Cognitive Challenges in the Use of EHRs

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Premises

1. Most of the challenges associated with the use of EHRs are cognitive in nature

2. They involve cognitive processes, such as attention, memory (working memory and long-term memory), comprehension, problem-solving, and decision-making, which are essential and integral aspect of clinical practice

3. These challenges can have a negative impact on clinicians’ performance and can compromise the quality of care delivered to patients
Understanding What is Underneath
Examples of Cognitive Challenges

1. Challenges which have impact on clinicians’ working memory, attentional resources and decision-making abilities
   - Information overload
   - Documentation burden
   - Alert fatigue

2. Challenges which create cognitive barrier to accessing and using patient information effectively
   - Lack of standardization
   - Interoperability Issues
   - Data entry errors

3. Cognitive load is a significant issue in the use of EHRs, and has important implications for patient safety, physician burnout, and healthcare quality
Cognitive Load

1. A psychological concept that refers to the amount of mental effort and resources required to complete a task.

2. The psychological mechanism of cognitive load involves the limited capacity of the human cognitive system to process information, and when demands of the task exceed the limit

- **Intrinsic cognitive load**: Mental effort demanded by the task/information.
- **Extraneous cognitive load**: Effort imposed by the environment (distraction)
- **Germane cognitive load**: Effort needed to convert new information into stable long-term learning. (It contributes to learning with storage in long term memory)
Mitigate Cognitive Challenges

• **Reduce** extraneous cognitive load and **increase** germane cognitive load.
  – Strategies such as simplifying tasks and instructions, providing adequate training and feedback, and minimizing distractions

• Design and implementation of EHRs should have intuitive interfaces that are easy to navigate
  – Allow for breaks and offer features that make it easy to pick up where the clinician left off to reduce burnout
  – Use a socio-technical approach to consider clinicians’ needs and the specific workflows of healthcare organizations.
Progressive Stages of Investigations

- Individuals
- Controlled
- Paper-based Simulations Scenarios
- Naturalistic
- Clinical Teams
- Audio-recording, Observations Time-Motion
- Computational
- Augmentation
- Sensor-based technology Contextual Computing

In-Vitro  In-Vivo  Digital
Cognitive Models of Medical Reasoning

- Expert doctors who accurately and quickly diagnose the patient problem use a patient-specific data-driven heuristic strategy.
- Doctors who are less than experts use a mixture of data-driven & hypothesis-directed reasoning strategies (reflecting uncertainty and/or complexity).
- Such differences in directionality are generic for all knowledge-rich domains (e.g., chess, physics).


Heuristically-Driven Strategy

Acute Bacterial Endocarditis with Aortic Insufficiency

- Drug abuse
- Puncture wounds
- Transient Blindness
- Urinary Findings
- Fever, Chills
- Emboli
- Aortic Valve Endocarditis
- Aortic Insufficiency
- Shortness of Breath
  Diastolic Murmur
  Wide Pulse Pressure
- Acute Process
- Aortic Valve Endocarditis
- Normal Spleen
- Aortic Valve Endocarditis

Emboli

- Emboli
- Drug abuse
Use of Mixed Strategies Under Uncertain Conditions
Effect of an EHR System on Human Cognition

• Transition from paper records to EHR and back to paper record
• Impact on knowledge organization and reasoning
• Information and other technologies are not merely tools to expedite, facilitate and enable the execution of task

This is a 74 year old woman, whose diagnosis of diabetes was made in February, as she had complained of polyuria/nocturia and fatigue for a few years. She was told her sugar was very high and she was sent to Dr. K., who started her on Diabeta 5 mg/d and sent her to Dr. S. in ophthalmology who reported normal retina. She lost weight, her polyuria improved, her bladder urgency got better, and her glucose values improved dramatically. She does no monitoring at home. She had to be hospitalized for an ankle fracture after falling on ice, for 3 months. At follow-up, Dr. K. seemed pleased with the results.
CHIEF COMPLAINT: Type II diabetes mellitus

PERSONAL HISTORY
SURGICAL: cholecystectomy: Age 60 years old

MEDICAL: hypothyroidism: asymptomatic since 25 years

LIFE STYLE

MEDICATION
DIABETA (Tab 2.5 MG)
Sig: 1 tab(s) Oral before breakfast
SYNTHROID (Tab 0.125 MG)
Sig: 1 tab(s) Oral before breakfast

HABITS: smoking: 0 alcohol: 0
Diabetes type I  X age 4
Currently on N54 - N28
R6 - R2
Measure with OT
Glucose levels:
- <130 AM
- 130-180
- >180

Lunch
Supper
Bedtime

Last HbA1C since April 96: 7.4/7.2/6.7/6.6/8.9 - higher values in log book

Introductory History of a Patient’s Illness ....cont

After Using EHR

Paper-Based
# Information in EHR and Hand-Written Medical Records

<table>
<thead>
<tr>
<th>Category of Information</th>
<th>Hand-Written Patient Record</th>
<th>Computer-Based Patient Record</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Chief Complaint</td>
<td>10</td>
<td>28</td>
</tr>
<tr>
<td>2. Past Medical History</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>3. Lifestyle</td>
<td>33</td>
<td>19</td>
</tr>
<tr>
<td>4. Psychological Profile</td>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td>5. Family History</td>
<td>-</td>
<td>14</td>
</tr>
<tr>
<td>6. History of Present Illness</td>
<td>55</td>
<td>27</td>
</tr>
<tr>
<td>7. Review of Systems</td>
<td>52</td>
<td>8</td>
</tr>
<tr>
<td>8. Physical Examination</td>
<td>60</td>
<td>55</td>
</tr>
<tr>
<td>9. Diagnosis</td>
<td>14</td>
<td>9</td>
</tr>
<tr>
<td>10. Investigation</td>
<td>29</td>
<td>17</td>
</tr>
<tr>
<td>11. Treatment</td>
<td>21</td>
<td>24</td>
</tr>
<tr>
<td><strong>TOTAL ENTRIES</strong></td>
<td><strong>304</strong></td>
<td><strong>225</strong></td>
</tr>
</tbody>
</table>
Cognitive Challenges

• Increase in cognitive load on working memory during information processing. Challenge to:
  • Provide decision support at the level of knowledge representation
  • Provide and retain relevant link to additional information to avoid information loss
• Understand how doctors make patient-care decisions
  • Provide decision support at the point of care to support doctors’ clinical tasks
Knowledge Based Solution Strategies in Medical Reasoning

VIMLA L. PATEL AND GUY J. GROEN
McGill University

The techniques of propositional analysis are used to examine the protocols of seven cardiologists in a task involving the diagnosis of a case of acute bacterial endocarditis and an explanation of its underlying pathophysiology. It is shown that the explanations of physicians making an accurate diagnosis can be accounted for in terms of a model consisting of pure forward reasoning through a network of causal rules, actuated by relevant propositions embedded in the stimulus text. These rules appear to derive from the physician's underlying knowledge base rather than any information in the text itself. In contrast, subjects with inaccurate diagnoses tend to make use of a mixture of forward and backward reasoning, beginning with a high level hypothesis and proceeding in a top-down fashion to the propositions embedded in stimulus text, or to the generation of irrelevant rules.

First paper to show knowledge organization and its relationship to reasoning processes in Medicine, using some ideas from AI.

Two issues:
• Expert Performance
• Experience
Impact of EHRs on Diagnostic Reasoning

Paper Record

Patient Data → Multiple Hypotheses

Return to Paper Record

Patient Data → Hypotheses

Same as EHR!
Importance of Intermediate Construct

- Provides patient-centered cognitive support
  
  Act as a common ground for team-based, patient-oriented decision making

- Provides flexibility early in the decision process

- Reduces Cognitive load

- Facilitates better organization of knowledge in memory which dictates specific reasoning strategies for problem solving

- Minimizes errors and increases patient safety
The coming of age of artificial intelligence in medicine

Vimla L. Patel a,*, Edward H. Shortliffe a,b, Mario Stefanelli c, Peter Szolovits d, Michael R. Berthold e, Riccardo Bellazzi c, Ameen Abu-Hanna f
Clinical Cognition and AI

See: Patel, VL and Cohen, TA.

Clinical Cognition and AI: From Emulation to Symbiosis

Key Messages (1)

• The human mind is a powerful, resilient resource, and it has unique but limited cognitive capacity

• Knowledge organization and related reasoning change constantly with new knowledge and sophisticated technologies. These require adequate support for representing knowledge and thereby for facilitating decision support.
Key Messages (2)

• There will never be a perfect EHR, but we need to trade off various factors to mitigate more serious errors so as to provide not only efficient and effective but also safe patient care.

• We must train clinicians to develop adequate mental models about capacities of information systems, while also assuring that the systems are developed to be sensitive to users’ needs and cognitive capacity, thereby seeking to reduce serious cognitive errors.
THANK YOU

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