Cooking with CQL: or How to Express eCQMs using CQL, QDM, and FHIR® Webinar

Supplemental Slides for the April 23, 2020 Session – FHIR and CQL

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Agenda

• Fast Healthcare Interoperability Resources (FHIR®) and Clinical Quality Language (CQL)
FHIR and CQL

- Primitives
- Choice Types
- Slices
- Extensions
### Patient Resource

A table showing the attributes of a Patient resource:

- **Name**
- **Flags**
- **Cardinality**
- **Type**
- **Descrip**

<table>
<thead>
<tr>
<th>Name</th>
<th>Flags</th>
<th>Card.</th>
<th>Type</th>
<th>Descrip</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient</td>
<td></td>
<td></td>
<td>DomainResource</td>
<td></td>
</tr>
<tr>
<td>identifier</td>
<td>Σ</td>
<td>0..*</td>
<td>Identifier</td>
<td>An ident</td>
</tr>
<tr>
<td>active</td>
<td>Σ</td>
<td>0..1</td>
<td>boolean</td>
<td>Whether</td>
</tr>
<tr>
<td>name</td>
<td>Σ</td>
<td>0..*</td>
<td>HumanName</td>
<td>A name</td>
</tr>
<tr>
<td>telecom</td>
<td>Σ</td>
<td>0..*</td>
<td>ContactPoint</td>
<td>A contact</td>
</tr>
<tr>
<td>gender</td>
<td>Σ</td>
<td>0..1</td>
<td>code</td>
<td>male</td>
</tr>
<tr>
<td>birthDate</td>
<td>Σ</td>
<td>0..1</td>
<td>date</td>
<td>Administ</td>
</tr>
<tr>
<td>deceased[x]</td>
<td>Σ</td>
<td>0..1</td>
<td>date</td>
<td>Indicates</td>
</tr>
<tr>
<td>deceasedBoolean</td>
<td></td>
<td></td>
<td>boolean</td>
<td></td>
</tr>
<tr>
<td>deceasedDateTime</td>
<td></td>
<td></td>
<td>date-time</td>
<td></td>
</tr>
<tr>
<td>address</td>
<td>Σ</td>
<td>0..*</td>
<td>Address</td>
<td>An address</td>
</tr>
<tr>
<td>maritalStatus</td>
<td>0..1</td>
<td></td>
<td>CodeableConcept</td>
<td>Marital status</td>
</tr>
</tbody>
</table>

- Elements
  - name
  - cardinality
  - type

4/23/2020

define TestPrimitives:
    Patient P
    where P.gender.value = 'male'
    and P.active.value is true
    and P.birthDate.value before Today()
    and ToConcept(P.maritalStatus) in "Marital Status"
    and ToConcept(P.maritalStatus) ~ "Marital Status - Married"

define TestChoice:
    Patient P
    where (P.deceased as FHIR.boolean).value is false
    or (P.deceased as FHIR.dateTime).value before Today()
Cooking with CQL

BP

Constraints
Slices

http://hl7.org/fhir/bp.html
define TestSlices:
    [Observation: "Blood pressure"] BP
    let
        SystolicBP: singleton from (BP.component C where ToConcept(C.code) ~ "Systolic blood pressure"),
        DiastolicBP: singleton from (BP.component C where ToConcept(C.code) ~ "Diastolic blood pressure")
        where ToQuantity(SystolicBP.value as FHIR.Quantity) < 140 'mm[Hg]'
        and ToQuantity(DiastolicBP.value as FHIR.Quantity) < 90 'mm[Hg]'

## Extensions (US Core Patient)

<table>
<thead>
<tr>
<th>Name</th>
<th>Flags</th>
<th>Card.</th>
<th>Type</th>
<th>Description &amp; Constraints</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>Patient</strong></td>
</tr>
<tr>
<td>us-core-race</td>
<td>S</td>
<td>0..1</td>
<td>(Complex)</td>
<td>US Core Race Extension</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>URL:</strong> <a href="http://hl7.org/fhir/us/core/StructureDefinition/us-core-race">http://hl7.org/fhir/us/core/StructureDefinition/us-core-race</a></td>
</tr>
<tr>
<td>us-core-ethnicity</td>
<td>S</td>
<td>0..1</td>
<td>(Complex)</td>
<td>US Core ethnicity Extension</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>URL:</strong> <a href="http://hl7.org/fhir/us/core/StructureDefinition/us-core-ethnicity">http://hl7.org/fhir/us/core/StructureDefinition/us-core-ethnicity</a></td>
</tr>
<tr>
<td>us-core-birthsex</td>
<td>S</td>
<td>0..1</td>
<td>code</td>
<td>Extension</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>URL:</strong> <a href="http://hl7.org/fhir/us/core/StructureDefinition/us-core-birthsex">http://hl7.org/fhir/us/core/StructureDefinition/us-core-birthsex</a></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>Binding:</strong> Birth Sex <em>(required)</em></td>
</tr>
<tr>
<td>identifier</td>
<td>S</td>
<td>1..*</td>
<td>Identifier</td>
<td></td>
</tr>
<tr>
<td>system</td>
<td>S</td>
<td>1..1</td>
<td>uri</td>
<td>The value that is unique within the system.</td>
</tr>
<tr>
<td>value</td>
<td>S</td>
<td>1..1</td>
<td>string</td>
<td></td>
</tr>
<tr>
<td>name</td>
<td>S I</td>
<td>1..*</td>
<td>HumanName</td>
<td><strong>us-core-8:</strong> Patient.name.given or Patient.name.family or both SHALL be present</td>
</tr>
<tr>
<td>family</td>
<td>S I</td>
<td>0..1</td>
<td>string</td>
<td></td>
</tr>
</tbody>
</table>
Extensions in CQL

```cql
define TestSimpleExtensions:
  Patient P
  let birthsex: singleton from (P.extension E
      where E.url.value = 'http://hl7.org/fhir/us/core/StructureDefinition/us-core-birthsex')
      where (birthsex.value as FHIR.code).value = 'M'

define TestComplexExtensions:
  Patient P
  let
    race: singleton from (P.extension E
        where E.url.value = 'http://hl7.org/fhir/us/core/StructureDefinition/us-core-race'),
    ombCategory: race.extension E where E.url.value = 'ombCategory',
    detailed: race.extension E where E.url.value = 'detailed'
  where (ombCategory O return ToConcept(O.value as FHIR.CodeableConcept)) contains "American Indian or Alaska Native" and (detailed O return ToConcept(O.value as FHIR.CodeableConcept)) contains "Alaska Native"
```
FHIRHelpers

- A library of conversion functions for use with FHIR

```java
3   using FHIR version '4.0.1'
4
5   include FHIRHelpers version '4.0.1'
```
# System-defined Types

<table>
<thead>
<tr>
<th>CQL Type</th>
<th>FHIR Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boolean</td>
<td>boolean</td>
</tr>
<tr>
<td>Integer</td>
<td>integer</td>
</tr>
<tr>
<td>Decimal</td>
<td>decimal</td>
</tr>
<tr>
<td>String</td>
<td>string</td>
</tr>
<tr>
<td>Date</td>
<td>date</td>
</tr>
<tr>
<td>DateTime</td>
<td>dateTime</td>
</tr>
<tr>
<td>Time</td>
<td>time</td>
</tr>
<tr>
<td>Quantity</td>
<td>Quantity</td>
</tr>
<tr>
<td>Ratio</td>
<td>Ratio</td>
</tr>
<tr>
<td>Code</td>
<td>Coding</td>
</tr>
<tr>
<td>Concept</td>
<td>CodeableConcept</td>
</tr>
</tbody>
</table>
define TestPrimitives:
    Patient P
    where P.gender.value = 'male'
        and P.active.value is true
        and P.birthDate.value before Today()
        and ToConcept(P.maritalStatus) in "Marital Status"
        and ToConcept(P.maritalStatus) ~ "Marital Status - Married"

define TestPrimitives:
    Patient P
    where P.gender = 'male'
        and P.active is true
        and P.birthDate before Today()
        and P.maritalStatus in "Marital Status"
        and P.maritalStatus ~ "Marital Status - Married"
BP in FHIR with Helpers

```cql
define TestSlices:
  [Observation: "Blood pressure"] BP
  let
    SystolicBP: singleton from (BP.component C where ToConcept(C.code) ~ "Systolic blood pressure"),
    DiastolicBP: singleton from (BP.component C where ToConcept(C.code) ~ "Diastolic blood pressure")
  where ToQuantity(SystolicBP.value as FHIR.Quantity) < 140 'mm[Hg]'
  and ToQuantity(DiastolicBP.value as FHIR.Quantity) < 90 'mm[Hg]'
```

```cql
define TestSlices:
  [Observation: "Blood pressure"] BP
  let
    SystolicBP: singleton from (BP.component C where C.code ~ "Systolic blood pressure"),
    DiastolicBP: singleton from (BP.component C where C.code ~ "Diastolic blood pressure")
  where SystolicBP.value < 140 'mm[Hg]'
  and DiastolicBP.value < 90 'mm[Hg]'
```
define TestSimpleExtensions:
  Patient P
  let birthsex: singleton from (P.extension E
    where E.url.value = 'http://hl7.org/fhir/us/core/StructureDefinition/us-core-birthsex'
    where (birthsex.value as FHIR.code).value = 'M'

define TestSimpleExtensions:
  Patient P
  let birthsex: singleton from (P.extension E
    where E.url = 'http://hl7.org/fhir/us/core/StructureDefinition/us-core-birthsex'
    where birthsex.value = 'M'
define TestComplexExtensions:
    Patient P
    let
        race: singleton from (P.extension E
            where E.url.value = 'http://hl7.org/fhir/us/core/StructureDefinition/us-core-race'),
        ombCategory: race.extension E where E.url.value = 'ombCategory',
        detailed: race.extension E where E.url.value = 'detailed'
where (ombCategory 0 return ToConcept(O.value as FHIR.CodeableConcept)) contains "American Indian or Alaska Native"
    and (detailed 0 return ToConcept(O.value as FHIR.CodeableConcept)) contains "Alaska Native"
using QICore version '4.0.0'

define TestPrimitives:
   Patient P
   where P.gender = 'male'
       and P.active is true
       and P.birthDate before Today()
       and P.maritalStatus in "Marital Status"
       and P.maritalStatus ~ "Marital Status - Married"

define TestChoice:
   Patient P
   where P.deceased is false
       or P.deceased before Today()
Slices in QICore

```cql
35  define TestSlices:
36       [Observation: "Blood pressure"] BP
37       let
38           SystolicBP: singleton from (BP.component C where C.code ~ "Systolic blood pressure"),
39           DiastolicBP: singleton from (BP.component C where C.code ~ "Diastolic blood pressure")
40       where SystolicBP.value < 140 'mm[Hg]'
41       and DiastolicBP.value < 90 'mm[Hg]'
```

```cql
29  define TestSlices:
30       ["observation-bp"] BP
31       where BP.SystolicBP.value < 140 'mm[Hg]'
32       and BP.DiastolicBP.value < 90 'mm[Hg]'
```
Extensions in QlCore

```cql
43  define TestSimpleExtensions:
44     Patient P
45     let birthsex: singleton from (P.extension E
46        where E.url = 'http://hl7.org/fhir/us/core/StructureDefinition/us-core-birthsex')
47        where birthsex.value = 'M'

34  define TestSimpleExtensions:
35     Patient P
36     where P.birthsex = 'M'
```
Complex Extensions in QICore

```cql
49  define TestComplexExtensions:
50       Patient P
51       let
52           race: singleton from (P.extension E
54           ombCategory: race.extension E where E.url = 'ombCategory',
55           detailed: race.extension E where E.url = 'detailed'
56           where (ombCategory 0 return 0.value) contains "American Indian or Alaska Native"
57           and (detailed 0 return 0.value) contains "Alaska Native"
```

```cql
38  define TestComplexExtensions:
39       Patient P
40       where P.race.ombCategory contains "American Indian or Alaska Native"
41       and P.race.detailed contains "Alaska Native"
```
Resources

- HL7 Standard: Clinical Quality Language Specification, Release 1 STU2
  - http://cql.hl7.org

- HL7 CDS Workgroup Project Homepage

- GitHub Tools Repository
  - https://github.com/cqframework/clinical_quality_language

- eCQI Resource Center - https://ecqi.healthit.gov
  - CQL Space - https://ecqi.healthit.gov/cql
FHIR Resources

- HL7 Fast Healthcare Interoperability Resources (FHIR)
  - http://hl7.org/fhir/
- Quality Improvement Core (QI-Core) Implementation Guide
- FHIR Quality Measure Implementation Guide
- Example FHIR Measures (based on 2020 program year)
Soliciting Examples for the Next Session

- Feedback Survey pop up at the close of this session
- ESAC CQL Email Account
  - cql-esac@esacinc.com
- ONC JIRA CQL Issue Tracker
  - https://oncprojecttracking.healthit.gov/support/browse/CQLIT