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Challenges in medical decision making and major cognitive errors in clinical reasoning: A historical perspective

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Abstract. Decision making in medicine is a difficult and complex process subject to several possible cognitive errors. General empirical knowledge and a number of scientific studies show that, when making clinical decisions, physicians often prefer cognitive processes called heuristics. Heuristics indicates a typology of informal reasoning frequently useful on practical grounds but potentially generative of a number of biases and limits deriving from an imperfect integration of personal professional experience with patient data and information. Possible cognitive errors emerging from the adoption of heuristics are numerous and, to a certain extent, codified. In this contribution significant challenges of medical decision making and major cognitive errors are analyzed in a historical perspective. In the seventies the pioneering research of Kahneman and Tversky in the fields of heuristics and cognitive biases opened the way to a comprehensive analysis of the patterns of human judgment and the pathways of decision-making. A full comprehension of established risk factors for cognitive errors is a first mandatory step on the road of prevention and in the containment of such flaws, and this initial awareness should lead to the implementation of cognitive strategies targeted to the prophylaxis and reduction of these errors. Taking into account the availability of current and future technological instruments functional for medical decision making, including artificial intelligence, the structural teaching of the correct and thoughtful adoption of such tools is called upon to become, with particular reference to the didactics of clinical reasoning, an integral part of modern medical education. (www.actabiomedica.it)

Key words: medical decision making, cognitive errors, methodological biases, differential diagnosis, history of medicine, medical humanities, heuristics

Introduction

Decision making in medicine is a difficult and complex process subject to several possible cognitive errors. Scientific methodological literature indicates that, when making clinical decisions, physicians may prefer cognitive processes called heuristics, a typology of informal reasoning frequently useful on practical grounds but potentially generative of a number of biases and limits. Possible cognitive errors emerging from the adoption of heuristics are, to a certain extent, codified; therefore, the awareness of their existence and the systematic attempt to identify them constitute rational premises to their containment and reduction in everyday clinical practice (1-3).

In a historical perspective, in the seventies the pioneering research of the Noble Prize Daniel Kahneman (1934-2024) and of the psychologist Amos Tversky (1937-1996) in the fields of heuristics and cognitive biases opened the way to a comprehensive analysis of the patterns of human judgment and the pathways of decision-making (4). The systematic deviations from rational choice theory which they demonstrated in different scientific papers were then evaluated in medicine as well, and successive studies regarding health professionals have provided evidence

of the fact that an excessive reliance on the mental shortcuts called heuristics may lead to wrong choices and mistakes (5-7).

Violation of the principle of regularity

In a classical paper dating back to thirty years ago, Redelmeier and Shafir aimed at exploring medical decision making in situations involving multiple alternatives (8). They mailed surveys containing medical cases formulated in one of two versions to two groups of neurologists and neurosurgeons affiliated with the North American Symptomatic Carotid Endarterectomy Trial (NASCET). The general medical scenario encompassed several patients awaiting carotid artery surgery and, because of a restriction in the availability of the operating room, prioritization was mandatory among these patients; the physicians and surgeons had to decide which patients were to be operated first. One group of health professionals received the description of two (A and B) patients needing carotid endarterectomy, and the other group received a version presenting three patients (A, B and C), the same first two plus a third similar to one of them (C similar to A). Patient A was a 52 year old woman with past alcoholism, mild diabetes and transient aphasia, carrying a 70% stenosis of the left carotid. Patient B was a 72 year old man in good general health conditions apart from left hand paralysis and a 90% stenosis of the right carotid. Patient C was a 55 year old man, current smoker with transient monocular blindness and a 70% stenosis of the ipsilateral carotid. The group of physicians and surgeons called to make a choice between A and B, selected B in 38% of cases, while the group of health professionals facing a scenario with three different patients selected B in 58% of cases (the difference between the two groups was statistically significant).

This research demonstrated a violation of the principle of regularity, which states that "the addition of an option to a choice set should never increase the probability of selecting an option from the original set" (7), and led Redelmeier and Shafir to conclude that the introduction of additional options may increase the difficulty of medical decisions, in particular when decisions involve similar patients. In the authors' opinion, this incremental difficulty might have led to avoiding the decision between similar patients (A and C), thus leading the professionals to opt for a patient (B) different from the two similar ones, anchoring their decision to a previously available alternative.

Anchoring errors

Anchoring is precisely one of the most frequent cognitive biases codified in clinical medicine, and typical anchoring errors occur when physicians constantly cling to an initial impression even in the presence of contradictory evidence (9). Such conflicting evidence may be disregarded by the health professionals guided by and adhering (anchored) to their strong first impression while, on the contrary, the accumulating data should constitute the trigger to look for alternative options (differential diagnosis).

A number of studies indicate that diagnostic errors not infrequently derive from a limit in the methodological ability of physicians to contemporaneously consider competing hypotheses and from neglecting relevant information useful to discriminate among such hypotheses. Anchoring errors may overlap with the so-called "confirmation bias", an expression indicating the inclination to look for supporting evidence in order to confirm an already formulated diagnosis, instead of keeping an open-minded tendency to seek and consider equally important counter-confirming evidence as well (10). This even in the case in which this latter evidence appears to be objectively more convincing and solid. In effect, stubbornly anchoring to an initial sound diagnosis, no matter how sound it may be, might be incorrect and even dangerous, because the selective acceptance of (only) clinical information confirming a working diagnostic hypothesis may lead inappropriately to discard, ignore or minimize useful data that do not confirm it.

It should always be remembered that the practice of clinical medicine is particularly articulated and complex because it requires a great amount of theoretical knowledge, and such knowledge has to be operatively applied to a large number of individual patients. William Osler (1849-1919), a Canadian clinician considered one of the fathers of modern medicine, has

written that "It is much more important to know what sort of a patient has a disease than what sort of a disease a patient has" (11,12).

Representativeness heuristics

"If it looks like a horse, walks like a horse, neighs like a horse, then it is a horse". Representativeness heuristics may be generally summarized with this simple statement, since it leads physicians to look for typical and pathognomonic manifestations of diseases so as to reach a diagnosis. The problem is that sometimes zebras, or other equines, may "mimic", at least to a certain extent, horses, and consequently the rigid maintenance of medical decision making along paradigmatic recognition patterns may lead to the missing of atypical cases (13).

Representativeness heuristics functions by comparing an event to an already known prototype; it can be a useful rapid tool in some medical scenarios, but it has to be strictly supervised because, already in the seventies, it was structurally demonstrated that it can lead to errors in clinical judgment. The so-called conjunction fallacy, a bias occurring in reasoning when the addition of details to a statement makes it appear (falsely) more probable, is an instance of how representativeness heuristics may be fallacious (14).

A possible medical scenario may be representative of the problems connected to representativeness heuristics: in the case of a 55 year old man who has recently suffered from myocardial infarction, would it be more probable, ten days after the acute event, that this patient should display (a) headache or (b) arrhythmia and headache? Since arrhythmia is a typical sequela of myocardial infarction, there might be the temptation to respond (b); nevertheless, the theory of probability clearly indicates that it is not possible that (b) would be more frequent than (a) precisely because whenever (b) occurs, (a) occurs as well (15).

Availability errors

A well categorized cognitive flaw known as availability error consists in considering more likely a specific clinical event if and when a higher number of previous such events, compared to alternative ones, has come to mind. The mnemonic availability of specific past clinical events may erroneously lead to the under-estimation of the real pre-test probability of a specific disease, determining diagnostic errors if this latter pathological condition is the correct one in the individual patient under examination (16).

Availability errors teach, sometimes dramatically, that generic experience out of context may be a double-edged sword. In effect, on the one hand, little experience (as in the case of young physicians) may lead, for example, to the under-estimation of a common symptom sustained by a serious pathology. On the other hand, the vivid and ready to mind memory of a critical medical event, especially if recent, may lead even experienced diagnosticians to inappropriately over-estimate the probability of a current similar clinical event, precisely on account of its speedy mnemonic availability (9,17).

Framing effects

The way people see reality is, or may surely be, profoundly conditioned by the way in which problems are framed. This is true for physicians as well, considering that, for example, the perceptions of health professionals relative to the risk for patients may be influenced by the manner in which the risk itself is expressed (e.g. the probability of dying versus the probability of living). Such a (potential) cognitive error is called framing effect, and classical studies clearly indicate that in the case in which both choices are framed positively as gains, the majority of persons opt for a gain that is certain, rather than for one that is probable, whereas when both choices are framed negatively as losses, the majority of individuals choose an uncertain loss rather than a certain one. This is also true when gains and losses refer to health conditions, quality of life or even life itself (18).

Already in the seventies paramount research by Tversky and Kahneman demonstrated that individuals perceive the results of a choice in terms of changes relative to a reference value, rather than in terms of absolute levels. Moreover, these researchers underlined that the same increase or the same decrease in

the probability of a specific outcome had, and today still has, a higher impact when it involves a difference between certainty and uncertainty rather than when it involves a difference among various levels of uncertainty (19,20). Therefore, in medical environments, physicians should be well aware of how patients and other health professionals frame real and/or potential outcomes of clinical problems, since framing effects are common and powerful.

Posterior probability errors

Posterior probability errors derive from inaccuracy in computing or interpreting posterior probabilities. These are probabilities arising after considering new evidence. Many examples of such cognitive flaws are available in the literature, pointing to the fact that they derive in medicine from incorrect diagnostic assumptions and/or from misinterpretations of clinical-instrumental results.

A classical example of this typology of errors is the medical scenario of a 50 year old man with pulmonary carcinoma presenting with transient neurological symptoms and a negative brain CT scan (21,22). To furnish an initial differential diagnosis, the question arises whether these symptoms are more likely to be related to brain metastases from pulmonary cancer or to transient ischemic attacks. By calculating appropriate evidence-based probabilities, it may be quantitatively demonstrated that the odds ratio is largely in favour of brain metastases (50 vs 1).

Clinical decision making from history to topicality: Occam's razor and Saint's triad

In the course of time many different approaches to clinical diagnosis have appeared. Among others, two, as paradigmatic as contrasting, are Occam's razor and Saint's triad (23). Occam's razor is named after William of Ockham, or Occam (1287-1347), an English Franciscan friar, philosopher and a major representative of medieval thought.

As extreme summary, Occam's razor suggests, from the perspective of parsimony, that the simplest explanation for a phenomenon is often, or is likely to be, the correct one, thus prompting simplification in diagnosis. Saint's triad is named after Charles Frederick Morris Saint (1886-1973), a British surgeon and emeritus professor, and in summary underlines the effective possibility of different concurrent diseases in a single patient, and therefore of multiple diagnoses, in particular in the presence of atypical symptoms. Saint's triad highlights, therefore, the interconnection and complexity of medical presentations in everyday clinical practice.

Conclusions

A full comprehension of established risk factors for cognitive errors is a mandatory step on the road of prevention and in the containment of such flaws. Lack of experience, overconfidence, fatigue, excessive workload and external pressures are some well known elements predisposing to cognitive errors (9). This initial awareness should lead to the implementation of cognitive strategies targeted to the prophylaxis and reduction of cognitive errors, including the keeping of an open-minded approach in considering alternatives, a dedicated training useful for a reflective approach to problem solving, the reduction of overconfidence in personal memory, and the setting up of a clear accountability and appropriate feedback (10).

Taking into account the availability of current and future technological instruments functional for medical decision making, including artificial intelligence (24), the structural teaching of the correct and thoughtful adoption of such tools is called upon to become, with particular reference to the didactics of clinical reasoning, an integral part of modern medical education.

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References

1. Conti AA, Gensini GF, Galanti G, Conti A. Decision making processes in sports and in medicine: refereeing the game. Clin J Sport Med 2010; 20(6): 402-4.
2. Christenson M, Shukla A, Patel JJ. Intensive Care Unit Decision-Making in Uncertain and Stressful Conditions Part 2: Cognitive Errors, Debiasing Strategies, and Enhancing Critical Thinking. Crit Care Clin 2022; 38(1): 89-101.
3. Conti AA, Conti A, Gensini GF, Medical decision making as a "historical" combination of art, statistics, experimentalism and evidence based practice. Vesalius 2010;16(1):19-23.
4. Tversky A, Kahneman D. Judgment under Uncertainty: Heuristics and Biases. Science 1974;185(4157):1124-31.
5. Tversky A, Kahneman D. The framing of decisions and the psychology of choice. Science 1981; 211(4481):453-8.
6. Schaller-Paule MA, Steinmetz H, Vollmer FS, Plesac M, Wicke F, Foerch C. Lessons in clinical reasoning - pitfalls, myths, and pearls: the contribution of faulty data gathering and synthesis to diagnostic error. Diagnosis (Berl) 2021;8(4):515-24.
7. Parvin TS. To err is human, but patient safety requires correcting medical errors. J Miss State Med Assoc 2004; 45(8):239-40.
8. Redelmeier DA, Shafir E. Medical decision making in situations that offer multiple alternatives. JAMA 1995;273(4):302-5.
9. Mandell BF. Cognitive Errors in Clinical Decision Making. Merck Manual professional version. Merck & Co., Inc., Rahway, NJ, USA, 2025.
10. Restrepo D, Armstrong KA, Metlay JP. Annals Clinical Decision Making: Avoiding Cognitive Errors in Clinical Decision Making. Ann Intern Med 2020;172(11):747-51.
11. Bliss M. William Osler. A life in medicine. University of Toronto Press, Toronto (Canada), 1999.
12. Craxì L, Giardina S, Spagnolo AG. A return to humane medicine: Osler's legacy. Infez Med 2017;25(3):292-7.
13. Gupta A, Quinn M, Saint S, et al. The variability in how physicians think: a casebased diagnostic simulation exercise. Diagnosis (Berl) 2020;8(2):167-75.
14. Redelmeier DA, Shafir E, Aujla PS. The beguiling pursuit of more information. Med Decis Making 2001;21(5):376-81.
15. Conti AA. Historical evolution of the concept of health in Western medicine. Acta Biomed 2018;89(3):352-4.
16. Conti AA. Nobel Prizes in Medicine as an overview on XX and XXI centuries biomedicine and health sciences: historical and epistemological considerations. Acta Biomed 2020;91(4):e2020091.
17. Johal HK, Danbury C. Conflict before the courtroom: challenging cognitive biases in critical decision-making. J Med Ethics 2020;47(12):e36.
18. O'Sullivan ED, Schofield SJ. Cognitive bias in clinical medicine. J R Coll Physicians Edinb 2018;48(3):225-32.
19. Motterlini M, Crupi V. Decisioni mediche. Un punto di vista cognitivo. Raffaello Cortina Editore, Milano, 2005.
20. Motterlini M. Trappole mentali. BUR, Milano, 2011.
21. Wilkinson I, Raine T, Wiles K, Hateley P, Kelly D, McGurgan I. Oxford Handbook of Clinical Medicine. Oxford University Press, Oxford (UK), 2024.
22. Ng IK, Goh WG, Nashi N, et al. Making better clinical decisions: How doctors can recognise and reduce bias and noise in medical practice. Ann Acad Med Singap 2025;54(5):310-3.
23. Hilliard AA, Weinberger SE, Tierney LM Jr, Midthun DE, Saint S. Clinical problem-solving. Occam's razor versus Saint's Triad. N Engl J Med 2004;350(6):599-603.
24. Espinoza-Vinces C, Martínez MC, Atorrasagasti-Villar A, Rodríguez MDMG, Ezpeleta D, Irimia P. Artificial intelligence in headache medicine: between automation and the doctor-patient relationship. A systematic review. J Headache Pain 2025;26(1):192.

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