UNIVERSITY OF TWENTE.
TEAM COMMUNICATION PATTERNS IN CRITICAL SITUATIONS
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WHAT DID WE DO?

• Live observations of 40 pediatric cardiac surgery cases in clinical setting

• Multi-method

• Trained human factors observers

HOW DID WE MAKE SENSE OF WHAT IS GOING ON HERE (OVER THE YEARS)?

1. **2010-2011**: correlational analyses over all data obtained (questionnaires, observations, teamwork ratings, patient outcomes)

2. **2011**: detailed analysis of four surgical procedures, controlled for complexity and patient outcome (2x2 matrix)

3. **2015**: Social Network Analysis of all team communication, with processes being contingent upon phase in the surgical procedure

4. **2019**: Relational Event Analysis of team communication patterns
CORRELATIONAL ANALYSES: SOME SURPRISING FINDINGS¹

• No association between teamwork and outcome
  • In fact, we found an inverted U-curve showing first increased teamwork by surgeons as patient outcomes worsened, then decreased teamwork as patient outcomes continued to deteriorate

• No association between teamwork and non-routine events
  • However, during cardiopulmonary bypass: significant correlation ($r=0.66, p<.01$) between surgical decision making and number of NREs (the more NREs, the better the decision making)

• Mental and physical preparation beforehand was not predictive of patient outcome; questionnaire immediately afterwards on unexpected events and team processes predicted 30% of the variance in 30-day postoperative outcome

Figure 4.3  Stress-Strain State Space diagram
WHAT HAVE WE LEARNED SO FAR?

- Law of Fluency might explain the inverted U-curve:
  - First, teams extend gracefully by employing their team resources
  - However, as demands increase, they run the risk of saturation, and team processes decrease in quality

- However, ‘teamwork’ was rated very coarsely using vague, high-level constructs, such as ‘leadership’, ‘situation awareness’, ‘decision making’, etc.

- Also, ‘teamwork’ was not seen as a dynamic construct, whose underlying processes can change and adapt to the demands of the situation

- Hence, we need to look at team processes in more detail, using real-time measures
# PROCESS FLOW IN PCS DURING THE VARIOUS EPOCHS

<table>
<thead>
<tr>
<th>Epoch</th>
<th>Process flow</th>
<th>Domain</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Patient in surgical holding area. Pre-operative events and medication. Patient transported to OR</td>
<td>Transport to OR</td>
</tr>
<tr>
<td>2</td>
<td>Patient in OR. <strong>Induction of anesthesia</strong>, insertion of lines. Preparing for surgery</td>
<td>Pre-surgery/Anesth. induction</td>
</tr>
<tr>
<td>3</td>
<td><strong>Incision.</strong> Desection. Canulation</td>
<td>Surgery/pre-bypass</td>
</tr>
<tr>
<td>4</td>
<td><strong>Go on cardiopulmonary bypass (CPB).</strong> Identification of structure. Surgical repair</td>
<td>Surgery/bypass</td>
</tr>
<tr>
<td>5</td>
<td>Off CPB. Heparine reversed. Hemostasis</td>
<td>Surgery/post bypass</td>
</tr>
<tr>
<td>6</td>
<td>Chest closed. <strong>Prepare for move and update ICU.</strong> Team leaves with patient to ICU</td>
<td>Transport to ICU</td>
</tr>
<tr>
<td>7</td>
<td><strong>Arrival at ICU.</strong> Nurses take over. Anesthetist/surgeon inform ICU attending</td>
<td>Handoff</td>
</tr>
</tbody>
</table>
EXAMPLE OF EPOCHS AND CRITICAL TRANSITION PERIODS

<table>
<thead>
<tr>
<th>Epoch</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time (total)</td>
<td>8:15</td>
<td>9:51</td>
<td>10:27</td>
<td>12:33</td>
</tr>
<tr>
<td>Time (passage ½)</td>
<td>9:03</td>
<td>10:08</td>
<td>11:29</td>
<td>12:34</td>
</tr>
<tr>
<td>Time (passage ¼)</td>
<td>9:27</td>
<td>10:18</td>
<td>12:01</td>
<td>13:06</td>
</tr>
<tr>
<td></td>
<td>9:52</td>
<td>10:09</td>
<td>11:30</td>
<td>13:40</td>
</tr>
<tr>
<td></td>
<td>10:18</td>
<td>10:58</td>
<td>12:49</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10:58</td>
<td>12:01</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
SCALE-FREE NETWORK STRUCTURE OF MEDICAL TEAM

Node degree distribution

RESULTS ON COMPLEXITY OF PROCEDURES (MEDIAN SPLIT)

• More complex procedures:
  • Have flatter communication structures, are less hierarchical
  • Show higher levels of reciprocity
“If the first surgeon is too busy, I’ll take over the communication with the rest of the team”
Assisting surgeon

Relational event unlikely to happen  ←  Relational event likely to happen

Critical
Non-critical

Effects

Recency-snd
Recency-rec
PSAB-BY
PSAB-BA
Inertia-snd
Inertia-rec
High Initiator
FEsnd-S3
FEsnd-S2
FEsnd-S1
FEsnd-P2
FEsnd-P1
FEsnd-N2
FEsnd-N1
FEsnd-A2
FEmerc-S3
FEmerc-S2
FEmerc-S1
FEmerc-P2
FEmerc-P1
FEmerc-N2
FEmerc-N1
FEmerc-A2
RESULTS RELATIONAL EVENT ANALYSIS

• Surgical team showed few changes in communication patterns:
  • But does change when more extreme situations are chosen (3 most critical vs. 3 least critical)
  • Changes with 8-member team as well (right panel)

Similar analyses done with Apollo 13 Mission Control team and Air France 447 team
CONCLUSIONS

• Findings indicate that teams adapt communication patterns in critical situations.
• They still adhere to institutional roles, closed-loop communication, and information seeking behavior in both critical and non-critical situations.
• However, they decentralize communication structures in critical situations.
BACK TO THE EXAMPLE OF STUDYING A SURGICAL TEAM AT WORK

- Telephone call was a non-routine event
- Anesthesist was caught in a double-bind: both answering the phone and taking the cardioplegia line
- Team members were very busy with their own coordination issues:
  - For 25 seconds, S1 and P1 were solving diminishing rate of return problem
  - Attention management: no one noticed A1 with phone, nor did A1 notify other team members (did he assess the workload of his fellow team members?)
  - S1 was simultaneously coordinating with S2 and N1
  - Scale-free network structure with S1 as single hub can be overloaded (in this case, S2 did not take over)