Dissertation Defense

Handling External Clinical Information in Independent Primary Care Practices: A Cognitive Work Analysis

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Katsushika Hokusai
(c. 1830)
Introduction

• Information overload
• Missing or incomplete information (underload)
• Scattered or fragmented information
• Conflicting or erroneous information

Beasley, et al. (2011)
Background: Literature review

Comprehensive review of 89 articles on information handling in primary care

Work practices
• Many studies on handling test results
• Few on referrals, discharge summaries
• Nearly all lack detailed descriptions

Information hazards
• Information missing or incomplete
• Diagnosis and follow-up delayed or absent
• Patients are not always informed of results
• Handling steps poorly documented
• Tracking of requests largely ad hoc

Interventions
• Few process interventions
• Electronic health records (EHRs)
• Used for test results, referrals
• VA and Partners Healthcare
• “Hybrid” systems performed poorly
What socio-technical factors shape how small primary care practices handle external clinical information?

**Aim 1:** Describe the context and work practices in multiple primary care practices.

**Aim 2:** Compare the socio-technical factors that shape these work practices.

**Aim 3:** Identify the implications for technology and process design.
Background: Conceptual model

Primary care as an “information system”

External Environment

Internal Environment

Primary Care Practice

Social System

Technical System

Primary Care

External clinical information

- Test results
- Consultations
- Summaries
- Medical Records
- Other...

- First-contact
- Longitudinal
- Comprehensive
- Coordinated
Methods: Design

Cross-case comparison of 4 primary care practices:

**Aim 1**: Field study and 4 independent Cognitive Work Analyses

**Aim 2**: Site comparison and synthesis

**Aim 3**: Implications for design
Methods: Sampling strategy

1. Deliver primary care, family medicine
2. Independent and “autonomous”
3. Practice size between 1 and 10 providers
4. Receive information from multiple external sources
5. Separated geographically
6. *With and without an electronic health record (EHR)*

Four sites were recruited from a pool of 12 Oregon practices.
Methods: Data collection and validation

- **Field Instruments**
  - Semi-structured interview guide with probes
  - Observation forms
- **Field Notes**
  - Notes and jottings
  - Maps, diagrams, and sketches
  - Reflective notes
- **Documents and artifacts**
- **Photographs**

- **Pilot Testing**
  - 3 mock interviews
  - 1 day of field observation

- **Data Validation**
  - Checked with participants (member-checking)
  - Compared across data types (triangulation)
Cognitive Work Analysis (CWA) is a comprehensive framework for understanding complex socio-technical systems as a basis for design

- Identifies constraints and capabilities
- Complements traditional task analysis, Cognitive Task Analysis (CTA)
- Flexible (multiple stages)
- Adaptable (many applications and approaches)
- Not widely adopted in healthcare (Jiancaro, et al. 2013)
In the parable of Simon’s ant, the beach shapes (constrains) the ant’s path...

...CWA seeks to understand the ant and the beach to design context-appropriate and adaptable systems.
Methods: Cognitive Work Analysis (CWA)

Adapted from Lintern (2009)

CWA analysts select one or more stages depending on their goals.
Methods: Cognitive Work Analysis (CWA)

Work systems (domains) are decomposed and analyzed at multiple levels of abstraction.
1. Work Situations

2. Functions

3. Tasks
   - Physical
   - Cognitive
   - Automated

4. Social Organization

Methods: Cognitive Work Analysis (CWA)
Methods: Cognitive Work Analysis (CWA)

Cognitive tasks are analyzed and represented in terms of “control tasks”

Example: Clinical information states

- Cues and triggers
- Decision criteria
- Options for action
- Plan for action

Rasmussens’s Decision Ladder

- Decision, Judgment
- Current State
- Situation assessment
- Detection, Awareness
- Chosen action
- Action plan, Procedure

Shortcuts
Aim 1: Individual CWA (n=4)

Aim 2: Comparison, synthesis

Aim 3: Design implications

Medical records desk and nurse’s office (Blue Clinic)
Results: Enrolled sites and field data

<table>
<thead>
<tr>
<th>Enrolled Site</th>
<th>Providers</th>
<th>Location</th>
<th>EHR?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Violet</td>
<td>1</td>
<td>Rural Willamette Valley</td>
<td>Vendor A</td>
</tr>
<tr>
<td>Red</td>
<td>1</td>
<td>Suburban Portland</td>
<td>Vendor B</td>
</tr>
<tr>
<td>Blue</td>
<td>6</td>
<td>Oregon Coast</td>
<td>Vendor C</td>
</tr>
<tr>
<td>Green</td>
<td>9</td>
<td>Columbia Gorge</td>
<td>Vendor B</td>
</tr>
</tbody>
</table>

Data collected between July and October, 2013

<table>
<thead>
<tr>
<th>Field time</th>
<th>20 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interviews</td>
<td>24 individuals</td>
</tr>
<tr>
<td>Observation</td>
<td>40 hours</td>
</tr>
</tbody>
</table>
## Results: Map of the work domain

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Receive and handle external clinical information to support primary care</th>
</tr>
</thead>
<tbody>
<tr>
<td>Values &amp; Priorities</td>
<td>External Priorities</td>
</tr>
<tr>
<td>Abstract Functions</td>
<td>Receive</td>
</tr>
<tr>
<td>Work Tasks</td>
<td>Physical Tasks</td>
</tr>
<tr>
<td>Resources</td>
<td>Information</td>
</tr>
</tbody>
</table>
Results: Functions and work tasks

• **Receive**
  - Receive
  - Retrieve
  - Monitor requests

• **Evaluate**
  - Screen (by non-clinical staff)
  - Triage (by clinical staff)
  - Review (by provider)

• **Incorporate**
  - Scan documents
  - Upload fax image
  - Interface test results
  - Create, update clinical notes
  - Dictate

• **Communicate**
  - Within practice
  - Outside practice
  - With patients (notify)
Results: Variations in work organization

Provider reviews and annotates original documents (Blue, Violet Clinics)

Provider reviews electronic images (Green, Red Clinics)

Other work situations:
- Information Source, Medium, and Receiving method
- Urgency, Need
- Time of day, Day of week
- Staffing levels
## Results: Receiving and retrieval

<table>
<thead>
<tr>
<th>Medium</th>
<th>Receiving Method</th>
<th>Blue Clinic</th>
<th>Green Clinic</th>
<th>Red Clinic</th>
<th>Violet Clinic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper</td>
<td>Fax (paper)</td>
<td>✓</td>
<td>(✓)</td>
<td>(✓)</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Fax (server)</td>
<td>--</td>
<td>✓</td>
<td>✓</td>
<td>(✓)</td>
</tr>
<tr>
<td></td>
<td>Dedicated printer</td>
<td>✓</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>Mail, courier</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Patient, proxy</td>
<td>(✓)</td>
<td>(✓)</td>
<td>(✓)</td>
<td>(✓)</td>
</tr>
<tr>
<td>Electronic</td>
<td>Interface</td>
<td>Lab (1)</td>
<td>Lab (2) Rad (1)</td>
<td>Lab (3) Rad (1)</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>Portal (external)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>Linked EHRs</td>
<td>✓</td>
<td>✓</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Verbal</td>
<td>Telephone</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Face-to-face</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>
Results: Incorporation

1. Scanning (Green, Red, Violet Clinic)

   - Document
   - Retrieve
   - Inspect
   - Prepare
   - Scan
   - EHR

2. Scanning (Blue Clinic)

   - Document
   - Retrieve
   - Inspect
   - Prepare
   - Name
   - Scan
   - DMS
   - EHR

Document management system

Green Clinic

Blue Clinic
Example: Indexing in the paper chart

Archived patient chart (Green Clinic)
Example: Indexing in the electronic record

EHR categories for scanned documents (Blue Clinic)

Document naming conventions for scanned and faxed documents (Green Clinic)

- CX [type] [date] [pos, neg] [Gram, Prelim, Final]
Results: Incorporation

3. Fax server (Green, Red)

4. Interface (Blue, Green, Red)

5. Other Incorporation practices:
   • Entry or dictation into EHR notes
   • Use of special EHR encounter
   • Cut and paste from portal
Results: Evaluation

1. Screening (non-clinical staff)
   - Detect
   - Identify
   - Screen

   - Urgent?
     - Yes: Expedite
     - No: Distribute

2. Triage and Review
   - Detect
   - Identify
   - Prioritize
   - Organize

   - Triage / Review
     - Interpret
     - Integrate
     - Compare

3. Other Evaluation practices
   - Remote access
   - Shared EHR queues
   - Proxy access to EHR inbox

Provider’s desk (Blue Clinic)
1. Patient notification and instruction

2. Internal communication
   - Verbal exchanges and written notes
   - Messaging within the EHR
   - Use of internal email system

3. External orders and requests

Mailed results card (Blue Clinic)
## Results: What explains practice variation?

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<td>Resources</td>
<td>Sources</td>
</tr>
</tbody>
</table>
Results: Abstract constraints, capabilities

External priorities:
- Laws and regulations (HIPAA)
- Standards of care, scope of practice
- Contractual obligations
- Coordinated, accountable care
- Community, patient expectations

Organizational priorities:
- Business and financial
- Management and culture

Individual values and priorities
- Personal and professional
- Work preferences (habits)
Results: Physical constraints, capabilities

Source capabilities
• Medium and delivery options

Information medium
• Limitations and affordances
• Visibility

Information form and content
• Content and meta-data
• Structure, format, readability

Receipt and retrieval methods
• Timing and reliability
• Push / Pull
• Synchronous / Asynchronous

Personnel and staffing
• Roles, skills, and experience
• Scope of practice
• Training and team configuration

Technical capabilities
• Availability and access
• Features, functions, and limitations
• Training and support

Human factors
• Perceptual
• Cognitive
• Physical
• Work space
Design goals:

• Improve efficiency and effectiveness
• Reduce or eliminate errors (safety)
• Enhance worker comfort and satisfaction
• Support and encourage adaptive activity (Lintern)
Design: Look for existing affordances

Affordance: The relationship between capability and opportunity.

Gibson (1979)

Multiple displays (Blue Clinic)

Perceptual cues (Blue, Green Clinics)
Design: Enhance situation awareness

- Make information states and queues visible
- Monitor and provide feedback on information flow
- Ensure automated tasks are transparent
- Highlight relevant and context-appropriate information for decision making:
  - Information content and metadata
  - Priority and urgency
  - Responsibility
  - Available resources
  - Operational status of systems, equipment
Design: Allow for worker adaptation

• Tasks may add value in unexpected ways (e.g., tight versus loose coupling, working in batches)
• Individuals organize and assimilate information differently
• There can be multiple mental models for organizing and representing clinical information
• Roles and responsibilities in small practices can be fluid
• Time and resource constraints often prevent improvement and experimentation (e.g., “hamster wheel” medicine)

“The worker should finish the design.”

Kim Vicente
Discussion

- CWA was an effective framework for answering the “how” and “why” questions posed in this research

- CWA stages, tools, and diagrams allowed a rigorous and systematic comparison of work domains, constraints, and capabilities

- The methods selected for data collection did not fully elicit values, priorities, and detailed cognitive strategies

- CWA is not without criticism, e.g., Cummings (2006)
Conclusions

- Information received and handled is heterogeneous
- Functions and work tasks were similar across sites, but actual work practices varied
- Situations and local work practices were shaped by multiple factors:
  - Delivery medium and method
  - Technical capabilities (source and recipient)
  - Personnel roles and responsibilities
  - External, organizational, and individual values and priorities
- Designs for this domain should:
  - Adapt to work context
  - Recognize unique affordances (e.g. paper, verbal communication)
Limitations

• Single investigator
• Available time and resources
• Scope and domain boundaries established by design
• Limited recruitment pool and small sample size
• Inherent variability and pace of change in small practices
• Novel application of Cognitive Work Analysis
• Potential bias in data collection and analysis
• Detecting theoretical saturation during data collection
• Retaining local meaning (emic) with abstraction
Future work

• Use CWA to study information handling in other settings

• Refine CWA as a method for comparing or evaluating clinical informatics interventions in context

• Possible research questions
  – How is cognition distributed in the “wilds” of primary care?
  – How do information structures constrain work practices?
  – What external factors limit local choices (myth of autonomy)?

• Fill in gaps in the framework
  – Cognitive work strategies
  – Organizational constraints
  – Individual constraints
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- David West
- Thomas Yackel
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“Information management is a means, not an end.”

Crandall, Klein, and Hoffman
Affordances of paper in field research