Diagnostic heuristics and their dangers
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Diagnostic error myth:
Errors are rare

• Medicine is an art of uncertainty
  – **Diagnostic error**: Diagnosis that is unintentionally delayed, wrong, or missed as judged from the eventual appreciation of more definitive information

• **Diagnostic errors are common, not rare!**
  – 10-15% error rate in initial diagnosis cited overall across specialties
Diagnostic error rate

- Autopsy series over decades: 10-15% error rates
- Institute of medicine (IOM) ‘To err is human’ Report: 13% diagnostic error rate
- Systematic review of 21 publications showed about 8/50 (16%) cancer diagnoses missed or delayed by a diagnostic error

- Compare this with the chances of dying in flight:
  - 1 in 2 million
- Air traffic accident rate 0.23% (2014 stats)

Diagnostic error rate in visual fields

- Interestingly, this rate lower among specialties of pathology and radiology (2-5% error rate)
- Implication: Visual reliance improves diagnosis
- Dermatology relies heavily on the visual for diagnosis
- What is the diagnostic error rates in dermatology?

Diagnostic errors in derm

- Studies of patient safety and diagnostic error rate in dermatology lag behind inpatient fields of medicine. [Cao, 2010]
- Some examples of areas being studied for misdiagnosed:
  - Cellulitis. [Weng, 2016]
  - Skin cancers and melanoma NNT study. [Hansen, 2009: Wilson, 2012]
  - Spitz nevi misdiagnosed as melanomas [Orchard, 1997]
  - Keratoacanthomas. [Rank, 1979]
  - Kaposi’s sarcoma in dark skin [Van Bogeart, 2012]
  - Study of benign cyst misdiagnosis for malignant
  - Lyme disease in non-endemic areas. [Grau, 2002]
  - Tinea barbae diagnosed as bacterial infection. [Roman, 2001]
The consensus of the literature on diagnostic error:

• Diagnostic error rates remain unacceptably high
• It is rarely a lack of knowledge causing error
• Most errors (>75%) are cognitive and result from flawed thinking via the application of one or more cognitive bias
• There are many steps at which errors can be made

Understanding cognitive underpinnings of diagnostic error

- Faulty knowledge
  - Knowledge gaps, inexperience
- Faulty data gathering
- Faulty information processing
  - Faulty pattern recognition
  - Misuse or misinterpretation of info
  - Inaccurate estimates of probability, prevalence, evidence strength
  - Cognitive bias
- Faulty verification
Outline: Cognitive error in dermatologic diagnoses

• Diagnostic reasoning
• Diagnostic heuristics
  – Classic heuristics
  – Dermatology heuristics
• Other sources of cognitive error
• Visual intelligence and its sources of error
• Improving our diagnoses
The Dual Process Theory as predominant working model of decision-making:

• Nobel laureate Herbert A Simon described:
  – **Bounded rationality**: rational decisions are limited by the available info, tractability of problem, cognitive limitations and time available to make decision
  – **Satisficing**: where people seek solutions or accept choices or judgments that are "good enough" for their purposes, but could be optimized
Dual approach of diagnostic reasoning

System 1
Fast Thinking
Intuitive/heuristic
Automatic
Effortless
Relies on pattern recognition

System 2
Slow Thinking
Analytical/ Reflective
Systematic/ Deliberate
Effortful
Decontextualized

System 1 characteristics:

- Intuitive
- Experience based
- Heuristic
- Gestalt/ gut/ instinct
- Pattern recognition
- Unconscious/ passive
- Low effort/ easy
- Habits (unthinking choices)
- Cognitive ‘miser’

We delegate simpler tasks to system 1

This can only be done well by someone with mastery or expertise
System 2 characteristics:

Analytical
Deductive
Unbounded rationality
Normative reasoning
Logical, critical decisions
Deliberate
Purposeful
Multiple branching

Atypical, complex, rare, esoteric case
Not pathognomonic
The only approach of the novice
We first learn with system 2 and with experience, use more system 1.

Examples of Reflexive activities:
- Reading EKGs
- Riding bike
- Driving car
- Playing instrument
- Dermoscopy
- Scanning nevi and SKs
When system 2 is not the best approach:

• If you don’t know what you are looking for, there is a good chance you won’t find it no matter how hard you look.

• Thoroughness for the sake of thoroughness as an initial data-gathering strategy is suboptimal and an indicator of diagnostic uncertainty.

[Bordage, 1999]
Cognitive continuum theory

• No dichotomy but a continuum between intuitive and analytical approach

• More pathognomonic, less uncertainty -> use more system 1

• and vice versa
System 1: Heuristics

- A mental shortcut that eases cognitive load of decision making
- Employs a practical method not guaranteed to be optimal or perfect
- Like a rule of thumb, an educated guess, an intuitive judgment, stereotyping, profiling or “common sense”.
- In a blink, fast thinking, Gestalt-using, pattern recognition and illness scripts

Classic heuristics in medicine

• Anchoring heuristic
• Availability heuristic
• Representativeness heuristic
• Affect heuristic
• Confirmation bias
• Contagion heuristic
• Effort heuristic
• Groupthink or blind obedience bias
• Fluency heuristic
• Gaze heuristic
• Peak-end rule
• Recognition heuristic
• Scarcity heuristic
• Similarity heuristic
• Simulation heuristic
• Social proof
• Halo effect
Anchoring heuristic/bias

• Touted as the most common source of diagnostic error in medicine
• Also called “premature closure”
• A failure to continue considering reasonable alternatives after a primary diagnosis is reached
• A tendency to rely heavily on first information obtained
• When the diagnosis is made, the thinking stops
• Tendency to look for, notice, remember information that fits your expectation, rather than look for disconfirming evidence to refute it, despite that it may be more persuasive or definitive

• “What screws us up most in life is the picture in our head of how it is supposed to be”

Socrates
Availability heuristic

• When judgments are made based on the ease with which examples come to mind, rather than what is most probable.

• “If you don’t find it often, you often don’t find it”

• The ‘one track mind’ clinician

Base rate neglect / Bias

• Related to availability and frequency heuristics
• Ignoring statistical information in favor of irrelevant information, that one incorrectly believes to be relevant, to make a judgment
• This usually stems from the irrational belief that statistics don’t apply to a situation, when in fact they do

Bx c/w SKs
Framing effect / heuristic

• The source and where the patient is seen, influences the way the patient is thought about.

Do you see sheep or people?

Framing heuristic and Illusory correlation

• There appears to be a universal human tendency to contextualize information, mostly in an effort to imbue meaning but also, to conserve cognitive energy

• Tendency to perceive two events as causally related, when in fact the connection is coincidental or non-existent

Examples:
- Homeopathy
- Tagamet for warts
- Placebo effect
Representativeness heuristic

- Judging a situation based on how similar the prospects are to the prototypes the person holds in his or her mind.
- Stereotyping
- Stereotypes are often correct (which is why they are used), except when they are not!
The diagnostic heuristics of dermatology

• 1 Primary lesion
• 2 morphology/shape
• 3 Location
• 4 Distribution
• 5 Pattern
• 6 Color
• 7 Feel/texture
• 8 Context
Perceptual filters

- No two people see things the same way
- We observe, notice and gather information differently and perceive that info differently
- Our perceptual filters allow us sometimes to treat assumptions as facts
- We are not limited by what we see, but by our focus

[Herman, 2016]
Myside bias/ wishful seeing/ tunnel vision bias

- “Our eyes are far too good for us. They show us so much that we can’t take it all in, so we shut out most of the world, and try to look at things briskly and as efficiently as possible.”

How we use our eyes
by James Elkins
Vision is a construct of your mind

- Construction is the essence of vision
- Everything you experience by sight is your construct
Perceptual filters in the diagnosis of one of a kind disease

- We see the same patients through different eyes
- No two patient cases are exactly the same
- There is no such thing as the same acne, melanoma, psoriasis, etc
- “To treat them otherwise is to deceive them and ourselves.”

Jumping to conclusions is an example of:

• Visual blindness
• “What you see is all that there is” thinking
• It’s a shortcut!

“Shortcuts are very pragmatic, but when you take them, you miss alot along the way: that’s what shortcuts are for.”

In-attentional blindness

- AKA Refrigerator blindness
  Hiding in plain sight
  Seeing the forest for the trees

- We do not process the majority of the stimuli our brains exposed to

- Brain decides what’s important,

- Brain automatically filters out background info in effort to concentrate, remove distraction
How can we improve our diagnoses?

It is possible to train the mind to make better decisions.

We can change our habits.

System 2 trained system 1 and can continue to control it.

**Metacognition**

The cognitive autopsy

*Errando discimus*

(to be taught by one’s own mistakes)
Heuristics are like cars with blind spots: Every car has its blind spots

- “Diagnostic errors fall in our blind spots- we tend to ignore them”
  
  Graber, 2005

- To drive safely you need to spend time behind the wheel, to become aware

- The same applies with visual diagnostic blind spots
Reducing blind spots

Diagnostic time-outs
  data without framing

Systematic approach to common problems
  ie ddx for papulosquamous disease

Prepare for worst case scenario
  remember zebras
  ie necrotizing fasciitis

Ask why this happened? What can’t be explained

Think probabilities: Bayesian theory and Base rate and Pre/post test probabilities

Avoid premature closure
Know when to be wary of System one:
If presentation is not classic
If all findings are not all agreeing
With high risk patients (HIV, transplant)
With common medico-legal risks

It’s not paranoia if they are out to get you!

Questions to ask yourself to avoid cognitive errors in diagnosis:

• Does something not fit?
• What are the traps here?
• What else can it be?
• Listen to your gut: Is this a case that makes you uncomfortable and you need to slow down? **Allow intuitive system 1 guide you back to system 2**
Reduce cognitive load

• Focus less on fact more on how to find and apply knowledge
• Simplify diagnostic/treatment protocols
• Clinical decision rules: practice guideline, BLS, ACLS, PALS, DRESS scoring system
• Diagnostic /prognostic criteria ie. Scarlett fever, Microscopic polyangiitis, dermoscopy of melanocytic dysplasia, SCORTEN
• Develop formal decision making tools to improve reasoning ie. Moh’s AUC criteria / app, ASA for cardioprophylaxis app
• Memory aids, nemonics
Other helpful tips to improve diagnosis

• Consider whether data is relevant rather than just salient
• Ask questions that will disprove rather than confirm your current hypothesis
• Be aware of where knowledge in case or general is limited
• Make a habit of seeking opinion of colleagues
Avoiding cognitive errors when using diagnostic heuristics

- Visual limitations to diagnosis
  - Where you focus
  - Jumping to conclusions
  - In-attentional blindness

- Limited fund of knowledge/examples:
  - You can’t find what you don’t know exists
  - Low prevalence-rare zebras
Embrace zebras
(the rare diagnoses)

You may not be seeing them,
But they are seeing you!
Zebras: Infrequent diagnoses
The Unexpected diagnosis: swimming against the tide analogy

• **Zen riddle**: If you never change direction, how can you tell there is a current?

• "**Those who travel with the current will always feel they are good swimmers; those who swim against the current may never realize they are better swimmers than they imagine.**"

• Diagnosing zebras is like swimming against the current: it's hard and requires skill and experience
Nurture your humility:

• Mindset: learn when you don’t have to
  – Just b/c I do something for a long time does not mean I am good at it
  – Be a better doctor tomorrow than I am today

• Read a lot
• Active reading
• Deliberate practice
• Get feedback
Avoid overconfidence: Remember that you are wrong more often than you think

• An example of how to improve diagnostics and get feedback:
  – Write ddx on every specimen, photograph lesions, and do my own CPC/cognitive autopsy when I get path back
  – A form of continued education
  – Get feedback on your diagnostic accuracy
Emotional bias

• Acknowledge how patient makes you feel:
• The annoying, difficult patient, psych disease, dementia
• Distraction, lack of focus
  – Door knob breathing
Sleep deprivation and fatigue increase diagnostic error rate five fold

Landrigan et al. NEJOM 2004;351:1838-1848.
“Genius diagnosticians make great stories, but they don’t make great health care. The idea is to make accuracy reliable, not heroic.”

Don Berwick, Boston Globe, 2002

What does it take to be a great diagnostician? People want to be heroes, but that is not what the system needs.
The future and what we need to improve diagnostic accuracy

• Make error visible for early detection and recovery
• Encourage reporting to identify system flaws
• Take the lead from high risk industries like flying, construction
  – Design with risk in mind
  – High reliability design, standardized, simplified, automatic
  – Anticipate system failure and provide backup plans
The heuristic controversy

- Orthodox medical decision theorists have historically emphasized scientific rigor (system 2)
- Prevailing perception that there is no scientific worth without quantification and stats
- System 1 has taken blame for many dx error
- Cognitive psychology studies of dual processing show that experts are as likely to commit errors using system 2 as system 1 (heuristics)
- Diagnostic errors are not simply a consequence of cognitive biases or over-reliance on one kind of thinking. They result from both analytical and non-analytical reasoning
In conclusion

• Goal: to enlighten (how we err) and motivate (how we may improve) more than to educate
• Diagnostic reasoning is prone to error
• Understand the cognitive underpinnings of diagnostic error
• Heuristics are important for efficient care, occur automatically, save effort and time and are in broad daily use
• Heuristics are not always optimal and may cause bias
• We tolerate ambiguity in medical decision making, but need to continuously work to optimize choices, minimize error
• Recognizing these strengths and risks is the first step to making better diagnoses
• Reflective reasoning and metacognition
• Interventions to reduce error remain speculative; there is no fail-safe approach