

Diagnostic Error

Human Expertise and Cognitive Biases

Diagnostic Error

- A recent article by Abraham Verghese looked a self-reported diagnostic error Verghese et al. *J. Med.* December 2015;128:1322-1324
- Inadequate physical exam (failure to examine) caused 2/3 of the errors, 1/10 was misinterpretation of an exam finding
- The errors caused missed/delayed Dx, increased cost, unnecessary exposure to radiation/medications, and in 1/25 cases, complications
- **Of note:** It took an average of 5 days to discover the error (range 1-66 days) and the number of physicians making the same error in diagnosis was 1 to more than 6, median 3, with treatment choices governed most often by key individuals or familiar colleagues rather than data see Also: O'Donoghue "What influences your therapeutic choices?" *Medscape* Jan 4, 2016
- **As a way of beginning:** What are the take home messages of this article?

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- **Six Sources for more information:**
- Nikhil Mull, James Reilly and Jennifer Myers "An elderly woman with 'heart failure': Cognitive biases and diagnostic error" *Cleveland Clinic Journal of Medicine* 82:745-753 (November 2015)
- HOW PHYSICIANS THINK Jerome Groppman Houghton and Miffin 2007
- THINKING, FAST AND SLOW Daniel Kahneman, Farrar, Straus and Giroux New York 2009
- BLINK: THE POWER OF THINKING WITHOUT THINKING Malcolm Gladwell, Little, Brown and Company New York 2005
- Norman, Monteiro, Sherbino et al *Academic Medicine* 92:1 23-30 (January 2017)
- Brush, Sherbino and Norman "How Expert Clinicians Intuitively Recognize a Medical Diagnosis" *The American Journal of Medicine* (2017) 130, 629-634

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- Both Kahneman and Gladwell agree with a model of human thought...
- Two "Systems" we use to reach a conclusion
- **System 1** operates automatically and quickly with little or no effort and no sense of voluntary control, based on associations between new information and memories of like things, related to the strength of the association
- **System 2** is effortful mental activity, associated with the subjective experience of choice and concentration, often used in complex computations, uncertain situations that force us to think deeply, and is considered "rational" and laborious, consistent with logical rules
- All of us believe we use System 2 [when necessary] to make important decisions, when in fact we use System 1 and usually avoid using System 2

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- But before discussing System 1 or System 2...
- ...there is **Inductive** or **Deductive Reasoning**
 - Which is better?
 - Which is based on facts?

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- Overlying all of what we will say next is the idea of **how data is applied to reach a conclusion**
- **Sherlock Holmes [Arthur Conan Doyle]** is said to have used Deductive Reasoning, when in fact he used both Inductive and Deductive Reasoning
- **Inductive Reasoning**: A logical process by which a conclusion is proposed that contains more information than the **observations or experience** on which it is based
- "Every crow ever seen was black. Therefore, all crows are black"
- Notice that the fact of the observations of crows is not in doubt, only the method of reaching a conclusion... that all crows are *necessarily* black
- A white crow is possible with more observations, but "the odds are low" ...the **zebra verses the horse** argument in medicine... "when you hear hoof beats, think of a horse not a zebra"

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- **Deductive Reasoning:** A logical process by which a conclusion is drawn from a set of premises the contains no more information than the premises taken collectively
- *The truth of the conclusion depends only on the method to reach the conclusion*
- "All dogs are animals. This is a dog. Therefore this is an animal."
- In this example, the definitions of the words "animal" and "dog" are not in doubt, they are "self contained," self defined to include the other...our "facts" are that good

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- **Inductive or Deductive Reasoning...and Diagnosis/Treatment in Medicine**
- Do we wait until all possible observations are made (e.g. all crows are observed and all of them are in fact black)
- Or do we "apply the art of medicine" and wait until our experience satisfies our uncertainty "enough" to proceed?
- **Now: Back to System 1 And 2**

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- **Very importantly: The debate among authorities is...**
- Do **errors** arise (1) from mistakes *generated* by System 1 and *not corrected* by System 2 (Kahneman) or (2) from both Systems
- **But the most persistent fallacy** in the common literature and teaching of residents is that Type I processes are the reason for all bad thinking and Type II processes necessarily lead to corrective (or correct) responses
- Good/Bad thinking is far too simplistic and not helpful

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- Experience and Expertise create the basis of System 1
- Some skills are acquired quickly and easily, such as a hot stove, the meaning of simple sentences and words, and easily understood facial expressions (disgust or anger)
- Other skills take practice and learning (knowledge), such as nuanced social situations, strong chess moves, and third and fourth level English words
- Many values and operations of System 1 are broadly shared among all of us, such as turning toward a loud and unexpected sound, or knowing that $2 + 2 = 4$
- Others are trained or experiential, such as knowing that Paris is the capital of France (common) but disliking the city or the Eifel Tower is experiential

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- What we know from Neurophysiology is that our brain processes over 11 million bytes/sec of input (largely System 1) but the ability to process new or unfamiliar information is 40-60 bytes/sec (largely System 2)
- For Example, from the experience of reading (using System 1) we see patterns easily in:
- I cdnuolt blveiee tahat I cluod aulacly uesdnatnrd wahat I was rdanieg. The phaonmneal pweor of the hmuan mnid! Aoccdrnig to rscheearch at Cmabrigde Uinervtisy, ity deson't mtttaer in wahat oredr the ltteers in a word are, the olny iprmoatnt tihng is tahat the frist and lsat ltteer be in the rghit pclae. Tshis is bcuseae the huamn mnid deos not raed ervey lteter by istlef, but the wrord as a wlohe

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- The operations of System 2 are highly diverse but have one single feature in common: System 2 requires attention and is disrupted when attention is drawn away
- Simple examples of the operation of System 2 are: Focusing on the voice of a particular person in a crowded and noisy room, looking for a woman with white hair, searching memory for a surprising (uncommon) sound, counting the number of times the letter "a" appears in this paragraph, or checking the validity of a complex, logical argument [fact checking, for example]
- It is the phrase we use with our children: "pay attention!"
- But: We have a limited "budget" of attention and cannot "pay" much at any one moment without losing attention
- It is difficult to impossible to compute the product of 23×17 while making a left turn into dense traffic with construction barriers

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- Intense focusing on a task can make us “blind” to stimuli that normally attract attention
- Note: Chabris and Simons THE INVISIBLE GORILLA, a short film in which counting the number of white shirts on basketball players required the “full” attention of subjects such that they did not “see” a woman wearing a gorilla suit for over 9 seconds, thumping her chest, then moving on
- “Blindness” and “Distraction” are common problems in System 2, allowing System 1 to be dominant when they occur

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- Errors made by System 1 are usually due to poor input, distraction, fatigue or little experience in the thing we are trying to recognize and process; here, **knowledge matters**
- One of the real problems is that we persist in our conclusions, even if in error and even after being shown we are wrong
- We rationalize, and say “yes, but...”
- System 1 is where we live everyday life, and System 2 is often [some would say usually] “lazy” even when challenged
- Recall: **System 1 is the core of expertise and expert opinion**

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- The Error of Representativeness (System 1)
- Assume we know that (1) On occasion people who act friendly are in fact friendly; (2) A professional athlete who is very tall and thin is much more likely to play basketball than football; (3) People with a PhD are more likely to subscribe to *The New York Times* than people who ended their education after high school (4) Young men are more likely than elderly women to drive aggressively
- You see a person on the New York subway reading *The New York Times*. Which is the most likely bet?
- She (1) has a PhD or she (2) does not have a college degree

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- The usual answer is “she has a PhD”...but that ignores the “base rate” of how many people on the subway have a PhD and would normally be wrong...we use a “hunch” rather than statistical analysis
- What if I told you that she is both a student and a shy poetry lover...which is more likely...that she studies Chinese literature or business administration?
- In making a diagnosis, we often use experience with past cases to “frame” a current case, ignoring the base rate of an occurrence
- If you diagnose a patient with hypertension as a patient with a pheochromocytoma, you will measure urinary metanephrines far more often for nearly 3 years after the diagnosis, even if not indicated
- Case Bias...the medical practice way of ignoring the “base rate”

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- In addition, we tend to be insensitive to the quality of the evidence we use to decide between alternatives, extrapolating from information that has marginal utility, a hunch upon a hunch without realizing we are doing it
- If I ask you (outside this discussion) “What color is hot” or “how long is short” you will have an opinion
- How about “He won’t go far as an academic; too many tattoos” ...based on what? “Birds of a feather flock together” has truth in it, but have we generalized from a second level abstraction when we focus on tattoos?
- We take a question that we cannot answer, and answer another question that was not asked, based on something that we have- in fact- experienced
- What color is hot? How long is short?

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- Consider: “Linda is 31 years old, single, outspoken and very bright. She majored in philosophy. As a student, she was deeply concerned with issues of discrimination and social justice, and also participated in antinuclear demonstrations”
- Is Linda: (1) is a teacher in elementary school; (2) works in a bookstore and takes yoga classes; (3) is active in the feminist movement; (4) is a psychiatric social worker; (5) is a volunteer member of Green Peace; (6) is a bank teller; (7) is an insurance salesperson; (8) is a bank teller and is active in the feminist movement [decide] Then...
- Which is more probable: (1) Linda is a bank teller or (2) Linda is a feminist bank teller

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- When Dr. Kahneman asked that question of undergraduates of all training and experience, 85%-90% said she was a feminist bank teller
- When he confronted the students with the error (a violation of an elementary rule of logic)...
- **Let me ask: what is the error?**
- ...he was greeted with indignation and "so what, I thought you asked my opinion" and "she can't just be a bank teller; read the description!"
- Las Vegas builds large hotels based on such logical fallacy, confusing coherence and plausibility with probability

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- A more controversial example:
- A 27 year old woman comes into an emergency room with her child. She has recent bruising over her arms, and redness over the skin of her right cheek, consistent with recent "slap" injury; she tells you her husband has been abusing her and her 3 year old child while he has been drunk, shaking the child. She is fed up with it, needs help in leaving her home. The child is fretful and needs a new diaper.
- You diagnose Spousal Abuse, and refer her to Social Services for immediate placement in a "safe place" home near the hospital
- You go home after your shift and tell your husband how much you appreciate him for being so loving...
- Have you made the world a better place?

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- In the article by Mull, Reilly and Myers, an elderly woman was admitted to the Cleveland Clinic Hospital late one evening with heart failure, and died nearly 3 weeks later with tuberculosis and pulmonary embolus
- In the ED, she had a CXR, exam and history, and initial lab including ABG's consistent with heart failure, was admitted on Lasix
- She was diabetic, hypertensive and had arthritis, received medications for all of those conditions. She spoke Spanish only, and her Son provided the history and all translation
- She c/o shortness of breath, weakness and a non-productive cough, all of which have worsened over the last 2 weeks
- The ED department Resident signed out to the Night Float Medicine Resident that "she is an elderly woman with hypertension, diabetes, and heart failure being admitted for a heart failure exacerbation."

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- The initial diagnosis of CHF was made more difficult by non-specific and vague symptoms, an atypical presentation of a common disease and confounding comorbidities...and contextual factors, including a chaotic ED, frequent interruptions, time pressure, poor handoff, insufficient data and multitasking
- And the expectations in the ED of rapid evaluation to reach a "working diagnosis" for the purposes of triage as much as patient care
- The contextual issues are commonly referred to as "Systems Errors," disasters waiting to happen
- Systems Errors were made most famous by Lucian Leape, *JAMA* 272:1851 (1994) ...for example, the sinking of the Titanic

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- **Physician Factors** (early and late)
- "Physician certainty and uncertainty at the time of the initial diagnosis does not uniformly appear to correlate with diagnostic accuracy." Mull et al page 746; however see Friedman et al *J.Gen.Int.Med.* 20:334-339 (2005)
- Here, **inappropriate selectivity in reasoning** (a simple error) occurred by not considering other diagnoses, selecting the "low lying fruit" as if that is all that needs to happen, a form of intellectual laziness (in a non-judgmental sense) with reliance on System 1 *coherence and plausibility*
- How much better it would have been if the patient were admitted with "respiratory failure and a history of diabetes and hypertension"?
- In essence, Linda could be a bank teller, a feminist bank teller, or maybe even work in a bookstore and take yoga classes, "rule out" or "rule in"
- Confidence in a diagnosis remains high regardless of the difficulty of the case or the eventual findings Meyer et al *JAMA Intern Med* 2013: 173:1952-1958

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- After 3 days, the woman did not improve, and the residents look at the admitting CXR again, bring up the possibility that the patient might have something other than CHF, but the attending "dismisses their concerns and comments that heart failure is the clinical diagnosis." Mull, page 747 (System 1 pattern thinking)
- Cognitive Errors are usually found on retrospective review, going back to "first principles," thinking "out of the box"
- The debate among experts revolves around the dispute between how physicians use System 1 or System 2, as binary or continuum... here, it was apparently binary

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• **Naming the Cognitive Errors**

- The Framing Effect; Began when the ED Resident labeled the patient with "heart failure" ...note experiments with chocolate yogurt and another with red wine
- Anchoring Bias (Premature Closure): Selective use of early diagnostic features and failing to adjust the initial diagnosis when those "facts" change or fail Croskerry Acad Med 2003; 88:775 Selective history taking is common; attribute [attribution] characteristics to persons based on experience; "pigeon-holing"
- Have you ever heard "First impressions matter"?

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• **Naming the Errors**

- Diagnostic Momentum: A "copy and paste" mental shortcut made prevalent by handovers in care and barriers in care, such as a language difference or personality difference
- Availability Bias: By reading the page of a previous physician, we are more likely to recall heart failure than a thought we may have had while reading; what "springs to mind"; also, a common problem is seen commonly, and CHF is "available" in our thinking
- Confirmation Bias: Probably the strongest bias, looking for facts that confirm a diagnosis rather than facts that make it less likely; a form of "personal investing" in an outcome that is rewarded by a sense of being correct... "I can rest now, go home and feel good."

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• **Confirmation Bias**

- "It takes far more mental effort to contemplate disconfirmation than confirmation. The physician can only be confident that something isn't disease A by considering all of the other things it might be."

Pat Croskerry "Overconfidence in Clinical Decision Making" May 2008 Am J Med 121(SA):S24-29

- One factor not commonly discussed: The more the patient is like us, the more likely we are to believe him, credit what he is saying as true and of weight, data worth knowing

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"...[G]ood medicine is less about brilliant diagnoses being made or missed and more about mundane mechanisms to ensure adequate follow-up...I believe [a missed diagnosis] is most often about the failure to establish a diagnosis that was considered by one or more physicians...

Gordon Schiff *Am J Med* May 2008; 121; S38-42

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•Let me tell you about the case of the "Profane Attorney"

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- Having thought about my thinking, recognized my emotions, and embraced uncertainty over more than 40 years of medical care, I would add:
- I know I am intellectually lazy, and I try to use System 1 thinking (my expertise and experience) whenever and wherever I can
- When I use or hear the words "clinical diagnosis" I think of a near random finding, one I hold lightly in my mind and one I subject to free criticism. I welcome uncertainty as a friend rather than something I must resist
- I do not invest my personality in making a diagnosis or recommending a treatment. I do not think of gain or loss when I think about what I have written on a page. I learn to put my thinking into words I can share

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- I realize that my patient is the best source of information throughout any treatment course, and do what I can to lower ordinary barriers to speech
- I avoid making a treatment decision that has finality, and anything "final" must involve the patient's full understanding, both of what I am proposing and what I am thinking
- I realize that cognitive bias is ordinary, common and unavoidable, and that my personal values determine how I use my cognitive bias
- How cognitive bias can be used (positive or negative) is a matter of deeply held moral values that influence the application of my hard-won expertise...which means I must ask myself what I really believe and what I really value...I cannot fake it

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- **In conclusion:**
 - The key is to realize that we usually use **Inductive Reasoning** in medicine
 - and to build in time, recognize the value of uncertainty, and put in place systems redundancy to revisit our errors
 - The **emotional challenge** is to be comfortable with uncertainty

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What I would say in closing is...

Good Luck

(and I hope I am not the subject of your mistake...)

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Thank You...
Any Questions?
