The Orderly and Effective Visit: Impact of the Electronic Health Record on Modes of Cognitive Control

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OVERVIEW

• Joint Cognitive Systems
• Contextual Control Model
• Concepts of effectiveness
• Aims of the Study
• Methods
• Results
• Conclusion
Overarching Goal

• Medical care is information intensive
• Current user interfaces are hard and unpleasant to use
• Must develop user information environments that improve efficiency and quality of care.
  – Efficiency measured in time (easy)
  – Quality measured in patient outcomes (hard)
• Need model to predict and measure effects of user interfaces on quality of reasoning
Joint Cognitive Systems

• *An* interdependent emergent system
• “*Cognition*” is distributed across system
  – computers, people, data, displays
• Dimensions of a joint cognitive system:
  – *Goal-orientation* – increase order/alignment
  – *Orderly/ Under Control* – a cycle that detects deviations from goal and institutes adaptive actions
  – *Co-agency* – Collective energy of the system
As-is EHR

- Building blocks of EHR are data domains
  - Meds, Labs, Rad, Notes, Diagnoses, etc.
- Results in bad thought-flow and workflow

ZHENG ET AL., Analysis of User Interactions with EHR System
Contrasts with Usual Approaches

• Cognitive support not decision support
  – quality of reasoning not right answer
• Joint not separate systems
  – Joint best not human best and computer best
• Cognitive-social psychology not ergonomics
  – Thought cycles over seconds to minutes not ms
Contextual Control Cycle

- Disturbances
  - Events/Feedback
    - Produces
      - Action/Care Plan
        - Determines
          - Construct/Shared understanding of patient health
            - Modifies
              - Healthcare of Patient
                - Physician
                - Patient
                - Nurse
                - Pharmacist
                - Social Worker etc.
Contextual Control Components

• **Goal Interactions** - the degree to which goals are defined and integrated

• **Time Horizon** - breadth of information, change over time and future forecasting

• **Assessment of Uncertainty** – Limitations of available information is identified, explained and adapted to

• **Decision heuristics** - Action plan is customized to the current situation
## Dependent Variables – Control Mode

### Characteristics of Control Modes

<table>
<thead>
<tr>
<th>Control Mode</th>
<th>Goal interactions</th>
<th>Time horizon considered</th>
<th>Assessment of uncertainty</th>
<th>Decision heuristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategic</td>
<td>Higher-level goals and interactions considered</td>
<td>Broad into past and future (feed forward)</td>
<td>Recognition and explanation of uncertainty</td>
<td>Adaptation of guidelines to situation, planning, consideration of dependencies</td>
</tr>
<tr>
<td>Tactical</td>
<td>Focus on defined, individual goals</td>
<td>Broad into past, minimal projections</td>
<td>Recognition</td>
<td>Guidelines, limited planning</td>
</tr>
<tr>
<td>Opportunistic</td>
<td>Poorly defined goals</td>
<td>Present</td>
<td>Limited recognition</td>
<td>Habits, pattern recognition</td>
</tr>
<tr>
<td>Scrambled</td>
<td>Lack of consideration</td>
<td>Immediate</td>
<td>None</td>
<td>Random</td>
</tr>
</tbody>
</table>
Description of Study
Aims / Hypotheses

• **Aim 1**: The intensity of pre-visit planning would differ performance level

• **Aim 2**: Higher level of performance associated with lower frequency of searching during visit.
METHODS

- **Design**: Correlational
- **Settings**: 5 VA hospitals
- **Participants**: 45 primary care providers (35 MDs, 10 mid-levels)
METHODS

Procedures

• 3 phases (audio-taped)
  – *Phase 1*: Interview prior to visit / prep
  – *Phase 2*: Interviews in person (audio-tapes); screen shots captured manually (notes, orders, medications, consults, and labs/procedure results).
  – *Phase 3*: Post-visit interview
Dependent Variables

- **Control Mode** (coded orderliness) (IRR > 0.80)
  - Strategic – highest level of control/orderliness
  - Tactical – structured, but rigid, guideline based
  - Opportunistic – scattered, bouncing from highly salient
  - Scrambled – very unstructured and chaotic

- **Pre-planning intensity**: coded on a 1 (low) to 7 (high) scale. Independent of Mode

- **Searching Activity**: the proportion of overall screen changes dedicated to searching alone
# Measurement Codes for Control Modes

*Coded by 2 independent raters using strict rules*

<table>
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<tr>
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<th>Strategic</th>
<th>Tactical</th>
<th>Opportunistic</th>
<th>Scrambled</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Goals:</strong></td>
<td>High-level goals/interactions</td>
<td>Specific, lower level goals</td>
<td>Little mention of goals of care</td>
<td>No goals mentioned</td>
</tr>
<tr>
<td><strong>Time Horizon</strong></td>
<td>Broad/Future and past trending</td>
<td>Broad view into past; little future trending</td>
<td>Present focus; little trending</td>
<td>Immediate only</td>
</tr>
<tr>
<td><strong>Uncertainty</strong></td>
<td>Recognition / Attempt to Explain</td>
<td>Recognition but no attempt to explain</td>
<td>Little recognition</td>
<td>None</td>
</tr>
<tr>
<td><strong>Heuristics</strong></td>
<td>Guidelines / Planning/ Considerations of dependencies</td>
<td>Heavy use of guidelines and rules; little adaptation to individual</td>
<td>Habits/ guidelines and pattern recognition</td>
<td>Random</td>
</tr>
</tbody>
</table>
## RESULTS - Descriptives

<table>
<thead>
<tr>
<th></th>
<th>Opportunistic</th>
<th>Tactical</th>
<th>Strategic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Years*</td>
<td>16</td>
<td>18</td>
<td>10</td>
</tr>
<tr>
<td>Role*</td>
<td>11</td>
<td>9</td>
<td>11</td>
</tr>
<tr>
<td>Work Pressure*</td>
<td>4.9</td>
<td>4.3</td>
<td>3.0</td>
</tr>
<tr>
<td>Time*</td>
<td>27.4</td>
<td>26.3</td>
<td>28.7</td>
</tr>
</tbody>
</table>
Screen Changes

- Mean # of screen changes = 18.5 per visit
  - 60% searching
  - 40% entering notes or orders
• **Control mode** NOT related to years since graduation, familiarity with the patient, ratings of levels of mental stress, and overall time of the visit.
Pre-planning Measurement: CTA

“Please think aloud what is in your mind while you do this task. Please indicate what you are trying to do. There are no right or wrong things to say.”

“Please tell me what you’re doing explicitly during the preparation templating and updating process. You’re doing this in order to do what? And you’re doing that by doing what?”
Intensity of Preparation Coding

• 1 (not well) to 7 (very-well) scale
• 2 independent coders, ( R>0.80)

  – Medication review
  – Pre-review of prior visits and intervening events (reading progress notes)
  – Review by problems/associated labs
  – Establishment of goals of visit
Aim 1: The intensity of pre-visit planning would differ across mode

- Mean = 4.9
- ANOVA (F_{2,23} = 5.64; p=0.01).
- Statistical significance remained after controlling for years of experience (F_{2,23} = 6.62; p=0.01).
RESULTS – Pre-Planning (1 to 7)
**Aim 2**: Higher level of performance associated with lower frequency of searching during visit

- Higher levels of performance associated with lower incidence of search activities
  \[(F_{2,30} = 6.54; p=0.004)\]
- After controlling for pre-planning:
  \[(F_{2,22} = 4.2; p=0.03)\]
Measurement of Search Activity

- Research assistants in room with patient and provider
- Used tablet with time-stamped software
- Tape-recorded visit
- Noted every change of screen
RESULTS – *Search Activity*

![Bar chart showing proportions of opportunistic, tactical, and strategic search activity.]

- **Proportion Search, Opportunistic**: 0.71
- **Proportion Search, Tactical**: 0.5
- **Proportion Search, Strategic**: 0.52
Entering Screens

• Visits rated at a higher level of control had higher proportion of computer interactions involving ordering.

\[ \text{ANOVA, } (F_{2,22} = 9.26; p=0.001) \]

• After controlling for pre-visit planning:

\[ (F_{2,22} = 4.9; p=0.02). \]
RESULTS – Entering Notes/Orders

- Opportunistic
- Tactical
- Strategic

- Properation Enter, Opportunistic, 0.29
- Properation Enter, Tactical, 0.5
- Properation Enter, Strategic, 0.57
Conclusions

• Pre-visit preparation of electronic note was significantly associated with higher levels of visit control after controlling for years of clinical experience.

• Searching activity significantly inversely associated with visit performance after controlling for degree of pre-planning efforts.

• Implication is that the EHR is not providing adequate cognitive support for visit workflow.
  
  – Information has to be very organized to support a complex primary care visit.

  – Searching during a visit is very distracting and decreases performance.
“IT applications appear designed largely to automate tasks or business processes. They are often designed in ways that simply mimic existing paper-based forms and provide little support for the cognitive tasks of clinicians or the workflow of the people who must actually use the system.” (p. 3)

Changing Work Processes

Adaptive Strategies

Information Overload
Limitations

• Not a randomly controlled trial

• Personality/cognitive factors may be associated with pre-planning and ALSO associated with visit performance (thus producing a confound)

• Study done in the VA which may not be generalizable
Acknowledgements

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