cost of $\$1,474 \times 8 = \$11,792$.

⁶ The project staff worked in collaboration with NCQA in development of this methodology for purposes of testing the initial set of measures. Users of the measures may need to implement their own methodology that does not rely on a price list from NCQA.

Calculating Standard Units of Service and Total Standard Cost: Ambulatory Pharmacy

For ambulatory pharmacy-related costs, standardized prices are developed at the NDC level, adjusted for days supply.

- Step 1** Identify all pharmacy services that occurred during the measurement year. The following pharmacy services should also be included:
- Prescriptions that may have been dispensed before the measurement year and had days supply that extended into the measurement year (e.g., a prescription with a dispensed date of December 15, 2007 and 30 days supply would extend 13 days into the measurement year beginning January 1, 2008)
 - Prescriptions that may have been dispensed during the measurement year and had days supply that extended into the following year (e.g., a prescription with a dispensed date of December 20, 2008)

Define a single, unique record describing the pharmacy service.

- Step 2** Identify the NDC code and the days supply for each prescription, whether or not some days fall outside the measurement year.
- If the days supply is not available for a given pharmacy claim, set the claim's standard cost to be equal to its listed payment amount.
- Step 3** Compute the days supply per diem multiplier. If the prescription's days supply fall completely within the measurement year, use the claim's listed days supply as the per diem multiplier. If the prescription's days supply do not fall completely inside the measurement year, count only the days within the measurement year (including the last day of the year) to compute the per diem multiplier.
- Step 4** For each NDC, calculate the total NDC-specific payments and the total days supply across all pharmacy claims within that NDC during the measurement year. Using these totals, calculate NDC-specific per-day-supply payment rates by dividing total NDC-specific payments by total days supply for each NDC.
- Step 5** Combine NDC-specific per-day-supply payment rates with the dataset containing eligible pharmacy events for the measure. For each event, multiply the per-day-supply payment rate by the event's days supply per diem multiplier to determine the event's total standard cost.

Calculating Standard Units of Service and Total Standard Cost: All Other

For all non-inpatient hospital, non-pharmacy costs, standardized prices are developed at the procedure code and modifier level.

- Step 1** Identify all non-inpatient hospital, non-pharmacy services that occurred during the measurement year.
- Step 2** Identify the primary procedure code (CPT, HCPCs, ICD-9, etc.) and the first modifier code for each service.
- Step 3** For each procedure-modifier combination, calculate the total procedure/modifier-specific payments across all non-inpatient-hospital, non-pharmacy claims with that procedure-modifier combination as well as the frequency of the procedure-modifier combination during the measurement year. Calculate procedure/modifier-specific payment rates by dividing total procedure/modifier-specific payments by the frequency for each procedure-modifier combination.
- Step 4** Combine procedure/modifier-specific payment rates with the dataset containing eligible non-inpatient-hospital, non-pharmacy events for the measure so that each procedure-modifier combination is paired with its corresponding payment rate. This payment rate is the event's total standard cost.

Section 4 – Create episode specific strata

Two criteria are used to create stratifications for this episode. Patients are stratified based on the presence of heart failure in the year preceding the qualifying event and on transfer status during the qualifying hospitalization.

Step 1. Determine if patients have heart failure in the year preceding the index event using the HCC indicator for heart failure (HCC80). Classify patients as heart failure or no heart failure.

Step 2. Determine if patients were transferred to another acute care hospital during their qualifying event. Transfers are identified based on discharge status for the initial hospitalization event. Classify patients as transfer or no transfer.

Step 3. Group patients into the following mutually exclusive categories: Heart failure and no transfer; Heart failure and transfer; No heart failure and no transfer; and no heart failure and no transfer.

Section 5 – Calculation of total individual episode costs

The resource use identified as AMI-related– and to which standardized prices have been applied (i.e., the collection of eligible events) – is used to calculate individual level episode costs. The following steps are used in the calculation of total individual level costs.

Step 1: For each individual included in the episode, sum all of the total standard costs linked to AMI-related events occurring during the measurement year at the BETOS level. This will provide an estimate of the costs of each category of service over the measurement year.

Step 2: For each individual in the episode, sum ALL total standard costs linked to AMI-related events to calculate TOTAL episode costs.

Section 6 – Calculation of risk adjusted costs

The model developed for comorbidity adjustment uses Hierarchical Condition Categories (HCC) to identify comorbidities. This reflects the risk adjustment methodology used by CMS and recently evaluated by NCQA for their Relative Resource Use (RRU) measures. However, there is an important distinction between the use of HCCs by CMS and the model evaluated by NCQA and the risk adjustment model used to estimate expected costs. The CMS and NCQA model use HCCs to adjust TOTAL costs of care, whereas this model focuses on episode-specific costs of care. Because models developed to adjust total costs of care may not reflect the expected costs for episode-specific resource use, new models were developed from a sample of commercially insured patients for risk adjustment. The following process was completed to develop the models:

1. Utilized quasi-Modified Delphi approach with the condition-specific workgroup to categorize HCCs into three groups:
 - Include in risk adjustment model;
 - Exclude in risk adjustment model; and
 - Test impact in risk adjustment model.
2. Identified HCCs in denominator population during the 12 months preceding the measurement year.
3. Tested 12 different model specifications shown in Table AMI-RA1, where the HCCs included in the model varied, and the distribution and link functions in the generalized linear models also varied. Models were developed in a stepwise manner as indicated. The first four models used a gamma distribution and a log link function. The first model included all HCCs identified by the condition-specific workgroup as “Include HCCs” with a prevalence in the population of $\geq 1\%$. The second model was a reduction of the

first model that only included HCCs where $p < 0.1$. The third model extended the second model by including HCCs with prevalence $\geq 1\%$ identified as “Test HCCs” by the condition-specific workgroup. The fourth model was a reduction of the third model and included only those HCCs where $p < 0.1$. The next set of four models (Models 5-8) repeated the process of the first four models but used a normal distribution and identity link function. Model 9 used all of the HCCs, with the exception of the HCC for the episode being evaluated (e.g., diabetes for the diabetes episode; however HCCs for complications of diabetes were included), and a gamma distribution with log link function. Model 10 was a reduction of Model 9 where only the HCCs with $p < 0.1$ were included. The final two models (Models 11-12) used the same process as Models 9 and 10 with a normal distribution and identity link function.

Table AMI-RA I. Risk Adjustment Model Specifications

Model #	Independent Variables						Distri- bution	Link function
	WG Specified ($> 1\%$)	WG specified ($> 1\%$) $p < 0.1$	Test conditions ($> 1\%$)	Test conditions ($> 1\%$) $p < 0.1$	All HCCs	All HCCs $p < 0.1$		
1	X						Gamma	Log
2		X					Gamma	Log
3		X	X				Gamma	Log
4		X		X			Gamma	Log
5	X						Normal	Identity
6		X					Normal	Identity
7		X	X				Normal	Identity
8		X		X			Normal	Identity
9					X		Gamma	Log
10						X	Gamma	Log
11					X		Normal	Identity
12						X	Normal	Identity

4. Models were developed in a split sample approach with 75% of the population randomly selected for model development and the remaining 25% used in model evaluation. Model performance was also evaluated in the full cohort.

5. The performance of each model was evaluated through comparisons of the observed and predicted distributions, comparisons of residuals, comparisons of absolute differences between observed and predicted, comparisons of observed-to-predicted ratios, and comparisons of mean squared errors across models. Summary information on model performance was presented to the condition-specific workgroup for selection of a risk adjustment model for the condition. Final model selection was based on the best performing model across metrics. Where model performance was similar, models using the normal distribution were preferentially chosen over the gamma distribution models for ease of implementation. More parsimonious models were also preferentially chosen.

The following is the model selected for estimating adjusted costs in the AMI Post-Acute episode.

Risk Adjustment Model

Risk Adjusted AMI Acute Episode Costs = \$13,878 + (Male x \$920) + (Age x-y x \$1829) + (Age x-y x \$2644) + (Age x-y x \$2451) + (Diabetes with Renal or Peripheral Circulatory Manifestations x \$4117) + (Diabetes with Neurologic or other Specified Manifestations x \$1904) + (Cardio-respiratory Failure and Shock x \$3749) + (Diabetes with Ophthalmologic or Unspecified Manifestation x \$4039) + (Diabetes without Complication x \$1978) + (Congestive Heart Failure x \$1614)

Measure implementers have two choices when calculating risk adjusted costs. The first is to follow the process specified above to create risk adjustment models that are specific to their population and their dataset. The second option is to follow the below steps and use the above estimates for calculating risk adjusted costs. While the latter is a straightforward calculation, caution is warranted as the risk adjusted equations were derived from a population that may be different from the population to which the measure is being applied.

To estimate risk adjusted costs using the above risk adjustment equations in the measurement population, use the following steps:

Step 1: Identify the presence of HCCs on any claim in the 12 months preceding the measurement year, utilizing both inpatient (primary diagnosis field only) and outpatient encounters (all diagnosis fields).

Step 2: Create a person level file that contains an indicator (yes/no) variable for each of the HCCs. These variables indicate whether or not the patient had evidence of each HCC during the previous 12 months.

Step 3: Calculate an adjustment factor of the average episode costs in the measure population and divide it by the average cost of the test episode (Table AMI-RA2). Apply the inflation factor to the risk adjustment coefficients to account for cost differences

between datasets used in development of the risk adjustment models and those used in calculating episode costs.

Table AMI-RA2. Summary estimates of the average cost for AMI post-acute episode in the test episode

Average Cost
\$16,712

Example: To calculate the inflation factor, determine the average episode cost for the population to which the measure is being applied. As an example, the average cost might be \$19,720. Calculate the adjustment factor by dividing the costs from the current population by the average cost in Table AMI-RA2. That would result in an adjustment factor of 1.18. The adjustment factor is then applied to the estimated coefficients to provide an adjusted risk adjustment model.

Risk and Mean Adjusted Model

Risk and Mean Adjusted Acute AMI Episode Costs = 1.18 * Risk Adjusted Acute AMI Episode Costs

Step 4: Use the equation for the appropriate age group to generate risk adjusted expected costs for each individual in the dataset.

Section 7 – Determination of attributable provider

Resource use and costs for AMI episodes are attributed at the hospital level. The results are attributed to the hospital with the majority of the length of stay during the initial AMI event.

Section 8 – Creation of provider summaries

The provider summaries are a report of the resource use for an individual hospital compared to all episodes in the dataset. Creation of the provider summaries uses the summary episode costs combined with the attributable provider data and the risk adjusted episode costs.

Step 1: Create a dataset that includes the following information: patient ID, total episode cost, attributable provider ID, attributable provider specialty type and episode expected costs from the risk adjustment model.

Step 2: Calculate the observed-to-expected ratio for each of the episodes by dividing observed costs for the episode by expected (predicted) costs for the episode.

Step 3: Create each strata of reporting by determining which strata the events fall into. Strata include transfer vs. not transferred and heart failure (HCC80) vs. no heart failure in preceding 12 months. These factors are used to create summary reports stratified by transfer status and presence of heart failure.

Step 4: Summarize the observed, expected and observed-to-expected ratio for each attributable hospital, overall and within each of the strata.

Step 5: Summarize the observed, expected and observed-to-expected ratio for the all of the episodes.

Step 6: For each hospital, determine the proportion of observed-to-expected ratios above the 75% percentile of all hospitals and calculate the 95% confidence interval

Step 7: Create provider summary reports for each attributable hospital

Section 9 – Reporting

The following section describes reports of unadjusted episode costs that were used to understand patterns of resource use associated with the episodes. Most of these reports are based on the classifications of related resource use by type-of-service category using the Berenson-Eggers Type of Services (BETOS) classification system. This system can be applied following the steps described below.

Reports by Categories of Service

For each of the claims / encounters identified for the episode's AMI-related resource use calculations, BETOS codes will be applied to categorize services. BETOS codes and crosswalks to procedure codes are available through the Centers for Medicare & Medicaid Services website.⁷

Step 1: Obtain BETOS files for the relevant year from the CMS website.

Step 2: Combine BETOS codes with eligible events (e.g., through a file merge).

Step 3: Categorize data from outpatient pharmacy files as pharmacy-related costs – these claims will not have a BETOS code to combine with the eligible events data. Similarly, categorize data from inpatient hospital files as inpatient facility-related costs.

⁷ https://www.cms.gov/HCPCSReleaseCodeSets/20_BETOS.asp

Step 4: Categorize BETOS codes into the 7 specified “major categories”:

1. Evaluation and Management (E&M)
2. Procedures
3. Imaging
4. Tests
5. Durable Medical Equipment (DME)
6. Other
7. Exceptions/Unclassified

These categories (along with categories for inpatient facility costs and pharmacy costs) will be used for reporting overall episode costs.

Step 5: Categorize any/all remaining services without corresponding BETOS codes as belonging to the Exceptions/Unclassified category.

Step 6: Create summary reports of the distribution of costs for each type of service category for all episodes.

The reports we completed to analyze this episode, relying on BETOS categories, included:

- Summaries of per-episode resource use by type of service, including mean, median, standard deviation and variance, other statistical variables: overall and for each episode stratum
- For each type-of-service category for non-inpatient, non-pharmacy claims, summaries of the 20 CPT and HCPCs codes among diabetes-related services most commonly appearing in episodes and the 20 CPT and HCPCs codes that account for the largest proportions of the category’s costs
- For each type-of-service category for non-inpatient, non-pharmacy claims, summaries of the 20 CPT and HCPCs codes among non-diabetes-related services most commonly appearing during the measurement window and the 20 CPT and HCPCs codes that account for the largest proportions of the category’s costs
- For inpatient hospitalization events, the 20 DRG codes and primary ICD-9 diagnosis codes most commonly appearing and accounting for the largest proportions of inpatient facility costs: both AMI-related and non-AMI-related
- For pharmacy claims, the 20 generic drug names and therapeutic classes most commonly appearing and accounting for the largest proportions of pharmacy costs: both AMI-related and non-AMI-related