Centers for Medicare & Medicaid Services

Office of the National Coordinator for
Health Information Technology

Electronic Clinical Quality Measure Logic and Implementation Guidance

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Table of Contents

List of Figures

List of Tables

1 Introduction

The Centers for Medicare & Medicaid Services (CMS) and the Office of the National Coordinator for Health Information Technology (ONC), based on research contributions of knowledgeable stakeholders in the electronic Clinical Quality Measures (eCQM) community, provide this guidance document for use with the updated Eligible Hospital (EH) and Eligible Professional (EP) measure specifications released on April 6, 2016 for the Eligible Professional and Eligible Hospital Electronic Clinical Quality Measures, initially released on December 21, 2012.

This document provides guidance for those interested in understanding, using, and/or implementing the clinical quality measure (CQM) electronic specifications. These specifications are released for eCQMs for eReporting for the 2017 Performance Period under CMS's Meaningful Use (MU) Electronic Health Record (EHR) Incentive Program. CMS and ONC strongly recommend that you review this document along with the electronic specifications for the eCQMs, which include human-readable descriptions and XML files, to build a complete understanding of each measure's intent and operation prior to any implementation. Updates to the information in this document and additional help can be found on the eCQI Resource Center.

This document provides the following information:

1. Sections 2 through 5 provide general implementation guidance, including defining how specific logic and data elements should be conceptualized and addressed during implementation of eCQMs.
2. The appendices provide additional detail on the technical release notes for the 2016 update, measure versioning, time interval calculations, and documentation for the calculation in CMS179.

For more information regarding measure titles, endorsement, and versioning, please see Appendix A – Versioning and Endorsement.

CMS and the Office of the National Coordinator for Health Information Technology (ONC) have implemented a system to allow vendors, implementers, providers, and other stakeholders to report issues or ask questions about the measure intent, specifications, certification, reporting, standards, and policy related to the EHR Incentive Program. Users can use the system to search for existing issues and questions or report new issues directly to the agencies through the website http://oncprojectracking.org/. A free username is required for most issue reporting to ensure that users may track the progress of their issue as it is resolved. A homepage with some resources for new users is available at http://oncprojectracking.org/.

For additional information that is directly relevant to implementing the 2016 eCQM updates, please refer to the following resources and standards:

1. CMS Clinical Quality Measures on the CMS Website
2. eCQI Resource Center
3. Quality Data Model
4. Measure Authoring Tool

5. Cypress – CQM Certification
6. JIRA eCQM Feedback Reporting System
7. Clinical Document Architecture (CDA) R2
8. Health Quality Measures Format (HQMF) R2.1
9. QDM-based HQMF Implementation Guide R1.2
10. Quality Reporting Document Architecture QRDA-I R3.1 (publication expected April 2016)
11. QRDA-III R1.1 (publication expected April 2016)
12. CMS QRDA IG (publication expected July 2016)

2 Electronic Clinical Quality Measure Types

Clinical quality measures can be classified based on the unit of scoring—patients or episodes—and how the score is computed—proportion or continuous variable. This section describes these classifications. Subsequent sections provide more detail on computing these measures.

2.1 Patient-based Measures

Measures that evaluate the care of a patient and assign the patient to membership in one or more populations are called patient-based measures. The vast majority of the eligible professional eCQMs are patient based.

All of the information in the patient record referenced in the measure must be considered when computing a patient-based measure. The criteria for inclusion of a patient in a measure population may require that conditions be satisfied during multiple episodes of care—for example, a diagnosis occurring in one episode of care and treatment happening in a subsequent episode of care. An episode of care is defined by the National Quality Forum (NQF) as a series of temporally contiguous healthcare services related to the treatment of a given spell of illness or provided in response to a specific request by the patient or other relevant entity. In other words, an episode of care is defined as all care provided within a setting—and the measure is about all such treatments (e.g., all admissions with specific criteria or a hospitalization and the care given before and after such an event).

2.2 Episode-of-Care Measures

Measures that evaluate the care during a patient-provider encounter, sometimes called an episode of care, and assign the episode of care to one or more populations are called episode-of-care measures. All of the Eligible Hospital measures are episode-of-care measures, as are 8 of the 64 of the Eligible Professional measures. In an episode-of-care measure, the episodes of care are identified in the Initial Population (IP). An episode based on a specific event that must be referenced in other segments of the measure (Initial Population, Denominator, Numerator, etc.), must also indicate a specific occurrence. For example, in measure CMS55, the IP identifies all inpatient encounters that are to be scored as “Occurrence A of Encounter, Performed: Encounter Inpatient”. The Measure Population identifies the associated emergency department (ED) visits that led to inpatient encounters as “Occurrence A of Encounter, Performed: Emergency Department Visit”. The measure observations are averaged over these ED visits.

Measures that include an “item count” are episode based. If “item count” is not included, the measure defaults to a patient-based measure (see Table 1 and Table 2).

2.3 Proportion Measures

Most of the eCQMs are proportion measures. In a proportion measure, the scored entities (either patients or episodes) for a collection of patients are assigned to the populations and strata defined by an eCQM, and the appropriate “rates” are computed. For example, if any one of the MU2 Eligible Hospital eCQM (all of which are episode-of-care) is computed for a collection of 100 patients with a total of 132 episodes of care (as defined by the measure), each population defined by the measure can contain between 0 and 132 episodes.

The populations defined by a proportion measure are:

- Initial Population (IPP): The set of patients or episodes of care to be evaluated by the measure.
- Denominator (DENOM): A subset of the IPP.
- Denominator Exclusions (DENEX): A subset of the Denominator that should not be considered for inclusion in the Numerator.
- Denominator Exceptions (DEXCEP): A subset of the Denominator. Only those members of the Denominator that are considered for Numerator membership and are not included are considered for membership in the Denominator Exceptions.
- Numerator (NUMER): A subset of the Denominator. The Numerator criteria are the processes or outcomes expected for each patient, procedure, or other unit of measurement defined in the Denominator.
- Numerator Exclusions (NUMEX): A subset of the Numerator that should not be considered for calculation.

The computation of a proportion measure proceeds as follows:

1. Patients or episodes of care are classified using the IPP criteria, and those satisfying the criteria are included in the IPP.
2. The members of the IPP are classified using the Denominator criteria, and those satisfying the criteria are included in the Denominator.
3. The members of the Denominator are classified using the Denominator Exclusion criteria, and those satisfying the criteria are included in the Denominator Exclusions.
4. The members of the Denominator that are not in the Denominator Exclusion population are classified using the Numerator criteria, and those satisfying the criteria are included in the Numerator.
5. Those members of the Denominator that were considered for membership in the Numerator, but were rejected, are classified using the Denominator Exceptions criteria, and those satisfying the criteria are included in the Denominator Exceptions.

For eCQMs with multiple numerators and/or strata, each patient/episode must be scored for inclusion/exclusion to *every* population. For example, if an eCQM has three numerators and the patient is included in the first numerator, the patient should be scored for inclusion/exclusion from the populations related to the other numerators as well. When the measure definition includes stratification, each population in the measure definition should be reported both *without* stratification and *stratified* by each stratification criteria.

Specific programs may require reporting of performance rates, but these are not required for certification. The performance rate is defined as: Rate = N/(D – DENEX – DEXCEP)

2.4 Continuous Variable Measures

Continuous variable measures can be either episode or patient based. They include the following elements:

- **Initial Population** of patients or episodes, roughly analogous to the Denominator in proportion measures
- **Measure Population** (subset of Initial Population), roughly analogous to the Numerator in proportion measures
- **Measure Observations** describe the computation to be performed over the members of the Measure Population. For example, measure CMS55 computes the median for the difference between the ED arrival and departure times over all ED visits in the Measure Population.

The computation of a continuous variable measure proceeds as follows:

1. Patients or episodes of care are classified using the IPP criteria, and those satisfying the criteria are included in the IPP.
2. The members of the IPP are classified using the Measure Population criteria, and those satisfying the criteria are included in the Measure Population.
3. Each member of the Measure Population is evaluated according to the criteria defined in the Measure Observations criteria, and all of these results are aggregated using the specified operator.

Results should be reported for each population without stratification as well as for each defined stratum separately. Results for a continuous variable measure, such as the IPP and Measure Population, require specifying the number of patients or episodes that fall into each of these populations without stratification, as well as stratified by any defined strata. The aggregated continuous variable computed, defined by the Measure Observation, should be reported for the unaggregated Measure Population, as well as for each stratum of the Measure Population.

Specific programs may require reporting of specific reporting and performance rates, but these are not required for certification. Table 1 lists the Eligible Professional eCQMs, while Table 2 lists the Eligible Hospital eCQMs.

Table 1. Eligible Professional eCQM Types and Versions

eCQM ID#	NQF #	Title	Type	Patient / Episode	Version
2	0418	Preventive Care and Screening: Screening for Clinical Depression and Follow-Up Plan	Proportion	Patient	6
22	Not Applicable	Preventive Care and Screening: Screening for High Blood Pressure and Follow-Up Documented	Proportion	Patient	5

eCQM ID#	NQF #	Title	Type	Patient / Episode	Version
50	Not Applicable	Closing the Referral Loop: Receipt of Specialist Report	Proportion	Patient	5
52	0405	HIV/AIDS: Pneumocystis Jiroveci Pneumonia (PCP) Prophylaxis	Proportion	Patient	5
56	Not Applicable	Functional Status Assessment for Total Hip Replacement	Proportion	Patient	5
61	Not Applicable	Preventive Care and Screening: Cholesterol – Fasting Low Density Lipoprotein (LDL-C) Test Performed	Proportion	Patient	6
62	Not Applicable	HIV/AIDS: Medical Visit	Proportion	Patient	5
64	Not Applicable	Preventive Care and Screening: Risk-Stratified Cholesterol – Fasting Low Density Lipoprotein (LDL-C)	Proportion	Patient	6
65	Not Applicable	Hypertension: Improvement in Blood Pressure	Proportion	Patient	6
66	Not Applicable	Functional Status Assessment for Total Knee Replacement	Proportion	Patient	5
68	0419	Documentation of Current Medications in the Medical Record	Proportion	Episode	6
69	0421	Preventive Care and Screening: Body Mass Index (BMI) Screening and Follow-Up Plan	Proportion	Patient	5
74	Not Applicable	Primary Caries Prevention Intervention as Offered by Primary Care Providers, including Dentists	Proportion	Patient	6
75	Not Applicable	Children Who Have Dental Decay or Cavities	Proportion	Patient	5
77	Not Applicable	HIV/AIDS: RNA Control for Patients with HIV	Proportion	Patient	5
82	Not Applicable	Maternal Depression Screening	Proportion	Patient	4
90	Not Applicable	Functional Status Assessment for Congestive Heart Failure	Proportion	Patient	6
117	0038	Childhood Immunization Status	Proportion	Patient	5
122	0059	Diabetes: Hemoglobin (HbA1c) Poor Control (>9%)	Proportion	Patient	5
123	0056	Diabetes: Foot Exam	Proportion	Patient	5

eCQM ID#	NQF #	Title	Type	Patient / Episode	Version
124	0032	Cervical Cancer Screening	Proportion	Patient	5
125	2372	Breast Cancer Screening	Proportion	Patient	5
126	Not Applicable	Use of Appropriate Medications for Asthma	Proportion	Patient	5
127	0043	Pneumococcal Vaccination Status for Older Adults	Proportion	Patient	5
128	0105	Anti-depressant Medication Management	Proportion	Patient	5
129	0389	Prostate Cancer: Avoidance of Overuse of Bone Scan for Staging Low Risk Prostate Cancer Patients	Proportion	Patient	6
130	0034	Colorectal Cancer Screening	Proportion	Patient	5
131	0055	Diabetes: Eye Exam	Proportion	Patient	5
132	0564	Cataracts: Complications within 30 Days Following Cataract Surgery Requiring Additional Surgical Procedures	Proportion	Episode	5
133	0565	Cataracts: 20/40 or Better Visual Acuity within 90 Days Following Cataract Surgery	Proportion	Episode	5
134	0062	Diabetes: Medical Attention for Nephropathy	Proportion	Patient	5
135	2907	Heart Failure (HF): Angiotensin-Converting Enzyme (ACE) Inhibitor or Angiotensin Receptor Blocker (ARB) Therapy for Left Ventricular Systolic Dysfunction (LVSD)	Proportion	Patient	5
136	0108	ADHD: Follow-Up Care for Children Prescribed Attention-Deficit/Hyperactivity Disorder (ADHD) Medication	Proportion	Patient	6
137	0004	Initiation and Engagement of Alcohol and Other Drug Dependence Treatment	Proportion	Patient	5
138	0028	Preventive Care and Screening: Tobacco Use: Screening and Cessation Intervention	Proportion	Patient	5
139	0101	Falls: Screening for Future Fall Risk	Proportion	Patient	5

eCQM ID#	NQF #	Title	Type	Patient / Episode	Version
140	0387	Breast Cancer: Hormonal Therapy for Stage I (T1b)-IIIC Estrogen Receptor/ Progesterone Receptor (ER/PR) Positive Breast Cancer	Proportion	Patient	5
141	0385	Colon Cancer: Chemotherapy for AJCC Stage III Colon Cancer Patients	Proportion	Patient	6
142	0089	Diabetic Retinopathy: Communication with the Physician Managing Ongoing Diabetes Care	Proportion	Patient	5
143	0086	Primary Open-Angle Glaucoma (POAG): Optic Nerve Evaluation	Proportion	Patient	5
144	2908	Heart Failure (HF): Beta-Blocker Therapy for Left Ventricular Systolic Dysfunction (LVSD)	Proportion	Patient	5
145	Not Applicable	Coronary Artery Disease (CAD): Beta-Blocker Therapy–Prior Myocardial Infarction (MI) or Left Ventricular Systolic Dysfunction (LVEF < 40%)	Proportion	Patient	5
146	Not Applicable	Appropriate Testing for Children with Pharyngitis	Proportion	Episode	5
147	0041	Preventive Care and Screening: Influenza Immunization	Proportion	Patient	6
148	Not Applicable	Hemoglobin A1c Test for Pediatric Patients	Proportion	Patient	5
149	Not Applicable	Dementia: Cognitive Assessment	Proportion	Patient	5
153	0033	Chlamydia Screening for Women	Proportion	Patient	5
154	0069	Appropriate Treatment for Children with Upper Respiratory Infection (URI)	Proportion	Episode	5
155	0024	Weight Assessment and Counseling for Nutrition and Physical Activity for Children and Adolescents	Proportion	Patient	5
156	0022	Use of High-Risk Medications in the Elderly	Proportion	Patient	5

eCQM ID#	NQF #	Title	Type	Patient / Episode	Version
157	0384	Oncology: Medical and Radiation – Pain Intensity Quantified	Proportion	Episode	5
158	Not Applicable	Pregnant women that had HBsAg testing	Proportion	Patient	5
159	0710	Depression Remission at Twelve Months	Proportion	Patient	5
160	0712	Depression Utilization of the PHQ-9 Tool	Proportion	Patient	5
161	0104	Adult Major Depressive Disorder (MDD): Suicide Risk Assessment	Proportion	Episode	5
163	Not Applicable	Diabetes: Low Density Lipoprotein (LDL-C) Control (<100 mg/dL)	Proportion	Patient	5
164	0068	Ischemic Vascular Disease (IVD): Use of Aspirin or Another Antiplatelet	Proportion	Patient	5
165	0018	Controlling High Blood Pressure	Proportion	Patient	5
166	0052	Use of Imaging Studies for Low Back Pain	Proportion	Patient	6
167	0088	Diabetic Retinopathy: Documentation of Presence or Absence of Macular Edema and Level of Severity of Retinopathy	Proportion	Patient	5
169	Not Applicable	Bipolar Disorder and Major Depression: Appraisal for alcohol or chemical substance use	Proportion	Patient	5
177	1365	Child and Adolescent Major Depressive Disorder (MDD): Suicide Risk Assessment	Proportion	Episode	5
179	Not Applicable	ADE Prevention and Monitoring: Warfarin Time in Therapeutic Range	Continuous Variable	Patient	5
182	Not Applicable	Ischemic Vascular Disease (IVD): Complete Lipid Profile and LDL-C Control (<100mg/dL)	Proportion	Patient	6

Table 2. Eligible Hospital eCQM Types and Versions

eCQM ID #	NQF #	Title	Type	Patient / Episode	Version
9	0480	Exclusive Breast Milk Feeding	Proportion	Episode	5
26	Not Applicable	Home Management Plan of Care (HMPC) Document Given to Patient/Caregiver	Proportion	Episode	4
30	Not Applicable	Statin Prescribed at Discharge	Proportion	Episode	6
31	1354	Hearing Screening Prior to Hospital Discharge	Proportion	Episode	5
32	0496	Median Time from ED Arrival to ED Departure for Discharged ED Patients	Continuous Variable	Episode	6
53	0163	Primary PCI Received Within 90 Minutes of Hospital Arrival	Proportion	Episode	5
55	0495	Median Time from ED Arrival to ED Departure for Admitted ED Patients	Continuous Variable	Episode	5
60	Not Applicable	Fibrinolytic Therapy Received Within 30 Minutes of Hospital Arrival	Proportion	Episode	5
71	0436	Anticoagulation Therapy for Atrial Fibrillation/Flutter	Proportion	Episode	6
72	0438	Antithrombotic Therapy By End of Hospital Day 2	Proportion	Episode	5
73	0373	Venous Thromboembolism Patients with Anticoagulation Overlap Therapy	Proportion	Episode	5
91	0437	Thrombolytic Therapy	Proportion	Episode	6
100	0142	Aspirin Prescribed at Discharge	Proportion	Episode	5
102	0441	Assessed for Rehabilitation	Proportion	Episode	5
104	0435	Discharged on Antithrombotic Therapy	Proportion	Episode	5
105	0439	Discharged on Statin Medication	Proportion	Episode	5
107	Not Applicable	Stroke Education	Proportion	Episode	5
108	0371	Venous Thromboembolism Prophylaxis	Proportion	Episode	5
109	Not Applicable	Venous Thromboembolism Patients Receiving Unfractionated Heparin with Dosages/Platelet Count Monitoring by Protocol or Nomogram	Proportion	Episode	5

eCQM ID #	NQF #	Title	Type	Patient / Episode	Version
110	Not Applicable	Venous Thromboembolism Discharge Instructions	Proportion	Episode	5
111	0497	Median Admit Decision Time to ED Departure Time for Admitted Patients	Continuous Variable	Episode	5
113	0469	Elective Delivery	Proportion	Episode	5
114	Not Applicable	Incidence of Potentially-Preventable Venous Thromboembolism	Proportion	Episode	5
171	0527	Prophylactic Antibiotic Received Within One Hour Prior to Surgical Incision	Proportion	Episode	6
172	0528	Prophylactic Antibiotic Selection for Surgical Patients	Proportion	Episode	6
178	Not Applicable	Urinary catheter removed on Postoperative Day 1 (POD 1) or Postoperative Day 2 (POD 2) with day of surgery being day zero	Proportion	Episode	6
185	0716	Healthy Term Newborn	Proportion	Episode	5
188	0147	Initial Antibiotic Selection for Community-Acquired Pneumonia (CAP) in Immunocompetent Patients	Proportion	Episode	6
190	0372	Intensive Care Unit Venous Thromboembolism Prophylaxis	Proportion	Episode	5

3 Measure Logic

The posted Health Quality Measures Format (HQMF) artifacts for the 2016 eCQMs, together with the documentation provided here, have a single, consistent interpretation capable of testing using the Cypress certification testing tool. This section provides clarification and guidance on the correct interpretation of the eCQMs and their implementation. The eCQMs have been carefully reviewed to ensure that the intent of the measure stewards is accurately reflected when the measures are interpreted according to the guidance in this document. The logic and data elements for the eCQMs are specified using the Quality Data Model (QDM) version 4.2 published in August 2015.

3.1 Evaluating QDM Logic

The evaluation of measure specifications differs from a typical procedural specification. A measure is composed of populations (such as Denominator, Numerator, etc.), and each population is composed from "lines" of logic that comprise a single AND/OR statement. The order of the lines within a population does not determine the computed result. Within a line, logic is evaluated according to the order of operations described in the following subsections. The only way to link the events described in one line of logic with those in another line of logic is through the use of specific occurrences, described subsection 3.3.

3.2 Operator Precedence

Within a single AND/OR statement, the precedence of operators is as follows:

1. Event code matches value set code. (Select procedures from patient based on matching code as defined by the value set.)
2. Events filtered by an element's data type context (e.g., performed, ordered, and administered)
3. Events filtered by negation rationale (i.e., Not done: reason not done)
4. Events filtered by attribute value set criteria (e.g., source, severity, and facility location)
5. Event filtered by temporal constraints (i.e., Starts After Start, During …)
6. Events filtered by value restriction (i.e., Ejection Fraction > 40%)
7. Event filtered by subset operator (FIRST, SECOND, MOST RECENT)
8. "Assign" the specific occurrence

The order of applying the subset operators is *critical* because the order in which subset operators are applied can change the results of execution. For instance, the result of selecting the first procedure and then restricting temporally to "during the measurement period" could produce a different result than restricting procedures temporally to "during the measurement period" and then selecting the first such procedure.

3.3 Specific Occurrences

Specific occurrences are the most challenging aspect of the QDM logic from an implementation perspective. This subsection describes the use and computation of specific occurrences informally. Section 4 describes QDM idioms that incorporate specific occurrences. The document "Implementing Computation of Specific Occurrences," available via the Cypress testing tool website (http://projectcypress.org), provides additional detail.

3.3.1 Simple Usage of Specific Occurrences

In the measure logic for eCQMs, there are labels corresponding to specific occurrences (e.g., "`Occurrence A of Procedure, Performed: Colonoscopy`"). When a specific occurrence of an event is specified in multiple clauses linked by AND in the logic, the logic is only satisfied if the logical statements evaluate to true using a specific (single) instance of the event.

As an example from CMS172, a patient may have had `IV, IM, PO Antimicrobial Medications` administered many times in an Inpatient encounter. The following logic assures that only patients who were administered those medications during the Inpatient encounter were the same as the encounter where they were given `General or Neuraxial Anesthesia`. In addition, the logic enforces that the Medication should be the ones whose administration route is `Route IV, oral or IM` and given more than `1440 minute(s)` before the anesthesia.

```
AND: "Occurrence A of Medication, Administered: IV, IM, PO
Antimicrobial Medications (route: Route IV, oral or IM)" >
1440 minute(s) starts before start of ("Occurrence A of
Procedure, Performed: General or Neuraxial Anesthesia"
during Occurrence A of $EncounterInpatient)

AND: "Occurrence A of Medication, Administered: IV, IM, PO
Antimicrobial Medications" during Occurrence A of
$EncounterInpatient
```

When an occurrence is not specified (e.g., "`Medication, Administered: IV, IM, PO Antimicrobial Medications`"), the measure refers to any instance of that event within the specified time period.

3.3.2 Multiple Specific Occurrences of the Same Event Type

A logical clause may reference other (distinct) specific occurrences of a particular type or specific occurrences of a different type. The following example from CMS144 references two specific occurrences of type "`Physical Exam, Performed: Heart Rate`" with a result less than 50 bpm:

```
AND: Most Recent: "Occurrence B of Physical Exam,
Performed: Heart Rate" starts before start of "Occurrence A
of Physical Exam, Performed: Heart Rate"
```

```
AND: "Occurrence A of Physical Exam, Performed: Heart Rate
(result < 50 bpm)" during Occurrence A of $HFEncounters144

AND: "Occurrence B of Physical Exam, Performed: Heart Rate
(result < 50 bpm)" during Occurrence A of $HFEncounters144
```

Specific occurrences of the same type will be referenced with an alphabetically incrementing label (e.g., "`Occurrence B`"). The order of the labeling does not have *any* significance other than indicating that they represent different instances. Specifically, no temporal relationship is implied by the alphabetical ordering of the occurrences; `Occurrence A` does not necessarily occur prior to `Occurrence B`. When a measure references `Occurrence A` and `Occurrence B` of an event type [i.e., `Physical Exam, Performed: Heart Rate(result < 50 bpm`)], the logic of the measure will evaluate true when `Occurrence A` and `Occurrence B` reference *distinct* instances of an event type. In the previous example, the logic is looking for two *different* heart rate measurements that are less than 50 bpm. Both measurements must occur during the same encounter as defined in the last two statements, and the `Most Recent` measurement ("`Occurrence B`") must start before the start of ("`Occurrence A`"), as defined in the first statement.

3.3.3 Multiple Specific Occurrences of the Different Event Types

Logic clauses can also reference occurrences of different types. The following example from CMS52, has specific occurrences referencing two different medications and a laboratory test result:

```
AND: "Occurrence A of Medication, Order: Dapsone and
pyrimethamine" < 3 month(s) starts after end of "Occurrence
A of Laboratory Test, (Result: CD4+ Count)"

AND: "Occurrence A of Medication, Order: Leucovorin" < 3
month(s) starts after end of "Occurrence A of Laboratory
Test, (Result: CD4+ Count)"
```

This logic will evaluate to true when a Laboratory Test, Result: CD4+ Count exists such that there are medication orders for "Dapsone and pyrimethamine" and "Leucovorin," and both start less than 3 months of the end of the lab test.

3.3.4 Specific Occurrences in OR Clauses and Negations

When multiple logical statements referencing a specific occurrence are joined by an OR clause, the logic can evaluate to true if there is an event that satisfies the specific occurrence that satisfies the logic in *at least one* of the branches of the OR clause. When logical statements containing specific occurrences are used as part of a negated clause (e.g., "AND NOT"), the specific occurrence of the event must either evaluate to false for the negated logic clause, or a viable specific occurrence for the event must not exist. In other words, in a negated clause, the specific occurrence must not evaluate to true, or the event must not exist. The case where an event does not exist is important where a specific occurrence is only referenced in negated clauses within a measure. If a specific occurrence is referenced by both negated and non-negated

clauses, then it must exist for the logic of the measure to hold, and it must evaluate to false for the negated logic.

3.3.5 Specific Occurrences between Populations

Conditions applied to specific occurrences carry forward from one population criteria to the next in the order they are calculated. See subsection 3.3.2 for details on the calculation order of the measures.

For instance, consider an encounter with "Occurrence A" restricted to the Measurement Period in the "Initial Population". That occurrence will carry into the "Denominator," thus restricting it to the Measurement Period as well. Similarly, occurrences in the "Denominator" will carry into the "Numerator". Thus, when a measure has two or more "Initial Population", the reference to that specific occurrence ("Occurrence A") will indicate the same instance whether it is the first of the "IPP"s or the second. In such cases, if the second "IPP" would like to evaluate a second instance, it would have to be referenced differently ("Occurrence B").

For "Denominator Exclusions," it is the negation of the specific occurrence conditions that is carried forward into the "Numerator." Consider an episode-of-care measure where an episode is excluded if the patient is pregnant during the encounter. In this case, the encounters where the patient was NOT pregnant will be considered for the Numerator.

Similarly, the negation of the conditions applied to the specific occurrences in the "Numerator" carry forward into the "Denominator Exceptions." This allows the "Denominator Exceptions" to only consider occurrences that did not evaluate to true in the "Numerator."

3.4 Computing Time Intervals

Assessing the relative timing of events within a patient's medical record is an essential part of computing eCQMs. To enable unambiguous interpretation of the eCQMs, clear definition of the computation of time intervals is required. A simple expression such as "the treatment must occur within 3 days of the diagnosis" has a number of possible interpretations, including "the treatment must occur within 72 hours of the diagnosis" and "the treatment must happen within 3 business days of the diagnosis." A mathematical definition of the computation of time durations in conjunction with the temporal operators used in the eCQMs is required to support consistent interpretation. Appendix C provides this definition, which should be strictly implemented.

3.5 Subset Operators

Subset operators (e.g., FIRST) require a temporally sorted set of events. Timestamps are determined for each event by first looking for an event start time and then looking for an event end time. FIRST extracts the events with the earliest timestamp, and MOST RECENT extracts the event with the latest timestamp. When a subset operator is applied to more than one data criteria, then all events are combined (i.e., as if the UNION operator were applied) regardless of the conjunction operator. In other words:

```
FIRST:
    AND Diagnosis A
    AND Diagnosis B
```

Is equivalent to

```
FIRST:
     OR Diagnosis A
     OR Diagnosis B
```

The subset operators strictly apply to left-most events in the logic they encompass. For example:

```
MOST RECENT:
     OR Diagnosis A starts after start of Procedure X
     OR Diagnosis A starts after start of Procedure Y
     OR Procedure Z starts after start of Diagnosis A
```

This would return the most recent “Diagnosis A” or “Procedure Z” that meets the given temporal criteria. If one sought instead the most recent “Diagnosis A” that meets the given criteria, the logic could be restructured as:

```
MOST RECENT:
     OR Diagnosis A starts after start of Procedure X
     OR Diagnosis A starts after start of Procedure Y
     OR Diagnosis A starts before start of Procedure Z
```

This now returns the only “Diagnosis A” events and ensures they meet the temporal limitations.

Additionally, subset operators are non-associative operations with respect to other operations used within the QDM. Therefore, the order that subset operators are applied will impact the result of the calculation. Subsection 3.2 outlines operator precedence in the QDM. Applying subset operators in a different order can change the results of the calculation.

3.5.1 Subset Operators and Specific Occurrences

Applying subset operators to specific occurrences is awkward. Specific occurrences represent a single instance of an event, and all conditions logically bound to a specific occurrence must apply to that instance. The single-instance nature of specific occurrences is at odds with subset operators such as FIRST, SECOND, MOST RECENT, etc. that act on sets of events. Essentially, this forces specific occurrences to be treated as both a single instance and a set of events as part of measure calculation.

Subset operators are applied, however, to specific occurrences almost exclusively within the context of a single logical statement. This allows the specific occurrence to be constrained to a single event before calculation progresses beyond the evaluation of a single statement, limiting the impact of having to treat specific occurrences as both a set of events and a single event. The following example shows a specific occurrence with a subset operator applied:

```
AND: FIRST: “Occurrence A of X” during “Measurement Period”
AND: “Occurrence A of X” starts after start of “Encounter
Performed: Y”
```

In this example, the defined order of operations restricts “Occurrence A of X” to the first event X during the measurement period, and that first event X must have an encounter of type Y that begins after the start of it.

3.6 COUNT Operator Usage

When the COUNT operator is applied to a disjunction of events, it will assess the size of the set of events reflecting the `Union` of the events during the `Measurement Period`. In the following example, COUNT is used to assess whether there were two or more encounters of types listed in the logic.

`Count>= 2: Union of:`

- `"Encounter, Performed: Office Visit"`
- `"Encounter, Performed: Outpatient Consultation"`
- `"Encounter, Performed: Nursing Facility Visit"`
- `"Encounter, Performed: Care Services in Long-Term Residential Facility"`
- `"Encounter, Performed: Home Healthcare Services"`
- `"Encounter, Performed: Patient Provider Interaction" during "Measurement Period"`

In some eCQMs (e.g., the denominator of Eligible Professional measure CMS64), COUNT will be applied to determine how many of the OR branches are true. In these cases, the logic has been constructed with a subset operator in each OR branch and assesses the number of encounter types, not the total number of encounters.

```
COUNT > 2
     OR:   FIRST: “Encounter performed: Office visit”
     OR:   FIRST: “Encounter performed: Nursing facility”
     OR:   FIRST: “Encounter performed: Home Health visit”
     OR:   FIRST: “Encounter performed: Outpatient visit”
```

3.7 Temporal Logic Operators

Within the QDM, events (e.g., “Procedure, Performed”) have start and end times. Some events have attributes that include start and end time (e.g., facility location). The QDM temporal operators are statements that relate the intervals defined by these start and end times to each other. Some intervals may only have start or end times specified. An interval with a “null” start time is considered to have started at an unknown time relative to the end time of the interval, whiles an interval with a “null” end time is considered to be ongoing. In other words, if the start time or the end time is missing, (e.g., *null*), the comparison will always evaluate to *false*. In such instances, an *Ends Before Start of* logical operator returns false if the left-hand side event has a missing end time or the right-hand side event has a missing start time.

The temporal logic operators in the MU eCQMs have strict definitions that differ from standard English usage. For the term “A during B”, the definition of during requires that event A start

after or concurrent with B, and end before or concurrent with B. In other words, the time interval of event A is *fully contained* within the time interval of B. If A starts before B and ends during or after B, it is not "during" B. To express that "A overlaps B"—that is, the time intervals of events A and B intersect, see subsection 4.1.

Note that for "A during B" to be true, A must have specified start and end times. Some data elements in medical records, for example diagnoses of chronic conditions, can be open ended. Such an event can neither contain another event temporally or be contained. In other words, if a chronic condition represented without a stop date is event A, there is no event B such that "A During B" or "B During A" is true.

Two events are considered "concurrent with" each other only if their start and end times are the same, ignoring seconds (i.e., within one minute of each other). This level of time resolution is too precise for most related events in the MU2 eCQMs, and thus, the "concurrent with" operator is rarely used.

"During," and all other temporal relationships such as "starts before the start of" and "starts after the start of", are defined in the Health Level Seven International (HL7) version 3 Vocabulary Standard. Figure 1 provides examples of some of these relationships.

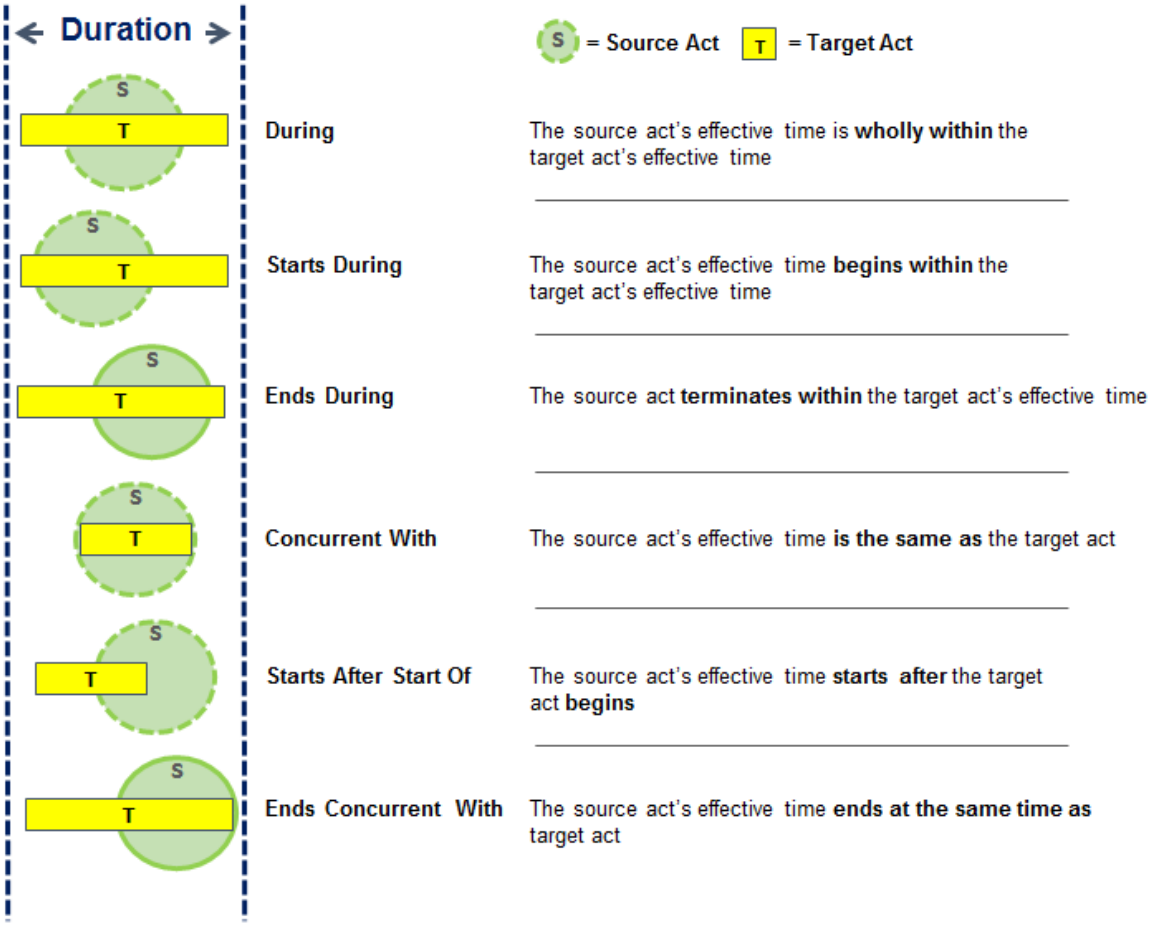

Figure 1. Definitions for "During" and "Concurrent With"

Temporal logic operators can also be applied to a series of logical statements. For example:

```
AND:
     OR: Medication A starts after start of Procedure X
     OR: Diagnosis B starts after start of Procedure X
     OR: Procedure C starts after start of Procedure X
```

Notice that all of the statements have the same temporal constraint of "starts after start of Procedure X". To help simplify the logic, we can move this to its own statement. The constraint will then apply to all other logic statements at the same indentation level, regardless of the ordering. The following example is logically equivalent to the original logic:

```
AND:
     OR: Medication A
     OR: Diagnosis B
     OR: Procedure C
     starts after start of Procedure X
```

Also note that the temporal constraint can only be applied once per indentation level. For example, if we wanted to further limit all events to "start before start of Procedure Y", the logic would need multiple levels of hierarchy and would look like:

```
AND:
     AND:
          OR: Medication A
          OR: Diagnosis B
          OR: Procedure C
          starts after start of Procedure X
     starts before start of Procedure Y
```

This now has the effect of limiting events to those that start after "Procedure X" but before "Procedure Y".

It is also important to recognize that the temporal constraints only apply to left-most data elements in the statements they encompass. Consider the following logic:

```
AND:
     OR: Medication A during Encounter Y
     OR: Diagnosis B
     OR: Procedure C
     starts after start of Procedure X
```

The “starts after start of Procedure X” constraint only applies to “Medication A”, “Diagnosis B”, and “Procedure C”, but does not constrain “Encounter Y”. Therefore, “Medication A” must be during “Encounter Y” and start after “Procedure X”, but “Encounter Y” does not necessarily have to start after “Procedure X”.

4 Common Logic Idioms and Their Significance

4.1 A Overlaps B

The `Overlaps` operator asserts that there exists some point in time at which the event on the left- hand side is at the same time as the event on the right-hand side.

The following example asserts that an inpatient encounter and the measurement period have a common interval (i.e., overlap):

```
"Encounter: Hospital Inpatient" overlaps "Measurement
Period"
```

The following example asserts that an active diagnosis of Atrial Fibrillation existed before the start of the measurement period and continued to exist after the measurement period began.

```
AND: "Diagnosis: Atrial Fibrillation/Flutter" satisfies all
        starts before start of "Measurement Period"
        overlaps "Measurement Period"
```

The example:

```
"Medication, Active: ACE Inhibitor or ARB" overlaps
Occurrence A of "Encounter, Performed: Outpatient
Consultation"
```

asserts the patient is on an ACE inhibitor or ARB medication during a specific occurrence of an Outpatient Consultation.

Since events can have a left overlap, right overlap, inner overlap, or outer overlap, the `Overlaps` operator uses the start date/time and end date/time of each event to determine if there is overlap.

In cases where an event lacks a recorded end date/time, the `Overlaps` operator will interpret the missing end date/time as *ongoing* (i.e., positive infinity). This interpretation allows common use cases (such as a diagnosis overlapping the measurement period) to work as measure developers intend.

Table 3 demonstrates the calculated results of an overlap operation for various sets of data corresponding to the QDM statement:

```
"Diagnosis: Diabetes" overlaps "Measurement Period"
```

Table 3. Example Inputs and Results for Overlaps

Dx Start	Dx End	MP Start	MP End	Dx Overlaps MP?
6/1/2010	6/1/2012	1/1/2013	12/31/2013	false
6/1/2010	6/1/2013	1/1/2013	12/31/2013	true
6/1/2010	6/1/2014	1/1/2013	12/31/2013	true

Dx Start	Dx End	MP Start	MP End	Dx Overlaps MP?
6/1/2010	none	1/1/2013	12/31/2013	true
6/1/2013	8/1/2013	1/1/2013	12/31/2013	true
6/1/2013	6/1/2014	1/1/2013	12/31/2013	true
6/1/2013	none	1/1/2013	12/31/2013	true
6/1/2014	8/1/14	1/1/2013	12/31/2013	false
6/1/2014	none	1/1/2013	12/31/2013	false

***Note*:** This interpretation of missing data is unique to `Overlaps` and does *not* apply to other temporal operators (e.g., `During`). In addition, measure developers should consider the potentially unintended consequences of using `Overlaps` with datatypes that are not usually ongoing. For example, if an EHR reports only a start date/time for a procedure, the `Overlaps` operator will treat the procedure as *ongoing* even though the procedure has likely ended. For this reason, EHR vendors are encouraged to always report an end date/time for events that are known to have ended (including events that occur at a single point in time).

4.2 Any Past Diagnosis

The presence of a "Diagnosis: Cancer" can be used as an indication of "any past diagnosis." The Diagnosis datatype allows two timing attributes, an onset date/time and an abatement date/time. Measure developers used this idiom to detect the presence of some chronic conditions in the medical record prior to the beginning of the measurement period or prior to an episode of care. Other developers looked for the presence of "Diagnosis: Cancer" at the start of the measurement period or episode of care (see subsection 4.3). If B is some event of interest, to specify a Diagnosis of A that preceded B would be written as follows:

```
"Diagnosis: Cancer" starts before start of "Measurement
Period"
```

In this example, it indicates that the patient had cancer before the Measurement Period began—i.e., past diagnosis.

Many EHRs are unable to determine onset date/time for Diagnoses, and therefore, capture only the documented date/time. The documented date/time is, accordingly, the time that will return to evaluate the measure. If the interest is only to address a Diagnosis that was present in the past, the abatement date/time (even if recorded) becomes irrelevant.

4.3 Diagnosis at a Particular Time

To detect that a Diagnosis for Cancer was active at the start of event E (e.g., the start of the measurement period) requires the following QDM logic. The `starts before or concurrent with Start of` operator asserts that a Diagnosis for Cancer had started before or started with the beginning of the Measurement period.

```
"Diagnosis: Cancer" starts before or concurrent with Start
of "Measurement Period"
```

4.4 Use of Specific Occurrences to Achieve Filtering by Value and Subset

Operator precedence specifies that value restriction filtering precedes the application of subset operators. This introduces some subtlety in interpreting the eCQM logic. Compare, for example, these two pieces of logic:

A. `MOST RECENT: Lab test performed X (result: > 10)`

B. `AND:  Occurrence A of Lab test performed X (result > 10)`

   `AND:  MOST RECENT: Occurrence A of Lab test performed X`

The statement A will find all Lab test performed Xs with result >10 and select the most recent instance, whereas statement B will find the most recent Lab test performed X and return true if its result is > 10.

5 Data Elements and Value Sets

The data elements used in the 2016 eCQMs are derived from the Quality Data Model located at: http://ecqi.healthit.gov/qdm. That site provides additional explanation and description of the elements contained in the QDM.

Value Sets – Value Set Authority Center

The National Library of Medicine (NLM), in collaboration with ONC and CMS, maintains the NLM Value Set Authority Center (VSAC) (https://vsac.nlm.nih.gov). The VSAC provides downloadable access to all official versions of vocabulary value set content contained in the eCQM specifications. The value sets are lists of coded identifiers with names (called "descriptors") for clinical and administrative concepts selected from standard vocabularies. Value sets are used to define the set of concepts (e.g., diabetes and clinical visit) that will identify selected patient populations and satisfy measure criteria in Clinical Quality Measures. Value sets used in eCQMs and available in the VSAC can either directly contain code system members or reference other value sets (i.e., "a grouping value set"). The VSAC also provides value set authoring capabilities for registered value set authors and maintains up-to-date value set content based on each new version of the underlying code systems used in value sets. To find the list of code systems, select 'help' in the VSAC.

NLM has an application programming interface (API) to the VSAC content in addition to a web interface. The API documentation is accessible in the Help section of the VSAC Web page (https://vsac.nlm.nih.gov).

The VSAC also offers the "Downloadable Resource" Table, accessible from the Download tab on the VSAC Web page. This location provides links to the value set content used in each of the official eCQM release sets, including the previous eCQM releases. The release downloads for the value set collections are provided in both Excel and Sharing Value Sets (SVS)-compliant XML for all Eligible Hospital and all Eligible Professional value sets. These downloads also provide delta files to help users identify which value sets have changed from the last release. The VSAC also provides two additional resources:

- The Data Element Catalogue (DEC) that identifies QDM data element datatypes and attributes associated with value sets required to be captured using EHR technology (http://www.nlm.nih.gov/healthit/dec/).
- The Binding Parameter Specification (BPS) is to be provided for the first time this year. The BPS contains the code system version, the value set definition version, and the expansion profile information used to create each of the value set expansions included in the annual release, sorted by measure and QDM, data element datatypes. ONC and CMS are interested in feedback on the use of BPS as an alternative format for the Data Element Catalog.

Access to the VSAC requires a free Unified Medical Language System® (UMLS) Metathesaurus License (available at https://uts.nlm.nih.gov/license.html). Any use of value sets must be consistent with the licensing requirements and copyright protections covered by this UMLS license.

NLM VSAC Collaboration Tool

On December 16, 2015, NLM VSAC launched VSAC Collaboration—a tool that supports communication, knowledge management, and document management by value set authors and stewards. VSAC Collaboration provides a central site where value set authors can post value sets for collaborative discussion. In that site, teams can share threaded discussions about the value sets, view recent value set expansions posted by site members, organize their value sets by usage and the team's workflow needs, and receive activity and change notifications from VSAC.

The VSAC Collaboration Tool can be accessed directly at https://vsaccollab.nlm.nih.gov and through the VSAC Authoring Tool (https://vsac.nlm.nih.gov Authoring Tab) The VSAC Collaboration Tool training webinars and slides are available at https://www.nlm.nih.gov/vsac/support/userforum/userforum.html.

Access to the VSAC and to the VSAC Collaboration Tool requires a free UMLS® Metathesaurus License. https://uts.nlm.nih.gov/license.html. Please send any feedback or questions to: https://www.nlm.nih.gov/research/umls/support.html.

Metadata Portal – United States Health Information Knowledgebase

The Agency for Healthcare Research and Quality (AHRQ), in collaboration with CMS, NLM, and ONC, maintains the Meaningful Use Portal in the United States Health Information Knowledgebase (USHIK) (http://ushik.ahrq.gov/mdr/portals/mu). USHIK presents the eCQMs, data elements, and their value sets, including versions from December 2012, April 2013, June 2013, and April 2014. The eCQMs may be downloaded in HL7's HQMF format (xml), Adobe (pdf), Excel (xls), and comma-separated value (csv) format. USHIK allows for comparisons between measure versions and provides a single flat-file format containing all the eCQM clinical data elements. All user feedback on measures received by USHIK is sent to the ONC Jira issue trackers for review.

The eCQI Resource Center will announce when the 2015 and 2016 measures become available in USHIK.

5.1 QDM Category and Code System

The "QDM Category and Code System" section of the Measure Authoring Tool User Guide describes the recommended code system for each QDM category. Most data elements are linked to a value set or grouping value set that complies with these recommendations. Downloadable resources of value sets by QDM datatype are also available on the VSAC website at the "Download" tab.

Some measures create multiple sub-clauses for a single data type, each referencing a value set for a single code system, rather than one clause for the data type referencing a single grouping value set with all the code systems included. This occurs most often with the encounter data type. An example can be found in the Initial Population for CMS131, where six distinct types of encounter, each linked to a grouped value set using a single code system, are combined together using logic statements. Together, these six types of encounter provide codes that cover the recommended code system, SNOMED, as well as the transitional code systems [Current Procedural Terminology (CPT) and Healthcare Common Procedure Coding System (HCPCS)].

Users of the 2016 eCQM updates are encouraged to report suggested additions and deletions to data elements both within value sets and between code systems using the JIRA Clinical Quality Measures Feedback System (homepage link) at http://jira.oncprojectracking.org/browse/CQM/ (direct link to issue tracking).

5.2 Drug Representations Used in Value Sets

Value sets referring to specific non-vaccine prescribable medications use generalized drug concepts (for example, RxNorm "SCD" - Semantic Clinical Drugs[1]). It is expected that vendors/providers will report the drug entities in patient data using the generalized drug concepts included in the defined value sets. This is in accordance with guidance from CMS about the preferred use of generalized drug concepts. Implementers should use the relationships found in RxNorm (http://www.nlm.nih.gov/research/umls/rxnorm/index.html) to support mapping between specific drug entities found in patient records to those found in the value sets provided. Vaccine medications are currently represented using CVX codes.

5.3 Discharge Medications

The use of "Medication, Discharge" has a very specific meaning in the 2016 Eligible Hospital measures. This designation refers to medications that have been reconciled and are listed on the patient's Discharge Medication List. It should not be confused with medications that happen to be active at the time of discharge. "Medication, Discharge" events should start and end within the time duration of the episode of care, even though the medication itself may not be started until after the episode ends. It is expected that, at the time of discharge, discharge medications will be the same as the subsequent home medication lists for those medications that are germane to the quality measure, but this cannot be assumed at the time of admission as changes may have occurred since the prior episode of care.

Example logic:

```
"Medication, Discharge: value set 'during' Occurrence A of
Encounter, Performed: value set"
```

Vendors/providers generating Quality Reporting Document Architecture (QRDA)-1 output will need to generate "Medication, Discharge" events for all medications on the discharge list with appropriate time stamps to enable the correct function of measure logic.

5.4 Allergies to Medications and Other Substances

In the initial publication of the 2012 eCQMs, medication value sets used codes representing general prescribable medications for all specific drug entities. It has been noted that there are a variety of ways to capture medications causing allergies in the field. Vendor and implementer feedback has indicated that medication concepts used to represent allergy and intolerance data in EHR records are typically based on ingredient or equivalent types of concept and not the more detailed "prescribable" representations using discrete drug concepts that include form and

[1] https://www.nim.nih.gov/research/umls/rxnorm/docs/2015/appendix5.html

strength. In addition, hospital inpatient medication records may not contain complete detailed prescribable drug entities for reasons related to inpatient pharmacy substitutions.

Specifically, in the 2012 eCQMs, measure clauses used to identify patients with an allergy/ intolerance to medication agents use the same value sets created to identify medication orders and administration (i.e., specific drug entities).

Beginning with the 2013 updated annual release, CMS/ONC has implemented the following:

9. All measures that reference allergy value sets have been updated to reference value sets that contain appropriate codes from RxNorm that align to ingredient-level concepts. Users can utilize RxNorm relationships to link ingredients to the specific drug entities that may occur in patient records. The reactions that occur, such as rash or wheezing, should be expressed using codes that represent the appropriate condition using SNOMED CT.

These changes in the updated value sets and measures should resolve the need for implementers to map patent EHR allergy data to a more specific drug concept when submitting a QRDA. For non-medication allergy-inducing entities, it is expected that they be coded using SNOMED-CT.

Moving forward, allergens included in "Medication, allergy: *medication allergen (or ingredient)*" value sets should be represented using RxNorm "ingredient-type" concepts. These concepts only identify the ingredient and not the form or strength and have the RxNorm term type (TTY) = IN (some value sets may also include TTY = BN). If patient allergy and intolerance data in the EHR is not recorded using an RxNorm IN-type concept, reporting entities will need to use RxNorm relationships to identify the correct ingredient concept for the drug concept used in the EHR.

5.5 Principal Diagnosis in Inpatient Encounters

Previously, QDM used the datatype "Diagnosis, Active (ordinarily: Principal)" to convey a specific meaning in the eCQMs for hospitals and should be consistent with its definition in the Uniform Hospital Discharge Data Set (UHDDS) as "that condition established after study to be chiefly responsible for occasioning the admission of the patient to the hospital for care." QDM 4.2 changed the way encounter-based diagnoses should be expressed. QDM 4.2 added attributes to "Encounter, Performed" to allow "Encounter, Performed (principal diagnosis)" or "Encounter, Performed (diagnosis)" and removed the "Diagnosis" *principal* attribute. The designation refers to the Principal Diagnosis of an episode of care, as in the previous definition. This is typically determined at or after discharge time by a coder and is used for the billing transaction. In EHRs, the Principal Diagnosis is typically chosen from among the diagnoses that were active during the encounter and, if consistent with the UHDDS definition, should be labeled as "Principal." For the purpose of measure computation, the principal diagnosis should be considered to start during the episode of care.

Admission and discharge diagnoses cannot be expressed using current data elements and will be expressed using timing of active diagnoses at the start or end of the episode of care. The admission or discharge diagnoses recorded by the provider should not be used as a substitute for the principal diagnosis unless they are concordant with the principal diagnosis as defined by CMS.

Vendors and providers generating QRDA-1 output will need to label diagnoses appropriately to enable the measure logic to function correctly. Although it is clinically possible for the principal diagnosis to commence prior to the episode of care, the principal diagnosis should always be reported with a QRDA-I entry that starts during the episode of care.

5.6 Principal Procedure in Inpatient Encounters

The use of "Procedure, Performed (ordinality: Principal)" had a very specific meaning in the Eligible Hospital measures. This designation refers to the principal procedure during an episode of care, as defined by CMS. This is typically determined at or after discharge time and is used for the billing transaction. The principal procedure is typically chosen from among the procedures performed during the encounter. The procedure that is chosen (post-discharge) as the principal procedure should be labeled as "Principal," and the timing should reflect the timing of the actual procedure.

Vendors/providers generating QRDA-I output will need to label procedures appropriate to enable the measure logic to function correctly.

5.7 Medical Reason, Patient Reason, System Reason

Because of limitations in EHRs and use of free text in some record systems, it may be difficult to capture certain data elements that should exclude patients or components of care (e.g., medication administration, physician order not done) from a measure. The use of negation to identify these exclusions is modeled using the concepts of medical reason, patient reason, and system reason and, when deemed appropriate by providers, is selected to attest to the reason for the exclusion. For example, a rare but relevant comorbidity would be a medical reason for exclusion, whereas a patient's religious preference would be a patient reason for exclusion. It is intended that these concepts be used only when the record has a documented reason for exclusion. Although it is not necessary to report that reason electronically, it is expected that there is a legitimate medical, patient, or system reason for exclusion and that that evidence supporting the reason is present in the record.

Health IT vendors/providers using these concepts are expected to have a documented reason for these exclusions and could be expected to demonstrate the relevant justification if audited. The CMS QRDA Implementation Guide provides more detailed guidance on how to use null values to describe activities that were "not done."

5.8 Activities That Were "Not Done"

A negation attribute may be used to identify situations where an action did not occur, an order was not placed or administered, or a finding was not observed for a documented reason. Prior to the April 2014 eCQM release, implementers representing that a therapy was not done due to a medical, patient, or system reason were expected to use the same detail-level value sets for the noted "not done" therapy. This raised issues given that, for medications, it was rare that a specific drug was noted as "not given." With the April 2014 release, documentation of "medication, ordered not done" and "medication, discharge not done" are now associated with ingredient-level RxNorm value sets; as a result, specific prescribable drugs are no longer used to document these "not done" events.

For the May 2016 release, the QRDA-I Release 3 and CMS Implementation Guide use null values to replace a specific code associated with a value set when describing activities that were negated or “not done.” This approach is intended for use with all datatypes except for “device” that use negation to describe activities “not done,” unlike the previous approach limited to medications that required creating new value sets with "general concepts”. This approach does not change the expression of negation in the HQMF; however, it does require an HL7 nullFlavor code to be used instead of a specific code from the value set that is associated with these activities in the QRDA-I file. For the case of a “device not done”, however, the Consolidated Document Architecture does not allow the direct negation approach. In this case, a separate Act must be created and then negated to allow the negation of devices. For all other negated datatypes in the eCQMs, the direct approach to negation outlined here is used.

The intent of the null flavor in this context is to specify that ALL the activities in the value set were intentionally not done, not that a single activity was not done or that it is not known why that activity was not completed. It is not appropriate for users to certify that an activity was not done using negation unless the provider intentionally did not order or perform the activity in question and documented a justification why that was the case.

The following is an example of a negation instance being “not done” in a QRDA-I file:

```
<entry>
        <!--Medication administered not done,
          patient refusal: Drug declined by patient - reason intolerance.
          No "Antibiotic Medications for Pharyngitis" were administered -->
        <act classCode="ACT" moodCode="EVN" negationInd="true">
          …
          <consumable>
            <manufacturedProduct classCode="MANU">
              …
              <manufacturedMaterial>
                <code nullFlavor="NA" sdtc:valueSet="2.16.840.1.113883.3.464.1003.196.12.1001">
                  <originalText>None of value set: Antibiotic Medications for
Pharyngitis</originalText>
                </code>
              </manufacturedMaterial>
            </manufacturedProduct>
          </consumable>
          …
        </act>
      </entry>
```

Vendors/providers using these concepts are expected to have a documented reason for these exclusions and could be expected to demonstrate the relevant justification if audited. The CMS QRDA Implementation Guide provides additional guidance on how to use null values to describe activities that were “not done.” The QRDA Category I specification has been updated to Release 3.1 to reflect the approach outlined above including the special case of “device not done”. It is expected to be published in April 2016. At the next publication of the CDA standard, device and other datatypes that may be needed for negation will be added to the allowable negations; however, this correction was not completed in time for the 2016 annual update.

In referencing value sets used to negate activities, developers had previously used ingredient-level value sets to group medications for negation because this provided improved usability to providers. Now that the updated approach allows negation of all the value set members, it is expected that the detailed value sets used for the measure logic can be applied in a more

workflow-friendly fashion and the use of ingredient-level value sets can and should be retired. This approach also should streamline additional types of negations, such as groups of procedures. While this approach may require some re-engineering, it is expected that this type of coding will benefit both users and developers in the long term.

5.9 Clinical Trial Participation

Participation in a clinical trial may be a clinical reason to exclude a patient from an expected course of action in some eCQMs; however, only participation in certain types of trials may be relevant based on the steward's intent. Due to limitations in data from EHRs, the specific nature of clinical trial participation cannot be captured in the eCQMs. Measure developers have taken two approaches to address this issue. In some cases, particularly for hospital measures, clinical trial participant exclusions have been removed from the measure. In other cases, measure developers have provided guidance for the type of clinical trial that should be considered to meet measure intent. As examples, CMS140 indicates that the clinical trial should be specific to breast cancer and CMS141 states that the clinical trial should be specific to colon cancer. It is recommended that implementers carefully review the guidance regarding clinical trial participation and developer intent regarding acceptable types of clinical trials.

5.10 Newborn/Gestational Age

Four of the eCQMs are designed to be used in the encounter including delivery, birth, or immediately after birth. Three of the four measures require capture of gestational age. In the 2016 specifications, a newborn at term indicates the gestational age is ≥ 37 weeks and 0 days using best estimated due date (EDD) and rounded off to the nearest completed week.

For the Eligible Hospital update published in 2013, systems were asked to capture gestational age using the gestational age codes from SNOMED CT; however, this created a QRDA standard violation. This problem has been corrected beginning with the 2014 annual update and carried forward in the 2016 annual update. Vendors/ providers generating QRDA-1 must now use the "physical exam, performed" QDM element with a scalar value in weeks to codify the gestational age.

5.11 Source

Current attributes in the eCQMs do not allow the electronic expression of the source of a diagnosis (e.g., a nurse versus a physician). The structure of the measures no longer requires this information at this time for certification. Although the intent of some measures is to use information from a specific source, this is not currently captured in the 2014 stage of eCQMs and will not be included in certification. It is expected that the ability to electronically capture the source of a data element will be incorporated into future stages of eCQMs.

5.12 Patient Characteristic Birthdate and Patient Characteristic Expired

Prior to the 2015 eCQM update, the Measure Authoring Tool required measure developers to enter a value set for the concept of "birthdate." In the early versions of measures, it was possible therefore to use multiple value sets to describe the same concept. These value sets were harmonized in the 2014 eCQM update, but it was realized that the definition of "Patient

Characteristic Birthdate" should in fact be locked to the Logical Observation Identifiers Names and Codes (LOINC) used for this purpose. In 2015, the Measure Authoring Tool was updated to require the LOINC code 21112-8 as the ObservationCriteria/code for the "Patient Characteristic Birthdate" template. Therefore, the value set exports and VSAC downloads no longer contain this concept. It is expected that systems still use this code to identify the data element for Patient Characteristic Birthdate with the value of the birthdate. The "Age at" operator in the MAT uses the Patient Characteristic, Birthdate LOINC code to calculate the response. *Please refer to the HL7 QDM-based HQMF Implementation Guide, R1.3 (vol. 1) to determine how the AgeAt operator in QDM is mapped to HQMF.*

Similarly, "Patient Characteristic Expired" is locked to the SNOMED-CT code 419099009 (Dead), and therefore, cannot be further qualified with a value set.

5.13 Supplemental Value Sets Representing Race & Ethnicity, and Administrative Sex

5.13.1 Race & Ethnicity

The eCQM specifications limit the reporting of patient race to the CDC value set "Race" 2.16.840.1.114222.4.11.836:

Code Description

1002-5 American Indian or Alaska Native

2028-9 Asian

2054-5 Black or African American

2076-8 Native Hawaiian or Other Pacific Islander

2106-3 White

2131-1 *Other Race*[2]

To report an individual patient with a single race category in QRDA category I (QRDA-I), place one of the 5 OMB race category codes (1002-5, 2028-9, 2054-5, 2076-8, and 2106-3) into raceCode. To report an individual patient with more than one race category, one race is reported in raceCode, and additional races should be placed into extension(s) using sdtc:raceCode. As in accordance with the standard, all the race codes placed here are equivalent in priority. For QRDA-I, Other Race 2131-1 should not be used as missing patient race information should be described using null values (described below).

For QRDA category 3 (QRDA-III) files, a patient with multiple races should be identified with raceCode category 2131-1 Other Race. This allows patients with multiple races to be expressed in an aggregate document without creating multiple entries for a single patient with multiple races. It should be noted that only QRDA-III files should use the raceCode 2131-1 Other Race to express a raceCode category.

[2] Use of the "Other Race" code is restricted to the approaches noted in this section. "Other Race" should **not be used** in QRDA-I.

Similarly, the specifications limit the reporting of ethnicity to the CDC value set "Ethnicity" 2.16.840.1.114222.4.11.837:

2135-2 Hispanic or Latino

2186-5 Not Hispanic or Latino

In addition, the Meaningful Use 2 rule objectives state:

> *Objective § 170.314 (a)(3) an EHR should be able to record that a patient declined to specify his/her race and ethnicity.*

However, the Centers for Disease Control and Prevention (CDC) value sets for race and ethnicity do not contain code(s) for "Patient Decline."

To communicate that a demographic element is unknown or that the patient declined to provide the information for race and ethnicity, use the built in "nullFlavor" feature of QRDA designed for this purpose. The nullFlavor feature works for race, ethnicity, preferred language, and other cases where the QRDA calls for a value from a value set and nullFlavor is allowed as specified by the standard.

Normally, one would communicate race in a QRDA like this:

```
<raceCode code="2106-3"
displayName="White"codeSystem="2.16.840.1.113883.6.238"/>
```

Where the value is unknown, one would use the nullFlavor UNK for "Unknown" like this:

```
<raceCode nullFlavor="UNK"/>
```

Where the patient declined to answer, one would use the nullFlavor ASKU for "Asked but Unknown" like this:

```
<raceCode nullFlavor="ASKU"/>
```

5.13.2 Administrative Sex

In order to comply with federal regulation (see https://s3.amazonaws.com/public-inspection.federalregister.gov/2015-25597.pdf), beginning with the April 2016 annual release, eCQMs are required to use the HL7 V3 value set for AdministrativeGender (not AdministrativeSex) when specifying birth sex. ONC has created a new definition version for all value sets in which the code system changed from AdministrativeSex to AdministrativeGender. The value set object identifiers (OID) of the two affected value sets remain the same. The code system does not include the HL7 V2 code "Unknown", which means the "Administrative Sex" value set (unchanged OID 2.16.840.1.113762.1.4.1) now contains only the codes:

F	Female
M	Male

The code system to be used when representing the gender of the patient is the AdminstrativeGender (OID: 2.16.840.1.113883.5.1) code system. This code system is already

used for the ONC Administrative Sex value set required for recording the patient gender in a QRDA type 1. With the 2016 Annual Update, the gender-specific value sets used within eCQM logic to identify gender-specific patient populations will also use the AdministrativeGender code system to define the included code in the value set. These value sets previously used the older "AdministrativeSex" code system. Since the actual codes—"M" and "F"—are the same in both code systems, the codes included in each gender-specific value set remain the same. With this change, the version of the value set will change. The two value sets affected are:

1. "Female" (OID: 2.16.840.1.113883.3.560.100.2)
2. "Male" (OID: 2.16.840.1.113883.3.560.100.1)

The value set intent is to capture the biologic phenotypic sex that would be captured on the patient's initial birth certificate. If the data is missing, it is not possible to determine the patient sex, or the patient's birth certificate sex is undetermined, then one should use the nullFlavor "UNK" as is described above in race and ethnicity.

The CMS QRDA Implementation Guide provides additional guidance on how to use null values to describe race, ethnicity, and administrative sex data when the response is declined by the patient or is unknown.

5.14 ICD-9 and ICD-10 Codes in Value Sets

In accordance with the recommendations of the ONC Health Information Technology Standards Committee, eCQM specifications have included both standard and transitional terminologies in value sets to support migration to clinical vocabulary standards. As an example, diagnosis value sets contain terms in the standard vocabulary (SNOMED CT) and the transition vocabularies (ICD-9 and ICD-10).

In October 2015, CMS formally retired the use of International Classification of Diseases, Ninth Revision (ICD-9) code systems for billing and reporting purposes. CMS designated a one-year period of transition to complete the phasing out of the ICD-9 content, which will end on October 1, 2016. The eCQMs, however, use ICD-9 codes in multiple ways, including look back periods or to reference historical data. Therefore, CMS and ONC provided the following guidance to developers:

> For ICD-9 codes in the 2016 measure update, measure developers were directed to review all ICD-9 codes in measure value sets as with any measure update. For ICD-9 value sets, the expectation is they will be removed if they only pull patients into the measure based on timing starting from the end of CMS's transition period to ICD-10. Therefore, it is expected that many ICD-9 value sets will remain to represent historical data and that is permitted per a consensus-based decision across the eCQM stakeholder federal agencies and partners. It is not expected that any new ICD-9 value sets will be added, however we are aware of one instance where ICD-9 was added to account for a data element requiring a look back period. Moving forward, we expect the gradual phasing out of ICD-9 codes in the value sets.

It is recommended that measure implementers carefully review technical release notes and value sets to determine where value set changes may affect their ability to capture data for the 2016 specifications and adjust accordingly.

5.15 Display of Human-Readable HQMF

The display of header information in the human-readable HQMF for eCQMs has changed as of 2016 to remove populations that are not included in the measure specifications. For proportion measures, references to measure population, measure population exclusions, and measure observations have been removed from the header. For continuous variable measures, references to denominator, denominator exclusions, numerator, numerator exclusions, and denominator exceptions have been removed.

6 Measure Guidance by CMS ID Measure Number

CMS provides measure guidance for the 2016 eCQM Annual Updates for Eligible Hospital and Eligible Professional eCQMs to assist with understanding and implementation of the new specifications. Measure guidance is available in HTML, XML, and simple XML files within the measure specification package zip files located on the eCQI Resource Center. The guidance can be found in the measure header as well as within the inline comments within the measure logic itself. Guidance should be considered as critical to correct implementation of the quality measure; however, certification testing and measure reporting will look only for the computable, coded elements present within the measure logic.

7 JIRA – Clinical Quality Measure Feedback System

CMS and ONC will continue to use JIRA to track issues, questions, and error reporting associated with the eCQMs.

The JIRA software program allows end users to report on newly identified issues and/or quickly search issues that have been resolved or are currently being addressed. The Jira instance contains projects that allow entry of many different types of feedback. For general issues with eCQMs, please select the "CQM Issue Tracker" when entering tickets; however, if your issue deals specifically with QRDA, QDM, Cypress, Bonnie, or Certification, use the project with that name to enter your ticket to route it to the correct user. The list of all available projects in Jira can be found at the ONC JIRA homepage: http://oncprojectracking.org/

When reporting an issue, users should first search the database to see whether a similar question has already been answered or asked. If the issue has been reported already, it is possible to include yourself as a "watcher", which will allow you to get notifications whenever updates are made to the issue. You must create and account and sign in to "watch" or "create" a measure.

When reporting a new issue, users should take care to fill in the complete ticket. Select a title that summarizes the issue at hand, and fill in a complete description of the issue in the "description" field. CMS/ONC encourages users to add attachments and sample logic, codes, or language wherever possible to encourage a quick and accurate response **as long as those do not contain Protected Health Information (PHI).** If insufficient information is entered, the issue will be labeled "Pending for clarification" and will not include further response unless the user updates the ticket. An issue in "Solution review" is a proposed solution, but is pending final approval and should not be considered final until "Resolved". Please note that tickets will not be closed until final correction of the identified issue has been completed; thus, for corrections that require an update to standards or republication of a measure, there may be significant delays between the "Resolution" and "Closure" of the issue.

If a response is insufficient to answer an issue entered, the reporter can "Reopen" the issue and should explicitly elaborate how the previous answer did not adequately address the issue at hand. At times, there may be delays in responding to issues that require policy responses, standards updates, or feedback from many stakeholders. It is appropriate to comment or email regarding a missing resolution if there has not been any update or response in over 2 weeks and there is not currently a comment from the assignee explaining why there is a delay and when the approximate resolution will be available.

Access JIRA at: jira.oncprojectracking.org.

For help using JIRA and to see all the JIRA projects, go to: http://oncprojectracking.org

Appendix A. Versioning and Endorsement

The electronic Clinical Quality Measures (eCQM) are labeled in a standard fashion. The Centers for Medicare & Medicaid Services (CMS) created a unique "CMS eMeasure Identifier" to clearly and consistently identify eCQM files. The naming convention combines the eMeasure identifier assigned to the eCQM in the Measure Authoring Tool (MAT) with the "eMeasure Version Number", which is prepended by "CMS". The eMeasure Version Number is a numeric value used to indicate the published version of the eMeasure. Based on this universal naming convention, Eligible Professional measure (NQF0056-Diabetes: Foot Exam) would display the following for the first version of the measure: **CMS123v1**.

In 2015, the Measure Authoring Tool released new functionality that allows minor versioning. This minor version will be visible in the human-readable Health Quality Measures Format (HQMF) under "eMeasure Version number", but only a single measure version will be released in the 2015 measure packages and that version will be locked for the 2016 measurement period. The measure versions will continue to be referred to by CMS as an integer that represents the major version number.

Individual eCQM Measure Package Components:

The file type (.xml or .html) is added to the CMS eMeasure ID to complete the naming convention for the components of the eCQM package. The following examples demonstrate this naming convention:

Type of Artifact File Name

HQMF (XML file) **CMS123v1.xml – this is the machine-readable**

HQMF (HTML file) **CMS123v1.html – this is the human-readable**

If downloaded from a site offering UMLS authentication, you may also find:

Value Sets (Excel file) CMS123v1.xls—this contains the codes and value sets in the measure.

Individual Measure Zip File and Folder Names

The naming conventions for the individual eMeasure packages (zip files and measure folder) that will contain the eMeasure XML file and human-readable rendition are described below in the order in which they must appear:

1. Setting for which the measure applies—"Eligible Professional" or "Eligible Hospital" measures. Use 2-letter abbreviation, EP for eligible professional or EH for eligible hospital.
2. CMS eMeasure ID.
3. NQF identifier—if not endorsed by NQF, the file will contain "NQFXXXX."
4. Abbreviated name for the clinical quality measure (example: "Colorectal_Cancer_Screen").

Zip file name structure: <EP|EH>_<CMSeMeasureID>_<NQFID>_<shortDescription>

Example: EP_CMS130v1_NQF0034_Colorectal_Cancer_Screen

Note: The National Quality Forum (NQF) ID reads NQF NOT APPLICABLE in the HQMF when the measure is not endorsed by the NQF. All measures have been recommended by CMS. but not all have been endorsed by the NQF.\

We recommend use of the CMS eCQM ID to identify measures and their versions.

Measure Set Package Naming

The file names combine attributes that identify the:

1. setting for which the measure applies—"EH_Hospital" or "EP_Professional"

2. publication date—format: YYYY_MM_DD

Measure set package name structure: <EP|EH>_<Hospital|Professional>_eMeasures_<date>

Example: EH_Hospital_eMeasures_2012_10_17 (assuming the release date for these EH measures is 10/17/2012)

Appendix B. Time Unit and Time Interval Definitions

ISO 8601:2004 defines data elements and interchange formats for the representation of dates and times, including time intervals. Table 4 summarizes important terms defined in the standard that are of particular importance and can be drawn upon to be used in time interval calculations for electronic Clinical Quality Measures (eCQM).

Table 4. Time Unit and Interval Definitions

Term	ISO Definition	ISO Notes
Time interval	Part of the time axis limited by two instants.	• A time interval comprises all instants between the two limiting instants and, unless otherwise stated, the limiting instants themselves.
Duration	Non-negative quantity attributed to a time interval, the value of which is equal to the difference between the time points of the final instant and the initial instant of the time interval, when the time points are quantitative marks.	• In case of discontinuities in the time scale, such as a leap second or the change from winter time to summer time and back, the computation of the duration requires the subtraction or addition of the change of duration of the discontinuity. • The SI unit of duration is the second.
Nominal duration	Duration expressed among others in years, months, weeks, or days.	• The duration of a calendar year, a calendar month, a calendar week, or a calendar day depends on its position in the calendar. Therefore, the exact duration of a nominal duration can only be evaluated if the duration of the calendar years, calendar months, calendar weeks, or calendar days used is known.
Second	Base unit of measurement of time in the International System of Units (SI) as defined by the International Committee of Weights and Measures.	
Minute	Unit of time equal to 60 seconds.	
Hour	Unit of time equal to 60 minutes.	
Day <unit of time>	Unit of time equal to 24 hours.	

Term	ISO Definition	ISO Notes
Calendar day	Time interval starting at midnight and ending at the next midnight, the latter being also the starting instant of the next calendar day.	• A calendar day is often also referred to as a day. • The duration of a calendar day is 24 hours, except if modified by: – The insertion or deletion of leap seconds, by decision of the International Earth Rotation Service (IERS), or – The insertion or deletion of other time intervals, as may be prescribed by local authorities to alter the time scale of local time.
Day <duration>	Duration of a calendar day.	• The term “day” applies also to the duration of any time interval which starts at a certain time of day at a certain calendar day and ends at the same time of day at the next calendar day.
Calendar week	Time interval of seven calendar days starting with a Monday.	• A calendar week is also referred to as a week.
Week	Duration of a calendar week.	• The term “week” also applies to the duration of any time interval which starts at a certain time of day at a certain calendar day and ends at the same time of day at the same calendar day if the next calendar week.
Calendar month	Time interval resulting from the division of a calendar year in 12 time intervals, each with a specific name and containing a specific number of calendar days.	• A calendar month is often referred to as a month.
Month	Duration of 28, 29, 30, or 31 calendar days depending on the start and/or the end of the corresponding time interval within the specific calendar month.	• The term “month” applies also to the duration of any time interval which starts at a certain time of day at a certain calendar day of the calendar month and ends at the same time of day at the same calendar day of the next calendar month, if it exists. In other cases, the ending calendar day has to be agreed on. • In certain applications a month is considered as a duration of 30 calendar days.
Calendar year	Cyclic time interval in a calendar which is required for one revolution of the Earth around the Sun and approximated to an integral number of calendar days.	• A calendar year is also referred to as a year. • Unless otherwise specified, the term designates in this International Standard a calendar year in the Gregorian calendar.

Term	ISO Definition	ISO Notes
Year	Duration of 365 or 366 calendar days depending on the start and/or the end of the corresponding time interval within the specific calendar year.	• The term "year" applies also to the duration of any time interval which starts at a certain time of day at a certain calendar date of the calendar year and ends at the same time of day at the same calendar date of the next calendar year, if it exists. In other cases, the ending calendar day has to be agreed on.
Common year	Calendar year in the Gregorian calendar that has 365 calendar days.	
Leap year	Calendar year in the Gregorian calendar that has 366 days.	

The standard also defines multiple formats for the representation of date and time as well as time intervals and durations. ISO 8601 postulates that duration can be expressed by a combination of components with accurate duration (hour, minute, and second) and components with nominal duration (year, month, week, and day). The standard allows for the omission of lower-level components for "reduced accuracy" applications.

Appendix C. Time Interval Calculation Conventions

The unit in which a time interval (or its duration) is expressed may depend on the necessary level of accuracy for the purposes of measurement. As such, the selection of the time unit to be used should be made according to the level of granularity needed to meet the intent of the measure.

These conventions are intended to standardize the interpretation of time calculation units for durations (i.e., difference between two date/time elements), typically with time relationships defined in the Quality Data Model, such as “starts after start of” and “ends before start of.” Table 5 presents the time intervals for calculations.

Table 5. Time Interval Calculations

Calculation Unit	Definition	Calculation[3,4,5]
Year	Duration of any time interval which starts at a certain time of day at a certain calendar date of the calendar year and ends at: • The same time of day at the same calendar date of the next calendar year, if it exists • The same time of day at the immediately following calendar date of the ending calendar year, if the same calendar date of the ending calendar year does not exist **Notes:** 1. When in the next calendar year the same calendar date does not exist, the ISO states that the ending calendar day has to be agreed upon. The above convention is proposed as a resolution to this issue. 2. The ISO permits the representation of dates and times with "reduced accuracy", when necessary. For the purposes of quality measures, duration expressed in years ignores the time of day associated with the date/time stamps used in the calculation—i.e., the number of years will not change until the month and day of date 2 reach (or surpass) the month and day of date 1; time of day should be ignored or set to 00:00:00 for this calculation.	**1. Month (date 2) < month (date 1):** Duration (years) = year (date 2) – year (date 1) – 1 **Example 1:** Date 1: 2012-**03**-10 22:05:09 Date 2: 2013-**02**-18 19:10:03 Duration = year (date 2) – year (date 1) – 1 = 2013 – 2012 – 1 **= 0 years** **2. Month (date 2) = month (date 1) and day (date 2) >= day (date 1)** Duration (years) = year (date 2) – year (date 1) **Example 2.a:** day (date 1) = day (date 2) Date 1: 2012-03-**10** 22:05:09 Date 2: 2013-03-**10** 08:01:59 Duration = year (date 2) – year (date 1) = 2013 – 2012 **= 1 year** **Note:** Time of day is ignored in this calculation. If time of day were to be considered for the calculation, the duration of the time interval would be 0 years according to the definition. **Example 2.b:** day (date 2) > day (date 1) Date 1: 2012-03-**10** 22:05:09 Date 2: 2013-03-**20** 04:01:30 Duration = year (date 2) – year (date 1) = 2013 – 2012 **= 1 year** **3. Month (date 2) = month (date 1) and day (date 2) < day (date 1)** Duration (years) = year (date 2) – year (date 1) – 1 **Example 3.a:** Date 1: 2012-02-**29** Date 2: 2014-02-**28** Duration = year (date 2) – year (date 1) – 1 = 2014 – 2012 – 1 = **1 year**

[3] For the purposes of this document, date 2 is assumed to be more recent than date 1.

[4] All dates are represented according to the extended formatted designated in ISO 8601: YYYY-MM-DD HH:MM:SS and a 24 hour timekeeping system.

[5] The result of the calculation is always an integer; if the result includes decimals, it should be truncated (rounded down) to the unit.

Calculation Unit	Definition	Calculation[3,4,5]
Year (continued)		**4. Month (date 2) > month (date 1)** Duration (years) = year (date 2) – year (date 1) **Example 4.a:** Date 1: 2012-**03**-10 11:16:02 Date 2: 2013-**08**-15 21:34:16 Duration = year (date 2) – year (date 1) = 2013 – 2012 **= 1 year** **Example 4.b:** Date 1: 2012-**02**-29 10:18:56 Date 2: 2014-**03**-01 19:02:34 Duration = year (date 2) – year (date 1) = 2014 – 2012 **= 2 years** **Note:** Because there is no February 29 in 2014, the number of years can only change when the date reaches March 1, the first date in 2014 that surpasses the month and day of date 1 (February 29).

Calculation Unit	Definition	Calculation[3,4,5]
Month	Duration of any time interval which starts at a certain time of day at a certain calendar day of the calendar month and ends at: • The same time of day at the same calendar day of the ending calendar month, if it exists • The same time of day at the immediately following calendar date of the ending calendar month, if the same calendar date of the ending month year does not exist **Notes:** 1. When in the next calendar year the same calendar date does not exist, the ISO states that the ending calendar day has to be agreed upon. The above convention is proposed as a resolution to this issue. 2. The ISO permits the representation of dates and times with "reduced accuracy," when necessary. For the purposes of quality measures, duration expressed in months ignores the time of day associated with the date/time stamps used in the calculation—i.e., the number of months will not change until the month and day of date 2 reach (or surpass) the month and day of date 1; time of day should be ignored or set to 00:00:00 for this calculation.	**1. Day (date 2) >= day (date 1)** Duration (months) = (year (date 2) – year (date 1))*12 + (month (date 2) – (month date 1)) **Example 1.a:** Date 1: 2012-03-01 14:05:45 Date 2: 2012-03-31 23:01:49 Duration = (year (date 2) – year (date 1))*12 + (month (date 2) – (month date 1)) = (2012 – 2012)*12 + (3 – 3) **= 0 months** **Example 1.b:** Date 1: 2012-03-10 22:05:09 Date 2: 2013-06-30 13:00:23 Duration = (year (date 2) – year (date 1))*12 + (month (date 2) – (month date 1)) = (2013 – 2012)*12 + (6 – 3) = 12 + 3 **= 15 months** **2. Day (date 2) < day (date 1)** Duration (months) = (year(date 2) – year(date 1))*12 + (month(date 2) – month (date 1)) – 1 **Example 2:** Date 1: 2012-03-10 22:05:09 Date 2: 2013-01-09 07:19:33 (currently the date is 2013-01-29, so 29 isn't less than 10) Duration = (year(date 2) – year(date 1))*12 + (month (date 2) – (month date 1)) – 1 = (2013 – 2012)*12 + (1 – 3) - 1 = 12 – 2 - 1 = 9 months (missing -1)

Calculation Unit	Definition	Calculation[3,4,5]
Week	Duration of any time interval which starts at a certain time of day at a certain calendar day at a certain calendar week and ends at the same time of day at the same calendar day of the ending calendar week. **Notes:** 1. The ISO permits the representation of dates and times with "reduced accuracy," when necessary. For the purposes of quality measures, duration expressed in weeks ignores the time of day associated with the date/time stamps used in the calculation—i.e., a complete week is always seven days long: a week has passed when the same weekday in the following week is reached; time of day should be ignored or set to 00:00:00 for this calculation.	**1. Duration = [date 2 – date 1 (days[6])]/7** **Example 1:** Date 1: 2012-03-10 22:05:09 Date 2: 2012-03-20 07:19:33 Duration = [# days (month (date 1)) – day (date 1) + # days (month (date 1) + 1) + # days (month (date 1) + 2) + … + # days (month (date 2) – 1) + day (date 2)]/7 = (20 – 10)/7 = 10/7 **= 1 week** (result truncated to integer).
Day	Duration of any time interval which starts at a certain calendar day and ends at the next calendar day (1 second to 47 hours, 59 minutes and 59 seconds); the number of times midnight is crossed. **Notes:** 1. The ISO permits the representation of dates and times with "reduced accuracy," when necessary. For the purposes of quality measures, duration expressed in days ignores the time of day associated with the date/time stamps used in the calculation— i.e., the number of days will not change until the month and day of date 2 surpasses the month and day of date 1.	The duration in days between two dates will be generally given by subtracting the start calendar date to the end calendar date, regardless of the time of day between the two dates. **Example 1:** Date 1: 2012-01-31 12:30:00 Date 2: 2012-02-01 09:00:00 Duration = 02-01 – 01-31 **= 1 day** **Example 2:** Date 1: 2012-01-31 12:30:00 Date 2: 2012-02-01 14:00:00 Duration = 02-01 – 01-31 **= 1 day**

[6] For information on how to calculate the duration, in days, of a time interval, please see "day".

Calculation Unit	Definition	Calculation[3,4,5]
Hours	The number of 60-minute cycles between two given dates. **Notes:** 1. Use the date, hour, and minute of the date/time stamps to compute the interval. 2. Seconds are not used in the calculation.	The duration in hours between two dates is the number of minutes between the two dates, divided by 60. The result is truncated to the unit. **Example 1:** Date/Time 1: 2012-03-01 03:10 Date/Time 2: 2012-03-01 05:09 Duration **= 1 hour** **Example 2:** Date/Time 1: 2012-02-29 23:10 Date/Time 2: 2012-03-01 00:10 Duration **= 1 hour** **Example 3:** Date/Time 1: 2012-03-01 03:10 Date/Time 2: 2012-03-01 04:00 Duration = **0 hours**
Minutes	The number of minutes between two given dates. **Notes:** 1. Seconds are **not** used in the calculation.	**Example 1:** Date/Time 1: 2012-03-01 03:10Date/Time 2: 2012-03-01 05:20 Duration **= 130 minutes** **Example 2:** Date/Time 1: 2012-02-29 23:10Date/Time 2: 2012-03-01 00:20 Duration **= 70 minutes**

Timing Relationships with No Calculation Unit Defined

When no threshold is defined in a measure phrase that compares timing between two elements, a common level of granularity needs to be established for comparisons within and across electronic health records (her). For instance, the criterion:

A starts before start of B

Depending on the level of granularity of the data (e.g., HH:MM:SS vs. HH:MM), the result of the timing comparison may vary if no comparison unit is defined:

Example 1

A: 2012-01-01 11:00:01

B: 2012-01-01
11:00:02

A starts before B = TRUE

Example 2

A: 2012-01-01
11:00

B: 2012-01-01
11:00

A starts before B = FALSE

To resolve this type of issue, calculations should be performed with dates represented with reduced accuracy to the minute (date/time truncated to minute prior to calculation—i.e., seconds not used in calculation):

Example 3

A: 2012-01-01
11:00:01

B: 2012-01-01
11:00:02

A starts before B = FALSE

Note: Seconds are not used in the calculation.

Example 4

A: 2012-01-01
11:00

B: 2012-01-01
11:00

A starts before B = FALSE

If no unit of comparison has been defined in the logic (e.g., A starts before start of B), minutes will be used as the default unit for the calculation. This convention effectively renders the following criteria equivalent:

- A starts before start of B
- A > 0 minute(s) starts before start of B
- A > 1 minute(s) starts before start of B

If another unit is intended, it should be specified in the criterion, for instance:

- If the intended unit of comparison is the second:
  - A starts before start of B would "default" to comparison in minutes.
  - A > 1 second(s) starts before start of B would explicitly refer the granularity intended for the calculation of duration between the two date/time stamps.
    (Criterion would be true if A started at least one second before B.)
- If the intended unit of comparison is the day:
  - A > 1 day(s) starts before start of B
    (Criterion would be true if A started at least one day before B.)

The best practice is to always explicitly define the unit of calculation because this shows intent on the part of the measure developer and provides a completely unambiguous interpretation of the level of granularity with which the computation should be performed. If no unit is defined, however, the foregoing convention determines that the computation unit should be minutes.

Other Date/time-related Calculations Using QDM Functions

The foregoing definitions focus on the calculation of durations; however, for certain applications, it may be necessary to compare portions of the date/time elements directly—e.g., comparing years or months. This can be achieved by using existing QDM/MAT functions that allow the extraction of specific portions of date/time elements. A complete list of these functions is available in the Measure Authoring Tool User Guide.

Appendix D. eCQMs for eReporting for the 2017 Reporting and/or Performance Period for Eligible Hospitals & Eligible Professionals – Release Notes – April 6, 2016

The Release Notes are available on the eCQI Resource Center for Eligible Hospitals and Eligible Professionals and also located on the CMS eCQM Library page.

Appendix E. CMS179v4 _Supplemental_SQL_Logic_Reference

ADE Prevention and Monitoring: Warfarin Time in Therapeutic Range

Supplemental SQL Logic Reference

(CMS179, version 5, updated 4/6/2016)

The purpose of this document is to support the implementation of the clinical quality measure "ADE Prevention and Monitoring: Warfarin Time in Therapeutic Range" by providing an example of the structured query language (SQL) that underwent field testing. The defined SQL logic below provides a full view of its content, but the specifications supplied in the header section of the Health Quality Measure Format (HQMF) of the clinical quality measure should be the primary basis for implementation of the measure. The HQMF files for this clinical quality measure contain instructions in the Definition and Guidance section which indicate the ultimate purpose of the SQL logic defined in this document. Since the SQL implementation may vary depending on an EHR system's table structure and data definitions, EHR system programmers and vendors should replace the field names and table names as needed based on their knowledge of their EHR system and its requirements in order to fulfill the measure's intent.

TTR percentage will be calculated for each patient that meets the criteria for the Measure Population. The average of these values is reported as the Measure Observation.

ADE Prevention and Monitoring

Percent of Time in Therapeutic Range (TTR)

The initial part of the SQL logic calculates the percent TTR for each patient (PctTTR in the temporary table #PatientTTR). Percent of time in therapeutic range (TTR) is calculated within the logic originally developed by the Veterans Affairs (VA).

Warfarin time in therapeutic range is the percentage of time in which patients with atrial fibrillation or flutter who are on chronic warfarin therapy have INR test results within the therapeutic range (2.0 - 3.0) during the measurement period.

The following filters are applied to the INR results prior to the calculation of TTR for each patient:

1) INR value closest to 2.5 when there are more than one INR result on a single date
2) INR values greater than 10 will be replaced with an INR value of 10
3) INR values less than 0.8 are ignored and eliminated from the final TTR calculation for each patient

The logic keeps track of the number of valid INR intervals for each patient. A Valid INR Interval is defined as a pair of INR start dates that are less than or equal to 56 days apart. Patients without 2 such intervals will be excluded from the calculation of the providers' Average PctTTR later on.

Identifiers for the patient's provider and the practice site are also included. The identifier for the provider that is ultimately responsible for warfarin management should be used. The identifier for the practice site at which the patient's warfarin is managed should be used.

```
USE [Datamart_Staging]
GO
/****** Object:  StoredProcedure [dbo].[ADE_TTRCalculationWithFilters]
Script Date: 04/10/2013 09:01:41 ******/
SET ANSI_NULLS ON
GO
SET QUOTED_IDENTIFIER ON
GO

ALTER PROCEDURE [dbo].[ADE_TTRCalculationWithFilters]

AS

SET NOCOUNT ON;

SELECT
          Patient_ID,
          Practice_Site,
          provider_ID,
          [QDM_Attribute Result Value],
          ABS(2.5 - [QDM_Attribute Result Value])AS ValDiff,
          DATEADD(DAY,0, DATEDIFF(DAY, 0,[Start DateTime])) AS [Start
DateTime]
INTO
          #LabResults1
FROM    dbo.ADE_LabResults a JOIN
            ADE_VocabularyDictionary b ON a.DataElement_Code = b.Code
WHERE
            b.[QDM Category] = 'Laboratory Test, Result' AND b.[Value Set
Name] = 'INR'
ORDER BY patient_ID, [Start DateTime]
SELECT      Patient_ID,
          [Start DateTime],
          MIN(ValDiff) AS ValDiff
INTO   #LabResults2
FROM   #LabResults1
GROUP BY Patient_ID,
            [Start DateTime]

SELECT  a.Patient_ID,
            Practice_Site,
            Provider_ID,
        a.[Start DateTime],
CASE WHEN a.[QDM_Attribute Result Value] >10 THEN 10 ELSE a.[QDM_Attribute
Result Value] END AS [QDM_Attribute Result Value]

INTO   #FilteredLabResults
FROM   #LabResults1 a
JOIN   #LabResults2 b ON a.Patient_ID = b.Patient_ID
AND    a.[Start DateTime] = b.[Start DateTime]
AND    a.ValDiff = b.ValDiff
WHERE  a.[QDM_Attribute Result Value] >= 0.8
```

```
DROP TABLE #LabResults2
DROP TABLE #LabResults1


SELECT
            Patient_ID,
            Practice_Site,
            Provider_ID,
            [QDM_Attribute Result Value],
            [Start datetime],
            RANK () OVER (PARTITION BY Patient_ID ORDER BY [Start
datetime]) AS INROrder
INTO
          #OrderedINRList
FROM    #FilteredLabResults

ORDER BY
          [Start datetime]

DECLARE          @INRLowerBound AS DECIMAL(20,4)
SET              @INRLowerBound = 2.0
DECLARE          @INRUpperBound AS DECIMAL(20,4)
SET              @INRUpperBound = 3.0

SELECT
            Patient_ID,
            Practice_Site,
            Provider_ID,
            INROrder,
            INR1Date,
            INR1Result,
            TimeBetweenSamples,
            INRDiff,
            INRShiftKPI2,
            IsValidInterval,
CASE
      WHEN
            INRShiftKPI2 = 0.0 AND (INR1Result >= @INRLowerBound AND
INR1Result <= @INRUpperBound
            AND INR2Result >= @INRLowerBound AND INR2Result <=
@INRUpperBound)THEN CAST(TimeBetweenSamples AS DECIMAL)
      ELSE isnull(cast(TimeBetweenSamples AS DECIMAL) * ABS((INRShiftKPI2
/ NULLIF(INRDiff,0))),0)
      END  AS TherapeuticDaysKPI2

INTO
      #TherapeuticDays
FROM
(
      SELECT
            inr1.Patient_ID,
            inr1.Practice_Site,
            inr1.Provider_ID,
```

```
            inr1.INROrder,
            inr1.[Start datetime] AS INR1Date,
            inr1.[QDM_Attribute Result Value] AS INR1Result,
            inr2.[Start datetime] AS INR2Date,
            inr2.[QDM_Attribute Result Value] AS INR2Result,
            DATEDIFF(DAY,inr1.[Start datetime],inr2.[Start datetime]) AS
TimeBetweenSamples,
            inr2.[QDM_Attribute Result Value] - inr1.[QDM_Attribute Result
Value] AS INRDiff,
            dbo.DifferenceWithinRange_v2  (inr1.[QDM_Attribute Result
Value],inr2.[QDM_Attribute Result Value],@INRLowerBound,@INRUpperBound) AS
INRShiftKPI2,
            CASE
                  WHEN (ABS(DATEDIFF(DAY,inr1.[Start datetime],inr2.[Start
datetime])) <= 56)
                        THEN 1
                        ELSE 0
            END AS IsValidInterval
      FROM
            #OrderedINRList inr1
            INNER JOIN #OrderedINRList inr2
            ON inr2.INROrder = inr1.INROrder + 1 AND inr1.Patient_ID =
inr2.Patient_ID
      WHERE
            inr2.[Start datetime] >= inr1.[Start datetime]
) x
ORDER BY
      INR1Date
SELECT
      Patient_ID ,
      Practice_Site,
      Provider_ID,
      ROUND(100 * (SUM(TherapeuticDaysKPI2) / SUM(TimeBetweenSamples)),2)
AS PctTTR,
      SUM(IsValidInterval) as NumValidIntervals
INTO
      #PatientTTR
FROM
      #TherapeuticDays

GROUP BY Patient_ID,Practice_Site, Provider_ID
ORDER BY Patient_ID


DROP TABLE #FilteredLabResults
DROP TABLE #TherapeuticDays
DROP TABLE #OrderedINRList
```

Cumulative Medication Duration

Cumulative medication duration (CMD) includes the total number of calendar days the patient is actively using Warfarin. The SQL logic below does not include the specific medication codes that are used to identify each individual warfarin prescription for a patient. In the HQMF file for the clinical quality measure, the value set for the data element Medication, Active "Warfarin" contains the RxNorm codes that should be used to identify patients on warfarin therapy. The HQMF file for the clinical quality measure also defines cumulative medication duration >=180 days.

For testing purposes, the measurement start date was set to 1/1/2011, and the look-back period for an active medication of warfarin is 200 days prior to measurement start date. Depending on how cumulative medication duration is captured in the site's EHR, SQL logic may need to be modified in order to include this particular data set.

```
DECLARE @MeasurementStartDate DATETIME
DECLARE @LookBackDate DATETIME

SET @MeasurementStartDate = '1/1/2011'
SET @LookBackDate = @MeasurementStartDate - 200

SELECT DISTINCT a.Patient_ID,
                      a.Practice_Site,
                      a.Provider_ID,
                      a.PctTTR,
                      B.[Start DateTime],
                      B.[Stop DateTime],
                      DATEDIFF(DAY,B.[Start DateTime] , B.[Stop
DateTime]) AS DateDifference,
                      CASE WHEN  b.[Start DateTime] < @LookBackDate THEN
DATEDIFF(DAY,B.[Start DateTime] ,
                                          B.[Stop DateTime]) -
DATEDIFF(DAY,B.[Start DateTime] , @LookBackDate)
                      WHEN       b.[Stop DateTime] >=
@MeasurementStartDate THEN DATEDIFF(DAY,B.[Start DateTime] ,
                                          B.[Stop DateTime]) -
DATEDIFF(DAY,@MeasurementStartDate,B.[Stop DateTime])
                      ELSE DATEDIFF(DAY,B.[Start DateTime] , B.[Stop
DateTime])  END AS ActualUsageIn200DayPeriod
INTO            #PatientTTRWithMedDates
FROM            #PatientTTR A
     JOIN       ADE_Medications B ON A.Patient_ID = B.Patient_ID
     JOIN       ADE_VocabularyDictionary C ON B.DataElement_Code = C.Code
WHERE           B.[Start DateTime] IS NOT NULL
                      AND   (b.[Start DateTime] >= @LookBackDate or
b.[Stop DateTime] >= @LookBackDate)
                      AND (b.[Start DateTime] <= @MeasurementStartDate)
                      AND C.[QDM Category] = 'Medication, Active'

SELECT     Patient_ID,
                Practice_Site,
                Provider_ID,
                PctTTR,
```

```
                SUM(ActualUsageIn200DayPeriod) AS
CumlativeMedicationUsage
INTO        #PatientTTRWithMin180DaysMeds
FROM        #PatientTTRWithMedDates
GROUP BY    Patient_ID,Practice_Site, Provider_ID,PctTTR
HAVING      SUM(ActualUsageIn200DayPeriod) >=180
ORDER BY    Patient_ID,Practice_Site, Provider_ID
```

Age Requirements

The logic in this section contains a filter that states the patient must be 18 years or older during the measurement period.

```
SELECT  a.Patient_id,
           b.BirthDate,
           a.Practice_Site,
           a.Provider_ID,
           a.PctTTR
INTO   #PatientTTRAbove18WithMin180DaysMeds
FROM   #PatientTTRWithMin180DaysMeds a
JOIN   ADE_Patients B ON a.Patient_ID = b.Patient_ID
WHERE  DATEDIFF(YEAR,b.birthdate,@MeasurementStartDate) >=18
ORDER BY A.Practice_Site
```

Active Diagnosis (including exclusion criteria)

Atrial Fibrillation Diagnosis

Patients who have an active diagnosis of atrial fibrillation or atrial flutter that started and did not end before the first day of the measurement period must be included in this measure.

Valvular Heart Disease

If patients contain an active diagnosis of valvular heart disease that started and did not end before the start of the measurement period, they should be excluded from the data set.

```
SELECT   a.Patient_Id,
           a.BirthDate,
           a.Practice_Site,
           a.Provider_ID,
           a.PctTTR
INTO     #PatientTTRAbove18WithMin180DaysMedsAndDiagnosis
FROM     #PatientTTRAbove18WithMin180DaysMeds a JOIN
           ADE_Diagnosis b ON a.Patient_id =B.Patient_ID
WHERE
           b.[start DateTime] < @MeasurementStartDate
           AND b.[Stop DateTime] > @MeasurementStartDate
```

```
            AND b.DataElement_Code IN (SELECT CODE FROM
ADE_VocabularyDictionary WHERE [QDM Category] = 'Diagnosis' AND ([Value
Set Name] = 'Atrial Fibrillation/Flutter'))
            AND b.Patient_id NOT IN (SELECT Patient_Id FROM ADE_Diagnosis
where (DataElement_Code IN (SELECT CODE FROM ADE_VocabularyDictionary
WHERE [QDM Category] = 'Diagnosis' AND ([Value Set Name] = 'Valvular Heart
Disease'))))
            AND (b.[start DateTime] <= @MeasurementStartDate AND b.[Stop
DateTime] >= @MeasurementStartDate)

ORDER BY A.Patient_ID

DROP TABLE #PatientTTRAbove18WithMin180DaysMeds
```

Valid INR Intervals

The SQL logic below calculates patients who have at least two valid INR intervals during the measurement period. A valid INR interval is defined as a pair of INR results that are less than or equal to 56 days apart. If multiple INR results are present on the same day, only one is noted for the TTR calculation (filter mentioned in Percent TTR section).

```
SELECT    A.Patient_Id,
              A.BirthDate,
              A.Practice_Site,
              A.Provider_ID,
              A.PctTTR
INTO      #PatientsWithTwoValidIntervals
FROM      #PatientTTRAbove18WithMin180DaysMedsAndDiagnosis A
JOIN    #PatientTTR B ON A.Patient_ID = B.Patient_ID
WHERE
            B.NumValidIntervals >= 2
```

Encounter Data

The logic below includes patients that have at least one outpatient visit during the measurement period. Patient encounter codes and definitions are site specific and must capture the relative encounters needed to meet the criteria of the measure.

```
SELECT    a.Patient_Id,
              a.BirthDate,
              a.Practice_Site,
              a.Provider_ID,
              a.PctTTR
INTO      #PatientTTRWithDaysAgeDiagnosisEncounter
FROM      #PatientsWithTwoValidIntervals a
JOIN      ADE_Encounters B ON A.Patient_Id = b.Patient_ID
```

```
JOIN    ADE_VocabularyDictionary C ON B.DataElement_Code = C.Code
WHERE
             (C.[Value Set Name] = 'Face-to-Face Interaction' OR C.[Value
Set Name] = 'Office Visit')
           AND b.[start datetime] >= @MeasurementStartDate
ORDER BY  Practice_site
```

Average TTR by Provider and Practice

In order to calculate an AverageTTR by provider, patients who meet all the criteria above will be grouped by unique provider identifier. The provider IDs should be assigned by the site (e.g., actual provider identifier). The identifier for the provider that is ultimately responsible for warfarin management should be used.

Note: the logic also includes the calculation of AverageTTR by practice site (e.g., an anticoagulation clinic). This is for reference purposes only and is not required for the quality measure or its reporting. Ideally, the identifier for the practice site at which the patient's warfarin is managed should be used.

```
SELECT Practice_Site,AVG(PctTTR) AS AvgTTRByPracticeSite
FROM #PatientTTRWithDaysAgeDiagnosisEncounter
GROUP BY Practice_Site

SELECT Provider_ID,AVG(PctTTR) AS AvgTTRByProvider
FROM #PatientTTRWithDaysAgeDiagnosisEncounter
GROUP BY Provider_ID
```

FUNCTION [dbo].[DifferenceWithinRange_v2]

The following function is required for the calculation of TTR. This function calculates the difference between two numbers that falls within a specified range. For example, given a range of 2.0 to 3.0, the difference between 1.5 and 2.5 within this range is 0.5. The function is intended for use in calculating differences between INR values within the context of the Rosendaal method of calculating TTR (time in therapeutic range), which requires the proportion of an INR difference from one sample to the next that falls within the therapeutic range.

```
USE [V01DW]
GO


/****** Object:  UserDefinedFunction [dbo].[DifferenceWithinRange_v2]
Script Date: 01/03/2013 13:51:42 ******/
SET ANSI_NULLS ON
GO

SET QUOTED_IDENTIFIER ON
GO

CREATE FUNCTION [dbo].[DifferenceWithinRange_v2]
(     --inputs:
      @Val1 as decimal(10,5),
      @Val2 as decimal(10,5),
      @LowerBound as decimal(10,5),
      @UpperBound as decimal(10,5)
)
RETURNS decimal(10,5)
AS
BEGIN
      -- Declare the return variable here
      DECLARE @result as decimal(10,5)


      set @result =
      (
      SELECT
            case
      -- inr values are both outside the range in the same direction
            when @Val1 > @UpperBound and @Val2 > @UpperBound then null
            when @Val1 < @LowerBound and @Val2 < @LowerBound then null
      -- inr values are straddling the range
            when (@Val1 > @UpperBound and @Val2 < @LowerBound)
                  OR (@Val2 > @UpperBound and @Val1 < @LowerBound)

                  then @UpperBound - @LowerBound
      -- both inr values are within the range
            when @Val1 between @LowerBound and @UpperBound
                        and @Val2 between @LowerBound and @UpperBound
                  then (@Val2 - @Val1)
```

```
	-- one value is in the range and one is outside
		when @Val1 > @Val2
				and @Val1 > @UpperBound
			then (@UpperBound - @Val2)*(-1) --/ (@Val1 - @Val2)
		when @Val2 > @Val1
				and @Val2 > @UpperBound
			then (@UpperBound - @Val1)*(-1) --/ (@Val2 - @Val2)

		when @Val1 > @Val2
				and @Val2 < @LowerBound
			then (@Val1 - @LowerBound)*(-1)
		when @Val2 > @Val1
				and @Val1 < @LowerBound
			then (@Val2 - @LowerBound)*(-1)
		else null
	end
	)

	-- Return the result of the function
	RETURN @result

END
GO
```

Acronyms

ACE	Angiotensin-Converting Enzyme
ADHD	Attention-Deficit/Hyperactivity Disorder
AHRQ	Agency for Healthcare Research and Quality
AIDS	Acquired Immune Deficiency Syndrome
API	Application Programming Interface
ARB	Angiotensin Receptor Blocker
BMI	Body Mass Index
BPS	Binding Parameter Specification
CAD	Coronary Artery Disease
CAP	Community-Acquired Pneumonia
CDC	Centers for Disease Control and Prevention
CMD	Cumulative Medication Duration
CMS	Centers for Medicare & Medicaid Services
CPT	Current Procedural Terminology
CQM	Clinical Quality Measure
CVX	The CVX code is a numeric string that identifies the type of vaccine product administered
DEC	Data Element Catalogue
DENEX	A subset of the Denominator that should not be considered for inclusion in the Numerator
DENOM	A subset of the IPP
DEXCEP	A subset of the Denominator
eCQI	Electronic Clinical Quality Improvement
eCQM	Electronic Clinical Quality Measure
ED	Emergency Department
EH	Eligible Hospital
EHR	Electronic Health Record
EP	Eligible Professional
ER/FR	Estrogen Receptor/ Progesterone Receptor
HCPCS	Healthcare Common Procedure Coding System
HF	Heart Failure
HIV	Human Immunodeficiency Virus
HL7	Health Level Seven International

HMPC	Home Management Plan of Care
HQMF	Health Quality Measures Format
HTML	HyperText Markup Language
ICD	International Classification of Diseases
IERS	International Earth Rotation Service
INR	International Normalized Ratio
IPP	Initial Population
ISO	International Organisation for Standards
IVD	Ischemic Vascular Disease
LDL-C	Low Density Lipoprotein - Control
LOINC	Logical Observation Identifiers Names and Codes
LVEF	Left Ventricular Ejection Fraction
LVSD	Left Ventricular Systolic Dysfunction
MAT	Measure Authoring Tool
MDD	Major Depressive Disorder
MI	Myocardial Infarction
MU	Meaningful Use
NLM	National Library of Medicine
NQF	National Quality Forum
NUMER	A subset of the Denominator
NUMEX	A subset of the Numerator that should not be considered for calculation
OID	Object Identifier
ONC	Office of the National Coordinator for Health Information Technology
POAG	Primary Open-Angle Glaucoma
POD	Postoperative Day
PCP	Pneumocystis Jiroveci Pneumonia
PHI	Protected Health Information
QDM	Quality Data Model
QRDA	Quality Reporting Document Architecture
RNA	Ribonucleic Acid
SCD	Semantic Clinical Drugs
SI	International System of Units
SNOMED	Systematized Nomenclature of Medicine
SQL	Structured Query Language
SVS	Sharing Value Sets

UHDDS	Uniform Hospital Discharge Data Set
TTR	Time in Therapeutic Range
URI	Upper Respiratory Tract Infection
USHIK	United States Health Information Knowledgebase
VSAC	Value Set Authority Center
XML	Extensible Markup Language