Anatomy of Diagnostic Errors

F011 - Approach to Improving Diagnosis
August 6, 202, 1:00 to 3:00 PM

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Director of Dermatopathology
Director of Pigmented Lesion Clinic
Department of dermatology and Cutaneous Biology
Thomas Jefferson University
I have no financial conflict to disclose
Objectives

• Summarize the classification of diagnostic errors
• Identify the cognitive processes and their pitfalls involved in clinical reasoning
• Evaluate the recommended strategies to minimize diagnostic errors
## Terms & Definitions

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<th>Cognitive biases</th>
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Representativeness heuristic

• **Heuristics**: mental shortcuts or strategies to quick decisions

• **Representativeness heuristic**: judgments based on applying seemingly similar situation to the new situation (eg: choosing diagnosis based on how well the case matches previously encountered diseases)

• **Availability heuristic**: judgments about the probability of events by the ease with which examples come to mind
Cognitive Biases

• Definition: Systematic error that recurs predictably in particular circumstances

• Over 185 cognitive biases have been described
Cognitive Biases

- **Diagnostic momentum**: biased by diagnosis or diagnostic suggestions by other physicians
- **Confirmation bias**: searches and interprets information and data to suit the initial impression
- **Search satisficing**: stopping the search once an abnormality is found
- **Premature closure**: diagnosis rendered before all information are obtained
Cognitive Biases

• Anchoring: anchors the diagnosis on initial information too early in the diagnostic process, failing to adjust or adjust sufficiently in light of later information

• Sunk-cost effect: pursuance of an earlier diagnosis despite later information not supporting it because there was much investment in the initial diagnosis

• Illusory correlation: two events believed to be related, when, in reality, they are not (“true & true” but unrelated)

• Overconfidence: overestimate how much we know and how reliably we know it
1999 The Birth of Patient Safety Movement

- 98,000 hospital deaths/yr
- Preventable medical errors
- Faulty systems and processes
  - adverse drug events
  - wrong-site surgery
  - mistaken patient identities
Medical error—the third leading cause of death in the US

Martin A Makary professor, Michael Daniel research fellow

Department of Surgery, Johns Hopkins University School of Medicine, Baltimore, MD 21287, USA

- 98,000 hospital deaths/year
- 251,454 hospital deaths/year

Makary MA, Daniel M. Medical error-the third leading cause of death in the US. BMJ. 2016;353.
Adverse effects medical treatment

- 5,200 deaths/year*
- Contributes ≈108,000 deaths/year

*1990—2016: 123,603 deaths
Medical Errors

Most of the research and emphasis have focused on reducing system-based errors by improving:

- communication (e.g. handoffs)
- coordination of care
- work flows, pathways, and processes
Diagnostic error: the hidden epidemic

Mark Graber, 2011

Represents an enormous unmeasured source of preventable mortality, morbidity, and cost.
Efforts to minimize system-based errors

- “Time out” prior to surgery
- 2 patient identifiers
- Medication reconciliation
- 80-hour work rule for residents
Where Medical Errors May Occur

**Assessment**
- history & physical
- diagnostic tests: biopsies, lab tests, imaging, etc.
- diagnosis

**Intervention**
- procedural
- medication

**Administrative**
- follow-up
- medical record
- billing
Diagnostic Errors

- Diagnostic errors reflect the complex interplay of system-based and cognitive factors with multiple root causes.

- The science of measuring diagnostic errors and their harms is at its infancy.

- Physicians often do not have personal insight into diagnostic errors.

Diagnostic Errors

• ~40,000 to 80,000 US hospital deaths result from misdiagnosis annually


Ali S Saber Tehrani,1 HeeWon Lee,2 Simon C Mathews,2 Andrew Shore,3 Martin A Makary,3 Peter J Pronovost,4 David E Newman-Toker1

Diagnostic Error

- $38.8 billion payout (1986 – 2010)
- ~50% result is serious harm (death or permanent injury)
- Largest proportion of closed claims (~30%)
- Largest proportion of the payments (~35%)
- Outpatient diagnostic errors > Inpatient diagnostic errors

Table 1  Distribution of malpractice allegations and payments by primary allegation group (1986–2010)

<table>
<thead>
<tr>
<th>Malpractice allegation group</th>
<th>n  (%)</th>
<th>Mean, US$</th>
<th>Median, US$</th>
<th>Malpractice payments in US$ millions (%)</th>
<th>SD in US$ millions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagnosis related</td>
<td>100249 (28.6)</td>
<td>386849</td>
<td>213250</td>
<td>38781 (35.2)</td>
<td>0.56</td>
</tr>
<tr>
<td>Treatment related</td>
<td>95635 (27.2)</td>
<td>196960</td>
<td>58805</td>
<td>18836 (17.1)</td>
<td>0.42</td>
</tr>
<tr>
<td>Surgery related</td>
<td>84980 (24.2)</td>
<td>280257</td>
<td>135935</td>
<td>23816 (21.6)</td>
<td>0.47</td>
</tr>
<tr>
<td>Obstetrics related</td>
<td>22951 (6.5)</td>
<td>651670</td>
<td>343245</td>
<td>14956 (13.6)</td>
<td>1.10</td>
</tr>
<tr>
<td>Medication related</td>
<td>18697 (5.3)</td>
<td>257333</td>
<td>92085</td>
<td>4811 (4.4)</td>
<td>0.63</td>
</tr>
<tr>
<td>Anesthesia related</td>
<td>10525 (3)</td>
<td>419126</td>
<td>168705</td>
<td>4411 (4.0)</td>
<td>0.86</td>
</tr>
<tr>
<td>Monitoring related</td>
<td>7101 (2)</td>
<td>354131</td>
<td>149663</td>
<td>2514 (2.3)</td>
<td>0.77</td>
</tr>
<tr>
<td>Other miscellaneous</td>
<td>6929 (2)</td>
<td>176781</td>
<td>44708</td>
<td>1224 (1.1)</td>
<td>0.45</td>
</tr>
<tr>
<td>Equipment/product related</td>
<td>1872 (0.5)</td>
<td>128204</td>
<td>35718</td>
<td>239 (0.2)</td>
<td>0.28</td>
</tr>
<tr>
<td>Intravenous and blood-products related</td>
<td>1080 (0.3)</td>
<td>294011</td>
<td>127165</td>
<td>317 (0.3)</td>
<td>0.55</td>
</tr>
<tr>
<td>Behavioural health related</td>
<td>687 (0.1)</td>
<td>212494</td>
<td>65550</td>
<td>145 (0.1)</td>
<td>0.45</td>
</tr>
<tr>
<td>Total</td>
<td>350706 (100)</td>
<td>313813</td>
<td>133250</td>
<td>110055 (100)</td>
<td>0.59</td>
</tr>
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“Diagnostic errors persist throughout all settings of care and continue to harm an unacceptable number of patients”

“Improving the diagnostic process is not only possible, but also represents a moral, professional, and public health imperative.”
2015: Improving Diagnosis in Health Care

Definition of Diagnostic Error

“the failure to (a) establish an accurate and timely explanation of the patient’s health problem(s) or (b) communicate that explanation to the patient.”

Diagnostic Errors

- Diagnostic error: 10-20% of the medical errors
  - 10%-15%: emergency medicine, internal medicine
  - <5%: radiology and pathology (perceptual specialty)
- Dermatology?

Diagnostic Errors in Dermatology

- What are the most common diagnostic errors in dermatology ("Top 10" diagnostic errors)
- What is the financial cost?
- What is the magnitude of the harm?
Classification of Diagnostic Error

1. No-fault error
2. Knowledge deficit ~25%
3. Affective influence
4. Cognitive Error ~75%
Sources of Diagnostic Error

1. No-fault error
   - Correct diagnosis is not expected:
     - extremely rare atypical presentation
     - patient-related error (deceptive patient)
     - system-related error (e.g., wrong bx report entered into the patient’s EMR)

2. Knowledge deficit

3. Affective influence

4. Cognitive Bias
Classification of Diagnostic Error

1. No-fault error
2. Knowledge deficit
   - novice clinician > experienced clinician
   - minimal contribution to diagnostic error (???)
3. Affective influence
4. Cognitive Error
Classification of Diagnostic Error

1. No-fault error
2. Knowledge deficit
3. Affective influence
4. Cognitive Error
# Affective influences

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<th>Endogenous Disorders</th>
<th>Situational Induced</th>
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<td>• Sleep deprivation</td>
<td>• Mood variation</td>
<td>• Fundamental</td>
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<td>• Mood disorders</td>
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Affective influence

• Fundamental attribution error
  • explaining someone’s behavior based on internal factors (personality and disposition) rather than situational factors
    • negative stereotyping (blame the patient)
    • positive stereotyping

• Countertransference error
  • Disagreeable feelings toward certain type of patients or disease
Affective influence

• Fundamental attribution error
  • explaining someone’s behavior based on internal factors (personality and disposition) rather than situational factors
    • negative stereotyping
    • positive stereotyping

• Countertransference error
  • Disagreeable feelings toward certain type of patients or disease
Affective influence

• Fundamental attribution error (correspondence error)
  • explaining someone’s behavior based on internal factors (personality and disposition) rather than situational factors
    • negative stereotyping
    • positive stereotyping

• Countertransference error
  • Disagreeable feelings toward certain type of patients or disease

May result in cursory assessment leading to misdiagnosis and inappropriate management of the patient
Classification of Diagnostic Error

1. No-fault error
2. Knowledge deficit
3. Affective influence
4. Cognitive Error

25%  75%
### Sources of Cognitive Errors

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# Dual Process Model of Reasoning

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<tr>
<th>System I (Fast)</th>
<th>System II (Slow)</th>
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<tbody>
<tr>
<td>Pattern recognition</td>
<td>Linear analysis</td>
</tr>
<tr>
<td>Differential recognition</td>
<td>Hypothetical-deductive</td>
</tr>
<tr>
<td>Stereotyping</td>
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<tr>
<td>Intuition</td>
<td></td>
</tr>
<tr>
<td>Heuristics</td>
<td></td>
</tr>
<tr>
<td>Acquired through clinical experience</td>
<td>Generate differential diagnosis</td>
</tr>
<tr>
<td></td>
<td>Gather information to validate</td>
</tr>
<tr>
<td>Unconscious &amp; rapid</td>
<td>Conscious &amp; slow</td>
</tr>
<tr>
<td>Low cognitive load</td>
<td>High cognitive load</td>
</tr>
<tr>
<td>Reliance by expert clinician</td>
<td>Reliance by novice clinician</td>
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System I

- unconscious
- effortless
- fast thinking ("mental shotgun")
- automatic function of associative memory that cannot be turned off
- responsible for the daily routine decisions
System I

- Pattern recognition
- Impressions
- Gut feeling
- Intuition
- Snap judgment

- Experience is the basis of accuracy
System II

- conscious deliberate reasoning (hypothetical-deductive reasoning)
- provides the checks and balances for System I
- effortful
- slow thinking
- utilizes more energy: glucose
System II

• System II is a careful evaluative process often taught to medical students and residents
  • Taking History
  • Prioritize the key clinical findings
  • Generate a list of differential diagnosis
System II

- System II is a careful linear analytical process
  - Taking History
  - Prioritize the key clinical findings
  - Generate a list of differential diagnosis

- Building of library of *illness scripts* takes place in System II

- With further experience, the clinician transitions to System I mode of diagnosis
Dual Mode of Clinical Reasoning

• Repeated use of System II leads to a more automated cognitive process (System I)

• Both systems can interact and/or override each other, but System II usually oversees System I

• System I (fast thinking) is widely believed to be the source of diagnostic errors
Given that

✓ System I (fast thinking) not perfect
✓ System II (slow thinking) is too time consuming

Which system should be chosen in any given situation?
How do we make decisions under conditions of uncertainty?

We gravitate toward System I mode of cognition.
System I
Cognitive Processes

Heuristics

- Mental shortcuts or strategies to quick decisions
Cognitive Strategies Involved in Heuristics

- Use past experience in new and unfamiliar situations to guide decisions
- Substitute a hard question with an easier one
- Focusing on one aspect of a complex problem, usually those that are familiar while ignoring others
Question

• Is this stock a winner?

• Will this candidate be a hard-working resident?

Substitute Question

• How cool is the name of the stock?

• Does the candidate have history of success in athletic endeavor?
System I Cognitive Process

**Heuristics**

- Mental shortcuts or strategies to quick decision
- Heuristics are subject to cognitive biases and can MISLEAD
System I

It is vulnerable to ERRORS

- suppresses ambiguity and doubt
- tendency to ignore logic and statistics
- COST of quick decisions is ACCURACY
System I
Heuristics

**Pros**
- They are accurate and work most of the time
- Efficient mental strategies to deal with uncertain and ambiguous world
- Operate at subconscious or unconscious level

**Cons**
- “Discourages” circumspection
- Encourages overconfidence
- Subject to systemic and predictable errors
### Sources of Cognitive Errors

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**Generation of diagnostic hypotheses**

First Impression

**Influences hypotheses refinement and final diagnosis**
Representativeness heuristic

- System I automatically presents a mental representation of seemingly similar situation to the new situation.

- Choosing diagnosis based on how well the case matches previously encountered diseases (prototype/exemplar/illness scripts).
Representativeness Heuristic

- **Base-rate neglect** is a common trap
- Be grounded in accurate base-rate/prevalence of diseases to predict accurate probability
- Think like a statistician to minimize pitfalls of representativeness heuristic
Availability (Familiarity) Heuristic

- Judgments about the probability of events by the ease with which examples come to mind
- Choosing diagnosis that are easily retrievable ("what is fresh or familiar in your mind")
  - example: subspecialists tend to over diagnose diseases in their specialty
Availability Heuristic

• Alternative diagnoses are not considered
• For novices, “zebras” are overdiagnosed and “horses” are underdiagnosed
• For experts, “horses” are overdiagnosed and “zebras” are underdiagnosed
• Subspecialists tend to over diagnose diseases in their specialty
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Diagnostic momentum: biased by diagnosis or diagnostic suggestions by other physicians

Minimize by framing the problem by yourself
Confirmation Bias

- Confirmation bias: searches and interprets information and data to suit the initial impression

- We selectively look for information that fits with our preexisting expectations…at the same time we *ignore* or *dismiss* information that contradict these expectations
Overconfidence

- General human trait
- Overconfidence is endemic in medicine
Overconfidence

Survey of academic physicians:
  94% rate themselves in the top half of their profession

Survey about driving:
  99% rate themselves above average
Overconfidence

- General human trait
- Overconfidence is endemic in medicine
- System I promotes overconfidence
- Discourages circumspection
- Contributes to premature closure bias
- Confidence is valued in medical profession
How to minimize diagnostic errors

1. System-based intervention
2. Implement strategies to avoid the predictable cognitive biases
3. Increase knowledge and work toward expertise
# How to minimize diagnostic errors

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<th>System-level</th>
<th>Individual level</th>
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<tr>
<td>Optimize patient volume</td>
<td>Minimize stress, fatigue, and sleep deprivation</td>
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<tr>
<td>Obtain second opinion</td>
<td>Increase knowledge</td>
</tr>
<tr>
<td>Use computer assisted diagnostic systems-e.g. Uptodate, VisualDx</td>
<td>Seek feedback and recalibrate</td>
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“Debias” yourself
Seek feedback and recalibrate

• Part and parcel of *Deliberate Practice* strategy

• There needs to be a conscious effort to obtain and receive feedback

• There are more opportunities to receive feedback and recalibrate in dermatology

• The feedback should be for both *correct* and *incorrect* diagnoses
Debiasing Strategies

- Metacognition
- Reflective Practice
- Deliberate Practice
- Thinking about our thinking
- Cognitive Autopsy
Change in Culture Needed

• There is no culture of feedback of diagnostic performance
• Discourages transparency and disclosure of diagnostic errors
Debiasing Strategies

1. Frame the problem yourself (stay objective)
2. Test hypothesis against data generated
3. Be aware of base rates of diseases
4. Diagnostic time out, especially when stakes are high and you are CONFIDENT! (OVERCONFIDENT)
Do the strategies work?

- Can we consciously control automatic thought processes that are subconscious or unconscious?

- Experts believe that some of the predictable errors can be avoided.

- Effectiveness of these *cognitive forcing strategies* have not been studied.
Conclusions

1. Diagnostic errors result from both system-related and cognitive factors

2. Cognitive factors underlie majority of the diagnostic errors

3. Cognitive forcing strategies have may decrease some of the known predictable errors

4. **Experience** is the best defense against diagnostic errors
“The only source of knowledge is experience”

Albert Einstein
The Thinker
Rodin Museum, Philadelphia