NCI Multilevel Geospatial and Contextual Webinar Series: Emerging Methods of Exploring the Team Microenvironment in Cancer Care
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Webinar Overview

Emerging Methods of Exploring the Team Microenvironment in Cancer Care

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Johns Hopkins School of Medicine
Towards a Social Data Science for Safety and Quality

Emerging Methods of Exploring the Team Microenvironment in Cancer Care

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Acknowledgements

Collaborators

• Hopkins (short list)
  – Salar Khaleghzadegan, Adam Sapirstein, Eileen Kasda, Carey Priebe, Mary Catherine Beach

• Rice
  – Ed Salas, Julie Dinh, Jensine Paoletti, Fred Osawald

Funders

[Logos of Gordon and Betty Moore Foundation, DARPA, and NASA]
Agenda

• Measuring the team microenvironment
  – Definitions of key concepts
  – Social Data Science Methods

• Representative projects
  – Individual and team workload, stress, and resilience
  – Shared decision making, respect and dignity
  – Coordination in Multi-Team Systems
  – Event-reporting, narrative dynamics, and local safety climate

• Future directions
Measuring the Team Microenvironment
Definitions, challenges, and methods
Teams, health system delivery, and social data science (SDS)

- The quality of teamwork impacts overall safety and quality of healthcare delivery systems\(^1\)
- The **team microenvironment** is… “the collection of factors that exert influence on the social interactions of people participating in care delivery.”\(^2\)
- **Social data science** (or computational social science) blends approaches for generating insights from large structured and unstructured data sets with theories of human behavior and social interactions at multiple scales.
You can learn a lot about a team without asking members questions or directly observing them: Four key unobtrusive measurement domains

- Linguistic Communication
- Paralinguistic Communication
- Physiological Dynamics
- Activity Tracking
### Representative findings for linguistic analysis in teams

**Measure type** | **Example metrics associated with team performance**
---|---
**Domain specific content** | • 50+ years of team and group communication research

**Non-domain specific content** | • The frequency of positive, assenting words vs dissenting words, the positive emotion words, use of first person plural, lower variability in word count across team members are positively associated with task performance outcomes\(^1,2\)

**Similarity in word use** | • Task related linguistic alignment predicts team task outcomes\(^3\)
• Linguistic style matching predicts affective and task outcomes\(^4\)
• Overall semantic similarity predicts task outcomes\(^5\)

**Sequence in word use** | • Closed-loop communication\(^6\)
• Anticipation ratio\(^7\)
What team members communicate without using words matters: Representative findings for paralinguistics in teams

<table>
<thead>
<tr>
<th>Measure type</th>
<th>Example metrics associated with team performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication flow</td>
<td>• Egalitarian turn taking predicts team task outcomes(^1,2)</td>
</tr>
<tr>
<td></td>
<td>• Lower stability in turn taking sequence predicts team task outcomes(^3)</td>
</tr>
<tr>
<td></td>
<td>• Speech duration predicts perceptions of emergent leadership (^4)</td>
</tr>
<tr>
<td>Facial expression and gaze behavior</td>
<td>• Synchrony in facial expressions positively predicts team affective and task outcomes(^5,6)</td>
</tr>
<tr>
<td></td>
<td>• Low synchrony in facial expressions predicts performance strategy shift(^6)</td>
</tr>
<tr>
<td></td>
<td>• Synchrony in gaze behavior predicts team task outcomes(^7)</td>
</tr>
<tr>
<td>Vocal features</td>
<td>• Large feature space models are predictive of individual affective states, personality, and perceptions of competence in persuasiveness(^8)</td>
</tr>
<tr>
<td>Gesture and posture</td>
<td>• Synchrony in postural sway negatively predicts team affective outcomes(^9)</td>
</tr>
</tbody>
</table>
### The physiological dynamics of interacting team members matter: Representative findings for physiological dynamics in teams

<table>
<thead>
<tr>
<th>Phys.</th>
<th>Inputs</th>
<th>Mediators</th>
<th>Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>EEG/ fNIRS</td>
<td><strong>Mixed findings</strong>: PS higher in competitive vs. cooperative tasks; higher for expert (vs. novice) teams. EEG shows PS increases with task demands and task uncertainty but fNIRS shows reduced PS with increased task demands.</td>
<td><strong>Limited findings</strong>: Non-linear ‘flexibility’ associated with more terse domain-specific communication.</td>
<td>No findings</td>
</tr>
<tr>
<td>EMG</td>
<td><strong>Many factors</strong>: Linear PS in smiling and frowning higher in competitive vs. cooperative tasks, with gender differences. PA higher for lower expertise team members.</td>
<td><strong>Mixed findings</strong>: Linear PS in facial EMG not related to team affective states, but higher non-linear PS was associated with higher negative emotions in the team.</td>
<td><strong>Limited findings</strong>: Non-linear (but not linear) PS in postural sway positively predicts affective outcomes.</td>
</tr>
<tr>
<td>Electro-dermal</td>
<td><strong>Many factors</strong>: No effect of composition (gender, inclusion of synthetic agent) on linear PS. Higher PA in cooperative vs. competitive tasks, with gender differences. Trait anxiety and empathy impacts linear and non-linear PS.</td>
<td><strong>Mixed findings</strong>: Non-linear PS negatively associated with leadership behaviors, but positively associated with positive affective states.</td>
<td><strong>Consistent findings</strong>: Linear PS positively predicted team task and affective outcomes.</td>
</tr>
<tr>
<td>Cardio-vascular</td>
<td><strong>Many factors</strong>: Linear PS is higher in competitive vs. cooperative tasks, varying with team composition (higher PS in males, lower with inclusion of synthetic agent). PA decreases with increasing expertise. Linear PS increases with task difficulty.</td>
<td><strong>Mixed findings</strong>: Linear PS was negatively associated with team process measures, while non-linear PS was both negatively and positively associated with team process.</td>
<td><strong>Mixed findings</strong>: Across studies linear PS both positively and negatively predicted team task outcomes, while PA negatively predicted task outcomes. Linear and non-linear PS negatively predicted affective outcomes.</td>
</tr>
</tbody>
</table>

Where team members are and what they are doing matter
Examples of activity tracking

• Co-location networks for measures of team risks\(^1\)
• Electronic health record access logs for measures of workload\(^2\) and team coordination\(^3\)
• Wearables for physical work process mapping\(^4\)
• Administrative data for mapping patient paths through healthcare delivery system\(^5\)
How are these measures applied?

<table>
<thead>
<tr>
<th>Topic</th>
<th>Study</th>
<th>Linguistic</th>
<th>Paralinguistic</th>
<th>TPD</th>
<th>Activity Tracking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual and Team Workload, Stress and Resilience</td>
<td>Nursing workload in the ICU</td>
<td>-</td>
<td>Y</td>
<td>-</td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td>Internal Medicine Resident Work</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td>Collective allostatic load in a PICU</td>
<td>-</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td>Teamwork competency assessment</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td>ECHO</td>
<td>Y</td>
<td>Y</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Shared decision making, respect and dignity</td>
<td>Handoffs and teamwork across units in an acute care facility</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Y</td>
</tr>
<tr>
<td>Climate and narrative dynamics</td>
<td>Event reporting and the language of blame</td>
<td>Y</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Individual and Team Workload, Stress and Resilience
Challenges with individual and team workload and it’s measurement

• Workload is related to:
  • Patient outcomes
    • Patient experience
    • HAIs
    • Delays in treatment
    • Postop complications
  • Workforce and organizational outcomes
    • Burnout and job dissatisfaction
    • Turnover, disengagement from or exiting the professions
    • Efficiency and productivity

• Existing approaches to measuring workload rely on:
  • Staffing ratios (sometimes weighted by acuity systems)
  • Observation
  • Survey

Study 1: RN workload in an ICU

Patient Factors:
- Level of care
- Insulin drip
- Vent.
- Vasoactive
- PA cath
- CVVHD
- Flap or spine checks
Study 1: RN workload in an ICU

Shift factors:
- # of patients
- Composite of # of patients by task factors
- CNA?
- When rounding occurred
Study 1: RN workload in an ICU

Self-report exertion:
- Q 4 hr ratings of mental and physical exertion
Example metric set for RN workflow

Time in location

Movement through space
- Transitions between areas (#)
- ‘Burstiness’ of transitions
- Shannon Entropy of locations over time

Audio
- Volume (mean, sd)
- Pitch (mean, sd)
- Time spent speaking
- ‘Burstiness’ of speaking

Accelerometer and gyroscope metrics
- Activity (energy) level
- Body movement
- Time standing / sitting
- Time walking
- ‘Burstiness’ of walking

Location x (Audio & Accel./gyro. Measures)
RN Workstation
• 3 stations ea.

Service Areas
• Med rm
• Supply rm
• Nutrition

Patient Rooms
• 2 sensor ea.
• 4 rms excluded

All else = “off the grid”
• Unaccounted for time

Analysis process

• Dataset
  - 356 work hours from 89 4-hour blocks across 35 shifts

• Dimension reduction
  - Elastic net method applied to 72 sensor features (plus pairwise interactions) for each outcome

• Multi-level Modeling
  - Test grouping structure (shift)
  - Level 1 predictors (sensor features)
  - Level 2 predictors (task demands)
  - Random coefficients
  - Cross-level interactions
Findings

Mental Exertion
- 63% of variance was between shifts
- Final model accounted for:
  - 5% of within shift variance
  - 73% of between shift variance
  - With:
    - 5 sensor features
    - 1 Task factor (pts on insulin drip)
    - 1 Cross-level interaction (pts on insulin drip x burstiness of speaking)

Physical Exertion
- 57% of variance was between shifts
- Final model accounted for:
  - 52% of within shift variance
  - 55% of between shift variance
  - With:
    - 10 sensor features
    - 1 Task factor (Average patient load)
    - 1 Cross-level interaction (Avg pt load x Volume speaking at RN station)

Overall patterns of interaction that matter
- Burstiness of speaking
- Time speaking outside of main work areas x Time at nursing stations
- Entropy of transitions x Burstiness of transitions

Context specific interactions that matter
- Patient on an insulin drip X Burstiness of speaking
- Average patient load x Volume while speaking at nursing stations
- Volume speaking at RN station x Burstiness of transitions
Study 2: Does this scale to residents?

Questions
How are residents spending their time, and do differences predict educational or well-being outcomes?

Pilot overview
43 Interns
July – Oct 2018
3,973 shifts
45,367.8 hrs

Single sensor
Location tracking system + EHR metrics
Study 3: Collective Allostatic Load in a PICU

1. Better understand the impact of **chronic** and **acute stressors** on **individual** and **team performance** in the PICU.
2. Explore **how team interactions exacerbate** or **ameliorate** these **stress effects**.

**Why do this?**
- Better **workload measurement systems** which can drive unit resource allocation decisions in near real-time
- **Counter measures** for staff to **minimize, manage, and mend** from stress effects
# Measurement framework

<table>
<thead>
<tr>
<th>Stressors / work demands</th>
<th>Stress responses</th>
<th>Teamwork</th>
<th>Task and team outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Administrative data:</strong> Measures characterizing patient cohort (census, churn, acuity scoring) and staffing levels (RN/pt ratio), and nursing activity (TISS-28, NAS)</td>
<td><strong>Self-reported workload:</strong> NASA-TLX revised</td>
<td><strong>Self-reported teamwork quality:</strong> Team process scale; Mayo High Perf. Teamwork Scale in codes</td>
<td><strong>Individual burnout:</strong> Maslach short</td>
</tr>
<tr>
<td><strong>Self-reported stressors:</strong> Custom survey capturing unique features of the work day that cause stress in the PICU</td>
<td><strong>Emotional state recognition:</strong> Physiology (Cardiac and electrodermal responses), and speech features (vocal stress)</td>
<td><strong>Team interaction patterns:</strong> Movement and communication patterns (involving no recordings of actual speech)</td>
<td><strong>Team affect:</strong> Mutual trust, team potency / efficacy</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>Objective task outcomes:</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Call button response latencies; CPR quality scores in codes</td>
</tr>
</tbody>
</table>
Study devices, and why we are using them

- **Staff location badge**
  - Movement and Physical Workload

- **Wrist worn physiology monitor**
  - Workload and stress measurement

- **Smartphone**
  - Surveys, emotional state detection, team interaction
Data collection overview: A day in the life of the study

1. Focus is on PICU Leadership Team (Fellows and Charge Nurses).
2. We need a whole team to collect data!

Start of Shift

1. Device Donning

Morning (~11 AM)

1. Core Survey
   - Workload
     - 12 items
   - Team process
     - 10 items
   - Stressors
     - 1 item
   - Code team evaluation
     - only if code occurred
     - 16 items

Afternoon (~3 PM)

1. Core Survey
   - Same as Morning
     - 22 items (+16 if a code occurred)

End of Shift (~7 PM)

1. Core Survey
   - Same as Morning and Afternoon
     - 22 items (+16 if a code occurred)
2. End of Day Survey
   - Team trust
     - 21 items
   - Team efficacy
     - 18 items
   - Burnout
     - 2 items
3. Device Doffing

~ 2 Minutes or less
~ 3-5 Minutes
~ 3-5 Minutes
~ 5-7 Minutes
Study 4: Sociometric Team Selection Project

- Generate construct and criterion validity evidence for individual and team LDSE behavioral competencies.
- Develop unobtrusive and sociometric indices of individual and team LDSE behavioral competencies.
- Develop technology and guidelines for the use of sociometric measures in astronaut selection.
Coordination and Multi-team Systems
Example Handoff Improvement Research (resident to resident)

- Resident handoff-improvement program in 9 sites
  - 23% decrease in medical error rate
  - 30% decrease in preventable adverse event rate
  - No change in non-preventable adverse event rate
    - Significant increase in inclusion of key handoff elements (verbal and written)
    - No significant change in handoff duration (2.4 to 2.5 minutes per patient), or resident workflow, patient-family contact, or computer time.

Study 5: Inter-unit patient transfers
1 FQ / ~12k pt admissions / ~ 1,000 bed hosp. / 108 units

Divers of Poor Teamwork Across Units
Upstream complexity and predictability
- Structural (variety of inputs)
- Temporal (turbulence)

Highways and Bi-ways
2959 UNIQUE patient paths
25% of patient visits take one of 18 paths
Avg. pt. visit has > 3 inter-unit handoffs
Study 5: Data and Analysis

Traditional unit metrics
- Bed size, ‘churn’, LOS

Temporal features of transitions
- # in AM/PM, wkdy/wknd
- ‘Burstiness’ in AM/PM, wkdy/wknd

Structural features of transitions
- In/out degree, centrality, betweenness, density, transitivity

Teamwork Across Hospital Units (TAHU)
- Hospital units do not coordinate well with each other. [R]
- There is good cooperation among hospital units that need to work together.
- It is often unpleasant to work with staff from other hospital units. [R]
- Hospital units work well together to provide the best care for patients.
Study 5: Findings (43 Units from one hospital)

<table>
<thead>
<tr>
<th>Predictor</th>
<th>$\beta$ (SE)</th>
<th>t (p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Betweenness Centrality (weighted)</td>
<td>0.40 (0.13)</td>
<td>3.0 (0.005)</td>
</tr>
<tr>
<td>Discharge Burstiness during Night Shift</td>
<td>0.27 (0.14)</td>
<td>2.0 (0.056)</td>
</tr>
<tr>
<td>Average Neighbor Degree</td>
<td>0.24 (0.14)</td>
<td>1.8 (0.086)</td>
</tr>
</tbody>
</table>

Adj $R^2 = 0.23$
$F(3,39) = 5.08$
p = 0.005
Patient safety event reporting, unit climate, and narrative dynamics
Challenges in patient safety event reporting

\[
\begin{array}{c}
\times \\
\sim 1 \text{ event report per bed per month} \\
\sim 1,000 \text{ utilized beds} \\
\hline
\sim 1,000 \text{ reports per month}
\end{array}
\]

Each requiring:
- Further analysis
- Problem solving
- Solution generation
- Implementation
- Evaluation
Study 6: Are there better ways?

- Apply **topic modeling** to safety event reports
- Explore **content validity**
  - Can we find coherent patterns? Of important safety trends?
  - How well are discovered patterns currently represented in event taxonomies?
- Explore **predictive validity**
  - Do topic scores account for variance in harm scores above and beyond existing event categories?
**Topic Modeling with LDA Example**

**Topic 1**
- Word | $P$
  - Medication | .41
  - Dose | .23
  - Route | .13
  - Pump | .11
  - Tomato | .001
  - ... | = 1

**Document 1**
Patient on infusion pump received incorrect **dose** of **medication** due to improper **dilution**.

**Topic 2**
- Word | $P$
  - Call | .31
  - Communication | .24
  - Unresponsive | .23
  - Verbal | .16
  - Tomato | .001
  - ... | = 1

**Document 2**
Verbal orders were given but not documented. Poor **communication** with pharmacy staff led to delay in medication administration.

**Document 3**
Difficulty **coordinating** patient transfer to unit with staff. They've been **unresponsive** to calls and pages. We've received **incomplete communication** and it endangers patients.

**Topic 1**
- Word | $P$
  - ... | ???
  - ... | ???
  - ... | ???
  - ... | ???
  - ... | ???
  - ... | = 1

**Topic 2**
- Word | $P$
  - ... | ???
  - ... | ???
  - ... | ???
  - ... | ???
  - ... | ???
  - ... | = 1
Study 6: Approach

• Topic modeling
  • 13,317 reports from over 15 months
  • 40 topic model was ‘best fitting’

• Topic labeling and rating
  • Review by 5 SMEs in 9 hours of focus groups
  • Ratings of coherence, importance, and current awareness / representation in event taxonomies

• Multi-level modeling of harm scores
  • Existing event categories used as grouping variable, and predict within and between group variance in harm scores
Study 6: Example Topics

**Topic 1: Blood Products**
- Blood
- Request
- Unit
- Product
- Bank
- Sent
- Transfus

**Topic 2: Infus Heparin**
- Rate
- Drip
- Weight
- CPN
- Start
- Heparin or High Risk Meds

**Topic 3: Bed Floor**
- Fell
- Bathroom
- Sit
- Head
- Chair
- Side

**Topic 4: Pressur Unable**
- Bleed Continu
- Would
- Eval
- Elev

**Topic 5: Chang Shift**
- Pain
- Errors at time of shift
- Day
- Every
- High
- Dilaudid
Study 6: Results

The majority of topics (72.5%) were rated as highly coherent, and only 5% were rated as having no discernable pattern.

<table>
<thead>
<tr>
<th>No</th>
<th>Topic</th>
<th>Coherence Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Risky env. Conditions patient, room, left, safety, enter</td>
<td>High</td>
</tr>
<tr>
<td>2</td>
<td>Comm. / coord. Breakdowns call, told, state, get, take</td>
<td>High</td>
</tr>
<tr>
<td>3</td>
<td>Skin damage site, arm, right, left, assess</td>
<td>High</td>
</tr>
<tr>
<td>4</td>
<td>Retained foreign object xray, needle, chest, count, case</td>
<td>High</td>
</tr>
<tr>
<td>5</td>
<td>Patient ID name, discharge, home, patient, mother</td>
<td>High</td>
</tr>
<tr>
<td>6</td>
<td>PCA use error catches chang, shift, pain, night, pca</td>
<td>High</td>
</tr>
<tr>
<td>7</td>
<td>Blood product management blood, red, cell, return, request</td>
<td>High</td>
</tr>
<tr>
<td>8</td>
<td>Specimen management lab, result, drawn, draw, test</td>
<td>High</td>
</tr>
<tr>
<td>9</td>
<td>Interpersonal conflict ask, said, put, know, want</td>
<td>High</td>
</tr>
<tr>
<td>10</td>
<td>No pattern back, one, came, still, come</td>
<td>High</td>
</tr>
<tr>
<td>11</td>
<td>Line placement / mngmnt. line, central, cathet, place, baby</td>
<td>High</td>
</tr>
<tr>
<td>12</td>
<td>Equipment contamination tray, set, clean, steril, instrument</td>
<td>High</td>
</tr>
<tr>
<td>13</td>
<td>Code issues bedsid, assess, immedii, vital, code</td>
<td>High</td>
</tr>
<tr>
<td>14</td>
<td>Ambig. or incorrect orders given, patient, review, chart, notifi</td>
<td>High</td>
</tr>
<tr>
<td>15</td>
<td>Orders and patient ID note, upon, document, may, follow</td>
<td>High</td>
</tr>
<tr>
<td>16</td>
<td>Medication errors medic, pharmacy, med, dose, administ</td>
<td>High</td>
</tr>
<tr>
<td>17</td>
<td>Med labeling error check, correct, label, doubl, wrong</td>
<td>High</td>
</tr>
<tr>
<td>18</td>
<td>Pt transfer issues patient, admit, transfer, floor, admis</td>
<td>High</td>
</tr>
<tr>
<td>19</td>
<td>Specimen labeling specimen, contain, locat, receiv, must</td>
<td>High</td>
</tr>
<tr>
<td>20</td>
<td>Patient aggression staff, secur, member, family, leav</td>
<td>High</td>
</tr>
<tr>
<td>21</td>
<td>No pattern use, anoth, make, complet, sure</td>
<td>High</td>
</tr>
<tr>
<td>22</td>
<td>Access to services care, provid, contact, clinic, today</td>
<td>High</td>
</tr>
<tr>
<td>23</td>
<td>Allergic reaction to contrast mri, contrast, scan, inject, patient</td>
<td>High</td>
</tr>
<tr>
<td>24</td>
<td>Med order/dosing errors order, dose, poe, receiv, enter</td>
<td>High</td>
</tr>
<tr>
<td>25</td>
<td>Falls bed, floor, assist, fall, fell</td>
<td>High</td>
</tr>
<tr>
<td>26</td>
<td>controlled substance waste wast, found, fentanyl, drop, pxyi</td>
<td>High</td>
</tr>
<tr>
<td>27</td>
<td>Blood sugar / insulin mgmng pts, blood, insulin, glucose, check</td>
<td>High</td>
</tr>
<tr>
<td>28</td>
<td>Distributed comm. Page, pacu, resid, anesthesia, servic</td>
<td>High</td>
</tr>
<tr>
<td>29</td>
<td>Missing wrist band patient, caus, wristband, must, phlebotomist</td>
<td>High</td>
</tr>
<tr>
<td>30</td>
<td>Patient consent report, place, prior, without, consent</td>
<td>High</td>
</tr>
<tr>
<td>31</td>
<td>Pt transfer w/o monitoring arriv, unit, charg, transport, notifi</td>
<td>High</td>
</tr>
<tr>
<td>32</td>
<td>Infusion pump &amp; tubing tube, pump, bag, fluid, run</td>
<td>High</td>
</tr>
<tr>
<td>33</td>
<td>Com. &amp; role clarity team, communic, picu, attend, plan</td>
<td>High</td>
</tr>
<tr>
<td>34</td>
<td>Dental and equip issues procedur, remov, attempt, pull, area</td>
<td>High</td>
</tr>
<tr>
<td>35</td>
<td>Pressure ulcers and BP pressur, unabl, bleed, continu, wound</td>
<td>High</td>
</tr>
<tr>
<td>36</td>
<td>Airway management equip, machine, oxygen, intub, sedat</td>
<td>High</td>
</tr>
<tr>
<td>37</td>
<td>Transitions of care nurs, inform, made, receiv, awar</td>
<td>High</td>
</tr>
<tr>
<td>38</td>
<td>Scheduling / coord. Issues time, need, hour, due, avail</td>
<td>High</td>
</tr>
<tr>
<td>39</td>
<td>Med infusion errors infus, heparin, rate, drip, weight</td>
<td>High</td>
</tr>
<tr>
<td>40</td>
<td>Med error – discrepancy day, number, system, record, occur</td>
<td>High</td>
</tr>
</tbody>
</table>

Table 2. Topic names and top 5 words for a 40 topic model of PSER data. **Green** = topics rated as highly coherent; **Yellow** = topics rates as somewhat coherent; **Red** = Topics rated as incoherent.
### Topic coherence and importance by awareness and representation (examples)

<table>
<thead>
<tr>
<th>Topic coherence and importance</th>
<th>High</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11 topics</td>
<td>14 topics</td>
<td></td>
</tr>
<tr>
<td>• OR controlled substances waste management</td>
<td>• Central lines</td>
<td></td>
</tr>
<tr>
<td>• ID/safety bands not scan-able</td>
<td>• Hypoglycemia events</td>
<td></td>
</tr>
<tr>
<td>• Blood wastage</td>
<td>• Pre-procedure issues</td>
<td></td>
</tr>
<tr>
<td>• ...</td>
<td>• Dose monitoring errors</td>
<td></td>
</tr>
<tr>
<td><strong>Low</strong></td>
<td></td>
<td>15 topics</td>
</tr>
<tr>
<td>0 topics</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Logistics and operational barriers</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Electronic ordering configuration</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Extubations</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Availability of resources</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• ...</td>
<td></td>
</tr>
</tbody>
</table>
Topics vs. PSN Event Types

- Heatmap – Proportion of events within PSN category classified into each topic
- One to one mapping (telling what we already know)
- Some join or split categories (new way to think about what we already know)
- Some have no clear correspondence (new pattern)
Study 6: Takeaways

Findings

- Existing event categories as a grouping variable
  - 51% of variance was between event categories
  - 49% of variance was within event categories
- Lexical features (sentiment analysis, LIWC)
  - 11% of between event variance
  - 3% of within event variance
- Topic scores
  - 27% of between event variance
  - 6% of within event variance

Future directions

- Language of blame in event reporting data as a marker of local climate
  - Natural experiment around a just culture implementation
- Towards measures of narrative stability and change as makers of climate
Summary of social data science (SDS) pilot studies: Describe, explain, predict, control

• SDS methods are useful for **description** and strong in **prediction**
  • The detail can be overwhelming, and requires engaging domain experts with complex data
  • Highly predictive, but poorly explanatory models are of limited interest

• SDS needs tighter coupling with social sciences to enable **explanation**
  • Ongoing process of applying, adapting, and building new theory
  • New methods enable more temporal theories of social interaction

• We’ve only scratch the surface of interventions for **control**
  • Better systems for selection, training and development, ongoing support, and operations management
Future directions for Social Data Science
SDS can enable translational organizational sciences.

**Better science**
- Reduced burden of data collection
- Increased scale of data collection
- Multi-method triangulation

**Better organizations**
- Selection systems
- Work redesign
- Risk monitoring
- Performance feedback
Thoughts on the road ahead

- Need to mature integrative frameworks
  - Huge variety in theories and methods available

- Need to invest in fundamental measure validation
  - What is an appropriate approach to scaling measures up

- Need to build the technical infrastructure
  - Current investments focus on clinical data (correctly), but do not include key SDS data sources (e.g., EHR access logs)

- Need to invest in the human capital
  - Introducing into
  - Brining strong research teams together
  - Best configurations of SDS skill sets across team members
Thanks for your time. Questions?

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