The WHAT, WHY and HOW of Developing Clinical Reasoning

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#MedEd
Disclosures

- I have no conflicts of interest to disclose

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- The content reflects the my views and does not necessarily represent the views of VUSM, the AMA or other participants in this Initiative, or the Kern Institute/NTN.
Objectives:

1) Describe the scope and cognitive processes involved in expert clinical reasoning

2) Compare and Contrast Strategies for Diagnostic and Therapeutic Clinical Reasoning

3) Describe the rationale for Adaptive Expertise in Medicine

4) Develop individual action plans to incorporate one new strategy to improve clinical reasoning teaching
Overview

1) Clinical Reasoning Scope & Definitions

2) Diagnostic Reasoning

3) Therapeutic Reasoning

4) Adaptive Expertise

5) Strategies to Improve Clinical Reasoning
Learner’s View of Clinical Reasoning...

"I think you should be more explicit here in step two."

by Sidney Harris
“Notwithstanding the many publications on clinical reasoning, there still exists no clear consensus regarding what clinical reasoning entails, let alone how it might best be taught and assessed, as well as the research and practice implications therein.”

Durning et al. (2013) Acad Med
What words to describe clinical reasoning?
Clinical Reasoning:

- “Educators agree that clinical reasoning is a central component of physician competence”

- “One of the core tasks assigned to clinical teachers is to enable students to sort through a cluster of features presented by a patient and accurately assign a diagnostic label, with the development of an appropriate treatment strategy being the end goal.”

- Synonyms:
  - Problem-solving
  - Decision-making
  - Cognitive Reasoning
  - Clinical Diagnostic Reasoning
  - Judgment
Clinical Reasoning

Diagnostic Reasoning
Diagnostic Reasoning Skills

“It is every doctor’s measure of his own abilities; it is the most important ingredient in his professional self-image.”

(Nuland SB. How We Die: Reflection on Life’s Final Chapter, 1994)
Overview

1) Clinical Reasoning Scope & Definitions
2) Diagnostic Reasoning
3) Therapeutic Reasoning
4) Adaptive Expertise
5) Strategies to Improve Clinical Reasoning
Diagostic Reasoning:

- Graber’s steps involved:
  - Perception
  - Hypothesis generation
  - Data interpretation
  - Verification
  

- Eva’s steps involved:
  - Careful observation
  - Historical information
  - Physical exam
  - Hypothesis generation
  - Data comparison
  - Confirm/Disconfirm hypothesis

Physicians essentially use 2 modes of thinking:

- **Non-Analytical Thinking — System 1:**
  - Clinician has seen the problem before
  - Fast (<10 sec), automatic, largely accurate

- **Analytical Thinking — System 2:**
  - Clinician is puzzled or can’t find the pattern
  - Slower and more conscious process

Diagnostic Reasoning

Deliberate

System 2: Analytical

Metacognition

Conscious

Quirk, M 2006; Croskerry 2003
Analytical Reasoning
Analytical Reasoning

- 2 yo male who isn’t gaining weight
- He “just doesn’t feel like doing anything”
- He has crossed 3 percentile lines (now <5%)
### Causes of fever of unknown origin in children

<table>
<thead>
<tr>
<th>Infectious disease</th>
<th>Collagen vascular disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bacterial</td>
<td>Juvenile idiopathic arthritis</td>
</tr>
<tr>
<td>Bartonella henselae</td>
<td>Polyarteritis nodosa</td>
</tr>
<tr>
<td>Brucellosis</td>
<td>Systemic lupus erythematosus</td>
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<tr>
<td>Leptospirosis</td>
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<tr>
<td>Liver abscess</td>
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<td>Malaria (chronic)</td>
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<td>Osteomyelitis</td>
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<td>Pelvic abscess</td>
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<td>Perinephric abscess</td>
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<td>Pyelonephritis</td>
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<td>Salmonellosis</td>
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<td>Sinusitis</td>
<td></td>
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<tr>
<td>Subdiaphragmatic abscess</td>
<td></td>
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<tr>
<td>Tuberculosis</td>
<td></td>
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<tr>
<td>Tularemia</td>
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</tbody>
</table>

**Viral**

- Adenovirus
- Arboviruses
- Cytomegalovirus
- Hepatitis viruses
- Enteroviruses
- Epstein-Barr virus (infectious mononucleosis)

**Chlamydial**

- Lymphogranuloma venereum
- Psittacosis

**Rickettsial**

- Q fever
- Rocky Mountain spotted fever

**Fungal**

- Blastomycosis (nonpulmonary)
- Histoplasmosis (disseminated)

**Parasitic**

- Malaria
- Toxoplasmosis
- Visceral larva migrans

**Unclassified**

- Sarcoidosis

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*Original table modified for this publication. Lorin NS, Feigin RD. Fever without localizing signs and fever of unknown origin. In: Textbook of Pediatric Infectious Disease, 4th ed, Feigin RD, Cherry JD (Eds), WB Saunders, Philadelphia 1999. Table used with the permission of Elsevier Inc, All rights reserved.*
Diagnostic Reasoning:

**Analytical** Strategies for decision-making:
- Hypothetico-deductive method
- Bayesian analysis
- Rule out worst-case scenario (ROWS)

Croskerry, P. (2002) *Acad Emerg Med*
Diagnostic Reasoning:

Figure 1.3  (a) The clinical reasoning process (adapted from Barrows and Tamblyn, 1980). (b) Analysis of the hypothetico-deductive reasoning model.

Diagnostic Reasoning: Different Strategies

Hypothetico-deductive method:

- Most widely studied method of clinical decision-making

  “the formulation, from the earliest clues about the patient, of a ‘short list’ of potential diagnoses or actions, followed by the performance of those clinical (history and physical) and paraclinical (e.g. laboratory, x-ray) maneuvers that will best reduce the length of the list.”

Figure 2. Cognitive influences on Top-down and Bottom-up processing in clinical decision making.

Bayesian Analysis:

“With Bayes’ theorem, the clinician can calculate the posterior probability of a disease by knowing the following:

- The prior probability of the disease
- The probability of a test result conditional upon the patient’s having the disease (PPV)
- The probability of the test result conditional upon the patient’s not having the disease (NPV)

Can be calculated using odds or Likelihood ratios and the Fagan nomogram

Diagnostic Reasoning

System 1: Non-analytical
- Intuition
- Rapid

System 2: Analytical
- Delegation
- Metacognition

Quirk, M 2006; Croskerry 2003
Diagnostic Reasoning:

What is this object?
What disease does this child have?
Diagnostic Reasoning:

Non-Analytical Strategies for decision-making:

- Algorithmic
- Pattern Recognition
- Heuristics

Croskerry, P. (2002) *Acad Emerg Med*
Diagnostic Reasoning: Different Strategies

Pattern Recognition:

- Use of the combination of “salient features “of a case presentation to quickly and immediately generate hypotheses

- “Doorway Diagnosis”

Diagnostic Reasoning: Different Strategies

Heuristics:
- “rules learned on the job”
- “rules of thumb”
- “shortcuts in problem-solving and clinical decision-making, which, for the majority of cases, work well.”
- Example—Occam’s Razor

Diagnostic Reasoning: Cognitive Biases

- **Availability**—“involves judging the probability of an event on the basis of readily recalled similar events.”

- **Representativeness**—“leads to looking for prototypical manifestations of a disease.”

- **Confirmation Bias**—“leads doctor to gather and interpret evidence that confirms an initial diagnosis rather than searching and considering evidence that refutes it, even when the latter is more definitive.”

- **Anchoring**—“doctor remains fixed on first impression of the case, and fails in adjusting hypotheses in light of new data.”

- **Premature Closure**—“occurs when a diagnosis is accepted before it is fully verified.”

Overconfidence – “lead to decisions based on incomplete information or hunches.”

Outcome bias – “tendency to opt for a diagnosis that will lead to good outcomes rather than those associated with bad outcomes.”

Value Bias – “tendency of people to express a stronger likelihood for what they hope will (or will not) happen rather than what they believe will happen.”

Diagnostic Reasoning:

- Perception: Availability, Representativeness, Value Bias
- Hypothesis Generation: Availability, Representativeness, Anchoring
- Data Interpretation: Confirmation Bias, Anchoring, Outcome Bias
- Verification: Confirmation Bias, Premature Closure, Overconfidence, Outcome Bias
Patient Presents → Case Representation → Hypotheses Tested

Non-analytic ← Interactive → Analytic
Non-Analytical and Analytical Diagnostic Reasoning

- 3 yo male with history of asthma presents with wheezing and respiratory distress
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5) Strategies to Improve Clinical Reasoning
Clinical Reasoning

Diagnostic Reasoning

Therapeutic Reasoning
Figure 1 A hypothetical model of therapeutic reasoning.

"It has been argued that much of an experienced practitioner’s daily practice has less to do with solving problems than with remembering solutions."

Regehr & Mylopoulos (2008) *JCEHP*
Gap between What is Known and What We Do

- 2001 IOM report “Crossing the Quality Chasm” described the chasm/gap between medical advances and medical care currently being provided.

- Study of over 400 quality indicators in 6700 patients from dozen metropolitan areas:
  - 45% are not receiving “recommended” care

- Average time lag of 17 years to translate discovery into clinical practice

Modern healthcare environment is rapidly changing

Pull up your socks: Prepare for rapidly changing healthcare environment

Managing Rapid Change In the Health Care Environment

Wrenching transformation in many forms is starting to be felt in many parts of the system. Here are ways to help resistant employees get on board.

Scott Guerin, PhD

Rapid Changes in American Family Life: Consequences for Child Health and Pediatric Practice

AUTHORS: Barbara H. Fiese, PhD,* Holly G. Rhodes, PhD,* and William R. Boardman, MD*
Continually changing practice context

- Changing patient demographics
- Changing expectations of society/patients/profession
- Increasing rates of chronic disease
- New Diseases/Re-emergence of “old” diseases
- Shifting standards of care and practice guidelines
- Improving health information technology
- Skyrocketing costs
- Advances in medical science → Expanding knowledge base

Jennett & Swanson (1994) *J Cont Ed in Health Prof*
The physician's conundrum: Too much information, too little time

July 25, 2013 | Denise Basow, MD - Vice President/General Manager and Editor-in-Chief, UpToDate

Too much information - how do doctors keep up?
Too Much Information: The Doctor’s Data Dilemma

By 2020, doctors will face 200x the amount of medical data and facts that a human could possibly process.¹

And it will get worse... The volume of medical data doubles every five years.²

81% of physicians can’t even spare 5 hours per month to keep up.²
Ideally, decisions guided by evidence-based medicine

- Gold standard—Randomized Control Trial
- Evaluation of efficacy of a given treatment
- Consideration of Risks/Side Effects
- Comparison to different therapies

Avoid anecdotal reports of therapeutic efficacy and risk

What We Do

Routine Expertise

What is Known

What is Known

Solutions to Novel Challenges

But also…
Overview

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Need for Adaptive Expertise

Routine Expertise

But also...

Adaptive Expertise

“They are complementary, equally necessary forms of expert activity”


Sep 20, 2017

THE IRISH TIMES

Fri, Oct 13, 2017

Obesity: A public health crisis
“The imperative for developing adaptive expertise in health professions education is growing as the workplace increasingly causes clinicians to confront new challenges.”

Any Movie Fans?

“We’ve never lost an American in space and we’re sure as hell not gonna lose one on my watch!

Failure is not an option.”

Gene Kranz, Apollo 13

We have to make this fit into the hole made for this using nothing but this
ADAPTIVE Expertise

- Expertise to function efficiently on everyday tasks
- Expertise to create solutions for workplace challenges

Skills of adaptive expertise used when an individual

- Recognizes that a “routine” approach will not work
  - Reframes the problem in a way that allows her
    - To explore new concepts (learning)
    - To invent new solutions (innovation)
ADAPTIVE Expertise

What is it?

“product of a learned skill set, characterized by habits of mind that develop over time and with practice”

Characterized by:

- Better developed metacognitive skills
- Flexibility
- Ability to innovate
- Continuous learning
- Seeking out challenges
- Creativity

Hatano & Inagaki (1986) *Child Development and Education in Japan*
Schwartz & Bransford (1998) *Cogn Instru*
Carbondell et al. (2014) *Educ Res Rev*
Mylopoulos & Woods (2017) *Med Ed*
Adaptive Expertise with Individual Patients

- Acute Otitis Media—What antibiotic to use for a patient family traveling without (no refrigeration)?
- Home Bipap for child without power
- Social workers are GOLD
Adaptive Expertise within a Panel of Patients or Clinical Unit

Central Line Bundle

- Every central line insertion should be done adhering to the central line bundle.
- Checklists have been shown to improve outcomes.

Central Line Insertion Care Team Checklist

- Before the procedure, did the protocol list.
- Circumferential access
- Gloved superiors, if needed (gloves above navel of abdominal area)
- Remove or circumferential
- Place tubing/guidewire immediately prior to puncturing
- Use multilayer protection
  - Standardized: Forensic shields, Cap, mask, sterile gown and gloves
  - Accession: Cap, mask (at risk for exposure, use sterile gown and gloves)
- Pre-op, proper preparation for insertion (need to anticipate)
- Sterile procedure: Avoid puncturing
- Allow area to be dry; if necessary, rub roller ball stasis with sterile prep (time before 10 min)
- Use sterile technique, to ensure sterile from head to toe
- Use local anesthetic, after dilation (PCD, predator in ultrasonic box)
- During the procedure, did the protocol list
- Maintain a sterile field
- Monitor that lines were not cut unnecessarily
- Clamp any groin not used during insertion (to avoid an embolism, keep at bedside post)
- Clinically qualified sound protocol
  - Allow inflow/no backflush after 3 unsuccessful attempts (except if emergent
    PCD or cipro)
  - Instruct from each lumen (to avoid an embolism and ensure infusate placement)
- After the procedure, add the protocol
  - Close blood/vascular access from site using sterile wear and apply clean dressing
  - Verify placement by x-ray

Make sure Central line Guide filled out and in chart, sticker placed

- Signature
- Additional comments:

http://www.pedagogy-inc.com/PedagogyInc/media/ClassMedia/TPN/infected-subclavian.png

http://slideplayer.com/slide/5841270/19/images/1/Central+Line+Bundle+Every+central+line+insertion+should+be+done+adhering+to+the+central+line+bundle.jpg
Adaptive Expertise with the Larger Population or Society

OPIOID ABUSE
BY THE NUMBERS

OPIOIDS INCLUDE:
Oxycodone, hydrocodone, codeine, morphine, fentanyl and heroin

From 2000 to 2015, more than half a million people died from drug overdoses.

91 AMERICANS die every day from an opioid overdose.

SOURCE: CENTERS FOR DISEASE CONTROL AND PREVENTION
In a survey of U.S. physicians, more than half reported experiencing at least one symptom of burnout—a substantial increase over previous years—indicating that burnout among physicians is becoming a national health crisis, according to a Health Affairs blog. Leadership is needed to address the root causes of the problem and to reposition the health care workforce for the future, the authors contend.
ADAPTIVE Expertise

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- Expertise to create solutions for workplace challenges

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5) Strategies to Improve Clinical Reasoning
Knowledge Base → Data Gathering → Data Interpretation → Diagnosis & Treatment
Errors—Knowledge Deficiency

- On my 3rd year Pediatric Clerkship
- 2 yo male admitted for work-up of fever
- I take him to examine him in the treatment room to examine his ears
- He started to seize

IDEA
Knowledge Base → Data Gathering → Data Interpretation → Diagnosis & Treatment

ERROR
My 2\textsuperscript{nd} year of Pediatric residency working in the PICU

Toddler admitted for respiratory failure

Needed sedation to keep him calm on the ventilator

I wrote an order for Fentanyl infusion
Errors—Faulty Management Planning

- **My INTENDED order**
  - Fentanyl 1mcg/kg/hr for a 13kg patient

- **My ACTUAL order**
  - Fentanyl 13mcg/kg/hr for a 13kg patient

- Hypotension developed
Knowledge Base → Data Gathering → Data Interpretation → Diagnosis & Treatment

ERROR

Stress, Fatigue, Emotions
How to Improve Clinical Reasoning and Avoid Errors?
Knowledge Base

Data Gathering

Data Interpretation

Diagnosis & Treatment

ERROR

Deficient Knowledge Base

Faulty Data Gathering

Faulty Data Processing

Faulty Metacognition
# Strategies for Improving Clinical Reasoning

**Table 1.** Proposed strategies to improve clinical reasoning

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<tr>
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<td></td>
<td>SNAPPS</td>
<td>Reflection</td>
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</table>

Curr Probl Pediatr Adolesc Health Care, October 2013
What are Illness Scripts?

- Breaking down the way physicians approach clinical reasoning to a very basic level

- The patient who “read the book”

- The way expert physicians STORE information related to disease presentation

Bowen (2006) NEJM
27 yo female
Admitted for acute abdominal pain
Has associated anorexia
Initial pain peri-umbilical, now localized in RLQ
Has rebound tenderness and pain over McBurney’s point

Appendicitis
Illness Scripts

- Expert clinicians store and recall knowledge as diseases, conditions or syndromes – “illness scripts” – that are connected to problem representations.

- These representations trigger clinical memory permitting the related knowledge to become accessible for reasoning.

- Knowledge recalled as illness scripts has a predictable structure:
  1) The predisposing conditions
  2) The pathophysiological insult
  3) The clinical consequences

Judith Bowen, NEJM 2006
<table>
<thead>
<tr>
<th>Predisposing Condition:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Who gets it &amp; why?</td>
</tr>
<tr>
<td>- What epidemiologic factors influence the probability that a patient is at risk for disease (age, gender, PMHx, environmental influences)?</td>
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<table>
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<th>Pathophysiological insult:</th>
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<tr>
<td>- What causes it?</td>
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<tr>
<td>- What are the major pathophysiologic insults that contribute to the disease state?</td>
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<table>
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<th>Clinical Consequences:</th>
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<tbody>
<tr>
<td>- What are the distinguishing features &amp; the progression of the disease?</td>
</tr>
<tr>
<td>- What are the signs and symptoms that may results from the predisposing conditions or pathophysiologic insult?</td>
</tr>
</tbody>
</table>
### Acute Appendicitis

**Predisposing conditions** – Who gets it & why?
- No clear predisposing factors
- All ages (unusual in the very young)

**Pathophysiological insult** – What causes it?
- Fecalith
- Ischemia of appendix wall
- Local inflammation / blockage
- Possible rupture / peritonitis

**Clinical consequences:**
- Severe acute abdominal pain periumbilical moving to McBurney’s point
- Nausea, Vomiting, Anorexia
- Fever, possible sepsis
- Peritoneal signs, Surgical abdomen

### Acute Gastroenteritis

**Predisposing conditions** – Who gets it & why?
- Overseas travel
- Sick contacts
- Eating at Jack in the Box

**Pathophysiological insult** – What causes it?
- Effacement of intestinal villi
- Bacterial/viral invasion
- Local inflammation

**Clinical Consequences:**
- Mild, diffuse abdominal pain
- Nausea, vomiting, anorexia, diarrhea
- Fever (plus/minus)
# Strategies for Improving Clinical Reasoning

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Problem Representation

- The “one-liner” that summarizes the specific case in abstract terms

- Physicians restructure pertinent patient details into abstract terms called **semantic qualifiers**

- Links stored knowledge with the current clinical case (illness scripts)

Bowen (2006) *NEJM*
Bordage (1999) *Acad Med*
What are Semantic Qualifiers?

- Adjectives which impart deeper understanding of signs and symptoms
  - Abstractions that turn *lay* terminology into *medical* terminology

- Exist in divergent paired descriptions which facilitate comparing and contrasting diagnoses

- Provide a framework to search for the diagnosis using ‘Illness scripts’
<table>
<thead>
<tr>
<th>What medical descriptors apply to the given patient?</th>
<th>Examples of Semantic Qualifiers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute</td>
<td>Chronic</td>
</tr>
<tr>
<td>Severe</td>
<td>Mild</td>
</tr>
<tr>
<td>Localized</td>
<td>Diffuse</td>
</tr>
<tr>
<td>Previously healthy</td>
<td>Significant PMHx</td>
</tr>
<tr>
<td>Right-sided</td>
<td>Left-sided</td>
</tr>
<tr>
<td>Sharp</td>
<td>Dull</td>
</tr>
</tbody>
</table>
Patient Description

- Johnny is a 12 yo white male who presents with the chief complaint of pain in his R knee. The pain started 3 weeks ago. He plays basketball and runs track at school but doesn’t remember injuring the knee. The pain increases with running and jumping. The pain is annoying but not overwhelming and is described as 4-5/10. Pt has mild tenderness and mild swelling over tibia of affected leg.
Johnny is a 12 yo white male who presents with the chief complaint of pain in his R knee. The pain started 3 weeks ago. He plays basketball and runs track at school but doesn’t remember injuring the knee. The pain increases with running and jumping. The pain is annoying but not overwhelming and is described as 4-5/10. Pt has mild tenderness and mild swelling over tibia of affected leg.
Semantic Qualifiers

1- Onset   3 weeks   Subacute
2- Site    R. knee   Extremity
3- Course  No injuries  Atraumatic
4- Severity 4-5/10 pain  Mild
5- Context Worse with...  Activity
6- Pt char. Johnny, 12yo  Adolescent male
Problem Representation with Semantic Qualifiers

“Pt is an adolescent male with a subacute onset of atraumatic mild lower extremity pain, which is exacerbated by activity.”
# Strategies for Improving Clinical Reasoning

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*Curr Probl Pediatr Adolesc Health Care, October 2013*
Knowledge Base
- Availability
- Representativeness
- Value Bias

Data Gathering
- Availability
- Representativeness
- Anchoring

Data Interpretation
- Confirmation Bias
- Anchoring
- Outcome Bias

Diagnosis & Treatment
- Confirmation Bias
- Premature Closure
- Overconfidence
- Outcome Bias
1. What is Clinical Reasoning?
- "encompasses the mental processes and behaviors that are shared (or evolve) between the patient, physician, and the environment (i.e., practice setting)."

2. What is Diagnostic Reasoning?
- Portion of clinical reasoning focused on correctly identifying the etiology of the patient problem/complain
- Susceptible to errors/need for development at multiple stages

3. What is Therapeutic Reasoning?
- Based on the correctly identifying the etiology of the patient problem/complain
- Selection of an appropriate treatment plan to address the patient problem/complaint

4. What is Adaptive Expertise?
- Routine Expertise—Efficient application of known solutions
- Adaptive Expertise—New Learning & Innovation to Solve Novel Challenges

5. What Strategies can Improve Clinical Reasoning?
- Must address the area(s) of struggle for the learner
- Can focus on:
  - Deficient Knowledge Base
  - Faulty Data Gathering
  - Faulty Data Processing
  - Faulty Metacognition
- Can include strategies such as:
  - Illness Scripts
  - Problem Representation
  - Semantic Qualifiers
Take Home

What was most meaningful for you in the last hour?

What is ONE idea or strategy that you WILL try in the next 48 hours?
Questions

Email Bill.Cutrer@Vanderbilt.Edu