Eliciting the intension of medication value sets

Nathan Bahr
Oregon Health & Science University
bahrn@ohsu.edu

Mentors: Rainer Winnenburg PhD, Olivier Bodenreider MD, PhD
National Library of Medicine, National Institutes of Health, Bethesda Maryland, USA
{rainer.winnenburg|olivier.bodenreider}@nih.gov
Motivation

- **Meaningful Use** specifies criteria that must be met to be eligible for incentive payments under the American Reinvestment and Recovery Act (ARRA).

- **Clinical Quality Measures (CQMs)** are tools used to measure the quality of care provided.
  - Providers and hospitals must report CQMs to fulfill MU2 requirements.

- **Value Sets** are lists of standardized terms used in CQMs.

- **The Value Set Authority Center (VSAC)** is the part of the NLM that is responsible for validating and delivering the value sets.

- **Assist in Quality Assurance of value sets**
  - Some work have been done on disease value sets
  - We look specifically at the medication value sets
Investigating 183 medication value sets

• Examples of value set names:
  – Statin
  – Methylxanthines
  – IV Antibiotics Used For Prophylaxis for Colon Surgery
  – Antibiotic Medications for Pharyngitis
  – ACE Inhibitor or ARB
  – ADHD Medications

• Value sets contain lists of clinical drugs or ingredients
  – We normalize to RxNorm IN
    • Atenolol 100 MG Oral Tablet → Atenolol
    • Lipitor → Atorvastatin
Objective

**Value set: Misc. Antidepressants**
- Bupropion
- Isocarboxazid
- Phenelzine
- Selegiline
- Tranylcypromine
- vilazodone

**Monoamine Oxidase Inhibitors**
- Isocarboxazid
- Phenelzine
- Selegiline
- Tranylcypromine
- rasagukube

Eliciting the intension for medication value sets to support quality assurance and curation task of clinical quality measures.

- Drug classes have an explicit, agreed-upon definition.
- Elicitation is performed by mapping the definition of the class onto the value set intension when the drug members are similar.
CQM for “Coronary Artery Disease: Beta-Blocker Therapy Prior Myocardial Infarction”

<table>
<thead>
<tr>
<th>eMeasure Title</th>
<th>Coronary Artery Disease (CAD): Beta-Blocker Therapy—Prior Myocardial Infarction (MI) or Left Ventricular Systolic Dysfunction (LVEF &lt;40%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>eMeasure Identifier</td>
<td>145</td>
</tr>
<tr>
<td>eMeasure Version number</td>
<td>3</td>
</tr>
<tr>
<td>NQF Number</td>
<td>0070</td>
</tr>
<tr>
<td>GUID</td>
<td>80744ae2-de81-4b16-a71d-69522eb865c5</td>
</tr>
</tbody>
</table>

**Initial Patient Population**
All patients aged 18 years and older with a diagnosis of coronary artery disease seen within a 12 month period

**Denominator Exclusions**
Equals Initial Patient Population who also have prior MI or a current or prior LVEF <40%

**Numerator**
Patients who were prescribed beta-blocker therapy

**Numerator Exclusions**
Not Applicable

**Denominator Exceptions**
Documentation of medical reason(s) for not prescribing beta-blocker therapy (eg, allergy, intolerance, other medical reasons)
Documentation of patient reason(s) for not prescribing beta-blocker therapy (eg, patient declined, other patient reasons)
Documentation of system reason(s) for not prescribing beta-blocker therapy (eg, other reasons attributable to the health care system)

\[
\text{Beta-Blocker Therapy} = \frac{\# \text{ Patients who recieved beta-blocker therapy}}{\# \text{ Patients diagnosed with Myocardial Infarction}}
\]

- "Medication, Active: Beta Blocker Therapy" using "Beta Blocker Therapy Grouping Value Set (2.16.840.1.113883.3.526.3.1174)"
- "Diagnosis, Resolved: Myocardial Infarction" using "Myocardial Infarction Grouping Value Set (2.16.840.1.113883.3.526.3.403)"
Myocardial infarction in VSAC

---

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>10273003</td>
<td>Acute infarction of papillary muscle (disorder)</td>
<td>SNOMEDCT</td>
<td>2013-09</td>
<td>2.16.840.1.113883.6.96</td>
</tr>
<tr>
<td>129574000</td>
<td>Postoperative myocardial infarction (disorder)</td>
<td>SNOMEDCT</td>
<td>2013-09</td>
<td>2.16.840.1.113883.6.96</td>
</tr>
<tr>
<td>15990001</td>
<td>Acute myocardial infarction of posterolateral wall (disorder)</td>
<td>SNOMEDCT</td>
<td>2013-09</td>
<td>2.16.840.1.113883.6.96</td>
</tr>
<tr>
<td>161502000</td>
<td>History of - myocardial infarct at age less than 60 (situation)</td>
<td>SNOMEDCT</td>
<td>2013-09</td>
<td>2.16.840.1.113883.6.96</td>
</tr>
<tr>
<td>161503005</td>
<td>History of - myocardial infarct at age greater than 60 (situation)</td>
<td>SNOMEDCT</td>
<td>2013-09</td>
<td>2.16.840.1.113883.6.96</td>
</tr>
<tr>
<td>1755008</td>
<td>Old myocardial infarction (disorder)</td>
<td>SNOMEDCT</td>
<td>2013-09</td>
<td>2.16.840.1.113883.6.96</td>
</tr>
<tr>
<td>19478004</td>
<td>Acute anterograde myocardial infarction (disorder)</td>
<td>SNOMEDCT</td>
<td>2013-09</td>
<td>2.16.840.1.113883.6.96</td>
</tr>
<tr>
<td>194802003</td>
<td>True posterior myocardial infarction (disorder)</td>
<td>SNOMEDCT</td>
<td>2013-09</td>
<td>2.16.840.1.113883.6.96</td>
</tr>
<tr>
<td>194809007</td>
<td>Acute atrial infarction (disorder)</td>
<td>SNOMEDCT</td>
<td>2013-09</td>
<td>2.16.840.1.113883.6.96</td>
</tr>
<tr>
<td>194856005</td>
<td>Subsequent myocardial infarction (disorder)</td>
<td>SNOMEDCT</td>
<td>2013-09</td>
<td>2.16.840.1.113883.6.96</td>
</tr>
<tr>
<td>22298006</td>
<td>Myocardial infarction (disorder)</td>
<td>SNOMEDCT</td>
<td>2013-09</td>
<td>2.16.840.1.113883.6.96</td>
</tr>
<tr>
<td>233835003</td>
<td>Acute widespread myocardial infarction (disorder)</td>
<td>SNOMEDCT</td>
<td>2013-09</td>
<td>2.16.840.1.113883.6.96</td>
</tr>
<tr>
<td>233838001</td>
<td>Acute posterior myocardial infarction (disorder)</td>
<td>SNOMEDCT</td>
<td>2013-09</td>
<td>2.16.840.1.113883.6.96</td>
</tr>
<tr>
<td>233839009</td>
<td>Old anterior myocardial infarction (disorder)</td>
<td>SNOMEDCT</td>
<td>2013-09</td>
<td>2.16.840.1.113883.6.96</td>
</tr>
<tr>
<td>233840006</td>
<td>Old inferior myocardial infarction (disorder)</td>
<td>SNOMEDCT</td>
<td>2013-09</td>
<td>2.16.840.1.113883.6.96</td>
</tr>
<tr>
<td>233841005</td>
<td>Old lateral myocardial infarction (disorder)</td>
<td>SNOMEDCT</td>
<td>2013-09</td>
<td>2.16.840.1.113883.6.96</td>
</tr>
<tr>
<td>233842003</td>
<td>Old posterior myocardial infarction (disorder)</td>
<td>SNOMEDCT</td>
<td>2013-09</td>
<td>2.16.840.1.113883.6.96</td>
</tr>
<tr>
<td>233843008</td>
<td>Silent myocardial infarction (disorder)</td>
<td>SNOMEDCT</td>
<td>2013-09</td>
<td>2.16.840.1.113883.6.96</td>
</tr>
<tr>
<td>275905002</td>
<td>History of - myocardial problem (situation)</td>
<td>SNOMEDCT</td>
<td>2013-09</td>
<td>2.16.840.1.113883.6.96</td>
</tr>
<tr>
<td>30277009</td>
<td>Acute myocardial infarction with rupture of ventricle (disorder)</td>
<td>SNOMEDCT</td>
<td>2013-09</td>
<td>2.16.840.1.113883.6.96</td>
</tr>
</tbody>
</table>
Prior work assessing the completeness and correctness of diagnosis value sets

Beta-blockers in VSAC

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1297753</td>
<td>Betaxolol Hydrochloride 10 MG Oral Tablet</td>
<td>RXNORM</td>
<td>2014-01</td>
<td>2.16.840.1.113883.6.8</td>
</tr>
<tr>
<td>1297757</td>
<td>Betaxolol Hydrochloride 20 MG Oral Tablet</td>
<td>RXNORM</td>
<td>2014-01</td>
<td>2.16.840.1.113883.6.8</td>
</tr>
<tr>
<td>152916</td>
<td>Atenolol 50 MC / Chlorthalidone 12.5 MG Oral Tablet</td>
<td>RXNORM</td>
<td>2014-01</td>
<td>2.16.840.1.113883.6.8</td>
</tr>
<tr>
<td>197379</td>
<td>Atenolol 100 MC Oral Tablet</td>
<td>RXNORM</td>
<td>2014-01</td>
<td>2.16.840.1.113883.6.8</td>
</tr>
<tr>
<td>197380</td>
<td>Atenolol 25 MG Oral Tablet</td>
<td>RXNORM</td>
<td>2014-01</td>
<td>2.16.840.1.113883.6.8</td>
</tr>
<tr>
<td>197381</td>
<td>Atenolol 50 MG Oral Tablet</td>
<td>RXNORM</td>
<td>2014-01</td>
<td>2.16.840.1.113883.6.8</td>
</tr>
<tr>
<td>197382</td>
<td>Atenolol 100 MC / Chlorthalidone 25 MG Oral Tablet</td>
<td>RXNORM</td>
<td>2014-01</td>
<td>2.16.840.1.113883.6.8</td>
</tr>
<tr>
<td>197383</td>
<td>Atenolol 50 MC / Chlorthalidone 25 MG Oral Tablet</td>
<td>RXNORM</td>
<td>2014-01</td>
<td>2.16.840.1.113883.6.8</td>
</tr>
<tr>
<td>198000</td>
<td>Bendroflumethiazide 5 MG / N达尔ol 40 MG Oral Tablet</td>
<td>RXNORM</td>
<td>2014-01</td>
<td>2.16.840.1.113883.6.8</td>
</tr>
<tr>
<td>198001</td>
<td>Bendroflumethiazide 5 MG / N达尔ol 80 MG Oral Tablet</td>
<td>RXNORM</td>
<td>2014-01</td>
<td>2.16.840.1.113883.6.8</td>
</tr>
<tr>
<td>198005</td>
<td>N达尔ol 160 MG Oral Tablet</td>
<td>RXNORM</td>
<td>2014-01</td>
<td>2.16.840.1.113883.6.8</td>
</tr>
<tr>
<td>198006</td>
<td>N达尔ol 20 MG Oral Tablet</td>
<td>RXNORM</td>
<td>2014-01</td>
<td>2.16.840.1.113883.6.8</td>
</tr>
<tr>
<td>198007</td>
<td>N达尔ol 40 MG Oral Tablet</td>
<td>RXNORM</td>
<td>2014-01</td>
<td>2.16.840.1.113883.6.8</td>
</tr>
<tr>
<td>198008</td>
<td>N达尔ol 80 MG Oral Tablet</td>
<td>RXNORM</td>
<td>2014-01</td>
<td>2.16.840.1.113883.6.8</td>
</tr>
<tr>
<td>198104</td>
<td>Pindolol 10 MG Oral Tablet</td>
<td>RXNORM</td>
<td>2014-01</td>
<td>2.16.840.1.113883.6.8</td>
</tr>
<tr>
<td>198105</td>
<td>Pindolol 5 MG Oral Tablet</td>
<td>RXNORM</td>
<td>2014-01</td>
<td>2.16.840.1.113883.6.8</td>
</tr>
<tr>
<td>198284</td>
<td>Timolol 10 MG Oral Tablet</td>
<td>RXNORM</td>
<td>2014-01</td>
<td>2.16.840.1.113883.6.8</td>
</tr>
<tr>
<td>198285</td>
<td>Timolol 20 MG Oral Tablet</td>
<td>RXNORM</td>
<td>2014-01</td>
<td>2.16.840.1.113883.6.8</td>
</tr>
<tr>
<td>198286</td>
<td>Timolol 5 MG Oral Tablet</td>
<td>RXNORM</td>
<td>2014-01</td>
<td>2.16.840.1.113883.6.8</td>
</tr>
<tr>
<td>199277</td>
<td>Pindolol 15 MG Oral Tablet</td>
<td>RXNORM</td>
<td>2014-01</td>
<td>2.16.840.1.113883.6.8</td>
</tr>
</tbody>
</table>
Drugs are organized into classes according to their chemical and pharmacological properties.
Measuring the equivalence between drug classes

\[ JC(A, M) = \frac{|A \cap M|}{|A \cup M|} (86\%) \]

ATC: Beta Blocking Agents
- Acebutolol
- Alprenolol
- Atenolol
- Betaxolol
- Bisoprolol
- Bopindolol
- Bupranolol
- Carteolol
- carvedilol
- Celiprolol
- esmolol
- Labetalol
- Metoprolol

MeSH: Adrenergic beta Antagonists
- Nadolol
- nebivolol
- mepindolol
- Oxprenolol
- Practolol
- Sotalol
- talinolol
- tertatolol
- Timolol
- Penbutolol
- Propranolol
- carazolol
- icatibant
- Levobunolol
- Metipranolol

Winnenburg, R., Bodenreider, O. A Framework for Assessing the Consistency of Drug Classes across Sources.
Measuring the equivalence between value sets and drug classes

**Value Set: Beta Blocker therapy**
- Acebutolol
- Atenolol
- Betaxolol
- Bisoprolol
- Carteolol
- Labetalol
- Metoprolol
- Nadolol
- Pindolol
- Propranolol
- Timolol

**ATC: Adrenergic beta-Antagonists**
- Alprenolol
- Bopindolol
- Bupranolol
- Celiprolol
- Esmolol
- Mepindolol
- Nebivolol
- Oxprenolol
- Penbutolol
- Practolol
- Sotalol
- Talinolol
- Tertatolol
Strategies for mapping value sets onto drug classes

1. Value set maps onto a single class

2. Value set maps onto an intersection of classes

3. Value set maps onto a union of classes
Materials

• Medication value sets (9/01/2014 release)
  – 98 value sets contained only 1 ingredient and were excluded
  – 5 value sets contained only multi-ingredient drugs and were excluded.

• RxClass and RxNorm API
  – ATC, MeSH, DailyMed, NDF-RT

<table>
<thead>
<tr>
<th>Source Terminology</th>
<th># Classes</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATC</td>
<td>882</td>
</tr>
<tr>
<td>DailyMed Chemical Structure</td>
<td>467</td>
</tr>
<tr>
<td>DailyMed Established Pharm. Class</td>
<td>431</td>
</tr>
<tr>
<td>DailyMed Mechanism of Action</td>
<td>348</td>
</tr>
<tr>
<td>DailyMed Physiological Effect</td>
<td>239</td>
</tr>
<tr>
<td>MeSH Pharm. Action</td>
<td>350</td>
</tr>
<tr>
<td>NDF-RT Disease</td>
<td>1434</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>~4,000</strong></td>
</tr>
</tbody>
</table>
Strategy 1: Value set maps onto a single class

Statin

- 24 HR Lovastatin 10 MG Extended Release Oral Tablet
- 24 HR Lovastatin 20 MG / Niacin 1000 MG Extended Release Oral Tablet
- 24 HR Niacin 1000 MG / Simvastatin 20 MG Extended Release Oral Tablet
- 24 HR fluvastatin 80 MG Extended Release Oral Tablet
- Amlodipine 10 MG / atorvastatin 10 MG Oral Tablet
- Amlodipine 5 MG / atorvastatin 80 MG Oral Tablet
- Fenofibrate 145 MG / Simvastatin 20 MG Oral Tablet
- Fenofibrate 145 MG / Simvastatin 40 MG Oral Tablet
- Lovastatin 10 MG Oral Tablet
- Pravastatin Sodium 10 MG Oral Tablet
- Rosuvastatin calcium 5 MG Oral Tablet
- Simvastatin 10 MG / sitagliptin 100 MG Oral Tablet
- MG Oral Tablet
- atorvastatin 10 MG Oral Tablet
- atorvastatin 20 MG / ezetimibe 10 MG Oral Tablet
- atorvastatin 20 MG Oral Tablet
- ezetimibe 10 MG / Simvastatin 10 MG Oral Tablet
- fluvastatin 20 MG Oral Capsule
- pitavastatin 1 MG Oral Tablet

RxNorm IN

- Lovastatin
- Pravastatin
- Simvastatin
- atorvastatin
- fluvastatin
- pitavastatin
- rosuvastatin

Multi-ingredient & non-prescribable drugs
Strategy 1: Value set maps onto a single class

DailyMed MoA: Hydroxymethylglutaryl-CoA Reductase Inhibitors

VS: Statin
Lovastatin
Pravastatin
Simvastatin
atorvastatin
fluvastatin
pitavastatin
rosuvastatin

\[ JC(A, M) = \frac{7}{7} (100\%) \]
Strategy 2: Value set maps onto an intersection of classes

Beta Blocker Therapy

24 HR Propranolol Hydrochloride 120 MG Extended Release Capsule
24 HR carvedilol phosphate 10 MG Extended Release Capsule
24 HR metoprolol succinate 100 MG Extended Release Tablet
Acebutolol Hydrochloride 100 MG Oral Capsule
Acebutolol Hydrochloride 200 MG / Hydrochlorothiazide 12.5 MG Oral Tablet
Atenolol 100 MG / Chlorthalidone 25 MG Oral Tablet
Atenolol 100 MG Oral Tablet
Atenolol 25 MG Oral Tablet
Bendroflumethiazide 5 MG / Nadolol 40 MG Oral Tablet
Bendroflumethiazide 5 MG / Nadolol 80 MG Oral Tablet
Betaxolol Hydrochloride 10 MG Oral Tablet
Betaxolol Hydrochloride 20 MG Oral Tablet
Bisoprolol Fumarate 10 MG / Hydrochlorothiazide 6.25 MG Oral Tablet
Bisoprolol Fumarate 10 MG Oral Tablet
Bisoprolol Fumarate 2.5 MG / Hydrochlorothiazide 6.25 MG Oral Tablet
Bisoprolol Fumarate 5 MG / Hydrochlorothiazide 6.25 MG Oral Tablet
Bisoprolol Fumarate 5 MG Oral Tablet
Carteolol Hydrochloride 2.5 MG Oral Tablet
Carteolol Hydrochloride 5 MG Oral Tablet
Clopamide 5 MG / Pindolol 10 MG Oral Tablet
Hydrochlorothiazide 25 MG / Labetalol hydrochloride 100 MG Oral Tablet
Hydrochlorothiazide 50 MG / Metoprolol Tartrate 100 MG Oral Tablet
Hydrochlorothiazide 50 MG / Pindolol 10 MG Oral Tablet
Labetalol hydrochloride 100 MG Oral Tablet
Labetalol hydrochloride 50 MG Oral Tablet
Metoprolol Tartrate 100 MG Oral Tablet
Nadolol 160 MG Oral Tablet
Pindolol 5 MG Oral Tablet
Propranolol Hydrochloride 10 MG Oral Tablet
Propranolol Hydrochloride 160 MG Oral Tablet
Timolol 10 MG Oral Tablet
carvedilol 12.5 MG Oral Tablet

Acebutolol
Atenolol
Betaxolol
Bisoprolol
Carteolol
Labetalol
Metoprolol
Nadolol
Pindolol
Propranolol
Timolol
carvedilol

RxNorm IN

Multi-ingredient & non-prescribable drugs
Strategy 2: Value set maps onto an intersection of classes

\[ JC(A, M) = \frac{12}{20} \ (60\%) \]
Strategy 2: Value set maps onto an intersection of classes

\[ JC(A, M) = \frac{12}{?} \]
Strategy 2: Value set maps onto an intersection of classes

Adrenergic beta-Antagonists AND Hypertension

MeSH: Adrenergic beta-Antagonists

VS: Beta Blocker
Acebutolol, Atenolol, Betaxolol, Bisoprolol, Carteolol, Labetalol, Metoprolol, Nadolol, Pindolol, Propranolol, Timolol, carvedilol

NDF-RT Disease: Hypertension
Amiloride, Diltiazem, Lisinopril, Valsartan, ...

\[ JC(A, M) = \frac{12}{14} (86\%) \]
Strategy 3: Value set maps onto a union of classes

Anticoagulant Therapy

0.4 ML Dalteparin Sodium 25000 UNT/ML Prefilled Syringe
0.4 ML Enoxaparin sodium 100 MG/ML Prefilled Syringe
0.4 ML Fondaparinux sodium 12.5 MG/ML Prefilled Syringe
0.5 ML heparin sodium, porcine 10000 UNT/ML Prefilled Syringe
0.8 ML Fondaparinux sodium 12.5 MG/ML Prefilled Syringe
1 ML Dalteparin Sodium 10000 UNT/ML Prefilled Syringe
3 ML heparin sodium, porcine 1 UNT/ML Prefilled Syringe
Dalteparin Sodium 10000 UNT/ML Injectable Solution
Enoxaparin sodium 100 MG/ML Injectable Solution
Fondaparinux sodium 12.5 MG/ML Injectable Solution
Warfarin Sodium 1 MG Oral Tablet
apixaban 2.5 MG Oral Tablet
apixaban 5 MG Oral Tablet
argatroban 100 MG/ML Injectable Solution
dabigatran etexilate 150 MG Oral Capsule
dabigatran etexilate 75 MG Oral Capsule
fondaparinux 5 MG/ML Injectable Solution
heparin sodium, porcine 0.2 UNT/ML Injectable Solution
heparin sodium, porcine 0.25 UNT/ML Injectable Solution
lepirudin 50 MG/ML Injectable Solution
rivaroxaban 10 MG Oral Tablet

Dalteparin
Enoxaparin
Warfarin
apixaban
argatroban
dabigatran etexilate
fondaparinux
heparin, porcine
lepirudin
rivaroxaban

RxNorm IN

Multi-ingredient & non-prescribable drugs
Strategy 3: Value set maps onto a union of classes

\[ JC(A, M) = \frac{8}{13} \times 62\% \]
Results Summary

• We performed ~320M comparisons
  – 80 value sets * 4000 classes = 320K
  – **80 value sets * 4M intersections = 320M**
  – 80 value sets * ~100 union candidates = 8k

• We incrementally augmented the single class comparisons with the intersections and unions
  – The **intersection** offered the largest improvement

• We elicited the intension with >70% equivalence for 54% (43/80) value sets.
Contribution of methods

![Graph showing Jaccard Score with different value sets and their average Jaccard scores]

- Single Class: 60%
- Single Class OR Disease Intersection: 71%
- Single Class OR Disease Intersection OR Union: 72%
Contribution of sources

![Bar chart showing the contribution of different sources to the Jaccard Score. The chart compares the number of value sets across various categories such as Pharmacological Action (PA), Physiological Effect (PE), Mechanism of Action (MOA), Established Pharmacological Class (EPC), Chemical Structure (Chem), ATC, and Disease. The Jaccard Score is represented on the x-axis, and the number of value sets is on the y-axis. The chart highlights the contribution of each source in different colors and provides a visual comparison of their contributions.]
Discussion

• Are we able to elicit the intension of the value sets?
  – 30% (24/80) of the value sets mapped to classes with high equivalence scores (100% Jaccard score)
  – We can infer the intension of the value set from the class

  – 23% (18/80) of the value sets mapped to classes with low equivalence scores (<50% Jaccard score)
  – We have not elicited the intension of the value set and further investigation is required
Limitations and future work

• There is an opportunity for Quality Assurance.
  – E.g. Should esmolol and Penbutolol be part of the beta-blocker value set?
  – Qualitative evaluation by an expert is needed.
  – We are working with a pharmacist to address this.

• There are different classification systems built for different purposes, which may result in different elicited intensions.
Acknowledgements

**NLM**
Dr Clement McDonald
Dr Paul Fontelo
Mary Walker

**VSAC**
Steven Emrick
Maureen Madden

**Joint Commission**
Ana Rute Martins Baptista

**Fellows**
Kalpa Gunaratna
Wei Wei
Raymonde Uy
Eliciting the intension of medication value sets

Nathan Bahr
Oregon Health & Science University
bahrn@ohsu.edu

Mentors: Rainer Winnenburg PhD, Olivier Bodenreider MD, PhD
National Library of Medicine, National Institutes of Health, Bethesda Maryland, USA
{rainer.winnenburg|olivier.bodenreider}@nih.gov