Introduction to Diagnostic Reasoning: Part One

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How do Doctors Think?
Goals

1) Become familiar with the dual process model of clinical reasoning
2) Begin to think about how to incorporate specific discussion of clinical reasoning into clinical teaching
Agenda

• Part One
  – Why is this important?
  – Dual Process Model of Clinical Reasoning

• Part Two
  – Clinical Reasoning at the Bedside
Why is this important?

• We need to understand clinical reasoning to teach it well
• It provides a structure upon which we can base our teaching
• It’s easier to remediate if we understand the process
Agenda

• Part One
  – Why is this important?
  – Dual Process Model of Clinical Reasoning

• Part Two
  – Clinical Reasoning at the Bedside
Types of Clinical Thought

• Pattern Recognition (Type I process)
• Analytical Thinking (Type II process)
  – Bayesian analysis
  – Algorithmic thinking
  – Hypothetico-deductive reasoning
  – Checklists (worse case scenario)
  – Metacognitive techniques
Context
Ambient conditions
Task difficulty
Task ambiguity
Affective state
Modular responsivity

Pattern Recognition
Repetition

Pattern Processor

RECOGNIZED

TYPE 1 processes

Rational override
Dysrationalia override

Calibration

Diagnosis

Intellectual ability
Education
Training
Critical thinking
Logical competence
Rationality
Feedback

TYPE 2 processes

NOT RECOGNIZED

Patient Presentation

RECOGNIZED

TYPE 1 processes

Rational override
Dysrationalia override

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Type I Process

• Pattern recognition
  – Basis for much clinical thought
  – Depends on the recognition of the significance of a few salient features of the presentation
  – “Aunt Minnie”
What is this?
• A 55 year-old woman with a history of congenital bicuspid aortic stenosis presents with fever and fatigue two weeks after having dental work.

• A 22 year-old man presents with a six-day history of shaking chills and rigors that began on his return trip from the Congo where he had been volunteering with an NGO in a rural area.

• A 72 year-old man presents with fatigue, low-grade fever and headaches as well jaw pain while chewing.
How does it work?

• Heuristics
  – Mental shortcuts/rules of thumb
  – Used every day (clinically and non-clinically)
Common Heuristics

• Availability
• Representativeness
Good things about Type I

• Fast
• Effortless
• Low cost
• Automatic
Problems with Type I process

- Prone to errors/unreliable
- Highly subject to affective state
- Dependent on heuristics
- Dependent on experience
- Not all patterns are recognizable
Problems with Type I process

- Prone to errors/unreliable
- Highly subject to affective state
- Dependent on heuristics
- Dependent on experience
- Not all patterns are recognizable
• A 65 year-old man who is otherwise healthy presents with a non-healing ulcerated nodule on his index finger two weeks after pruning his roses.

• A 65 year-old man presents with headache and fatigue. He has also noticed hot showers cause generalized itchiness without a rash.

• A 69 year old man from Maine presents with fever, fatigue and a pulmonary infiltrate. He has recently returned from a bike trip through the Central Valley of California.
Problems with Type I process

- Prone to errors/unreliable
- Highly subject to affective state
- Dependent on heuristics
- Dependent on experience
- Not all patterns are recognizable
Pattern Recognition

• Fast, effortless, low cost, often right
• Often wrong, subject to affective error
Types of Clinical Thought

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  - Metacognitive techniques
Bayesian Analysis

- Set threshold for treating or discounting diagnosis
- Establish a pretest probability
- Expose the patient to a test with specific characteristics
- Determine the post-test probability
- Compare the post-test probability to the thresholds for action
Bayesian Analysis

- Set thresholds
- Set pre-test probability
- Use test
- Set post-test probability
- Compare post-test probability and thresholds

- Set thresholds
  - Pulmonary embolism
    - Threshold to treat 80%
    - Threshold to discount diagnosis 2%
Bayesian Analysis

- Set thresholds
- Set pre-test probability
- Use test
- Set post-test probability
- Compare post-test probability and thresholds

- Set thresholds
  - Treat > 80%; Stop < 2%
- Set pre-test probability
  - PIOPED
    - Low probability 10%
    - Moderate probability 30%
    - High probability 80%
Bayesian Analysis

- Set thresholds
- Set pre-test probability
- Use test
- Set post-test probability
- Compare post-test probability and thresholds

- Set thresholds
  - Treat > 80%; Stop < 2%
- Set pre-test probability
  - Low probability (10%)
- Use test
  - D-dimer
    - LR+ 2
    - LR- 0.14
Set post-test probability

Negative test

Positive test
Bayesian Analysis

- Set thresholds
- Set pre-test probability
- Use test
- Set post-test probability
- Compare post-test probability and thresholds

- Set thresholds
  - Treat >80%; Stop <2%
- Set pre-test probability
  - Low probability (10%)
- Use test
- Set post-test probability
  - Negative test <2%
  - Positive test ~20%
Bayesian Analysis

• Compare post-test probability and thresholds

• Set thresholds
  – Treat > 80%; Stop < 2%

• Set post-test probability
  – Negative test < 2%

The diagnosis of PE is sufficiently unlikely that the diagnosis can be safely discounted.
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VTE Diagnostic Algorithm

1. Complete Predict PE Probability score (Wells rule)

2. PE Unlikely
   - Decision Rule Score ≤ 4
     - Normal D-Dimer Result (D-Dimer < 200 ng/mL)
       - Out of VTE Diagnostic algorithm
         - Continue diagnostic evaluation as appropriate
     - Abnormal D-Dimer Result (D-Dimer ≥ 200 ng/mL)
       - D-Dimer Test
       - Chest CT Indicated
         - CT Positive PE Confirmed
         - CT Negative
   - PE Likely
     - Decision Rule Score > 4
     - Chest CT Indicated
       - CT Positive PE Confirmed
       - CT Negative
     - Lower extremity Doppler
       - LE Doppler Positive
         - DVT Confirmed
       - LE Doppler Negative
         - If high clinical suspicion consider testing as appropriate:
           - VO scan, PA gram, or LE DVT
           - Ultrasound chest follow up

3. Treatment
   - AS APPROPRIATE
     - [See DVT/PE Weight Based Heparin Order Set]
     - [Enoxaparin DVT/PE Anticoagulant Order Set]

References:
- PCCMNET (2010-2010:286-2337-27)
- SMB 106-572-320-5
- ACOEMM M W 2004 140-588-6522
- EBM 2002-5823 530-09
Types of Clinical Thought

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Hypothetico-Deductive Reasoning

• Consider the elements of a presentation that support and refute a specific diagnosis

• Stepwise Process
  – Hypothesis Generation
  – Hypotheses Refinement
  – Diagnostic Testing
  – Causal Reasoning
  – Diagnostic Verification
Types of Clinical Thought

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Checklists

• Explicitly consider the worst possible diagnosis
  – All cellulitis is necrotizing fasciitis/DVT
  – All chest pain is one of the “Serious Six”
    • ACS, dissection, pericarditis/tamponade, PE, pneumothorax, esophageal rupture
Checklists

• SAFER
  – Serious diagnoses
  – Alternative diagnoses
  – Feelings affecting thinking
  – Extraneous data…is it really extraneous?
  – Reasons why this happened
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Metacognitive techniques

• Thinking about your thinking and your feelings
Types of Clinical Thought

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  – Metacognitive techniques
Analytical Reasoning

• High cost, slow, effort dependent
• Reliable
Intellectual ability
Education
Training
Critical thinking
Logical competence
Rationality
Feedback

Patient Presentation
Pattern Processor
NOT RECOGNIZED

TYPE 2 processes

Calibration
Diagnosis
Context
Ambient conditions
Task difficulty
Task ambiguity
Affective state

Intellectual ability
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Pattern Recognition

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RECOGNIZED

TYPE 1
processes

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TYPE 2
processes

Repetition
A Quiz

(Eight seconds per question; write down your answers)
A bat and a ball cost $1.10 in total. The bat costs $1.00 more than the ball.

How much does the ball cost?
If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets?
In a lake, there is a patch of lily pads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half the lake?
Now we’ll go back and you can check your answers.

Take as much time as you like.

Do not change any of your original answers, but write down whether you now think your original answer is correct.
A bat and a ball cost $1.10 in total. The bat costs $1.00 more than the ball.

How much does the ball cost?
If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets?
In a lake, there is a patch of lily pads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half the lake?
Correct answers:

- 5 cents
- 5 days
- 47 days
### Table 1
CRT Scores, by Location

<table>
<thead>
<tr>
<th>Locations at which data were collected</th>
<th>Mean CRT score</th>
<th>&quot;Low&quot;</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>&quot;High&quot;</th>
<th>N =</th>
</tr>
</thead>
<tbody>
<tr>
<td>Massachusetts Institute of Technology</td>
<td>2.18</td>
<td>7%</td>
<td>16%</td>
<td>30%</td>
<td>48%</td>
<td>61</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Princeton University</td>
<td>1.63</td>
<td>18%</td>
<td>27%</td>
<td>28%</td>
<td>26%</td>
<td>121</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boston fireworks display(^a)</td>
<td>1.53</td>
<td>24%</td>
<td>24%</td>
<td>26%</td>
<td>26%</td>
<td>195</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carnegie Mellon University</td>
<td>1.51</td>
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<td>25%</td>
<td>25%</td>
<td>25%</td>
<td>746</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Harvard University(^b)</td>
<td>1.43</td>
<td>20%</td>
<td>37%</td>
<td>24%</td>
<td>20%</td>
<td>51</td>
<td></td>
<td></td>
</tr>
<tr>
<td>University of Michigan: Ann Arbor</td>
<td>1.18</td>
<td>31%</td>
<td>33%</td>
<td>23%</td>
<td>14%</td>
<td>1267</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Web-based studies(^c)</td>
<td>1.10</td>
<td>39%</td>
<td>25%</td>
<td>22%</td>
<td>13%</td>
<td>525</td>
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</tr>
<tr>
<td>Bowling Green University</td>
<td>0.87</td>
<td>50%</td>
<td>25%</td>
<td>13%</td>
<td>12%</td>
<td>52</td>
<td></td>
<td></td>
</tr>
<tr>
<td>University of Michigan: Dearborn</td>
<td>0.83</td>
<td>51%</td>
<td>22%</td>
<td>21%</td>
<td>6%</td>
<td>154</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Michigan State University</td>
<td>0.79</td>
<td>49%</td>
<td>29%</td>
<td>16%</td>
<td>6%</td>
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<td></td>
</tr>
<tr>
<td>University of Toledo</td>
<td>0.57</td>
<td>64%</td>
<td>21%</td>
<td>10%</td>
<td>5%</td>
<td>138</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Overall</strong></td>
<td>1.24</td>
<td>33%</td>
<td>28%</td>
<td>23%</td>
<td>17%</td>
<td>3428</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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Why is this useful to think about?

• Helps structure thinking about our thinking
• Helps structure thinking about our teachers’ thinking
So how does this all play out at the bedside?
Clinical Reasoning in Action

• Stepwise Process
  – Hypothesis Generation
  – Hypotheses Refinement
  – Diagnostic Testing
  – Causal Reasoning
  – Diagnostic Verification
Goals

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