Clinical Quality Language (CQL) 201: Training for Measure Developers

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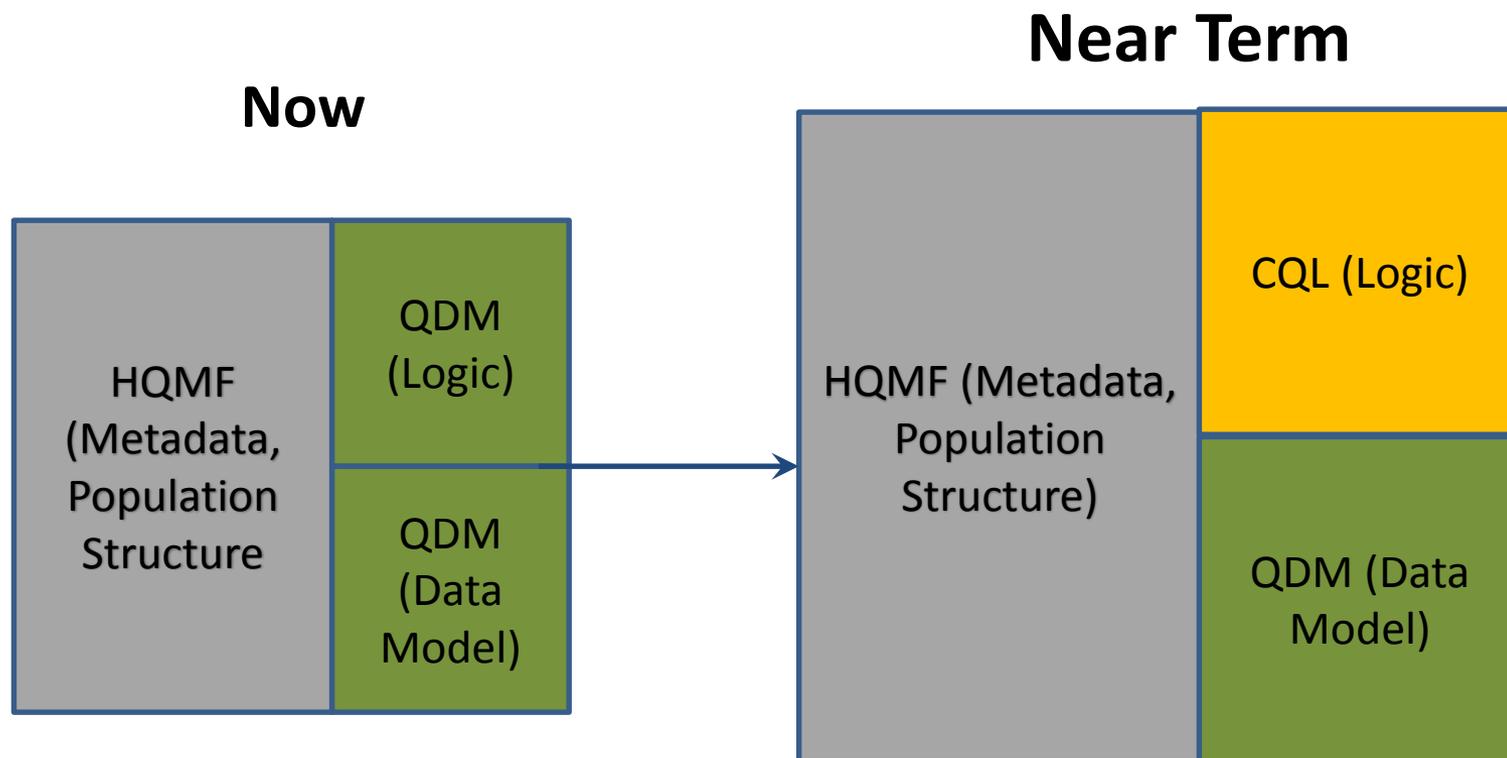
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CQL Training for Measure Developers: Agenda

- Welcome and Background
- Quality Data Model (QDM) and CQL
- Retrieval and Filtering
- Relationships and Comparisons
- Building a Measure

CQL Training for Measure Developers: Evolving eCQM Standards

Now

Near Term

| HQMF (Metadata, Population Structure | QDM (Logic) |
| | QDM (Data Model) |

→

| HQMF (Metadata, Population Structure) | CQL (Logic) |
| | QDM (Data Model) |

Definitions:

HQMF – Health Quality Measure Format

CQL – Clinical Quality Language

QDM – Quality Data Model

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CQL Training for Measure Developers: Differences Between the Quality Data Model (QDM) Now and When using Clinical Quality Language (CQL)

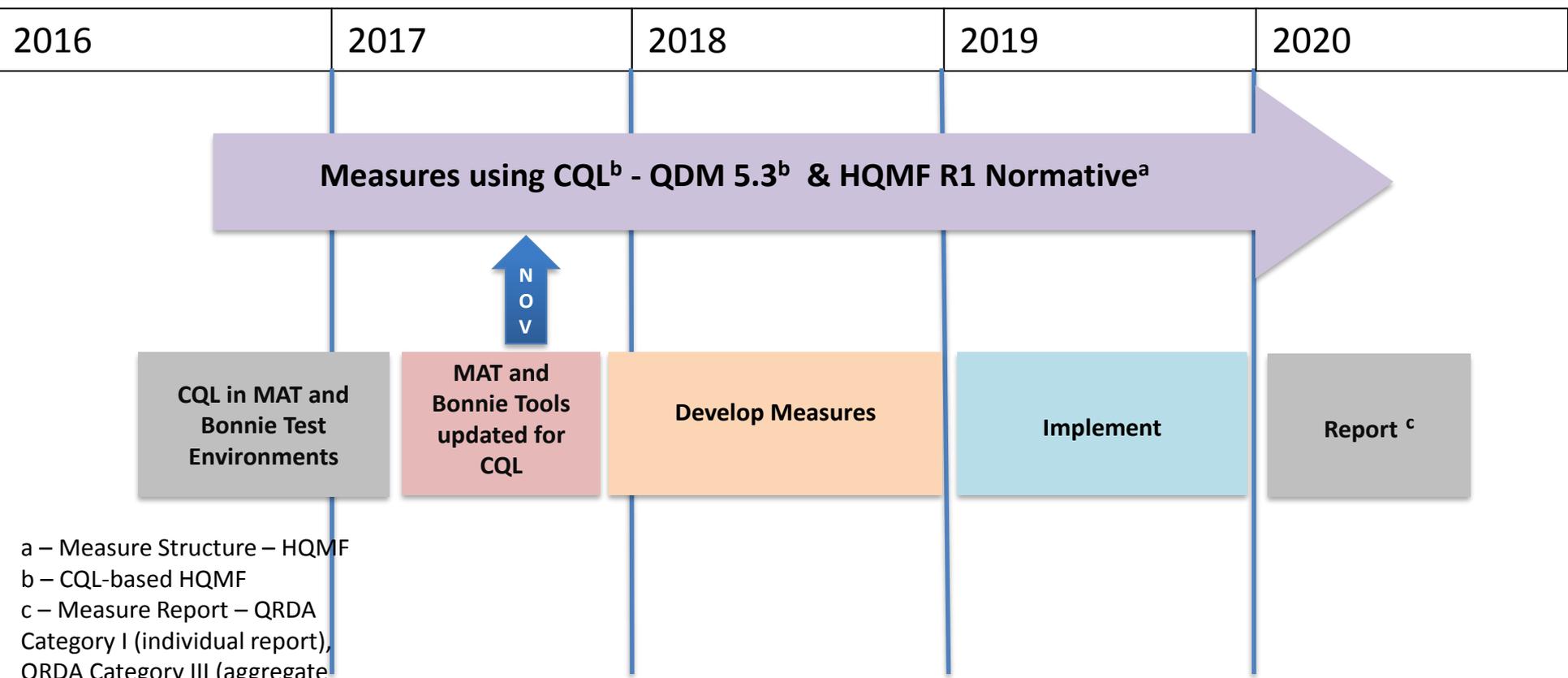| QDM Now	QDM with CQL
• Data Model and Logic are both in the QDM	• The Data Model will continue to exist as the QDM • CQL will provide the logic expressions and will replace that function currently in the QDM

CQL Training for Measure Developers: Benefits of CQL

		QDM Logic	CQL Logic
Modularity and Computability		Low	High
Data Model Flexibility	**	None	High
Expressive and Robust Logic Expression		Low	High
Duplicative work for Implementers, Vendors, and Developers		Yes	Lower

CQL Training for Measure Developers: Proposed Timeline For Updating Standards

2016	2017	2018	2019	2020

Measures using CQL[b] - QDM 5.3[b] & HQMF R1 Normative[a]

NOV

CQL in MAT and Bonnie Test Environments	MAT and Bonnie Tools updated for CQL	Develop Measures	Implement	Report [c]

a – Measure Structure – HQMF
b – CQL-based HQMF
c – Measure Report – QRDA Category I (individual report), QRDA Category III (aggregate report)
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BUILDING MEASURES WITH CQL AND QDM

CQL Training for Measure Developers: Clinical Quality Language (CQL)

- Health Level 7(HL7) standard designed to
    - Enable automated point-to-point sharing of executable clinical knowledge
    - Provide a clinically focused, author-friendly, and human-readable language
- Developed as part of a larger Clinical Quality Measure – Clinical Decision Support (CQM-CDS) harmonization effort (Clinical Quality Framework [CQF])
- Currently a Draft Standard for Trial Use (DSTU) publication

CQL Training for Measure Developers: Quality Data Model (QDM)

- Describes clinical concepts in a standard format
  - Category – Single clinical concept
    - e.g., Medication, Procedure, Encounter
  - Datatype – Context of use for each category
    - e.g., "Medication, Active", "Medication, Administered"
  - Attribute – Provides specific detail about an element
    - e.g., admissionDatetime, result
  - QDM Element – Specific category and associated datatype
    - e.g., "Encounter, Performed: Inpatient Encounter"

CQL Training for Measure Developers: QDM Elements in CQL

Category   Data Type   Value Set

```
58
59     ["Encounter, Performed": "Inpatient"]
60
```

QDM Element
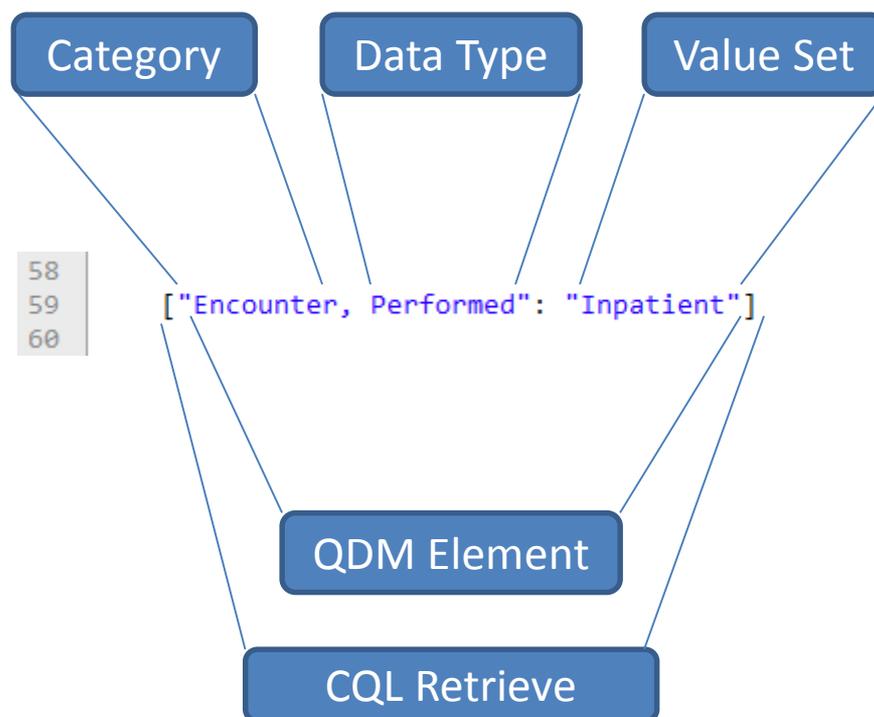
CQL Retrieve

CQL Training for Measure Developers: CQL Retrieval

```
58
59     ["Encounter, Performed": "Inpatient"]
60
```

- Returns all encounters whose *code* attribute is a member of the "Inpatient" value set
- *code* is the default for retrieves

```
60
61     ["Encounter, Performed": diagnosis in "Pharyngitis"]
62
```

- Returns all encounters whose *diagnosis* attribute is a member of the "Pharyngitis" value set

CQL Training for Measure Developers: CQL Retrieval Example

```
58
59        ["Encounter, Performed": "Inpatient"]
60
```

id	typeCode	diagnosis	admissionDateTime	dischargeDateTime
1	INP-01	PHRYNG	1/1/2015 3:33:00 PM	1/5/2015 10:11:00 AM
2	INP-02	PHRYNG	2/1/2015 3:33:00 PM	2/5/2015 10:11:00 AM
3	INP-03	ASTHMA	3/1/2015 3:33:00 PM	3/5/2015 10:11:00 AM

```
60
61        ["Encounter, Performed": diagnosis in "Pharyngitis"]
62
```

id	typeCode	diagnosis	admissionDateTime	dischargeDateTime
1	INP-01	PHRYNG	1/1/2015 3:33:00 PM	1/5/2015 10:11:00 AM
2	INP-02	PHRYNG	2/1/2015 3:33:00 PM	2/5/2015 10:11:00 AM

CQL Training for Measure Developers: Negation

- Negation is indicated in QDM with the *negationRationale* attribute

```
 2
 3   /* Encounters that were performed */
 4   ["Encounter, Performed": "Inpatient"] Encounter
 5     where Encounter.negationRationale is null
 6
 7   /* Encounters that were not performed */
 8   ["Encounter, Performed": "Inpatient"] Encounter
 9     where Encounter.negationRationale is not null
10
11   /* Encounters that were not performed for a specific reason */
12   ["Encounter, Performed": "Inpatient"] Encounter
13     where Encounter.negationRationale in "Encounter Not Done Reason"
14
```

- Default retrieves encounters with and without a *negationRationale*, so the intended result must be specified with a filter

CQL Training for Measure Developers: Negation Examples

```
2
3   /* Encounters that were performed */
4   ["Encounter, Performed": "Inpatient"] Encounter
5     where Encounter.negationRationale is null
6
```

id	typeCode	diagnosis	admissionDateTime	dischargeDateTime	negationRationale
1	INP-01	PHRYNG	1/1/2015 3:33:00 PM	1/5/2015 10:11:00 AM	<No Value>
2	INP-02	PHRYNG	2/1/2015 3:33:00 PM	2/5/2015 10:11:00 AM	<No Value>

```
6
7   /* Encounters that were not performed */
8   ["Encounter, Performed": "Inpatient"] Encounter
9     where Encounter.negationRationale is not null
10
```

id	typeCode	diagnosis	admissionDateTime	dischargeDateTime	negationRationale
3	INP-03	ASTHMA	3/1/2015 3:33:00 PM	3/5/2015 10:11:00 AM	PT-REASON

```
10
11  /* Encounters that were not performed for a specific reason */
12  ["Encounter, Performed": "Inpatient"] Encounter
13    where Encounter.negationRationale in "Encounter Not Done Reason"
14
```

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CQL Training for Measure Developers: Filtering by Existence

QDM filters by existence of *result* attribute

```
2
3  /* "Occurrence A of Laboratory Test, Performed: CD4+ Count (result)" */
4
```

CQL uses a *null* test

```
11
12  define "CD4+ Count With Results and Medications":
13    ["Laboratory Test, Performed": "CD4+ Count"] CD4Count
14      where CD4Count.result is not null
15
```

Note that comparison to *null* is not correct

```
17
18  define "CD4+ Count With Results and Medications":
19    ["Laboratory Test, Performed": "CD4+ Count"] CD4Count
20      where CD4Count.result <> null
21
```

This will not return any results because the answer to a comparison with *null* is "unknown"

CQL Training for Measure Developers: Filtering by Existence Example

```
11
12  define "CD4+ Count With Results and Medications":
13    ["Laboratory Test, Performed": "CD4+ Count"] CD4Count
14      where CD4Count.result is not null
15
```

```
id typeCode   result
-- ---------  ------
2  CD4+COUNT 10
```

```
17
18  define "CD4+ Count With Results and Medications":
19    ["Laboratory Test, Performed": "CD4+ Count"] CD4Count
20      where CD4Count.result <> null
21
```

```
id typeCode result
-- -------- ------
```

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CQL Training for Measure Developers: CQL Filtering by Value Set

- In addition to filtering within the retrieve, value sets can be used to filter within the *where* clause using the *in* operator

```
26
27  define "Denominator Exclusions 1":
28      "Encounter Inpatient" Encounter
29          where Encounter.facilityLocation in "Neonatal Intensive Care Unit (NICU)"
30              or Encounter.dischargeStatus in "Patient Expired"
31              or Encounter.dischargeStatus in "Discharge To Acute Care Facility"
32
```

CQL Training for Measure Developers: CQL Filtering by a Single Code

- Single code filters can also be applied using a *code* definition

```
3
4   codesystem "SNOMED-CT": '2.16.840.1.113883.6.96' version '2016A'
5
6   code "Breastfeeding intention": '123456789' system "SNOMED-CT" display 'Breastfeeding intention'
7
8   define "Breastfeeding Intention":
9     ["Risk Assessment, Performed": "Breastfeeding intention"] RiskAssessment
10      where RiskAssessment.negationRationale is null
11
```

CQL Training for Measure Developers: Filtering by Values and Quantities

- ## QDM filter by quantity

```
5
6   /* "Laboratory Test, Performed: LDL-c Test (result < 100 mg/dL)" */
7
```

- ## CQL equivalent

```
49
50  define "LDL-c Test In Range":
51    ["Laboratory Test, Performed": "LDL-c Test"] LDLCTest
52      where LDLCTest.result < 100 "mg/dL"
53
```

- ## CQL uses UCUM units to specify quantities

CQL Training for Measure Developers: Related Information

- ## QDM provides temporal relationships

```
2
3   /*
4     "Encounter, Performed: Hospital Inpatient"
5       starts before start of "Diagnosis: Diabetes"
6   */
7
```

- ## CQL equivalent

```
61
62  define "Valid Encounters":
63    ["Encounter, Performed": "Hospital Inpatient"] Encounter
64      with ["Diagnosis": "Diabetes"] Diagnosis
65        such that Encounter.admissionDatetime occurs before Diagnosis.onsetDatetime
66
```

CQL Training for Measure Developers: CQL Date and Time Comparisons

Date and Time comparisons can be precision-based

Operator	Precision-based Operator
=	same <precision> as
<	before <precision> of
>	after <precision> of
<=	same <precision> or before
>=	same <precision> or after

```
69
70   define "Valid Encounters":
71     ["Encounter, Performed": "Hospital Inpatient"] Encounter
72       with ["Diagnosis": "Diabetes"] Diagnosis
73         such that Encounter.admissionDatetime occurs same day as Diagnosis.onsetDatetime
74
```

Hospital inpatient encounters with diabetes diagnoses such that the admission was on the same day as the diagnosis onset

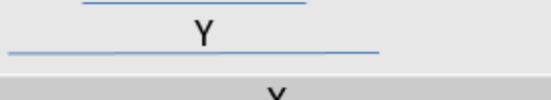# CQL Training for Measure Developers: Interval Comparisons

QDM "during"

```
3
4   "Encounter, Performed: Hospital Inpatient" during "Diagnosis: Diabetes"
5
```

CQL equivalent

```
81
82   define "Valid Encounters":
83     ["Encounter, Performed": "Hospital Inpatient"] Encounter
84       with ["Diagnosis": "Diabetes"] Diagnosis
85         such that Interval[Encounter.admissionDatetime, Encounter.dischargeDatetime]
86           during Interval[Diagnosis.onsetDatetime, Diagnosis.abatementDatetime]
87
```

CQL Training for Measure Developers: CQL Interval Operators

Operator/Inverse	Diagram	Interpretation
X same as Y Y same as X	X Y	start of X = start of Y and end of X = end of Y
X before Y Y after X	X Y	end of X < start of Y
X meets before Y Y meets after X X meets Y	X Y	successor of end of X = start of Y
X overlaps before Y Y overlaps after X X overlaps Y	X Y	start of X <= start of Y and start of Y <= end of X
X begins Y	X Y	start of X = start of Y and end of X <= end of Y
X included in (during) Y Y includes X	X Y	start of X >= start of Y and end of X <= end of Y
X ends Y	X Y	start of X >= start of Y and end of X = end of Y

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CQL Training for Measure Developers: Combining Conditions

- ## QDM encounters in a range

```
5
6    AND: "Occurrence A of Encounter, Performed: BH Outpatient encounter" >=
7        42 day(s) starts before start of "Measurement End Date"
8    AND: "Occurrence A of Encounter, Performed: BH Outpatient encounter"
9        starts after start of "Measurement Start Date"
10
```

- ## CQL equivalent

```
97
98   define "Valid Encounters":
99     ["Encounter, Performed": "BH Outpatient encounter"] Encounter
100       where Encounter.admissionDateTime occurs 42 days or less before end of "Measurement Period"
101         and Encounter.admissionDateTime occurs after start of "Measurement Period"
102
```

CQL Training for Measure Developers: Combining Conditions (cont'd)

- ## Finding follow up visits

```
3
4    AND: "Occurrence A of Encounter, Performed: HIV Visit" during "Measurement Period"
5    AND: "Occurrence B of Encounter, Performed: HIV Visit" during "Measurement Period"
6    AND: "Occurrence B of Encounter, Performed: HIV Visit" >= 90 day(s)
7      starts after end of "Occurrence A of Encounter, Performed: HIV Visit"
8
```

- ## CQL equivalent

```
109
110  define "HIV Visits During Measurement Period":
111    ["Encounter, Performed": "HIV Visit"] Encounter
112      where Interval[Encounter.admissionDateTime, Encounter.dischargeDateTime] during "Measurement Period"
113
114  define "HIV Followup Visits":
115    "HIV Visits During Measurement Period" FollowupVisit
116      with "HIV Visits During Measurement Period" PriorVisit
117        such that FollowupVisit.admissionDateTime occurs 90 days or more after PriorVisit.dischargeDateTime
118
```

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CQL Training for Measure Developers: Combining Conditions (cont'd)

- ## Medications ordered after a specific lab

```
3
4    AND: "Occurrence A of Medication, Order: Dapsone and pyrimethamine" <=
5      3 month(s) starts after end of "Occurrence A of Laboratory Test, Performed: CD4+ Count (result)"
6    AND: "Occurrent A of Medication, Order: Leucovorin" <= 3 month(s)
7      starts after end of "Occurrence A of Laboratory Test, Performed: CD4+ Count (result)"
8
```

- ## CQL equivalent

```
126
127  define "CD4+ Count With Results and Medications":
128    ["Laboratory Test, Performed": "CD4+ Count"] CD4Count
129      with ["Medication, Order": "Dapsone and pyrimethamine"] DapsoneOrder
130        such that DapsoneOrder.signedDatetime occurs 3 months or less before CD4Count.stopDateTime
131      with ["Medication, Order": "Leucovorin"] LeucovorinOrder
132        such that LeucovorinOrder.signedDatetime occurs 3 months or less before CD4Count.stopDateTime
133      where CD4Count.result is not null
134
```

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CQL Training for Measure Developers: Building a Measure – CMS 126v4

- **Initial Population =**
    - AND: Age >= 5 year(s) at: "Measurement Period"
    - AND: Age < 64 year(s) at: "Measurement Period"
    - AND: "Diagnosis, Active: Persistent Asthma" overlaps "Measurement Period"
    - AND: Union of:
        - "Encounter, Performed: Office Visit"
        - "Encounter, Performed: Face-to-Face Interaction"
        - "Encounter, Performed: Preventive Care - Established Office Visit, 0 to 17"
        - "Encounter, Performed: Preventive Care Services - Established Office Visit, 18 and Up"
        - "Encounter, Performed: Preventive Care Services-Initial Office Visit, 18 and Up"
        - "Encounter, Performed: Preventive Care- Initial Office Visit, 0 to 17"
        - "Encounter, Performed: Home Healthcare Services"
        - during "Measurement Period"
- **Denominator =**
    - AND: Initial Population
- **Denominator Exclusions =**
    - OR: Union of:
        - "Diagnosis, Active: Chronic Obstructive Pulmonary Disease"
        - "Diagnosis, Active: Emphysema"
        - "Diagnosis, Active: Cystic Fibrosis"
        - "Diagnosis, Active: Acute Respiratory Failure"
        - overlaps "Measurement Period"
- **Numerator =**
    - AND: "Medication, Dispensed: Preferred Asthma Therapy" during "Measurement Period"
- **Numerator Exclusions =**
    - None
- **Denominator Exceptions =**
    - None

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CQL Training for Measure Developers: CMS 126v4 – Initial Population

- **Initial Population =**
    - AND: Age >= 5 year(s) at: "Measurement Period"
    - AND: Age < 64 year(s) at: "Measurement Period"
    - AND: "Diagnosis, Active: Persistent Asthma" overlaps "Measurement Period"
    - AND: Union of:
        - "Encounter, Performed: Office Visit"
        - "Encounter, Performed: Face-to-Face Interaction"
        - "Encounter, Performed: Preventive Care - Established Office Visit, 0 to 17"
        - "Encounter, Performed: Preventive Care Services - Established Office Visit, 18 and Up"
        - "Encounter, Performed: Preventive Care Services-Initial Office Visit, 18 and Up"
        - "Encounter, Performed: Preventive Care- Initial Office Visit, 0 to 17"
        - "Encounter, Performed: Home Healthcare Services"
        - during "Measurement Period"

- 3 main components
  - Demographic
  - Asthma diagnosis
  - Valid encounter

CQL Training for Measure Developers: CMS 126v4 – In Demographic

- Patients between 5 and 64 years

```
39
40      AND: Age >= 5 year(s) at: "Measurement Period"
41      AND: Age < 64 year(s) at: "Measurement Period"
42
```

```
2
3   define "In Demographic":
4     AgeInYearsAt(start of "Measurement Period") >= 5
5       and AgeInYearsAt(start of "Measurement Period") < 65
6
```

CQL Training for Measure Developers: CMS 126v4 – Asthma Diagnosis

- Patients with an diagnosis of asthma

```
53
54      AND: "Diagnosis, Active: Persistent Asthma" overlaps "Measurement Period"
55
```

```
177
178  define "Asthma Diagnosis":
179    ["Diagnosis": "Persistent Asthma"] Diagnosis
180      where Interval[Diagnosis.onsetDatetime, Diagnosis.abatementDatetime] overlaps "Measurement Period"
181
```

CQL Training for Measure Developers: CMS 126v4 – Valid Encounters

- ## Encounters during measurement period

```
67
68    AND: Union of:
69         "Encounter, Performed: Office Visit"
70         "Encounter, Performed: Face-to-Face Interaction"
71         "Encounter, Performed: Preventive Care - Established Office Visit, 0 to 17"
72         "Encounter, Performed: Preventive Care Services - Established Office Visit, 18 and Up"
73         "Encounter, Performed: Preventive Care Services-Initial Office Visit, 18 and Up"
74         "Encounter, Performed: Preventive Care- Initial Office Visit, 0 to 17"
75         "Encounter, Performed: Home Healthcare Services"
76         during "Measurement Period"
77
```

```
181
182   define "Valid Encounters":
183     (["Encounter, Performed": "Office Visit"]
184       union ["Encounter, Performed": "Face-to-Face Interaction"]
185       union ["Encounter, Performed": "Preventive Care - Established Office Visit, 0 to 17"]
186       union ["Encounter, Performed": "Preventive Care Services - Established Office Visit, 18 and Up"]
187       union ["Encounter, Performed": "Preventive Care Services-Initial Office Visit, 18 and Up"]
188       union ["Encounter, Performed": "Preventive Care- Initial Office Visit, 0 to 17"]
189       union ["Encounter, Performed": "Home Healthcare Services"]
190     ) E where Interval[E.admissionDateTime, E.dischargeDateTime] during "Measurement Period"
191
```

CQL Training for Measure Developers: CMS 126v4 – Initial Population

- Patients in the demographic with a diagnosis of asthma and at least one valid encounter

```
191
192   define "In Initial Population":
193     "In Demographic"
194       and exists "Asthma Diagnosis"
195       and exists "Valid Encounters"
196
```

CQL Training for Measure Developers: CMS 126v4 - Denominator

- Initial population criteria is implied, so the definition is omitted from the CQL

- Leave a comment instead

```
17
18    /* Denominator is the same as the initial population */
19
```

CQL Training for Measure Developers: CMS 126v4 – Denominator Exceptions

- ## Patients with COPD, emphysema, etc.

```
110
111       OR: Union of:
112           "Diagnosis, Active: Chronic Obstructive Pulmonary Disease"
113           "Diagnosis, Active: Emphysema"
114           "Diagnosis, Active: Cystic Fibrosis"
115           "Diagnosis, Active: Acute Respiratory Failure"
116           overlaps "Measurement Period"
117
```

```
2
3   define "Excepted Diagnoses":
4     (["Diagnosis": "Chronic Obstructive Pulmonary Disease"]
5       union ["Diagnosis": "Emphysema"]
6       union ["Diagnosis": "Cystic Fibrosis"]
7       union ["Diagnosis": "Actue Repiratory Failure"]
8     ) Diagnosis
9     where Interval[Diagnosis.onsetDatetime, Diagnosis.abatementDatetime]
10       overlaps "Measurement Period"
11
12  define "Denominator Exceptions":
13    exists "Excepted Diagnoses"
14
```

CQL Training for Measure Developers: CMS 126v4 - Numerator

- Patients with preferred asthma therapy

```
132
133          AND: "Medication, Dispensed: Preferred Asthma Therapy" during "Measurement Period"
134
```

```
211
212   define "Preferred Asthma Therapy":
213     ["Medication, Dispensed": "Preferred Asthma Therapy"] Medication
214       where Interval[Medication.startDatetime, Medication.stopDateTime] during "Measurement Period"
215
216   define "Numerator":
217     exists "Preferred Asthma Therapy"
218
```

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CQL Training for Measure Developers: CMS 126v4 – Criteria

• Criteria definitions for the measure

```
 3
 4   define "In Initial Population":
 5     "In Demographic"
 6       and exists "Asthma Diagnosis"
 7       and exists "Valid Encounters"
 8
 9   /* Denominator is the same as the initial population */
10
11   define "Denominator Exceptions":
12     exists "Excepted Diagnoses"
13
14   define "Numerator":
15     exists "Preferred Asthma Therpay"
16
```

CQL Training for Measure Developers: Resources

- CQL Specification - CQL Release 1, Standard for Trial Use (STU) 2
    - http://www.hl7.org/implement/standards/product_brief.cfm?product_id=400
- eCQI Resource Center
    - CQL Space, including the QDM v5.3 and v5.3 Annotated
        - https://ecqi.healthit.gov/cql
    - Check the eCQI Resource Center Events page and CQL Educational Resources page for more information
        - https://ecqi.healthit.gov/ecqi/ecqi-events
        - https://ecqi.healthit.gov/cql/cql-educational-resources

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CQL Training for Measure Developers: Resources (cont'd)

- CQL Formatting and Usage Wiki
  - https://github.com/esacinc/CQL-Formatting-and-Usage-Wiki/wiki
- CQL GitHub Tools Repository
  - https://github.com/cqframework/clinical_quality_language
- Measure Authoring Tool
  - https://www.emeasuretool.cms.gov/
- Bonnie Testing Tool
  - https://bonnie.healthit.gov/
- To submit an issues ticket for CQL, please visit the ONC JIRA site
  - https://oncprojectracking.healthit.gov/support/projects/CQLIT

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