VIRTUAL PATIENT SIMULATION: A METHOD TO VALIDATE A THEORY OF MEDICAL DIAGNOSIS

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Outline

• Diagnosis
  • Development of a new model of diagnosis
  • Example/explanation of model

• Validating the model of diagnosis
  • Use of Decision Simulation software
    • Example of “classic” decision simulation scenario
  • Diagnosis-model simulation
    • Use of rules
      • Enhance fidelity of simulation
      • Measure situation awareness

• Wrap up
  • Questions/comments
In the beginning…

- Recognized deficiency in description of diagnosis
  - General model of diagnosis
A new model of diagnosis

- Used Work Domain Analysis (WDA) to analyze diagnosis training literature
  - WDA Analyzes where information comes from in the environment and how the information is useful to fulfilling the purpose of a particular domain’s work
- Resulted in a depiction/description of the diagnostic process
WDA model of diagnosis

Legend: General Model of Diagnosis

- Knowledge
  - Synthesis
    - Diagnostic hypothesis
- Clinical data

Clinical Purpose

MENTAL MODEL (i.e., DIAGNOSIS)

- Etiology (Explanation of disease; Cause)
  - Why did this person become ill?
- Anticipation of future patient state

Values and Priorities

- Pathophysiology (Change detection)
  - How did this person become ill?
- Severity of illness

Determines

- Generation of differential diagnoses
- Further investigation (Physical Resources)
- Treatment options
- Alternative disease models closely associated with patient model

Work Functions

- Pattern recognition
- Temporal synthesis
- Mental simulation
- Confirm/reject hypothesis

Technical Functions

- Signs:
  - Physical abnormalities, appearance, touch, smell, sound, and taste
- Vitals:
  - BP, HR, RR, Temp.
- Additional tests:
  - Imaging studies, blood counts, biopsy labs, additional tests

Disease Information:

- Disease descriptions, presentation information, etc.
- Patient care notes, known comorbidities, personal history, allergies

Historical evidence:

- Patient perceptions of abnormality, patient chief complaint, illness narrative

*Symptoms:

- Patient perceptions of abnormality, patient chief complaint, illness narrative

*Therapeutic trial:

- Physical procedures, medication

Physical Resources

- Patient appearance
- Physical Examination
- Examination tools
- Vitals monitor
- Medical literature
- Expert consultant
- Medical record
- Patient history
- Treatment
- Medical devices
- Medical techniques
- Drug administration equipment
WDA model of diagnosis: Essentials
Remainder of fellowship: Validation of WDA model of diagnosis

- **Method**
  - Virtual patient simulation using Decision Simulation software
  - Participants:
    - Medical students, residents, faculty participating in training sessions offered by NCPS

- **Assess strength of relationships between:**
  - Situation Awareness (SA)
  - Time to diagnose
  - Diagnostic Accuracy
  - Expertise
Remainder of fellowship: Validation of WDA model of diagnosis

- **Method**
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- **Assess strength of relationships between:**
  - Situation Awareness (SA) ➤ ➤ ➤ Hypotheses
  - Time to diagnose ➥ ➥ ➥
  - Diagnostic Accuracy ➤ ➤
  - Expertise ➤
Building the simulation scenario

- Developed a difficult diagnostic case to elicit differences between experts and novices
- Took a fundamental portion of the WDA model of diagnosis to act as the “spine” for the scenario
Decision Simulation Software

- Developed for education purposes
- Create stories for students to experience consequences of their decisions
  - Similar to powerpoint but with choices
- Keeps track of:
  - Nodes participants visited in scenario
  - Time spent at each node
  - Time spent in the scenario
You'll experience a "Day in the Life" as a Resident, Dr. Lindsey Edwards, at a Medical Center. You will receive instructions from and interact with your Chief Resident and others, provide care for a patient, and experience the consequences of your decisions.

 Resident: Dr. Lindsey Edwards (That's You!)
Decision Simulation Example

Author View

Participant/”In scenario” view

Diagnostic Tests

Having completed the history and physical exam, you are ready to order laboratory studies and tests to investigate why Mr. Hernandez has not improved despite antibiotics.

You: (Thinking to yourself) Ah, the benefits of the computerized physician order entry (CPOE). Now, let’s just see...

Select the best answer.
- Chest X-Ray, CBC, metabolic panel, and MRI
- Chest X-Ray, CT Scan, and Pulmonary Function Tests (PFT’s)
- Chest X-Ray, CT Scan, CBC, and Ultrasound
- Ultrasound, Metabolic Panel, MRI, and Coagulation Profile
Decision Simulation Example

Author View

Participant/”In scenario” view

Interruption

Bobbie Rose: (Interrupting) Lindsey, I just admitted a G.I. bleeder next door. Can you draw a new type and cross? Apparently, the Blood Bank did not receive the specimen that the ER sent. We have got to get going, busy day . . .

Your next step. Select the best answer.
- Begin the thoracentesis under supervision
- Cancel the procedure
- Re-start the time-out
- Complete the time-out from where you left off on the checklist
Wrong-Side Thoracentesis

You: (After anesthetizing the left side and inserting thoracentesis needle) That's odd. No fluid. I suspected plenty.

Ritchie Hernandez: (Coughing, and trying to catch his breath) Doc, that hurts quite a bit when I take a breath.

You: (Talking to yourself) Wait a minute... Let's take a look at that chest X-ray.

Tony Patton: Doc, looks like your site mark is kind of covered by the drape over there on the patient's right side.

Ritchie Hernandez: (Coughing and trying to catch his breath)
Decision Simulation Example

Author View

Participant/”In scenario” view

Re-start Time-Out

You: Sorry about that. Sir, could you re-state your name and date of birth?
You: Let’s review the medical images.
Validating WDA model of diagnosis with Decision Simulation

- Slightly different approach to node map development
  - Developed to explore process of diagnosis
  - Not developed for educational purposes
WDA model of diagnosis node map
Decision Simulation: WDA model of diagnosis node map

Sources of Information

Please select from the sources of information. Once you have collected enough information to make a diagnosis, select “Make Diagnosis” and type your diagnosis in the space provided.

Keep in mind, the patient’s condition may deteriorate throughout the scenario, and each source of information can be selected multiple times!
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- Physical exam
- Patient record
- Lab/image
- Medical literature
- Patient History (speak with the patient)
- Vitals
- Make Diagnosis
WDA Decision Simulation Example

Author View

Participant/”In scenario” view

VITALS

Go back (Back to sources of information)
Sources of Information

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Rules within simulation

• Enhance fidelity
  • Adds a sense of time to the scenario
    • Patient will continually deteriorate as scenario unfolds

• Important to implement SA queries
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- Medical literature
- Patient History (speak with the patient)
- Vitals
- Make Diagnosis
Rules: Time Example – T1

Author View

Participant/”In scenario” view
Rules: Time Example – T2

Author View

Participant/”In scenario” view

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- Patient record
- Lab/image
- Medical literature
- Patient History (speak with the patient)
- Vitals
- Make Diagnosis
Rules: Time Example – T2

Author View

Participant/"In scenario" view

Vitals

HR 130 90
SpO2 98 94
NBP 153/95 (94)
Pulse 50
awRR 30 8
Tperi 91.9 78.6

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Go back (Back to sources of information)
Situation Awareness Queries

- Situation Awareness General Assessment Technique (SAGAT)
  - Freeze simulation scenario
  - Query participants on details of scenario including:
    - Information they have collected
    - Their comprehension of this information/situation
    - Where they anticipate this situation is headed in the near future

- Use of rules are vital to implement this technique!
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- Vitals
- Make Diagnosis
Rules: SA Queries Example

Author View

Participant/”In scenario” view

Situation Awareness Query 1/6

Explain "FREEZE!"

Based on your understanding of this patient, write a brief SOAP note or give a brief report about the status of this patient.

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Submit
Rules: SA Queries Example

Author View

Participant/”In scenario” view

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- Patient record
- Lab/image
- Medical literature
- Patient History (speak with the patient)
- Vitals
- Make Diagnosis
Post-diagnosis information collection

• Participants record diagnosis & anticipated treatment plan
• Complete a 10 question survey inquiring about their experience with diagnosis
• Debrief
  • Tell them the actual diagnosis of the case
  • Provide information regarding this study
Currently…

- Finishing up the details of the simulation scenario
- Pilot testing

- Fingers-crossed
  - Data collection will start in July
Questions / Comments?

- Development of a new model of diagnosis
- Validating the model of diagnosis
  - Use of Decision Simulation software
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