Performance Summary Display Ontology (PSDO)
Feedback intervention content, delivery, and interpreted information

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I have no competing interests to declare
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Takeaways

● PSDO is a lightweight application ontology we developed to improve the study of clinical performance feedback

● We used BFO classes of role, quality, and information content entity to define elements of performance summaries

● PSDO may enable standardization of feedback intervention metadata in feedback systems for health care
Meet Dr. Jane

- Attending anesthesiologist at Michigan Medicine
- Gets a feedback email every month from the Multicenter Perioperative Outcomes Group (MPOG)
  - Quality of care
  - Care outcomes
Hello Dr. Jane,

Below is your MPOG quality performance report. For a case-by-case breakdown of any measures’ result, click on the link at left to visit your quality dashboard.

Your Performance vs All Other Attendings
4/1/2019 to 4/30/2019

<table>
<thead>
<tr>
<th>Measure</th>
<th>Your Performance</th>
<th>All Other Attendings</th>
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</thead>
<tbody>
<tr>
<td>NMB-01: Train of Four Taken</td>
<td>You, 100% (9 / 9)</td>
<td>66% (2303 / 2389)</td>
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<tr>
<td>NMB-02: Reversal Administered</td>
<td>You, 100% (9 / 9)</td>
<td>99% (2367 / 2390)</td>
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<tr>
<td>PUL-01: Tidal Volume</td>
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</table>
Feedback email about care quality

Contains ~15 performance measures (aka indicators, metrics)

<table>
<thead>
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Feedback email about care quality

For each measure, Dr. Jane is compared to:

- organizational goal (dotted line)
- peer average (gray bar).
Hello Dr. Jane,

Below is your MPOG quality performance report. For a case-by-case breakdown of any measures’ result, click on the link at left to visit your quality dashboard.

Feedback email about care quality

Automated feedback, delivered to 6,000+ providers in a national network

### Your Performance vs All Other Attendings

**4/1/2019 to 4/30/2019**

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Feedback is foundational in health systems

○ Feedback loop: A process that delivers evaluative or corrective information to a living system

○ More than a century of theory development on feedback in organizations

○ Hundreds of trials of feedback about clinical practice
A research community guided by evidence and theory

- Research community: Audit and Feedback MetaLab
- Clinical Performance Feedback Intervention Theory (CP-FIT)
  - Reflects our best understanding of how feedback works
  - Can improve our communication, learning, and future research
However, feedback research has hit a wall

○ As a research community, we have not learned much about improving feedback in recent decades.

○ Hundreds of trials show a pattern of mixed effects:
  ■ Potential for large effects
  ■ Small to moderate effects are common

○ Growing interest in studying *how and when* different kinds of feedback are effective
Areas of imprecise thinking

- We lack a well-defined model of our “active ingredients”, aka the **content** and **delivery** of feedback interventions.

- **Charts and graphs** plays an important role in the success of feedback interventions.
  - Differences in cognitive burden, graph literacy and numeracy.
How an ontology may advance our thinking

What we might do as a research community:

○ Adopt ontologically consistent definitions

○ Specify feedback interventions with greater granularity to enable better evidence synthesis

○ Better differentiate the **content** and **delivery** of feedback interventions to better compare different kinds
Confusion around content vs delivery

- Example: Are charts and graphs part of the content or delivery of a feedback intervention?

- Terms for kinds of content are used with alternate meanings
  - **Goal**: A metric vs a comparator
  - **Trend**: Change in performance vs comparison over time
  - **Velocity**: Amount of change vs frequency of feedback
Current state of email feedback

General problems for clinicians:

○ Information chaos (Beasley et al 2011)

○ Significant time pressure
Current state of email feedback

Dr Jane’s question: Is it worth my time to follow-up about this?

Performance information is

- Frequently not actionable
- Not motivating
- Not surprising
Assumptions

- People are different
- Context matters
- Things change

Source: https://www.pchalliance.org/news/how-do-you-change-behavior
Our team’s research focus:

Precision feedback

Hello Alex,

You reached the top performer benchmark this month for the measure **PUL-01: Protective Tidal volume, 10mL/Kg PBW.**
Objective

To develop an ontology of a performance summary in a clinical performance feedback intervention, for the purposes of standardizing research metadata.
Methods

- Adopted BFO as an upper ontology because of semantic interoperability with related ontologies in health

- Iteration over three activities:
  a. Identifying terms from theoretical constructs
  b. Searching for relevant ontologies and classes
  c. Specifying existing performance summaries
Methods, continued

- Our work was conducted by a small team of faculty and students
- We developed the ontology via iterative specification of performance summaries from many clinical domains
- Our modeling decisions choices were guided by our use case of precision feedback, without community involvement
Results

- PSDO is a lightweight application ontology, focused on the content and delivery of performance information.

- We developed the classes of the ontology primarily within 3 BFO classes:
  a. information content entity
  b. quality
  c. role
Basic Formal Ontology
Information Artifact Ontology
Performance Summary
Display Ontology

'Is_A' Relation
other relation

continuant
(BFO)

generically
dependent
continuant

specifically
dependent
continuant

independent
continuant

material
entity

material
information
bearer

mark

mark
 quality

role

represented
role

performance
report

performance
summary
display

information
content
entity

quality

inheres in

concretized by

bearer of

has part

Measures
Ascribees
Performance
levels
Time
intervals
Precision feedback use-case

- We are preparing for a cluster-randomized trial of precision feedback with ~3500 providers in an anesthesia quality improvement network (MPOG)

- PSDO is the ontological foundation for a knowledge-based system that generates precision feedback email
## Input 1: Performance data

**Quality metric:** Avoiding post-operative nausea and vomiting

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<tr>
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Input 2: Email message template

Your performance has dropped to 80% for the quality measure Avoiding Post-Operative Nausea and Vomiting, remaining below the peer benchmark for 3 months.

Input 3: PSDO classes (exerpt)

<table>
<thead>
<tr>
<th>Loss content</th>
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<td>Social comparator content</td>
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**Input 1: Performance data**

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**Input 2: Email message template**

- Your performance has dropped to 80% for the quality measure **Avoiding Post-Operative Nausea and Vomiting**, remaining below the peer benchmark for 3 months.

**Input 3: PSDO classes (excerpt)**

| Loss content
| Social comparator content
| Loss set
| Social comparator element |
Input 1: Performance data

Quality metric: Avoiding post-operative nausea and vomiting

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Input 3: PSDO classes (excerpt)

- Loss content
- Social comparator content
- Loss set
- Social comparator element

Input 4: Knowledgebase (excerpt)

Feedback loop assertions
- Social Status Loss is a causal pathway
- Social Status Loss has preconditions:
  - Loss content,
  - Social comparator content,
  - Loss set,
  - Social comparator element,
Input 1: Performance data

Quality metric: Avoiding post-operative nausea and vomiting

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A software module annotates the performance data using PSDO classes.

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*Feedback loop assertions*

**Social Status Loss**

Is a causal pathway

**Social Status Loss** has preconditions:
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A software module annotates the performance data using PSDO classes

Output 1: Assertions about a candidate email message (data + template)

Performance data is about:
- Loss content
- Social comparator content

Input 2: Email message template

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Output 1: Assertions about a candidate email message (data + template)

- Performance data is about Loss content
  - Social comparator content
- Email message template is about Loss set
  - Social comparator element

Email message templates are manually annotated.
Input 1: Performance data

Quality metric: Avoiding post-operative nausea and vomiting

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Output 1: Assertions about a candidate email message (data + template)

Performance data
- Loss content
  - Social comparator content
- Email message template
  - Loss set
  - Social comparator element

Input 2: Email message template

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Quality metric: Avoiding post-operative nausea and vomiting

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Input 3: PSDO classes (exerpt)

- Loss content
- Social comparator content
- Loss set
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Input 4: Knowledgebase (exerpt)

Feedback loop assertions
Social Status Loss
is a causal pathway
Social Status Loss
has preconditions:
- Loss content,
- Social comparator content,
- Loss set,
- Social comparator element.

Output 1: Assertions about a candidate email message (data + template)

Performance data
is about
- Loss content
is about
- Social comparator content
Email message template
is about
- Loss set
is about
- Social comparator element

A software module matches assertions for a candidate email message with preconditions for a feedback loop.

Output 2: Assertion about a feedback loop

Candidate message acceptable by Social Status Loss
**Input 1: Performance data**

Quality metric: Avoiding post-operative nausea and vomiting

<table>
<thead>
<tr>
<th>Month</th>
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Provider benchmark: 93% 95% 88% 91% 92% 94%

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**Input 4: Knowledgebase (exerpt)**

Feedback loop assertions

Social Status Loss is a causal pathway

Social Status Loss has preconditions:
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Output 1: Assertions about a candidate email message (data + template)

Performance data is about:
- Loss content
- Social comparator content

Email message template is about:
- Loss set
- Social comparator element

A software module matches assertions for a candidate email message with preconditions for a feedback loop.

Output 2. Assertion about a feedback loop

Candidate message acceptable by Social Status Loss

A software module scores the candidate message along with other acceptable candidates to select the highest-value email message for a feedback recipient.
Discussion

- We developed PSDO to better understand feedback, and to enable our research on precision feedback.

- PSDO may improve the evaluation of feedback through:
  a. Specification of new types of data in large-scale, automated feedback systems
  b. Better standardization of data in systematic reviews and meta-analyses
Limitations

- We have not yet formally evaluated the ontology, but plan to evaluate its fitness for research purposes with domain experts.
- The ontology is under-specified, however this may provide an avenue for community engagement.
Conclusion

- PSDO is an ontology about performance summary information for the study of feedback interventions
- PSDO has potential to improve the standardization of research data collected in feedback systems
Thank you!
1) Percent of Patients ≥65 Years Old Filling a Prescription for Beta-blockers Within 30 Days Post-discharge

Target rate: 85%
Your hospital: 50%
Average for Quebec teaching hospitals (SD): 67% (5)
Quebec average (SD): 57% (4)
Performance levels

Data about events, scores, percentages

1) Percent of Patients ≥65 Years Old Filling a Prescription for Beta-blockers Within 30 Days Post-discharge

Target rate:
Your hospital: 85%
Your hospital: 50%
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Target rate = 85%
Opportunity and risk of large scale systems

- Feedback systems create both opportunity and risk
  - Learning and improvement at large scale
  - Wasted time, attention, and energy of providers

- Common tools:
  - Email and clinical quality dashboards
  - Decision support systems
  - Patient-reported outcomes

- Usability gains importance with increasing system scale