



Centers for Medicare & Medicaid Services

Guide for Reading Electronic Clinical Quality Measures (eCQM)

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1. Introduction

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

1.1 Using This Guide

This guide is intended to help providers, quality analysts, implementers, and HIT vendors understand eCQMs and eCQM-related documents. The guide provides background on an eCQM package, the building blocks of an eCQM, and an overview for understanding the human-readable format of the eCQM. 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

An eCQM is created in the [Measure Authoring Tool \(MAT\)](#) and exported as a measure package. Each measure package contains the following components for use when implementing an eCQM:

- **Human-readable HyperText Markup Language file (.html):** Displays the eCQM content in a human-readable format directly in a web browser.
- **[Health Quality Measure Format \(HQMF\)](#) Extensible Markup Language (XML) file (.xml):** Provides the machine-processable description of the measure data and population criteria and includes a header and a body. The header provides metadata about the measure. The body contains key eCQM sections, for example, [population criteria](#), [data criteria](#), and [supplemental data elements](#). The HQMF points to the CQL [library](#) and associated ELM files discussed below.
- **Clinical Quality Language (CQL) file (.cql):** Provides the expression logic for data criteria, population criteria, and supplemental data elements. It provides a formal description of the computable content in the measure and is organized into libraries that can be reused or shared between measures and other artifacts like decision support rules.
- **Expression Logical Model (ELM) file (.xml, .json):** 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 needed to automatically retrieve data from an EHR.
- **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, may depend on other CQL libraries that are often used in or shared with other eCQMs. The measure package includes these CQL and ELM files. They provide CQL source and ELM rendering for collections of CQL expressions used across measures. The JSON file is a JavaScript format of the ELM file. There are several format versions of the [CQL libraries](#) so that local implementers can use those most appropriate to their own software and data analysis tools.

2.1.1 Measure Packaging by Setting

CMS publishes two eCQM zip files annually: one for eligible professional (EP)/eligible clinicians (EC), and one for eligible hospital (EH)/critical access hospitals (CAH). Each file contains the eCQMs for a specific reporting/performance period. The files are labeled with the setting followed by the publication date (format: YYYY-MM). The following are examples:

- EH_CAH_eCQM_2019-05.zip
- EP_EC_eCQM_2019-05.zip

2.1.2 CMS eCQM ID

During eCQM development in the MAT, a unique CMS eCQM ID is assigned for each eCQM. The eCQM ID includes two parts: the eCQM Identifier and a major eCQM Version Number. These identifiers 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. Given this naming convention, EP measure *Diabetes: Hemoglobin A1c (HbA1c) Poor Control (> 9%)* would be displayed as **CMS122v7**, as shown in Table 1.

Table 1. CMS eCQM Identifier and Version Number

eCQM Information	Value
eCQM Identifier (MAT)	122
eCQM Version Number	7
CMS eCQM ID	CMS122v7

2.1.3 eCQM Zip File and Folder

An eCQM package is published as a zip file. The 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, CMS122v7.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	CMS122v7.zip
HTML	{CMS eCQM ID}.html	CMS122v7.html
HQMF XML	{CMS eCQM ID}.xml	CMS122v7.xml
CQL	{eCQM Title}-{CQL Library Version }.cql	DiabetesHemaglobinA1cHbA1cPoorControl9-MyLibrary-7.4.000.cql
ELM XML	{eCQM Title}-{CQL Library Version}.xml	DiabetesHemaglobinA1cHbA1cPoorControl9-MyLibrary-7.4.000.xml
ELM JSON	{eCQM Title}-{CQL Library Version}.json	DiabetesHemaglobinA1cHbA1cPoorControl9-MyLibrary-7.4.000.json

2.2 Download, Extract, and Access eCQM Documents

For an individual eCQM, the measure package can be downloaded and viewed in two ways:

- Download the eCQM zip file that contains *all the measures* for the relevant setting from the [eCQI Resource Center](#).
- Go to the *individual* web page associated with an eCQM on the eCQI Resource Center to view and download the specific zip file.

To open the file,

1. Download the zip file to your computer.
2. Once downloaded, double click on the zip file to open it.
3. Double click on the file you wish to view.

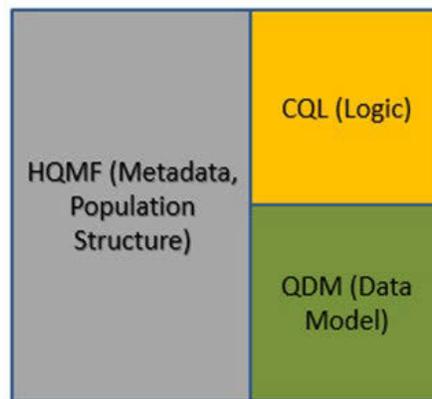
Note: To view the XML coding, right click to open the document with a text reader such as Wordpad, Notepad, or a third-party XML reading software. To open in a text editor or an XML editor, right click on the file, select “Open with” and then select the text editor or an XML editor.

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, briefly described in the following subsections.

Figure 1. eCQM Standards



Definitions:

HQMF – Health Quality Measure Format

CQL – Clinical Quality Language

QDM – Quality Data Model

3.1.1 Health Quality Measure Format

HQMF is a Health Level Seven (HL7)¹ standard format for documenting the content and structure of a quality measure. It is intended to represent quality measures used in a healthcare 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 used by measure developers to define the data needed to describe the measure components (for example, what information distinguishes the numerator from the denominator in a proportion measure). Creating an eCQM involves defining measure data elements consistently based on the QDM model. This helps to define the data criteria used in the eCQM. This process is specified in the [Blueprint for CMS Measures Management System](#). More information on the [QDM](#) is available at the eCQI

¹Health Level Seven International (HL7) is a non-profit, American National Standards Institute (ANSI)-accredited standards developing organization.

Resource Center. A brief overview of some of the key elements of the QDM that can help in reading and interpreting eCQMs is provided in the following subsections.

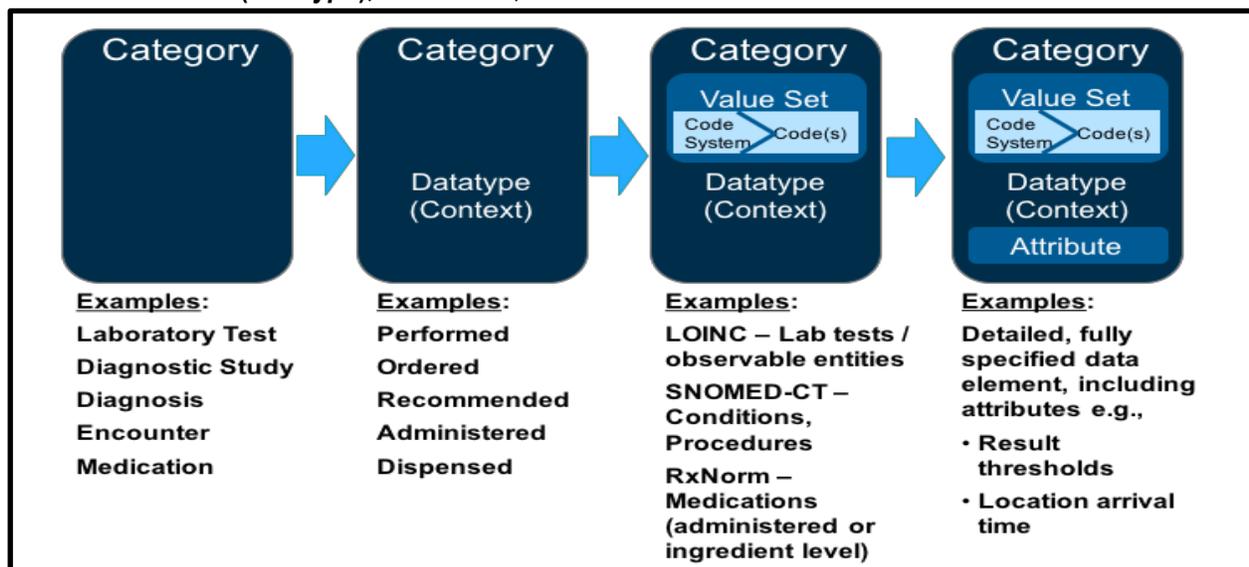
3.1.2.1 QDM Data Element

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 can be addressed in a quality measure (for example, *Diagnosis, Medication, Procedure, and Laboratory Test*).
2. *QDM datatype* starts with the *QDM category* and adds the context in which the information category is expected to be found with respect to electronic clinical data (for example, *Laboratory Test, Performed; Laboratory Test, Order*).
3. *QDM data elements* start with the *QDM datatype* and include specific values for signifying 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 EHR 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.

Combining the *QDM datatype* with a value set or direct reference code makes a *QDM data element*. For complete technical details about the QDM, such as definitions for all its *QDM datatypes* and *attributes*, please refer to the [QDM v5.4](#) specification.

Figure 2. QDM Structure – Building a Quality Data Element Using QDM Categories, Context (Datatype), Value Sets, or Direct Reference Codes and Attributes



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. Figure 3 shows how the QDM components are used with a CQL-based eCQM.

Figure 3. Description of a Laboratory Test

- **HQMF**
 - Laboratory Test, Performed: Antinuclear Antibody (ANA)
 - Uses a LOINC value set for ANA

[Attributes expressed via CQL]
- **CQL**
 - Union of:
 - Component: Homogeneous Pattern (result >= 1:80)
 - Component: Speckled Pattern (result >= 1:80)
 - Uses LOINC value sets for "homogeneous pattern" and "speckled pattern"

Lab test

Value Set / Direct Reference Code

LOINC

➤

Code(s)

Performed (Context)

Homogeneous (result)

Speckled (result)

Examples of all available metadata defined in the QDM 5.4 Data Model:

Laboratory Test, Performed

- Method
- Negation Rationale
- Reason
- Reference Range High
- Reference Range Low
- Result
- Result DateTime
- Relevant Period
- Status
- Author Datetime
- Code
- Component (may appear 0 or many times) (Each component will have:
 - code
 - result
 - reference range High (optional)
 - reference range Low (optional))

Dataflow attributes:

- Source
- Recorder
- Health Record Field

3.1.3 Clinical Quality Language

Clinical Quality Language (CQL) is an HL7 standard for trial use (STU) that defines a high-level, clinically focused language for use in specifying measure criteria and clinical decision support rules. The language is understandable for humans, yet structured enough to be processed electronically, streamlining implementation of eCQMs. CQL is used in eCQM implementation specifications beginning with the 2019 performance period. CQL is applied to harmonize 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 Measure Authoring Tool

Measure developers use the 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 implementation by EHR vendors 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, from standard clinical vocabularies hosted by the National Library of Medicine (NLM), that define clinical and administrative concepts such as diabetes, clinical visit, 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 NLM maintains the VSAC, provides downloadable access to the value sets, and publishes updates to the value sets used in CMS quality programs one or more times each year. Access to eCQM value sets through the VSAC requires a free [Unified Medical Language System \(UMLS\) 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 that are 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, can be found 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 NLM 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 *attributes* may be used for more than one *QDM category*. 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 clinical concept can be defined by a single code instead of a collection of codes, 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, as well as the OIDs of the code system from which the codes are derived (for example, SNOMED CT or LOINC).

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 shown in the following examples:

- 20170425
- 20180118

This version identification system is viewable 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. There are six or eight key components of a quality measure, depending on measure type and level of detail.

4.1 Header

The header of an eCQM is referred to as metadata and provides important general information about the measure. The header describes the steward and developer of the measure, 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 may 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.
- **Reporting Stratification** – Variable groupings on which the measure is designed to report, such as diagnosis or age.
- **Definitions** – Additional CQL definitions (expression logic) that may be referenced by the population definitions. 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 name or direct reference code description 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 may be used for risk adjustment or population health analytics.
- **Risk Adjustment Variables** – Outcome measures may require risk adjustment to account for the complexity of patient conditions that may affect their ability to achieve

outcomes. Risk adjustment variables are used to identify these patients. The variables may be used in statistical models to revise measure scores based on these patient characteristics.

- **Measure Observations** – Used only in ratio and continuous variable eCQMs, measure observations provide 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.

4.2.1 Population Criteria and Definitions

Population criteria are a set of specified characteristics for a given measure that includes 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.

Following are the populations defined in the population criteria of a measure:

- **Initial Population (IP)** – The set of patients or episodes of care to be evaluated by the measure.
- **Denominator (DENOM)** – 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.
- **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 do not meet numerator criteria 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.
- **Measure Population** (used only in continuous variable measures) – A subset of the initial population for a continuous variable measure that further constrains the population for the purpose of the measure. The measure population can be equivalent to the initial population.
- **Measure Observations** (used only in continuous variable measures) – Describes the computation to be performed over the members of the measure population. For example, measure CMS111 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 CMS122:

- Patients 18–75 years of age with diabetes 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 CMS122

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. The following two examples illustrate this.

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.”

Figure 5. Example of Population Criteria Definition

Denominator

```
"Initial Population"
```

Note that the definition “Initial Population” includes other definitions such as “Qualifying Encounters.” The viewer should scroll to the definition section to find what is included in each definition (for example, what is meant by a “Qualifying Encounter”). 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, 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.

The next set of figures shows how CQL displays *QDM data elements*. In CQL, *QDM data elements* are displayed in brackets with the *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 datatype* alias Diabetes followed by the *attribute* prevalencePeriod (Diabetes.prevalencePeriod).

Figure 6. Example of QDM Data Element Expressed in CQL

```
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 which value or value set the *QDM datatype* requires. The *QDM data element* “Diagnosis: Diabetes” uses the Diabetes value set with its object identifier. Subsection 3.2.3 provides a high-level description of the VSAC where 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 redefinition of patient age in each eCQM, the developer uses the function “CalendarAgeInYearsAt” from a global library, as shown in Figure 8.

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 shown in Figure 10 with the referenced definition Hospice.Has Hospice to reference that the patient is receiving hospice care. Libraries can also be shared globally, across all measures, as in Figure 10, 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 to be used in a measure. The list includes 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 may be found in a measure. QDM refers to this additional information as *attributes*. All *QDM datatypes* have a “code” *attribute* that is compared to 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* may 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 in this way, it is not part of the data criteria, but does appear in the terminology section.

For example, CMS131, *Diabetes: Eye Exam*, includes as part of the numerator all patients with a negative retinal exam in the previous year. To identify a negative retinal examination in the past year, the logic requires existence of a retinal or dilated eye exam that has a negative result within one year before the measurement period. The “result” is a *QDM attribute* of “Physical Exam, Performed”: “Retinal or Dilated Eye Exam.” An example of CQL expression for a negative retinal exam in the prior 12 months (namely, negative finding) is shown in Figure 11.

Figure 11. Example of CQL Expression for a Negative Retinal Exam in the Prior 1 Year

```

Negative Retinal Exam in Prior 1 Year

["Physical Exam, Performed": "Retinal or Dilated Eye Exam"]
NegativeRetinalExam

    where NegativeRetinalExam.relevantPeriod 1 years or less before
    start of "Measurement Period"

    and NegativeRetinalExam.result in "Negative Finding"

```

The “result” *attribute* “Negative Finding” references a value set; 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 may 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 may 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 may define reporting strata—variable groupings the measure is designed to report on. For example, they may 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, “None” is displayed by default. If a measure contains reporting stratifications, each of the reporting strata is listed under its own heading, as shown in Figure 13 (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")>= 3
    and Global."CalendarAgeInYearsAt"(BirthDate.birthDatetime,
    start of "Measurement Period")< 11
```

Stratification 2

```
exists ["Patient Characteristic Birthdate":"Birth date"] BirthDate
  where Global."CalendarAgeInYearsAt"(BirthDate.birthDatetime,
    start of "Measurement Period")>= 11
    and Global."CalendarAgeInYearsAt"(BirthDate.birthDatetime,
    start of "Measurement Period")< 17
```

4.2.6 Risk Adjustment Variables

Outcome measures may require risk adjustment to account for the complexity of patient conditions that may affect their ability to achieve outcomes. Risk adjustment variables are used 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 are used in ratio and continuous variable eCQMs only. They describe how to evaluate performance, for example, the mean time from arrival to departure for all ED 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 to the departure  
    from the Emergency Department*/  
    duration in minutes of Interval["Admit  
    Decision"(Encounter).authorDatetime, "Departure  
    Time"("Related ED Visit"(Encounter))]  
)
```

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 (ONC) Project Tracking System (Jira) located at <https://oncprojecttracking.healthit.gov>.

Appendix A. Sample eCQM Header

This appendix presents header component definitions in the order displayed in the sample header in Figure 15.

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 positive integer value 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](#) (QPS) to verify measure endorsement status.

GUID: Represents the globally unique identifier for an eCQM. The MAT automatically generates this field and 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 intent.

Copyright: Identifies the organization(s) that owns the intellectual property represented by the eCQM.

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 whether the eCQM is used to examine a process or an outcome over time (for example, structural, process, or outcome measure).

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 be used 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 important criteria such as impact, gap in care, and/or 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: Used to allow measure developers to provide additional guidance so implementers can understand greater specificity than could be provided in the logic for data criteria.

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

Proportion eCQM: The following sections are found in the header of a Proportion Measure:

- **Initial Population:** Refers to all patients to be evaluated by a specific performance eCQM who share a common set of specified characteristics within a measurement set to which a given measure belongs. Details often include information based on age groups, diagnoses, diagnostic and procedure codes, and enrollment periods.
- **Denominator:** The denominator 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.
- **Different measures within an eCQM set may have different Denominators:** Continuous Variable eCQMs do not have a Denominator but instead define a Measure Population.
- **Denominator Exclusions:** Patients who should be removed from the eCQM population and denominator before determining whether numerator criteria are met. Denominator exclusions are used in proportion and ratio measures to help narrow the denominator.
- **Numerator:** Numerators are used in proportion and ratio eCQMs. In proportion measures, the numerator criteria are the processes or outcomes expected for each patient, procedure, or other unit of measurement defined in the denominator. In ratio measures, the numerator is related but not directly derived from the denominator (for example, a numerator listing the number of central line blood stream infections and a denominator indicating the days per thousand of central line usage in a specific time period).
- **Numerator Exclusions:** Numerator Exclusions are used only in ratio eCQMs to define instances that should not be included in the numerator data (for example, if the number of central line blood stream infections per 1,000 catheter days were to exclude infections with a specific bacterium, that bacterium would be listed as a numerator exclusion).

- **Denominator Exceptions:** Denominator exceptions are those conditions that should remove a patient, procedure, or unit of measurement from the denominator only if the numerator criteria are not met. Denominator exceptions allow for adjustment of the calculated score for those providers with higher-risk populations. Denominator exceptions are used only in proportion eCQMs.

Denominator exceptions allow for the exercise of clinical judgment and should be defined where capturing the information in a structured manner fits the clinical workflow. Generic denominator exception reasons used in proportion eCQMs fall into three categories:

- Medical reasons
- Patient reasons
- System reasons

Continuous Variable Measure: The header of a continuous variable measure contains the following sections:

- **Measure Population:** Used only in continuous variable eCQMs. It is a narrative description of the eCQM population (for example, all patients seen in the Emergency Department during the measurement period).
- **Measure Observations:** Used only in continuous variable eCQMs. They 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 be used to show where disparities exist or where there is a need to expose differences in results. 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	7.4.000
NQF Number	0059	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	National Quality Forum		
Description	Percentage of patients 18-75 years of age with diabetes who had hemoglobin A1c > 9.0% during the measurement period		
Copyright	<p>This Physician Performance Measure (Measure) and related data specifications 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 (eg, 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) 2012-2017 National Committee for Quality Assurance. All Rights Reserved.</p> <p>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.</p> <p>CPT(R) contained in the Measure specifications is copyright 2004-2017 American Medical Association. LOINC(R) copyright 2004-2017 Regenstrief Institute, Inc. This material contains SNOMED Clinical Terms(R) (SNOMED CT[R]) copyright 2004-2017 International Health Terminology Standards Development Organisation. ICD-10 copyright 2017 World Health Organization. All Rights Reserved.</p>		
Disclaimer	<p>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.</p> <p>Due to technical limitations, registered trademarks are indicated by (R) or [R] and unregistered trademarks are indicated by (TM) or [TM].</p>		
Measure Scoring	Proportion		
Measure Type	Outcome		
Stratification	None		
Risk Adjustment	None		

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
EHR	Electronic Health Record
EC	Eligible Clinician
ED	Emergency Department
ELM	Expression Logical Model
EP	Eligible Professional
GUID	Globally Unique Identifier
HHS	Department of Health and Human Services
HIT	Health Information Technology
HL7	Health Level Seven
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
NLM	National Library of Medicine
NQF	National Quality Forum
OID	Object Identifier
ONC	Office of the National Coordinator for Health Information Technology
QDM	Quality Data Model (previously known as Quality Data Set)
QPS NQF	Quality Positioning System (NQF)
SNOMED CT	Systematized Nomenclature of Medicine, Clinical Terms
XML	Extensible Markup Language