Centers for Medicare & Medicaid Services

Guide for Reading Electronic Clinical Quality Measures (eCQMs)

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1.   Introduction

Electronic clinical quality measures (eCQMs) use data electronically extracted from electronic health records (EHRs) or health information technology (HIT) systems to measure the quality of health care. eCQMs are used to search electronic health record data and create reports for quality reporting. The Centers for Medicare & Medicaid Services (CMS), which uses eCQMs in quality reporting programs, is working to reduce the burden of collecting and reporting health care quality performance data by making use of the capabilities of electronic health records.

1.1   Using This Guide

This guide seeks to help providers, quality analysts, implementers, and HIT vendors understand eCQMs and their related documents. The guide provides background on eCQM packages, which are the building blocks of eCQMs, and an overview for a user to understand the human-readable format of eCQMs. For information on how to develop an eCQM, please refer to the [Blueprint for the CMS Measures Management System](#). For more information on implementing an eCQM, please refer to the eCQM Logic and Implementation Guidance document on the eCQI (Electronic Clinical Quality Improvement) Resource Center website. For more information on understanding harmonization efforts across the eCQMs, please refer to the CQL (Clinical Quality Language) Style Guide on the [eCQI Resource Center website](#).

2. eCQM Package

2.1 eCQM Package Naming Conventions

Measure developers create an eCQM in the Measure Authoring Tool (MAT) and export it as a measure package. Each measure package contains the following components for use in implementing an eCQM:

- **Human-readable hypertext markup language (HMTL) file (.html):** File that shows the eCQM content in a human-readable format directly in a web browser.

- **Health Quality Measure Format (HQMF) Extensible Markup Language (XML) file (.xml):** File that provides the machine-processable description of the measure data and population criteria, including a header and a body. The header provides metadata about the measure. The body contains key eCQM sections such as population criteria, data criteria, and supplemental data elements. The HQMF points to the CQL library and associated Expression Logical Model (ELM) files discussed here.

- **CQL file (.cql):** File that provides the expression logic for data criteria, population criteria, and supplemental data elements. It describes the computable content in the measure and is organized into libraries that can be reused or shared between measures and other artifacts, such as decision support rules.

- **ELM file (.xml, .json):** File that provides a machine-readable representation of the measure's logic in XML and JavaScript Object Notation (JSON) formats. The ELM file is intended for machine processing and provides the information necessary to automatically retrieve data from an electronic health record.

- **Shared CQL libraries (.cql, .xml, and .json):** Libraries, the basic units of sharing CQL, consist of a foundation of CQL statements used within a measure. Every measure has at least one main CQL library. The main CQL library, referenced from HQMF, might depend on other CQL libraries that are often used in or shared with other eCQMs. The measure package includes these CQL and ELM files, which provide CQL source and ELM rendering for collections of CQL expressions used across measures. The JSON format of the ELM is also included. There are several format versions of the CQL libraries so that local implementers can use those most appropriate to their software and data analysis tools.

2.1.1 Measure Packaging by Setting

CMS publishes two eCQM zip files annually: one for eligible professionals (EPs) or eligible clinicians (ECs) and one for eligible hospitals (EHs) or critical access hospitals (CAHs). Each file contains the eCQMs for a specific reporting or performance period. The files are labeled using the setting and then publication date (format: YYYY-MM) as in the following examples:

- EH-CAH-eCQM-2021-05.zip
- EP-EC-eCQM-2021-05.zip

2.1.2   CMS eCQM ID

During its development in the MAT, each eCQM receives a unique CMS eCQM ID. The eCQM ID's two parts, the eCQM Identifier and a major eCQM Version Number, are found in the header of the HQMF for the measure. The CMS eCQM ID is created by prefacing the eCQM Identifier with "CMS" followed by "v" and the major version number. For example, the CMS eCQM ID of EP/EC measure *Diabetes: Hemoglobin A1c (HbA1c) Poor Control (> 9%)* would be **CMS122v9**, as shown in Table 1.

Table 1. CMS eCQM Identifier and Version Number

eCQM Information	Value
eCQM Identifier (MAT)	122
eCQM Version Number	9
CMS eCQM ID	CMS122v9

2.1.3   eCQM Zip File and Folder

An eCQM package is published as a zip file. The published zip file contains the HTML, XML, CQL, ELM (JSON and XML), and CQL libraries discussed in section 2.1. There are separate CQL and ELM (JSON and XML) files for each CQL library. The eCQM package name for each measure includes the CMS eCQM ID—for example, CMS122v9.zip.

2.1.4   Individual eCQM File Components

Table 2 shows examples of these filenames for eCQMs posted on the eCQI Resource Center. The eCQM zip, HTML, and HQMF XML filenames refer to the CMS eCQM ID. The CQL, ELM XML, and ELM JSON file names refer to the abbreviated eCQM title from the MAT and the CQL library version number.

Table 2. Measure-Specific eCQM File Formats

File Type	Filename Standard	Filename Example
Zip	{CMS eCQM ID}.zip	CMS122v9.zip
HTML	{CMS eCQM ID}.html	CMS122v9.html
HQMF XML	{CMS eCQM ID}.xml	CMS122v9.xml
CQL	{eCQM Title}-{CQL Library Version }.cql	DiabetesHemaglobinA1cHbA1cPoorControl9-9.3.000.cql
ELM XML	{eCQM Title}-{CQL Library Version}.xml	DiabetesHemaglobinA1cHbA1cPoorControl9-9.3.000.xml
ELM JSON	{eCQM Title}-{CQL Library Version}.json	DiabetesHemaglobinA1cHbA1cPoorControl9-9.3.000.json

2.2   Download, Extract, and Access eCQM Documents

Users can download and view an eCQM's measure package in two ways:

- Downloading the eCQM zip file that contains *all the measures* for the relevant setting from the eCQI Resource Center
- Going to the *individual* web page associated with an eCQM on the eCQI Resource Center to view and download the specific zip file.

Users can open the file by doing the following:

1. Download the zip file.
2. After it finishes downloading, double click on the zip file to open it.
3. Double click on the file you wish to view.

Note: To view the XML coding, right click to open the document with a text reader such as Wordpad, Notepad, or a third-party XML-reading software. To open in a text editor or an XML editor, right click on the file, select "Open with," and then select the text editor or an XML editor.

3. eCQM Building Blocks – Standards and Tools

3.1 Standards

Measure developers use several standards to identify the data, define the data elements used in eCQMs, and express the timing and relationships between them. Figure 1 shows the relationships between these standards, and the following subsections briefly describe them.

Figure 1. eCQM Standards

HQMF (Metadata, Population Structure)

CQL (Logic)
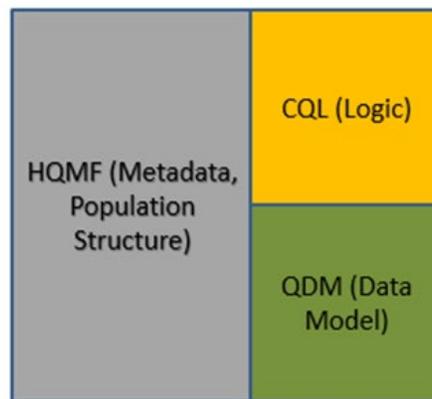
QDM (Data Model)

Definitions:
HQMF – Health Quality Measure Format
CQL – Clinical Quality Language
QDM – Quality Data Model

3.1.1 HQMF

HQMF is a Health Level Seven–standard format for documenting the content and structure of a quality measure.[1] Intended to represent quality measures used in a health care setting, it is an XML document that describes how to compute a quality measure. Through standardization of a measure's structure, metadata, definitions, and logic, the HQMF provides consistency and unambiguous interpretation. More information on HQMF is available at the eCQI Resource Center.

3.1.2 Quality Data Model

The Quality Data Model (QDM) is an information model that measure developers use to define the data necessary to describe the measure components (such as the numerator and denominator for a proportion measure). Creating an eCQM involves defining measure data elements consistently based on the QDM model, which helps to define the data criteria used in the eCQM.

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[1] Health Level Seven International is a nonprofit standards developing organization accredited by the American National Standards Institute.

This process is specified in the [Blueprint for CMS Measures Management System](#). More information on the [QDM](#) is available at the eCQI Resource Center. The following subsections provide a brief overview of some of the key elements of the QDM that can help in reading and interpreting eCQMs.

3.1.2.1   QDM Data Element

The QDM data model uses a specific structure to define a *QDM data element*. Figure 2 shows the structure of a *QDM data element:*

1. QDM category is the particular class or group of information that a quality measure can address (for example, Diagnosis, Medication, Procedure, and Laboratory Test).

2. QDM datatype starts with the QDM category and adds the context in which the information is expected to be found with respect to electronic clinical data (for example, Laboratory Test, Performed; Laboratory Test, Ordered).

3. QDM data elements start with the QDM datatype and include specific values to signify precisely the information desired. The values are referenced as a single code or a value set.

4. QDM *attributes* represent information about a QDM data element (or metadata) that must exist in data retrieved from the electronic health record to calculate the eCQM results. Attributes include concepts such as start and stop times, results, and locations. Each QDM datatype has a specific set of attributes acceptable for use in an eCQM.

Figure 2. QDM Structure – Building a Quality Data Element Using QDM Categories, Context (Datatype), Value Sets, or Direct Reference Codes and Attributes
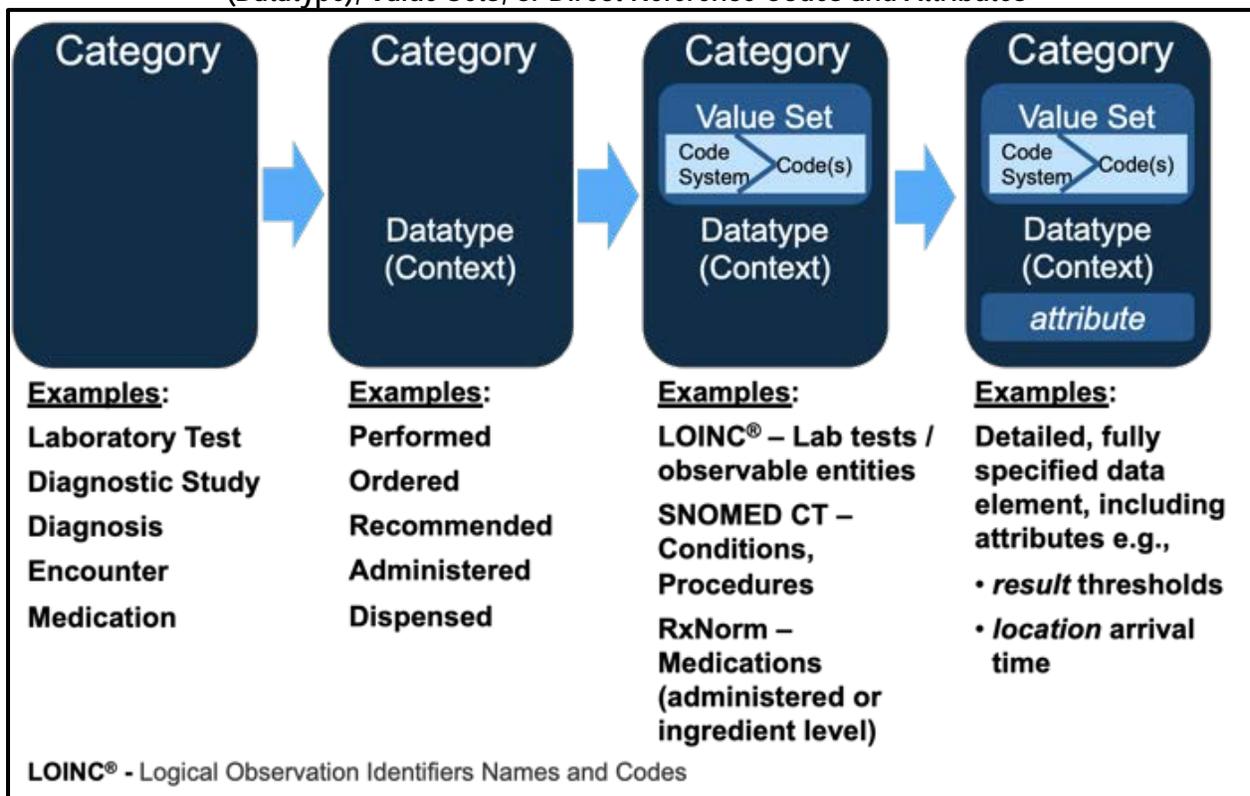
Combining the QDM datatype with a value set or direct reference code makes a QDM data element.

The QDM v5.5 introduces a new concept called entities. Entities are not QDM datatypes or attributes. Rather, they represent concepts that can be used to specify details about the actor (or performer) of any QDM datatype. An eCQM can use entities to provide further information required for an individual or organization actor to meet the measure's criteria.

The new QDM entities are Patient, Related Person, Practitioner, and Organization. Patient refers to an individual receiving health care services. Related Person is someone who is involved in the care of a patient but is not the direct target of care; this entity includes an identifier and a relationship (for example, mother to a newborn infant). Practitioner is a person with formal responsibility to provide healthcare with an ability to reference an identifier, role, qualification or specialty. Organization is a grouping of people or organizations with a common purpose and includes identifier and type attributes. Full definitions of the four entities and their attributes can be found in the QDM v5.5 documentation.

For complete technical details about the QDM, such as definitions of all its QDM datatypes and *attributes,* please refer to the [QDM v5.5](#) specification. For information on versions to use in each reporting period, please visit the [eCQI Resource Center.](#)

An eCQM specified with CQL logic expressions uses QDM by describing data criteria based on the QDM datatype and its related value or value set. CQL references the QDM *attributes* separately as part of the CQL expression detail. Therefore, the data criteria section of the eCQM references only the QDM data elements. Any values or value sets referenced by QDM *attributes* (for example, specific allowable results) appear within the logic expression, and the values or value sets appear only in the terminology section of the eCQM. Note that the QDM datatype appears in the HQMF, whereas the *attributes* appear in the CQL portion of the eCQM. Figure 3 shows how the QDM components are used with a CQL-based eCQM.

Figure 3. Description of a Laboratory Test
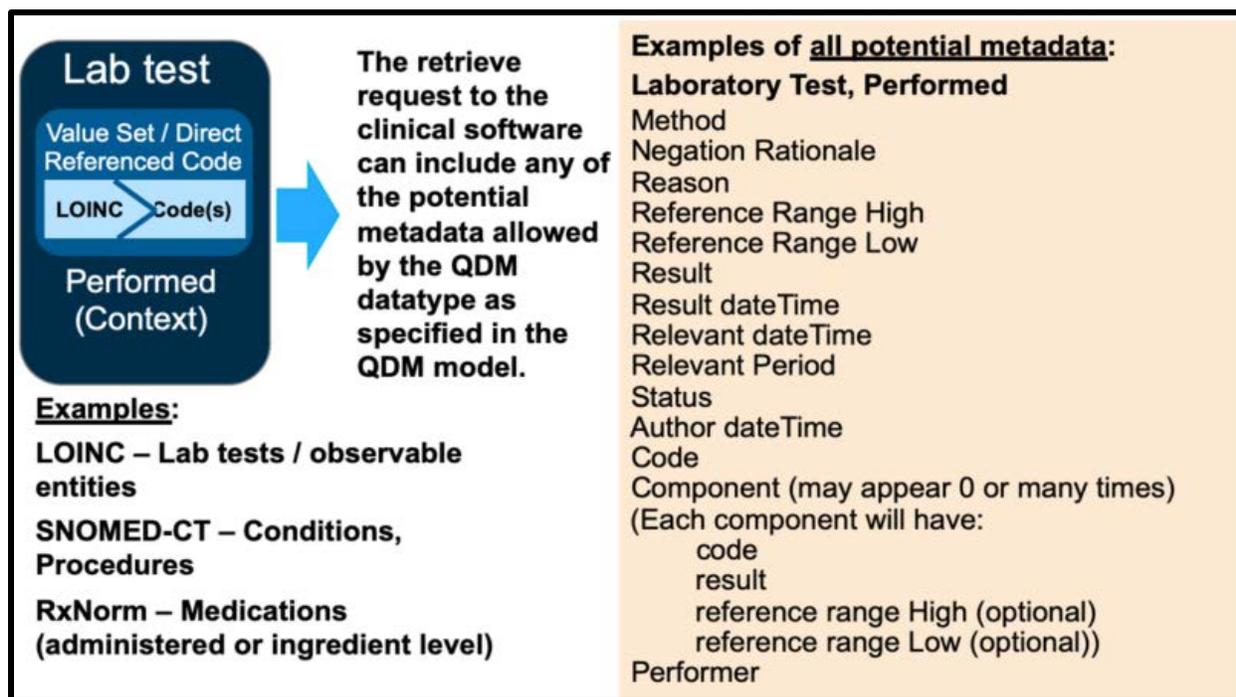
3.1.3　CQL

CQL is a Health Level 7 standard for trial use that defines a high-level, clinically focused language used to specify measure criteria and clinical decision support rules. The language is understandable to humans but structured enough to be processed electronically, streamlining implementation of eCQMs. CQL has been used in eCQM implementation specifications since the 2019 performance period. It is applied to harmonize the standards used for eCQMs and clinical decision support. More information on CQL is available at the eCQI Resource Center.

3.2　Tools

3.2.1　MAT

Measure developers use MAT to create eCQMs in a highly structured format using the QDM, CQL, and standard vocabularies. Measures developed using the MAT produce HQMF-compliant outputs. All eCQMs used in CMS quality reporting programs are authored in and exported from the MAT. To learn how to use the MAT to author eCQMs, please refer to the Measure Authoring Tool User Guide.

3.2.2　Bonnie

Bonnie is a software tool that enables eCQM developers to test and verify the behavior of their eCQM logic. The main goal of the Bonnie application is to reduce the number of defects in eCQMs before electronic health record vendors implement them by providing a robust and automated testing framework. The Bonnie application helps measure developers execute a

measure's logic against a constructed patient test deck and evaluate whether the logic aligns with the intent of the measure.

3.2.3 Value Set Authority Center

The Value Set Authority Center (VSAC) is a central repository for the official versions of value sets that support the eCQMs. Value sets are lists of codes and corresponding terms, drawn from standard clinical vocabularies hosted by the National Library of Medicine, that define clinical and administrative concepts such as diagnoses, clinical visits, and patient characteristics. Examples of standard clinical vocabularies used to create value sets are Current Procedural Terminology (CPT), International Statistical Classification of Diseases and Related Health Problems Revision 10 (ICD-10), Systematized Nomenclature of Medicine – Clinical Terms (SNOMED CT), and Logical Observation Identifiers Names and Codes (LOINC). The National Library of Medicine maintains the VSAC, provides downloadable access to the value sets, and updates the value sets used in CMS quality programs once or more each year. Access to eCQM value sets through the VSAC requires a free Unified Medical Language System account.

A complete list of eCQM Tools and Resources used in various stages of eCQM development, testing, implementation, and reporting is available at the eCQI Resource Center.

3.2.3.1 Value Sets

A value set is a specific set of codes and their descriptions that define a clinical concept. The codes can be drawn from one or more code systems, such as CPT, ICD-10, SNOMED CT, and LOINC, among others. Value sets contain the codes expected to appear (or be available via mapping) in the clinical record or administrative data. Each value set is identified by an assigned numeric object identifier (OID). In the human-readable HTML document, value sets are referred to by both a name (*value_set_name*) and an identifier (*value_set_OID*). In CQL, the use of a given value set in an eCQM is indicated by square brackets. The following example depicts a value set within CQL:

```
exists ["Diagnosis": "Diabetes"]
```

Here, Diabetes is the *value_set_name,* and the details of the value set, including the OID, are available in the terminology section at the end of the document: *valueset "Diabetes" using "2.16.840.1.113883.3.464.1003.103.12.1001"*. This value set is an example of a grouping value set that groups together several other value sets. Value sets used in eCQMs are created, managed, and distributed in the National Library of Medicine VSAC.

The VSAC provides several options for downloading value set information. Excel spreadsheets containing individual value set metadata and contents are available through the Search Value Sets tab. The download tab in the VSAC provides Excel workbooks that compile value sets by quality reporting program, measure, value set name, and QDM category. These workbooks provide additional detail related to the value set, including code system OIDs and versions. Please note that for value sets used exclusively to describe *QDM attributes,* the compiled workbooks will have a blank in the *QDM category* because more than one QDM category might use attributes. An additional method for browsing and downloading eCQM value sets is the Search Value Sets tab in the VSAC filtered by program (CMS eCQM). Finally, users can retrieve eCQM value sets programmatically with the VSAC SVS API, using the release parameter and correct release name.

3.2.3.2 Direct Reference Codes

If a single code—rather than a collection of codes—can define a clinical concept, then there is an alternative method for associating the concept to the QDM data element. Instead of creating a single-code value set, the code is directly embedded into the CQL logic statements. This method of expression is called a direct reference code. Direct reference codes are listed in the terminology section of the HQMF and in the OIDs of the code systems from which the codes derive (for example, SNOMED CT or LOINC). For example, the terminology section for CMS154v9, *Appropriate Treatment for Children with Upper Respiratory Infection (URI)*, contains three direct reference codes, which are shown at the top of the section:

Terminology

- code "Birth date" ("LOINC Code (21112-8)")
- code "Discharge to healthcare facility for hospice care (procedure)" ("SNOMEDCT Code (428371000124100)")
- code "Discharge to home for hospice care (procedure)" ("SNOMEDCT Code (428361000124107)")
- valueset "Antibiotic Medications for Pharyngitis" (2.16.840.1.113883.3.464.1003.196.12.1001)
- valueset "Comorbid Conditions for Respiratory Conditions" (2.16.840.1.113883.3.464.1003.102.12.1025)
- valueset "Competing Conditions for Respiratory Conditions" (2.16.840.1.113883.3.464.1003.102.12.1017)
- valueset "Emergency Department Visit" (2.16.840.1.113883.3.464.1003.101.12.1010)
- valueset "Encounter Inpatient" (2.16.840.1.113883.3.666.5.307)
- valueset "Ethnicity" (2.16.840.1.114222.4.11.837)
- valueset "Hospice care ambulatory" (2.16.840.1.113762.1.4.1108.15)
- valueset "Hospital Observation Care - Initial" (2.16.840.1.113883.3.464.1003.101.12.1002)
- valueset "Office Visit" (2.16.840.1.113883.3.464.1003.101.12.1001)
- valueset "ONC Administrative Sex" (2.16.840.1.113762.1.4.1)
- valueset "Payer" (2.16.840.1.114222.4.11.3591)
- valueset "Preventive Care Services - Established Office Visit, 18 and Up" (2.16.840.1.113883.3.464.1003.101.12.1025)
- valueset "Preventive Care Services, Initial Office Visit, 0 to 17" (2.16.840.1.113883.3.464.1003.101.12.1022)
- valueset "Preventive Care Services-Initial Office Visit, 18 and Up" (2.16.840.1.113883.3.464.1003.101.12.1023)
- valueset "Preventive Care, Established Office Visit, 0 to 17" (2.16.840.1.113883.3.464.1003.101.12.1024)
- valueset "Race" (2.16.840.1.114222.4.11.836)
- valueset "Telephone Visits" (2.16.840.1.113883.3.464.1003.101.12.1080)
- valueset "Upper Respiratory Infection" (2.16.840.1.113883.3.464.1003.102.12.1022)

It is important to note that the value set workbooks available on the downloads tab of the VSAC, discussed in section 3.2.3.1, do not include the direct reference codes used in measures. To obtain a separate listing of direct reference codes, users must select "Direct Reference Codes Specified with eCQM HQMF files, Publication Date: *MM DD, YYYY*" on the download tab of the VSAC.

3.2.3.3 Versioning Value Sets

The VSAC is updated regularly. All value set versions contained in the VSAC are identified by the publication date (format: YYYYMMDD) as the following examples show:

- 20190510
- 20200507

Users can view this version identification system by reviewing the measure on the VSAC website or on the exported Excel spreadsheet.

Value sets undergo maintenance, during which time codes can be removed, added, or changed. When value sets are modified and the purpose and intent remain the same, the value set version will change within the VSAC, but the OID will not. When value sets are modified and the purpose and intent of the value set change, a new OID will be assigned to the value set.

4. Understanding an eCQM Human-Readable HTML Format

The eCQM human-readable format (in HTML) contains a header and body. Quality measures have six or eight key components, depending on measure type and level of detail.

4.1 Header

The header of an eCQM, referred to as metadata, provides important general information about the measure. The header describes the measure's developer and steward, the dates during which it is valid, and other details about how the measure works or is used. Appendix A includes header component definitions and a sample eCQM header.

4.2 Body

The body contains the description of the measure. The elements of the measure body include the following:

- **Population Criteria:** A representation of the CQL definitions that specify the populations for the eCQM. These CQL definitions typically include the set of characteristics for a given measure that could include information on specific age groups, diagnoses, procedures, encounters, and timing relationships (for example, the periods during which the procedures must have occurred to be included). Population criteria might include the initial population, denominator, denominator exclusions, numerator, numerator exclusions, denominator exceptions, measure population, measure population exclusions, measure observation, and stratification. For definitions of these populations, please refer to section 4.2.1.

- **Stratification:** Variable groups on which the measure is designed to report, such as diagnosis or age.

- **Measure Observation:** Used only in ratio and continuous variable eCQMs. This element provides instructions on how to compute performance, such as the mean time from arrival to departure for all emergency department visits during the measurement period. Measure observations normally count or assess something other than patients or encounters.

- **Definitions:** Additional CQL definitions (expression logic) that the population definitions might reference. A CQL definition is the basic unit of logic within the CQL library.

- **Functions:** A CQL expression that performs a calculation frequently found in eCQMs and is designed to return a value. Age calculations, for example, are expressed as functions.

- **Terminology:** A list of the value sets and direct reference codes used in the measure.

- **Data Criteria (QDM Data Elements):** A list that contains the QDM datatypes and value set names or direct reference code descriptions used in the measure. These are the building blocks used to assemble the population criteria of an eCQM.

- **Supplemental Data Elements:** Specific information to be retrieved for each patient reported in the eCQM, such as race, ethnicity, payer, and sex. Supplemental data elements might be used for risk adjustment or population health analytics.

- **Risk Adjustment Variables:** Outcome measures might require risk adjustment to account for the complexity of patient conditions that could affect the ability to achieve outcomes. Risk adjustment variables are used to identify these patients. The variables might be used in statistical models to revise measure scores based on these patient characteristics.

4.2.1   Population Criteria and Definitions

Population criteria are specified characteristics for a measure that include information on specific age groups, diagnoses, procedures, medications, and timing relationships. Population criteria consist of a definition statement or reference another definition. These definitions are described in the definition section within the human-readable format of the measure. CQL specifies the data criteria within each population criterion and references the data elements based on the QDM data model.

The populations defined by a proportion measure follow:[2]

- **Initial Population:** All events to be evaluated by a specific quality measure involving patients who share a common set of specified characteristics within a specific measurement set to which a given measure belongs. All patients counted (for example, as numerator, as denominator) are drawn from the initial population.

- **Denominator (DENOM):** This is the lower part of a fraction used to calculate a rate, proportion, or ratio. It can be the same as the initial population or a subset of the initial population to further constrain the population for the purpose of the measure. Continuous variable measures do not have a denominator but instead define a measure population.

- **Denominator Exclusions (DENEX):** A case that should be removed from the measure population and denominator before determining if numerator criteria are met. Denominator exclusions are used in proportion and ratio measures to help narrow the denominator. For example, patients with bilateral lower extremity amputations would be listed as a denominator exclusion for a measure requiring foot exams.

- **Denominator Exceptions (DEXCEP):** Any condition that should remove a patient, procedure, or unit of measurement from the denominator of the performance rate only if the numerator criteria are not met. A denominator exception allows for adjustment of the calculated score for those providers with higher risk populations. A denominator exception also provides for the exercise of clinical judgment and should be specifically defined where capturing the information in a structured manner fits the clinical workflow. A denominator exception is used only in proportion measures. Denominator exception cases are removed from the denominator. However, the number of patients with valid

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[2] Except for measure population and measure observations, all definitions are available at the eCQI Resource Center website: https://ecqi.healthit.gov/glossary.

exceptions may still be reported. Allowable reasons fall into three general categories - medical reasons, patient reasons, or system reasons.

- **Numerator (NUMER):** The upper portion of a fraction used to calculate a rate, proportion, or ratio. Also called the measure focus, it is the target process, condition, event, or outcome. Numerator criteria are the processes or outcomes expected for each patient, procedure, or other unit of measurement defined in the denominator. A numerator statement describes the clinical action that satisfies the conditions of the performance measure.

- **Numerator Exclusions (NUMEX):** Defines an instance that should not be included in the numerator data. Numerator exclusions are only used in ratio and proportion measures.

- **Measure Population** (used only in continuous variable measures): The eCQM population—for example, all patients seen in the emergency department during the measurement period. The measure population could be the same as, or contain a subset of, the IP.

- **Measure Observations** (used only in continuous variable measures): The computation to be performed on the members of the measure population after removing the measure population exclusions. For example, measure CMS111v9, *Median Admit Decision Time to ED Departure Time for Admitted Patients*, computes the median duration from the decision to admit to the departure from the emergency department.

For example, Figure 4 defines the following specifications about the initial population of CMS122v9:

- Patients ages 18 to 75 with a visit during the measurement period

- Patients who have been seen by the provider being measured during a qualifying adult outpatient encounter

- Patients who have a diagnosis of diabetes that was identified any time up to the end of the measurement period

Figure 4. Initial Population Criteria in CMS122v9


```
⊿ Initial Population
    exists ( ["Patient Characteristic Birthdate": "Birth date"] BirthDate
            where Global."CalendarAgeInYearsAt"(BirthDate.birthDatetime, start of "Measurement Period")in Interval[18, 75 )
    )
        and exists ( AdultOutpatientEncounters."Qualifying Encounters" )
        and exists ( ["Diagnosis": "Diabetes"] Diabetes
                where Diabetes.prevalencePeriod overlaps "Measurement Period"
        )
```

Note that CQL uses common linking operators and timing phrases such as "exists" and "overlaps" in the example in Figure 4. The following examples demonstrate common linking operators and timing phrases found within CQL expressions:

> and, not, or, is, is not, starts/ends, during, before, on or before/after, same or before/after, with/without, overlaps, count, sort, null, is true/false, greater/less, same as, equal, exists, intersects, sort, first/last, return, let, where, union, intersect, except, includes

Definitions. The CQL expression also uses definitions, which are common clauses of data elements and their interrelationships. The definition title, displayed in quotation marks, is a human-readable name that enables the measure to reference expressions without having to repeat all of the logic each time. Each eCQM has a definition section in which each definition title is followed by the expression logic used to characterize it.

Figure 5 shows a simple definition, "Initial Population," that describes all patients included in the denominator. The "Initial Population" definition was previously defined in Figure 4, which specifies the content of the definition "Initial Population."

<div align="center">Figure 5. Example of Population Criteria Definition</div>

```
Denominator
      "Initial Population"
```

Note that the definition "Initial Population" includes other definitions such as "Qualifying Encounters" (see Figure 4). The user should review the definition section of the specification to determine what each definition includes (for example, what a "Qualifying Encounter" means). In the human-readable HQMF, definitions are organized alphabetically by the definition name.

Aliases. Aliases are words or easily understood abbreviations that help describe logic statements meant to reduce the complexity of the statements. By using aliases in CQL, the developer can reduce complexity and the need for repeating. In the Figure 4 example, the QDM data element ["Diagnosis": "Diabetes"] is followed by the alias Diabetes. That means that the reference to the timing can use the alias instead of the full data element detail.

Figures 6 and 7 show how CQL displays *QDM data elements*. In CQL, *QDM data elements* are displayed in brackets and QDM datatype in quotation marks, followed by a colon and then the value or value set used to specify the element—for example, [*"Diagnosis": "Diabetes"*].

QDM defines a set of allowable *attributes* for each datatype. In Figure 6, Diagnosis is the QDM datatype, and it includes a number of *attributes,* one of which is the prevalence period. QDM defines prevalence period as an interval starting with the onset date and ending with the abatement date (the date the diagnosis ends). If there is no abatement date, the eCQM assumes the diagnosis remains active. The CQL references *attributes* using a period between the alias for the *QDM data element* and its *attribute*. This example shows the *QDM data element* alias Diabetes followed by the *attribute* prevalencePeriod (Diabetes.prevalencePeriod).

<div align="center">Figure 6. Example of QDM Data Element Expressed in CQL</div>

```
and exists ( ["Diagnosis": "Diabetes"] Diabetes
      where Diabetes.prevalencePeriod overlaps "Measurement Period" )
```

Figure 7 presents the final example of the completed QDM data element in the data criteria section of the eCQM, which lists the value or value set the QDM datatype requires. The QDM data element "Diagnosis: Diabetes" uses the Diabetes value set with its OID. Subsection 3.2.3 provides a high-level description of the VSAC, in which all of the eCQM value sets and their OIDs can be found.

Figure 7. Example of QDM Data Element Listed in Data Criteria Section

```
Data Criteria (QDM Data Elements)

    •   "Diagnosis: Diabetes" using "Diabetes
        (2.16.840.1.113883.3.464.1003.103.12.1001)"
```

4.2.2   Functions

A function is a CQL expression that performs a calculation frequently found in eCQMs. Rather than repeating common calculations in each measure, the logic can be written to access a library of functions and include selected functions as part of the measure logic. Functions exist within CQL expressions and perform a variety of calculations. For example, to avoid redefining patient age in each eCQM, the developer uses the function "CalendarAgeInYearsAt" from a global library, as Figure 8 shows.

Figure 8. Example of Use of CQL Function

```
Initial Population

    exists ( ["Patient Characteristic Birthdate":"Birth date"] BirthDate

                where
                Global."CalendarAgeInYearsAt"(BirthDate.birthDatetime,
                start of "Measurement Period")in Interval[18, 75 )

    )

        and exists ( AdultOutpatientEncounters."Qualifying Encounters" )

        and exists ( ["Diagnosis": "Diabetes"] Diabetes

                where Diabetes.prevalencePeriod overlaps "Measurement
                Period"

        )
```

Some functions are global functions and exist in the global common library; that is, they can be used across many measures. Figure 9 depicts the "CalendarAgeInYearsAt" function as an example of a global calendar function from the global library.

Figure 9. Example of CQL Global Function

```
Functions

    Global.CalendarAgeInYearsAt(BirthDateTime DateTime, AsOf DateTime)

    years between ToDate(BirthDateTime)and ToDate(AsOf)
```

4.2.2.1   Libraries

Definitions or functions can be shared and used in other measures via libraries. Sharing can occur locally and be used across several measures, as Figure 10 shows with the referenced definition "Hospice.Has Hospice" determining whether the patient is receiving hospice care. Libraries can also be shared globally across all measures, as in Figure 9, with use of the global library function Global.CalendarAgeInYearsAt().

Figure 10. Example of Population Criteria Using a Local Library

```
Hospice.Has Hospice

      exists ( ["Encounter, Performed": "Encounter Inpatient"]
      DischargeHospice

                where ( DischargeHospice.dischargeDisposition as Code ~
                "Discharge to home for hospice care (procedure)"

                        or DischargeHospice.dischargeDisposition as
                        Code ~ "Discharge to healthcare facility for
                        hospice care (procedure)"

                )

                and DischargeHospice.relevantPeriod ends during
                "Measurement Period"

      )

        or exists ( ["Intervention, Order": "Hospice care ambulatory"]
        HospiceOrder

                where HospiceOrder.authorDatetime during "Measurement
                Period"

        )

        or exists ( ["Intervention, Performed": "Hospice care
        ambulatory"] HospicePerformed

                where HospicePerformed.relevantPeriod overlaps
                "Measurement Period"

        )
```

4.2.3   Terminology and Data Criteria (QDM Data Elements)

The terminology section provides a complete list of value sets and direct reference codes used in a measure, including the value set name with its unique OID. For direct reference codes, the list contains the code and terminology version and the OIDs of the terminologies used by the direct reference codes.

This section is used to assemble the population criteria of an eCQM. Data criteria consist of *QDM data elements* and the values or value sets that define them. The data criteria section of the human-readable HTML file lists all unique *QDM data elements,* with corresponding value sets, used by an eCQM in alphabetical order.

Note that QDM also defines additional information about a QDM data element that a measure might contain. QDM refers to this additional information as attributes. All QDM datatypes have a *code* attribute that is compared with a value set. Other QDM attributes are often used in a "where" clause to further narrow the instances of QDM data elements within a population. For example, a "relevantPeriod" *attribute* could provide the time interval for a hospital admission and discharge. CQL logic can test whether this relevantPeriod is within the Measurement Period.

CQL expressions reference the attributes of QDM data elements to further refine and restrict the criteria. Sometimes these criteria involve quantities, such as restricting lab results to a certain threshold. In other cases, these criteria involve terminology testing, such as whether the negation rationale for an event not performed is in a "Patient refusal" value set. When terminology is referenced in expressions this way, it is not part of the data criteria, but it does appear in the terminology section.

For example, CMS138, *Preventive Care and Screening: Tobacco Use: Screening and Cessation Intervention*, includes in its numerator all patients receiving a tobacco screening. To identify a tobacco screening, the logic looks for an assessment performed 24 months or less before the end of the measurement period. The *result* is a QDM attribute of "Assessment, Performed": "Tobacco Use Screening." Figure 11 shows an example of this CQL expression.

Figure 11. Example of a CQL Expression for a Tobacco Screening

Most Recent Tobacco Use Screening Indicates Tobacco User

```
( Last(["Assessment, Performed": "Tobacco Use Screening"] TobaccoUseScreening
     where TobaccoUseScreening.relevantDatetime during "Measurement Period"
     sort by relevantDatetime
)) MostRecentTobaccoUseScreening
  where MostRecentTobaccoUseScreening.result in "Tobacco User"
```

The *result attribute* references a value set "Tobacco User;" however, the data criteria section does not include the value set reference because the *result* attribute (and associated value set) is

not in the CQL retrieve filter. In this case, the data criteria section can be thought of as criteria used in the retrieve filter. The value set reference appears only in the eCQM terminology section.

4.2.4 Supplemental Data Elements

All CMS eCQMs include a supplemental data element section. This section requests specific information to be retrieved for each patient reported in the eCQM. The information collected can be used for various risk adjustment or population analytics, but the supplemental elements are not calculated as part of the basic measure logic. Figure 12 shows an example of the supplemental data element section with the four elements required by CMS (ethnicity, payer, race, and sex). Individual eCQMs might include additional supplemental data elements.

Figure 12. Supplemental Data Element Section of an eCQM

```
Supplemental Data Elements

     SDE Ethnicity

          ["Patient Characteristic Ethnicity": "Ethnicity"]

     SDE Payer

          ["Patient Characteristic Payer": "Payer"]

     SDE Race

          ["Patient Characteristic Race": "Race"]

     SDE Sex

          ["Patient Characteristic Sex": "ONC Administrative Sex"]
```

4.2.5 Reporting Stratification

Measure developers might define reporting strata (that is, variable groupings the measure is designed to report on). For example, they might report different rates by age or by type of intensive care unit in a facility.

The reporting stratification section is always included in an eCQM human-readable rendition. If a measure does not have reporting strata defined, it displays "None" by default. If a measure contains reporting stratifications, each of the reporting strata is listed under its own heading, as Figure 13 shows (example from the eligible clinician measure CMS155, *Weight Assessment and Counseling for Nutrition and Physical Activity for Children and Adolescents*).

Figure 13. Reporting Stratification

(a) Stratification Section in Header

Stratification	Report a total score, and each of the following strata: Stratum 1 - Patients age 3-11 Stratum 2 - Patients age 12-17

(b) Stratification Section in CQL Logic Definitions

Stratification 1

```
    exists ["Patient Characteristic Birthdate":"Birth date"] BirthDate

        where Global."CalendarAgeInYearsAt"(BirthDate.birthDatetime,
        start of "Measurement Period")in Interval[3, 11]

 Stratification 2

    exists ["Patient Characteristic Birthdate":"Birth date"] BirthDate

        where Global."CalendarAgeInYearsAt"(BirthDate.birthDatetime,
        start of "Measurement Period") in Interval[12, 17 )
```

4.2.6   Risk Adjustment Variables

Outcome measures might require risk adjustment to account for the complexity of patient conditions that could affect the ability to achieve outcomes. Risk adjustment variables serve to identify these patients. The variables may be used in statistical models to revise measure scores to reflect these patient characteristics. Risk adjustment variables will be captured and expressed in a measure. The risk adjustment methodology will likely be included as an attachment or link in the measure header to describe how to adjust scores using the variables. Currently, there are no eCQMs in CMS quality programs that use risk adjustment variables.

4.2.7   Measure Observations

Measure observations, used in ratio and continuous variable eCQMs only, describe how to evaluate performance (for example, the mean time from arrival to departure for all emergency department visits during the measurement period).

Figure 14 shows an example of measure observation logic referencing the Related ED Visit function located in the functions section of CMS111:

Figure 14. Measure Observation Example

```
Measure Observation

Median (
      /*The duration from the Decision to Admit (order or assessment) to
    the departure from the Emergency Department*/
    duration in minutes of Interval[Coalesce(
    "AdmitDecisionUsingAssessmentDuringLastEDBeforeDeparture"(
    EncounterInpatient).relevantDatetime,
    "AdmitDecisionUsingEncounterOrderDuringLastEDandBeforeDeparture"(
    EncounterInpatient).authorDatetime,
    "EDDepartureTime"("LastEDEncounter"(EncounterInpatient))]
)
```

5. Connect for Assistance

For questions related to eCQM implementation specifications, logic, data elements, standards, or tools, use the eCQM Issue Tracker project in the Office of the National Coordinator for Health IT Project Tracking System (Jira) at https://oncprojectracking.healthit.gov.

Version History

Version	Date	Author / Owner	Description of Change
4.0	May 4, 2018	CMS	Initial updated draft for comments
5.0	May 2019	CMS	Updated measure examples, figures, hyperlinks, and versions of standards referenced throughout. Revised text based on input from stakeholders and external reviewers. Added Section 3.2.3.2, Direct Reference Codes.
6.0	May 2020	CMS	Updated measure examples, figures, hyperlinks, and versions of standards referenced throughout. Revised text based on input from stakeholders and external reviewers.
7.0	May 2021	CMS	Updated measure examples, figures, hyperlinks, and versions of standards referenced throughout. Revised text based on input from stakeholders and external reviewers.

Appendix A. Sample eCQM Header

This appendix presents header component definitions in the order shown in the sample header in Figure 15, which appears after this list of definitions.

eCQM Title: The title of the eCQM.

eCQM Identifier (Measure Authoring Tool): A unique eCQM identifier that is automatically generated by the MAT.

eCQM Version Number: A number used to indicate the version of the eCQM. The combination of the eCQM Identifier and the eCQM Version number creates the CMS eCQM ID.

NQF Number: Specifies the NQF number if one has been assigned. An NQF number is only included if an eCQM is endorsed. The assigned NQF number can be cross-referenced with NQF's Quality Positioning System to verify measure endorsement status.

GUID: Represents the globally unique identifier for an eCQM. The MAT automatically generates this field, and the GUID does not change from year to year when eCQM specifications are updated.

Measurement Period: The time period for which the eCQM applies.

Measure Steward: The organization responsible for the continued maintenance of the eCQM. The measure steward can be the same as the measure developer.

Measure Developer: The organization that developed the eCQM.

Endorsed By: The organization that has endorsed the eCQM through a consensus-based process. All endorsing organizations are to be included.

Description: A general description of the eCQM's intent.

Copyright: Identifies the organization or organizations that own the intellectual property represented by the eCQM or its contents.

Disclaimer: Disclaimer information for the eCQM.

Measure Scoring: Indicates how the calculation is performed for the eCQM (for example, proportion, continuous variable, or ratio).

Measure Type: Indicates what the eCQM is measuring, such as a structure, process, or outcome.

Stratification: Describes the strata for which the measure is to be evaluated. There are several bases for stratification, including (1) different age groupings within the population described in the measure; (2) a specific condition, discharge location, or both; and (3) different locations within a facility.

Risk Adjustment: The method of adjusting for clinical severity and conditions present at the start of care that can influence patient outcomes for making valid comparisons of outcome measures across providers. Risk adjustment indicates whether an eCQM is subject to the statistical process for reducing, removing, or clarifying the influences of confounding factors to allow more useful comparisons.

Rate Aggregation: Describes how to combine information calculated based on logic in each of several populations into one summarized result. It can also serve to describe how to risk adjust the data based on supplemental data elements described in the eCQM.

Rationale: Succinct statement of the need for the measure. Usually includes statements pertaining to importance criteria, such as impact, gap in care, and evidence.

Clinical Recommendation Statement: Summary of relevant clinical guidelines or other clinical recommendations supporting the eCQM.

Improvement Notation: Information on whether an increase or decrease in score is the preferred result (for example, a higher score indicates better quality OR a lower score indicates better quality OR quality is within a range).

Reference(s): Identifies bibliographic citations or references to clinical practice guidelines, sources of evidence, or other relevant materials supporting the intent and rationale of the eCQM.

Definition: Description of individual terms provided as needed.

Guidance: Allows measure developers to provide additional guidance so that implementers can more easily interpret and implement components of the measure.

Transmission Format: Can be a TBD, URL, or hyperlink to the transmission formats that are specified for a reporting program.

> **Continuous Variable Measure:** A continuous variable is a measure score in which each individual value for the measure can fall anywhere along a continuous scale and can be aggregated using a variety of methods, such as the calculation of a mean or median (for example, the mean number of minutes between presentation of chest pain to the time of administration of thrombolytics). The header of a continuous variable measure contains the following sections:

> - **Measure Population:** This is a narrative description of the eCQM population (for example, all patients seen in the emergency department during the measurement period).

> - **Measure Observations:** These describe how to evaluate performance (for example, the mean time across all emergency department visits during the measurement period, from arrival to departure). Measure observations are described using a statistical methodology such as count, median, and mean.

Supplemental Data Elements: CMS defines four required Supplemental Data Elements (payer, ethnicity, race, and sex), which are variables used to aggregate data into various subgroups.

Comparison of results across strata can serve to show places disparities exist or areas in which exposing differences in results is necessary. Additional supplemental data elements required for risk adjustment or other purposes of data aggregation can be included in the Supplemental Data Element section.

Figure 15. eCQM Header for Diabetes: Hemoglobin A1c (HbA1c) Poor Control (> 9%)

eCQM Title	Diabetes: Hemoglobin A1c (HbA1c) Poor Control (> 9%)		
eCQM Identifier (Measure Authoring Tool)	122	eCQM Version Number	9.3.000
NQF Number	Not Applicable	GUID	f2986519-5a4e-4149-a8f2-af0a1dc7f6bc
Measurement Period	January 1, 20XX through December 31, 20XX		
Measure Steward	National Committee for Quality Assurance		
Measure Developer	National Committee for Quality Assurance		
Endorsed By	None		
Description	Percentage of patients 18-75 years of age with diabetes who had hemoglobin A1c > 9.0% during the measurement period		
Copyright	This Physician Performance Measure (Measure) and related data specifications are owned and were developed by the National Committee for Quality Assurance (NCQA). NCQA is not responsible for any use of the Measure. NCQA makes no representations, warranties, or endorsement about the quality of any organization or physician that uses or reports performance measures and NCQA has no liability to anyone who relies on such measures or specifications. NCQA holds a copyright in the Measure. The Measure can be reproduced and distributed, without modification, for noncommercial purposes (e.g., use by healthcare providers in connection with their practices) without obtaining approval from NCQA. Commercial use is defined as the sale, licensing, or distribution of the Measure for commercial gain, or incorporation of the Measure into a product or service that is sold, licensed or distributed for commercial gain. All commercial uses or requests for modification must be approved by NCQA and are subject to a license at the discretion of NCQA. (C) 2012-2019 National Committee for Quality Assurance. All Rights Reserved. Limited proprietary coding is contained in the Measure specifications for user convenience. Users of proprietary code sets should obtain all necessary licenses from the owners of the code sets. NCQA disclaims all liability for use or accuracy of any third party codes contained in the specifications. CPT(R) contained in the Measure specifications is copyright 2004-2019 American Medical Association. LOINC(R) copyright 2004-2019 Regenstrief Institute, Inc. This material contains SNOMED Clinical Terms(R) (SNOMED CT[R]) copyright 2004-2019 International Health Terminology Standards Development Organisation. ICD-10 copyright 2019 World Health Organization. All Rights Reserved.		
Disclaimer	The performance Measure is not a clinical guideline and does not establish a standard of medical care, and has not been tested for all potential applications. THE MEASURE AND SPECIFICATIONS ARE PROVIDED "AS IS" WITHOUT WARRANTY OF ANY KIND. Due to technical limitations, registered trademarks are indicated by (R) or [R] and unregistered trademarks are indicated by (TM) or [TM].		
Measure Scoring	Proportion		

Measure Type	Intermediate Clinical Outcome
Stratification	None
Risk Adjustment	None
Rate Aggregation	None
Rationale	As the seventh leading cause of death in the U.S., diabetes kills approximately 79,500 people a year and affects more than 30 million Americans (9.4 percent of the U.S. population) (Centers for Disease Control and Prevention [CDC], 2017a, 2017b). Diabetes is a long-lasting disease marked by high blood glucose levels, resulting from the body's inability to produce or use insulin properly (CDC, 2019). People with diabetes are at increased risk of serious health complications including vision loss, heart disease, stroke, kidney failure, amputation of toes, feet or legs, and premature death (CDC, 2016). In 2017, diabetes cost the U.S. an estimated $327 billion: $237 billion in direct medical costs and $90 billion in reduced productivity. This is a 34 percent increase from the estimated $245 billion spent on diabetes in 2012 (American Diabetes Association, 2018). Controlling A1c blood levels help reduce the risk of microvascular complications (eye, kidney and nerve diseases) (CDC, 2014).
Clinical Recommendation Statement	American Diabetes Association (2019): - A reasonable A1C goal for many nonpregnant adults is <7%. (Level of evidence: A) - Providers might reasonably suggest more stringent A1C goals (such as <6.5% [48 mmol/mol]) for selected individual patients if this can be achieved without significant hypoglycemia or other adverse effects of treatment (i.e. polypharmacy). Appropriate patients might include those with short duration of diabetes, type 2 diabetes treated with lifestyle or metformin only, long life expectancy, or no significant cardiovascular disease (CVD). (Level of evidence: C) - Less stringent A1C goals (such as <8% [64 mmol/mol]) may be appropriate for patients with a history of severe hypoglycemia, limited life expectancy, advanced microvascular or macrovascular complications, extensive comorbid conditions, or long-standing diabetes in whom the goal is difficult to achieve despite diabetes self-management education, appropriate glucose monitoring, and effective doses of multiple glucose-lowering agents including insulin. (Level of evidence: B)
Improvement Notation	Lower score indicates better quality
Reference	American Diabetes Association. (2018). Economic costs of diabetes in the U.S. in 2017. Diabetes Care, 41, 917-928. Retrieved from http://care.diabetesjournals.org/content/early/2018/03/20/dci18-0007
Reference	American Diabetes Association. (2019). 6. Glycemic targets: Standards of medical care in diabetes—2019. Diabetes Care, 42(Suppl. 1), S61-S70. https://doi.org/10.2337/dc19-S006
Reference	Centers for Disease Control and Prevention. (2014). National diabetes statistics report, 2014. Atlanta, GA: U.S. Department of Health and Human Services, CDC. Retrieved from http://www.thefdha.org/pdf/diabetes.pdf

Reference	Centers for Disease Control and Prevention. (2016). At a glance 2016: Diabetes—Working to reverse the U.S. epidemic. Atlanta, GA: Author. Retrieved from https://upcap.org/admin/wp-content/uploads/2016/06/Diabetes-at-a-Glance.pdf
Reference	Centers for Disease Control and Prevention. (2017a). Health, United States, 2016: With chartbook on long-term trends in health. Retrieved from https://www.cdc.gov/nchs/data/hus/hus16.pdf
Reference	Centers for Disease Control and Prevention. (2017b). National diabetes statistics report, 2017. Atlanta, GA: U.S. Department of Health and Human Services, CDC. Retrieved from https://www.cdc.gov/diabetes/pdfs/data/statistics/national-diabetes-statistics-report.pdf
Reference	Centers for Disease Control and Prevention. (2019). About diabetes. Retrieved from https://www.cdc.gov/diabetes/basics/diabetes.html
Definition	None
Guidance	Patient is numerator compliant if most recent HbA1c level >9%, the most recent HbA1c result is missing, or if there are no HbA1c tests performed and results documented during the measurement period. If the HbA1c test result is in the medical record, the test can be used to determine numerator compliance. Only patients with a diagnosis of Type 1 or Type 2 diabetes should be included in the denominator of this measure; patients with a diagnosis of secondary diabetes due to another condition should not be included. This eCQM is a patient-based measure. This version of the eCQM uses QDM version 5.5. Please refer to the eCQI resource center (https://ecqi.healthit.gov/qdm) for more information on the QDM.
Transmission Format	TBD
Initial Population	Patients 18-75 years of age with diabetes with a visit during the measurement period
Denominator	Equals Initial Population
Denominator Exclusions	Exclude patients whose hospice care overlaps the measurement period. Exclude patients 66 and older who are living long term in an institution for more than 90 consecutive days during the measurement period. Exclude patients 66 and older with advanced illness and frailty because it is unlikely that patients will benefit from the services being measured.
Numerator	Patients whose most recent HbA1c level (performed during the measurement period) is >9.0%
Numerator Exclusions	Not Applicable
Denominator Exceptions	None
Supplemental Data Elements	For every patient evaluated by this measure also identify payer, race, ethnicity and sex

Acronyms

CAH	critical access hospital
CDA	Clinical Document Architecture
CMS	Centers for Medicare & Medicaid Services
CPT	Current Procedural Terminology
CQL	Clinical Quality Language
eCQM	electronic clinical quality measure
EH	eligible hospital
EC	eligible clinician
ED	emergency department
ELM	Expression Logical Model
EP	eligible professional
GUID	globally unique identifier
HHS	U.S. Department of Health and Human Services
HIT	health information technology
HQMF	Health Quality Measure Format
HTML	Hypertext Markup Language
ICD-9-CM	International Classification of Diseases, Ninth Revision, Clinical Modification
ICD-10-CM	International Classification of Diseases, Tenth Revision, Clinical Modification
JSON	JavaScript Object Notation
LOINC	Logical Observation Identifiers Names and Codes
MAT	Measure Authoring Tool
NQF	National Quality Forum
OID	object identifier
ONC	Office of the National Coordinator for Health Information Technology
QDM	Quality Data Model
SNOMED CT	Systematized Nomenclature of Medicine, Clinical Terms
VSAC	Value Set Authority Center
XML	Extensible Markup Language