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Episode-based Resource Use Measures

Episode-of-Care for Management of Coronary Artery Disease Post-Revascularization over 1-Year Period

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The Episode-based Resource Use Measures (Measures) and related data specifications, developed by the American Board of Medical Specialties Research and Education Foundation (ABMS REF), are intended to facilitate quality improvement activities by physicians.

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Episode-of-Care for Management of Coronary Artery Disease Post-Revascularization over 1-Year Period

Measure Description

Resource use and costs associated with management of coronary artery disease (CAD) care over a one-year period post-revascularization (coronary artery bypass graft [CABG] or percutaneous coronary intervention [PCI]) without an acute myocardial infarction (AMI). Patients are identified who had a revascularization and CAD-related resource use and costs during a 12-month period post revascularization are measured.

Required Data Elements

Administrative claims data

Calculation

For patients meeting inclusion criteria, determine CAD-related resource use and costs over a 12-month period post-revascularization. Prices from a standard price list will be applied to the CAD-related resource use to estimate the costs of the episode of care related to CAD. Resources will be defined for ten categories: 1) inpatient facility; 2) evaluation and management; 3) procedures; 4) imaging; 5) tests; 6) DME; 7) other drugs and services; 8) medications; 9) outpatient facility; and 10) other. Population will be stratified based on whether patients did or did not have multiple revascularizations during the 12-month measurement period. 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 event. Hospitalizations will be included as CAD-related if and only if the primary diagnosis code for the hospitalization is CAD-related. For each of the other resource use categories, standardized prices will be assigned to each type of utilization that is defined as CAD-related. Episodes with \$0 costs in the measurement period will be excluded.

Episode Definition

CAD-related care over a 12-month period post-revascularization.

Rationale

The Institute of Medicine and AQA (formerly known as the Ambulatory Care Quality Alliance) have identified angina/CAD as one of 20 conditions that should be considered priority areas in need of quality improvement based on its relevance to a significant volume of patients, its impact on those patients, and the perception of opportunity to significantly improve the quality and efficiency of related care. Approximately 7 million people in the U.S. were living with angina during 2007, and

there are 400,000 new angina cases annually.¹ CAD had also been previously identified as a priority area in other national initiatives including the Agency for Healthcare Research and Quality's Medical Expenditure Panel Survey and the U.S. Department of Veterans Affairs' Quality Enhancement Research Initiative.² In addition, the costs of treatment for CAD patients can be very high in some cases – one study noted, “U.S. healthcare expenditures in the treatment of patients with acute chest pain total \$10 billion to \$12 billion annually, despite the fact that most of these patients do not have acute coronary syndromes.”³ Furthermore, these costs can vary dramatically from one provider to the next as well as across regions because of variations in practice patterns.

CAD is a chronic condition and, following a revascularization, should be managed accordingly. Therefore the measurement period will be a 12-month period following the triggering revascularization service (which could be a PCI or CABG procedure). Patients who underwent a revascularization during the previous 12 months are excluded from this measure so as to limit the measure to the management of initial revascularizations – however, patients with and without multiple revascularizations during the measurement period will be stratified and measured separately. Patients with more severe confounding comorbidities such as AMI or vasculitis observed during the year prior to the measurement year will be excluded from the measure.

This measure will be attributed at the individual physician level because the patient's cardiologist or primary care doctor will be responsible for the vast majority of the patient's CAD-related evaluation, management, and treatment decisions during the measurement period. To the extent this individual physician is responsible for more than 70 percent of the patient's E&M visits, this physician will be the only one attributed the episode. If more than one physician is responsible for at least 30 percent of the patient's E&M care, each of those physicians would be attributed the full costs of the episode. If no physician was responsible for at least 30 percent of the patient's E&M care, then the episode would not be attributed to any physician.

Measures

- CAD-related resource use / costs
 - Inpatient Facility
 - Evaluation and Management
 - Procedures
 - Imaging
 - Tests
 - DME
 - Other drugs and services

¹ “What is Angina?” National Heart Lung and Blood Institute. November 2007. <http://www.nhlbi.nih.gov>. Accessed Jan. 21, 2009.

² Priority Areas for National Action: Transforming Health Care Quality. Institute of Medicine. Karen Adams and Janet Corrigan Editors. March 10, 2003.

³ S. Wood. “Multislice CT Angiography Offers Effective Evaluation of Chest Pain in ED.” Medscape. www.medscape.com/viewarticle/552469

- Exceptions / Unclassified
- Other
- Pharmacy
- Outpatient Facility

Eligible Population

Age	Age ≥ 18 yrs
Enrollment Criteria	Continuous medical and pharmacy benefit enrollment for at least one year preceding the measurement year and during the measurement year, with no more than one gap in enrollment of more than 45 days during each year of continuous enrollment.
Inclusion Criteria	Patients included in the measure must have a revascularization (CABG or PCI) (See Table CADPR-A for codes).
Exclusion	<p>Patients with a diagnosis of AMI during the 14-365 day period before the revascularization are excluded (See Table CADPR-E1 for codes)</p> <p>Patients with revascularization (CABG or PCI) in the year prior to the trigger revascularization (See Table CADPR-E2 for codes)</p> <p>Persons with any of the following diagnoses in the during the 12-month periods before or after the trigger revascularization are excluded (See Tables CADPR-E3-8 for codes):</p> <ul style="list-style-type: none"> active cancer; end stage renal disease (ESRD); dialysis; organ transplant; HIV/AIDS; pregnancy; vasculitis

Table CADPR-A: Codes to identify patients with a revascularization (trigger event)

Description	CPT	HCPCS	ICD-9 Procedure
Coronary artery bypass graft (CABG)	33510, 33511, 33512, 33513, 33514, 33516, 33517, 33518, 33519, 33521, 33522, 33523,		36.15, 36.16

	33530, 33533, 33534, 33535, 33536		
Percutaneous coronary intervention (PCI)	92980, 92981, 92982, 92984, 92995, 92996	G0290, G0291	00.66, 36.09, 36.06, 36.07, 36.03

These CPT, HCPCs or ICD-9 procedure codes, present in any field, will be used to identify CAD revascularization patients, regardless of corresponding ICD-9 codes. One-day hospitalizations cannot trigger episodes.

Table CADPR-B: Codes to identify clinically relevant services during a CAD post-revascularization episode

Table CADPR-BI: Diagnostic codes to identify clinically relevant services during a CAD post-revascularization episode

Description	ICD-9 Code
Other and unspecified mitral valve diseases	394.9
Hypertensive disease	401.x, 402.xx, 403.xx, 404.x, 405.x
Ischemic heart disease	410.x, 411.xx, 412, 413.x, 414.xx,
Diseases of pulmonary circulation	415.1, 415.11, 415.19, 417.8
Other forms of heart disease	420.xx, 421.xx, 422.xx, 423.xx, 424.1, 424.9, 425.x, 426.0, 426.1x, 426.3, 426.4, 426.5x, 426.6, 426.7, 426.8, 426.82, 426.89, 426.9, 427.xx, 428.xx, 429.2, 429.3, 429.4, 429.5, 429.6, 429.7x, 429.8x
Cerebrovascular disease	431, 432.0, 432.9, 433.xx, 434.x, 435.x, 436, 437.0, 437.1, 437.2, 437.3, 437.4, 437.6, 437.7, 437.8, 437.9, 438.xx,
Diseases of arteries, arterioles, and capillaries	440.xx, 441.xx, 442.xx, 443.0, 443.2x, 443.81, 443.89, 443.9, 444.xx, 445.xx, 447.0, 447.1, 447.2, 447.5, 447.8, 447.9, 448.x, 449
Diseases of veins and lymphatics, and other diseases of circulatory system	458.xx, 459.xx
Anomalies of aortic arch	747.21
Unspecified anomaly of circulatory system	747.9
Symptoms involving cardiovascular system	785.xx

Nonspecific abnormal results of function studies, Cardiovascular	794.3x
Electrolyte/fluid disorders nec	276.9
Hyperpotassemia	276.7
Hypopotassemia	276.8
Fluid overload	276.6
Abnormal blood chemistry nec	790.6
Abnormal coagulation profile	790.92
Long-term use anticoagulants	V58.61
Mechanical complication of cardiac device, implant, and graft	996.0x
Mechanical complication of other vascular device, implant, and graft	996.1
Chest Pain	786.50, 786.51, 786.52, 786.59
Other specified gastritis with hemorrhage	535.41
Abnormal chest sounds	786.7
Tietze's disease	733.6
Other postoperative infection	998.59
Other respiratory complications	997.39
Arteriovenous fistula, acquired	447.0
Benign intracranial hypertension	348.2

These ICD-9 codes, present in any field, will be used to identify related services during the measurement period.

Table CADPR-B2: Evaluation and management codes

Description	CPT Codes
General physician office visits	99201-99205, 99211-99215
Preventive medicine/screening	99394-99397, 99401-99404, 99411, 99412, 99420, 99429, 99384-99387
Observation care	99217-99220
Emergency dept care	99281-99285
Home health	99341-99345, 99347-99350
Skilled nursing facility	99304-99310, 99315, 99316, 99318, 99324-99328, 99334-99337
Office consultation	99241-99245
Unlisted	99455, 99456

These codes will be used to help identify those services that should be categorized as “E&M” during our analyses. Such services, when present during the measurement

period, are counted to determine the provider or providers to whom the episode will be attributed.

Table CADPR-B3: Repeat revascularizations

(see Table CADPR-A for repeat revascularizations performed during the measurement period)

Table CADPR-C: Codes to identify diagnostic procedures relevant to a CAD post-revascularization episode

Description	CPT	HCPCs	ICD-9 Procedure
Catheterizations	93510, 93511, 93524, 93526, 93527, 93528, 93529, 93530, 93531, 93532, 93533, 93539, 93540, 93545, 93555, 93556		
Stress Cardiac MR	75563, 75564		
Single photon emission computed tomography (SPECT)	78460, 78461, 78469, 78494, 78464, 78465, 78478, 78480	A9500, A9502, A9505, J0152, J1245, J1250	
Cardiac CT		0144T, 0145T	
Stress Positron Emission Tomography (PET)	78491, 78492		
Angiography	71275, 71555, 75635, 93508	0146T, 0147T, 0148T, 0149T, 0150T, 0151T	88.5, 88.50, 88.51, 88.52, 88.53, 88.54, 88.55, 88.56, 88.57, 88.58, 88.59
Positron Emission Tomography (PET)	78459		
Cardiac Monitors	93290, 93297, 93299		
Echocardiogram	93303, 93304, 93305, 93306, 93307, 93308, 93312, 93313, 93314, 93315, 93317, 93318, 93320, 93321, 93325, 93350	A9900	
Stress testing	93015, 93016, 93017, 93018, 93024		
Injections			
Tirofiban hcl, 6.25 mg		C9109	
Injection, argatroban		C9121	
Abciximab injection		J0130	
Adenosine injection		J0152	
Injection anistreplase 30 u		J0350	
Aprotonin, 10,000 kiu		J0365	
Bivalirudin		J0583	

Digoxin injection		J1160	
Digoxin immune fab (ovine)		J1162	
Dipyridamole injection		J1245	
Inj dobutamine HCL/250 mg		J1250	
Eptifibatide injection		J1327	
Inj heparin sodium per 10 u		J1642	
Inj heparin sodium per 1000u		J1644	
Dalteparin sodium		J1645	
Inj enoxaparin sodium		J1650	
Fondaparinux sodium		J1652	
Tinzaparin sodium injection		J1655	
Retepase injection		J2993	
Inj streptokinase /250000 IU		J2995	
Alteplase recombinant		J2997	
Tenecteplase injection		J3100	
Tirofiban hydrochloride		J3245	
Tirofiban HCl		J3246	
Injection torsemide 10 mg/ml		J3265	
Urokinase 5000 IU injection		J3364	
Urokinase 250,000 IU inj		J3365	

Table CADPR-D: Prescription medications related to CAD post-revascularization episode (during the measurement period)

Description	Medication		
ACE inhibitors	benazepril	captopril	Enalapril
	Fosinopril	lisinopril	Moexipril
	perindopril	quinapril	ramipril
	trandolapril		
Beta blockers	metoprolol	carvedilol	Bisoprolol
ARBs	candesartan	eprosartan	Irbesartan
	losartan	olmesartan	Telmisartan
	valsartan		

Table CADPR-E3: Active cancer treatment

Description	ICD-9 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 CADPR-E4: 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 CADPR-E5: 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 CADPR-E6: HIV-AIDS

Description	ICD-9 Diagnosis
HIV	042

Table CADPR-E7: Pregnancy

Description	CPT	ICD-9 Diagnosis
Normal Pregnancy		V22.x
Treat ectopic pregnancy	59120, 59121, 59130, 59135, 59136, 59140, 59150, 59151	
D & c after delivery	59160	
Insertion of cervical dilator	59200	
Episiotomy or vaginal repair	59300	
Revision of cervix	59320, 59325	
Repair of uterus	59350	
Obstetrical care	59400, 59409, 59410	
Antepartum manipulation	59412	
Deliver placenta	59414	
Antepartum care only	59425, 59426	
Care after delivery	59510, 59514, 59515, 59525	
Vbac delivery	59610, 59612, 59614	
Attempted vbac delivery	59618, 59620, 59622	
Treatment of miscarriage	59812, 59820, 59821	
Treat uterus infection	59830	
Abortion	59840, 59841, 59850, 59851, 59852, 59855, 59856, 59857, 59866	
Remove cerclage suture	59871	
Fetal invas px w/us	59897	
Laparo proc, ob care/deliver	59898	
Maternity care procedure	59899	
Ob us < 14 wks	76801, 76802	
Ob us >= 14 wks	76805, 76810	
Ob us	76811, 76812, 76813, 76814, 76815, 76816,	
Transvaginal us	76817	
Fetal biophys profile	76818, 76819	
Umbilical artery echo	76820	
Middle cerebral artery echo	76821	
Echo exam of fetal heart	76825	
Anesth	01958, 01960, 01961	
Complications of pregnancy, childbirth, and the puerperium		630-676

Table CADPR-E8: Other diagnoses to identify patients for exclusion from CAD post-revascularization measure

Description	ICD-9
Vasculitis	
Polyarteritis nodosa and allied conditions	446.xx
Arteritis, unspecified	447.6

Risk Adjustment Method

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

Episode Severity / Disease Staging

Patients included in the post-revascularization measure will be stratified by whether patients did or did not have multiple revascularizations during the 12-month measurement period (see **Table CADPR-A**).

Level of Measurement/Analysis

Measurement will take place at the level of the individual physician. All E&M codes for CAD care on separate dates during the measurement year will be identified (for acute care, count only one claim per event). Costs and resource use assigned to a single provider if that physician has at least 70% of the E&M claims during the measurement period (“single attribution”); OR
 If no provider has more than 70% of the E&M claims, costs and resource use are assigned to each of the providers that have at least 30% of the E&M claims for a patient during the measurement period (“multiple attribution”); OR
 If no provider has at least 30% of the E&M claims during the measurement period, the costs and resource use for that patient are not attributed to any provider (“no attribution”).

Technical Appendix

Episode-of-Care for Management of Coronary Artery Disease Post-Revascularization over 1-Year Period

Appendix Overview

The following document provides step-by-step methods for implementing the Episode-of-Care for Patients with Coronary Artery Disease (CAD) over a 1-year period post-revascularization measured 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 associated with management of patients with CAD over a one-year period post-revascularization (coronary artery bypass graft [CABG] or percutaneous coronary intervention [PCI]). Episode-related resource use for patients with CAD is identified and standardized costs are applied. Total CAD-related costs are calculated for each patient and summarized at the attributable provider level. Observed costs are compared to risk-adjusted expected costs at the provider 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 includes a 12-month identification period, a 12-month measurement period. The 12-month identification period is also used to identify exclusions and comorbidities for risk adjustment.

Definitions

Identification period	12-month period used to identify patients eligible for inclusion in the measure
Triggering event	A revascularization during the identification period
Prior period	12-month period before the triggering event
Measurement period	12-month period over which CAD-related resource use is measured; immediately follows triggering event
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 during the identification or measurement period will be defined as the patient's age at the first day of the identification period.
CAD-related¹	Healthcare encounters defined as being related to CAD care
Continuous enrollment	As identified in eligibility or enrollment information, full medical and pharmacy benefit enrollment during both the prior period and the measurement period
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

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

Section I – Eligible Population Identification

The process of identifying patients to be included in the measure is divided into four 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

Step 4: Combine prior steps to identify measure population

Step 1: Identify patients that meet episode inclusion criteria

- I. Identify patients that meet the following criteria

A revascularization during the identification period (see **Table CADPR-A**) The CPT, HCPCs or ICD-9 procedure codes, present in any field, will be used to identify CAD revascularization patients during the measurement period, regardless of corresponding ICD-9 codes. One-day hospitalizations cannot trigger episodes.

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

1. Age
 - a. Identify patients 18 years and older
2. Eligibility
 - a. Identify benefits during the measurement and prior period
 - b. To be included persons must have both of the following benefits
 - i. Medical benefit
 - ii. Pharmacy benefit
3. Continuous enrollment
 - a. Determine enrollment during both the measurement and prior period
 - b. To be eligible, persons must have medical and pharmacy coverage for the measurement period and prior period

Step 3: Identify patients with exclusion criteria

- I. Identify patients that meet one or more exclusion criteria during the prior period 12 months before the triggering event:
 - Patients with Acute myocardial infarction (AMI) (See **Table CADPR-EI** for codes) 14 to 365 days before the triggering event:

- Patients with revascularization (See **Table CADPR-E2** for codes):
 - Coronary artery bypass graft (CABG)
 - Percutaneous coronary intervention (PCI)
2. Identify patients that meet one or more exclusion criteria during the prior period OR the measurement period (**Tables CAD-E3 – CAD-E8**): active cancer, ESRD, organ transplant, HIV, pregnancy, vasculitis

Step 4: Combine prior steps to identify measure population

1. Identify eligible CAD post-revascularization population
2. Exclude those patients not meeting general inclusion criteria (e.g. age, continuous eligibility)
3. Exclude those 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 CAD-related diagnosis codes or procedure codes. These events will be used to determine the related resource use.

Inpatient and Outpatient events

Identify all inpatient and outpatient claims / encounters with a CAD-related diagnostic code appearing in *any* position (see **Table CADPR-BI**) or a subsequent revascularization (see **Table CADPR-A**).

Procedures and laboratory

Identify all claims / encounters with a CAD related CPT, HCPCs, or ICD-9 procedure codes (see **Tables CADPR-C, CADPR-D**). These procedure codes will be used to identify CADPR-related services during the measurement period, regardless of corresponding ICD-9 diagnosis codes.

Prescription drugs

Identify the CAD-related medications by therapeutic class or generic/brand medication name during the measurement period (See **Table CADPR-D**):

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 CAD-related.

Standard Cost Calculation

- Step 1** Identify all claims paid for services rendered during the measurement period 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 Aggregate Diagnostic Service Category (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 period. Include

stays that may have started before the measurement period or ended after the close of the measurement period. 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 period. Also identify the stay's LOS group based on the stay's LOS and the information contained in Table CADPR-LOS below.

Table CADPR-LOS: 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 period, use the total number of paid days as the per diem multiplier. If the inpatient stay does not fall completely inside the measurement period, count only the days within the measurement period (including the last day of the period) 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 periods. 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.²
- Step 6** Calculate the DRG-specific per-diem payment rate by adjusting the standard daily prices for inflation to a reference year using 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

² 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.

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.

Example³ Assume the calculated DRG-specific per-diem payment rate for DRG 127 for FY 2007 is \$900.17. An eligible member had an inpatient stay with the following characteristics:

- A principal diagnosis of 414.2
- A DRG of 127 (Heart Failure and Shock)
- A measurement period of January 1, 2007 to December 31, 2007
- 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 127 for FY 2007 is \$900.17. An eligible member had an inpatient stay with the following characteristics:

- A principal diagnosis of 414.2
- A DRG of 127 (Heart Failure and Shock)
- A measurement period of January 1, 2007 to December 31, 2007
- Date of admission of December 29, 2007 and date of discharge of January 4, 2008
- A LOS of 6 days, and a LOS per diem multiplier of 2 days (December 30-31).

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

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.⁴ An alternative would be to create average prices

³ Figures presented in this example are arbitrary and do not reflect any particular dataset or patient.

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.

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 of 493.1 (eligible event), and therefore 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 $\$1,474 \times 8 = \$11,792$.

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 period. The following pharmacy services should also be included:

- Prescriptions that may have been dispensed before the measurement period and had days supply that extended into the measurement period (e.g., a

prescription with a dispensed date of December 15, 2007 and 30 days supply would extend 13 days into a measurement period beginning January 1, 2008)

- Prescriptions that may have been dispensed during the measurement period and had days supply that extended into the following year (e.g., a prescription with a dispensed date of December 20, 2007 for a 30 days supply if the measurement period was from January 1, 2007 through December 31, 2007)

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 period.

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 period, 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 period, count only the days within the measurement period (including the last day of the period) 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 period. 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 period.
- 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 period. 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

Patients included in the post-revascularization measure will be stratified by whether patients did or did not have multiple revascularizations during the 12-month measurement period (see **Table CADPR-A**).

Section 5 – Calculation of total individual episode costs

The resource use identified as CAD-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 CAD-related events occurring during the measurement period at the BETOS level. This will provide an estimate of the costs of each category of service over the measurement period.

Step 2: For each individual in the episode, sum ALL total standard costs linked to CAD-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 period.

2. Tested 12 different model specifications shown in **Table CADPR-RAI**, 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., CAD for the CAD post revascularization episode), 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 CADPR-RAI. 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 CAD post-revascularization episode.

Risk Adjustment Model

CAD Post-Revascularization Episode Risk Adjusted Costs = \$13,175+ (Male*-\$871)+ (Specified Heart Arrhythmias*\$3,375)+ (Vascular Disease*\$3,934)+ (Renal Failure*\$1,880)+ (Septicemia/Shock*\$3,715)+ (Multiple Sclerosis*\$11,084)+ (Parkinsons and Huntingtons Diseases*\$17,716)+ (Respirator Dependence/Tracheostomy Status*\$9,932)+ (Cardio-Respiratory Failure and Shock*\$4,590)+ (Congestive Heart Failure*\$3,739)+ (Cerebral Hemorrhage*\$21,722)+ (Ischemic or Unspecified Stroke*\$2,837)+ (Vascular Disease with Complications*\$4,359)+ (Chronic Obstructive Pulmonary Disease*\$2,007)+ (Major Head Injury*-\$13,617)+ (Vertebral Fractures without Spinal Cord Injury*-\$11,872)

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 period, 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 CADPR-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 CADPR-RA2. Summary estimate of the average cost for the test episode

Average Cost	
CAD Post Revascularization	\$12,641

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 = \$15,169. Calculate the adjustment factor by dividing the costs from the current population by the average costs in Table CAD-RA2. That would result in an adjustment factor = 1.20 (15,169/12,641). These adjustment factors are then applied to the estimated coefficients to provide an adjusted risk adjustment model.

Adjusted Risk Adjustment Model

Risk and Mean Adjusted CAD Post-Revascularization Episode Costs = 1.20*

CAD Post-Revascularization Episode Risk Adjusted Cost

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

Section 7 – Determination of attributable provider

Resource use and costs for CAD post-revascularization episodes are attributed to one or more physicians on a hierarchical basis. The total counts of E&M codes by unique provider ID are used for provider attribution. For each episode identify all such E&M services occurring during the measurement period. The E&M codes are used to assign attribution using the following hierarchy:

1. Costs and resource use assigned to a single provider if that physician has at least 70% of the E&M claims during the measurement period (“single attribution”); OR
2. If no provider has more than 70% of the E&M claims, costs and resource use are assigned to each of the providers that have at least 30% of the E&M claims for a patient during the measurement period (“multiple attribution”); OR
3. If no provider has at least 30% of the E&M claims during the measurement period, the costs and resource use for that patient are not attributed to any provider (“no attribution”).

To identify the attributable provider, the following steps will be used:

Step 1: Identify qualifying E&M codes for the episode from **Table CADPR-B2**.

Step 2: For each individual included in the episode, sum the total qualifying E&M visits by each provider for that individual.

Step 3: Calculate the proportion of E&M visits for each provider that had a claim for each of the patients:

- Proportion of Care = Total count of provider’s E&M qualifying claims divided by total count of all qualifying E&M claims

Step 4: Assign attribution based on the hierarchical attribution model described above.

Section 8 – Creation of provider summaries

The provider summaries are a report of the resource use for an individual provider compared to their peer group, their non-peer group and 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: Summarize the observed, expected and observed-to-expected ratio for each attributable provider.

Step 4: Summarize the observed, expected and observed-to-expected ratio for each provider type.

Step 6: Summarize the observed, expected and observed-to-expected ratio for the all of the episodes.

Step 7: For each attributable provider, determine the proportion of observed-to-expected ratios above the 75% percentile of the peer group and calculate the 95% confidence interval

Step 8: Create provider summary reports for each attributable provider in the dataset (See CAD Post-Revascularization-Provider Summary below for example)

**CAD Post-Revascularization Episode
Provider Summary
Report for Physician #170632708**

Provider type = Cardiology

	MD	Peer Group	Non-Peer Group	National Avg
Episodes	12	3,189	8,179	11,380
Observed Costs*				
Average	\$ 16,740	\$ 13,142	\$ 13,372	\$ 13,311
Min	\$ 4,380	\$ 3,276	\$ 3,276	\$ 3,276
Median	\$ 16,724	\$ 9,513	\$ 9,444	\$ 9,465
Max	\$ 29,481	\$ 56,815	\$ 56,815	\$ 56,815
Predicted Costs				
Average	\$ 12,944	\$ 13,312	\$ 13,322	\$ 13,319
Min	\$ 12,303	\$ 12,303	\$ (1,313)	\$ (1,313)
Median	\$ 12,303	\$ 12,303	\$ 12,303	\$ 12,303
Max	\$ 18,244	\$ 30,282	\$ 41,991	\$ 41,991
Observed-to-Expected Ratio				
Average	1.31	0.99	1.00	1.00
Min	0.36	0.27	(5.83)	(5.83)
Median	1.23	0.72	0.72	0.72
Max	2.40	4.62	11.06	11.06
% ≥ 2.0	16.7%	8.7%	10.0%	10.3%
% ≥ 2.5	0%	5.5%	6.1%	7.1%

% ≥ 75th percentile peers 50.0% (21.1%, 78.9%)

* Observed costs adjusted for outliers (winsorized)

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 CAD 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.⁵

Step 1: Obtain BETOS files for the relevant period 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.

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

⁵ https://www.cms.gov/HCPCSRReleaseCodeSets/20_BETOS.asp

- For each type-of-service category for non-inpatient, non-pharmacy claims, summaries of the 20 CPT and HCPCs codes among CAD-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-CAD-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 related and non-related to the CAD post-revascularization episode
- For pharmacy claims, the 20 generic drug names and therapeutic classes most commonly appearing and accounting for the largest proportions of pharmacy costs: both related and non-related to the CAD post-revascularization episode.