Cognitive Aspect of Diagnostic Errors

Dong Haur Phua, [1]*FAMS, FCEM, MRCS (Edin)*, Nigel CK Tan, [2]*FAMS, FRCP (Edin)*

Abstract

Diagnostic errors can result in tangible harm to patients. Despite our advances in medicine, the mental processes required to make a diagnosis exhibits shortcomings, causing diagnostic errors. Cognitive factors are found to be an important cause of diagnostic errors. With new understanding from psychology and social sciences, clinical medicine is now beginning to appreciate that our clinical reasoning can take the form of analytical reasoning or heuristics. Different factors like cognitive biases and affective influences can also impel unwary clinicians to make diagnostic errors. Various strategies have been proposed to reduce the effect of cognitive biases and affective influences when clinicians make diagnoses; however evidence for the efficacy of these methods is still sparse. This paper aims to introduce the reader to the cognitive aspect of diagnostic errors, in the hope that clinicians can use this knowledge to improve diagnostic accuracy and patient outcomes.

Keywords: Affective influence, Analytical, Diagnostic errors, Heuristics, Reflective practice

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Introduction

It was an unusually busy ward round. The newly promoted registrar was keen to review the patients handed over to him. But there were constant distractions from the other things he needed to attend to quickly.

The patient, Madam Sumar was referred by her family doctor for chest pain with shortness of breath; ischaemic chest pain was his concern. The junior doctor who saw her planned for investigation of possible ischaemic heart disease. The young registrar reviewed her, and concurred with his colleague's assessment. But Madam Sumar was unhappy with her assigned ward and complained repeatedly; she also had other vague complaints such as giddiness and pain in her leg. The registrar wanted to move on to his next duty. Four hours later, Madam Sumar was dead from pulmonary embolism.

This case was based on a real patient. The registrar had made a diagnostic error, resulting in a preventable death. But other culprits were also in play, namely, diagnostic momentum, availability, anchoring and under-adjustment, overconfidence, environmental stress, and counter-transference. What are these other culprits?

Diagnostic errors occur when the diagnosis is unintentionally delayed (sufficient information was available earlier), wrong (another diagnosis was made before the correct one) or missed (no diagnosis ever made) as judged from the eventual appreciation of more definitive information.[1] Cognitive factors are the most common cause of diagnostic errors in internal medicine[1] and emergency medicine.[2]

The rate of diagnostic errors have been estimated to be between 0.6% to 12%.[3] Some estimates are as high as 15%.[4] The rate of negative outcome or adverse effects of diagnostic errors range from 6.9% to 17%.[3,5] A longitudinal study of autopsies in unselected patients in Switzerland suggests that the absolute rate of diagnostic errors may be decreasing over time.[6] However, in a study of autopsy findings in

[1]Emergency Department, Tan Tock Seng Hospital, Singapore
[2]Department of Neurology, National Neuroscience Institute, Singapore
Address for Correspondence: Dr Phua Dong Haur, Emergency Department, Tan Tock Seng Hospital, 11 Jalan Tan Tock Seng, Singapore 308433.
Email: phuadh@gmail.com

malignant neoplasms, the rate of clinical misdiagnosis in 1998 was found to have changed little compared to earlier studies in 1923 and 1972.[7] A review concluded that the spectrum of diseases that are prone to diagnostic errors (namely pulmonary embolism, acute myocardial infarction, malignancy and infection) has not changed over the years, suggesting that diagnostic errors result from inherent difficulties in diagnosing these conditions and are not affected by improvement in technologies or training.[5]

We do not have local data on the rate of diagnostic errors nor do we know what percentage of patient adverse outcomes arise from diagnostic errors. Nevertheless, we can probably concur with authors who view diagnostic errors as being one of the more consequential types of medical errors,[8-10] as it often leads to wrong investigations and management.

Unlike physical sciences, clinical medicine has been described as an ill structured field of knowledge.[5] When trying to make diagnoses, clinicians often face dynamic situations with evolving information. There is uncertainty as to when the search for information can be terminated; approaches used in previous similar scenarios may not be applicable in the current situation. Others have described making clinical diagnosis as a "wicked problem".[11] Clinicians have to reframe patient symptoms into clinical problems and these problems may not be unambiguously true or false. Available solutions may only be partial and any action taken by the clinician can alter the situation in significant and irreversible ways, to the extent that the problem itself may be altered.

Furthermore, the goals of management can be incomplete, vague, mutable, or at times, contradictory. In many situations, there is no immediate or ultimate test to tell the clinician if he or she is right. Immediate feedback is often unavailable to clinicians; the diagnosis may be delayed or hidden, or the problem may change without any action being taken. These limitations restrict the ability of clinicians to re-calibrate themselves.

In many instances, the diagnosis and decisions are not only dependent on the clinician's thinking but are conjoint cognitive outcomes of the clinician, the patient, patient's kin and the prevailing situations.[11-13] The diagnosis may also have arisen over a period of time like over several consultations instead of a single point in time.[11,13]

How Clinicians Make Diagnoses

The normative model for making clinical diagnoses is Bayes' theorem,[14] where doctors use pieces of information regarding the prevalence of various clinical features in different disease entities to calculate the probability that a particular disease is present. However, this method is impractical in actual clinical practice due to the complexity of the calculations; and much of the required information may be unavailable.[15]

How then do clinicians actually make diagnoses? Investigators believe that it is impossible for any clinician to search for or consider all information or evaluate all possible hypotheses, hence the search for the correct clinical diagnosis is typically limited to satisfactory solutions within the constraints of the clinical environment.[16] Most authors accept that the dual process model of reasoning explains how clinicians make diagnoses.[16-18] It appears that we make choices using 1 of the 2 systems of thinking. System 1 is intuitive, automatic and requires little cognitive capacity. System 2 is reflective, analytical and requires cognitive capacity.

System 2 which is analogous to the hypothetical-deductive or analytical method is often taught to medical students. The process consists of first taking a history from the patient, and using a key finding to generate a list of differential diagnoses. Further information gathered is then used to pare down the list of differential diagnoses until only 1 or 2 are left. Much time is then invested to obtain information to confirm the final diagnosis.[5]

The list of differential diagnoses is generated relatively early during consultation (mean duration 28 seconds into consultation); the final diagnosis is derived at between 1 and 7 minutes.[5] The earlier the diagnosis is arrived at, the more likely the diagnosis will be correct; this may be due to the diagnosis being an easy one to make. The initial list of differential diagnoses is limited by our short-term memory and consists of no more than 2 to 6 choices. If this initial list does not have the correct diagnoses, the chance of finally arriving at the correct diagnosis appears to be slim. This process of making diagnosis is energy intensive, relies on working memory and appear to localise to the right inferior prefrontal cortex.[19]

In contrast, System 1 is described as the heuristic or pattern recognition method of making diagnoses; it is often used by experienced clinicians. System 1 is developed through clinical experience;[20] these accumulated experiences are stored in the memory of clinicians as illness scripts,[21] which can be represented as a past example or as an abstract prototype.[22] Upon encountering a case, a clinician will match the pattern of the case to his stored illness scripts and arrive at a diagnosis. This mode of making diagnoses imposes less cognitive load, and is relatively fast and efficient when compared to System 2. Clinicians are shown to match the right diagnoses within 10 seconds of consultation.[5] The process appears to localise to the ventral medial prefrontal cortex (Table 1).[19]

Medical students and clinicians start their career using System 2 to make diagnoses. With experience, they

Table 1. Comparison Between System 1 and System 2 Types of Clinical Reasoning

System 1	System 2
Heuristic Pattern recognition	Hypothetical-deductive Analytical method
Developed through clinical experience	Generate differential diagnoses list Gathering information to validate
Less cognitive load Faster Right diagnosis about 10 seconds Efficient	More cognitive load Slower Diagnosis about 1 to 7 minutes Relies on working memory
Appears to localise to the ventral medial prefrontal cortex	Appears to localise to the right inferior prefrontal cortex

accumulate illness scripts; this allows them to transition to more System 1 reasoning. However, when they encounter a novel clinical scenario that is not represented by their stored illness scripts they may revert to System 2 reasoning.[18,21] An expert clinician is believed to have a large store of illness scripts.[20] System 1 mode of making diagnoses is heavily reliant on past experiences and intuition; it is usually recognised as a component of clinical expertise.[23] Both systems can interact and/or override each other, and repeated use of System 2 can lead to formation of illness scripts that are eventually used in System 1 (Figs. 1 and 2).[24]

However there are concerns that System 1 kind of reasoning is prone to failure, thus some authors advocate that System 2 be applied more conscientiously.[24] There are some evidence that System 2 mode of reasoning may achieve better diagnostic accuracy.[25-27] Critics however point out that in most psychology literature, System 1 is more accurate and is a more efficient mode of reasoning.[28]

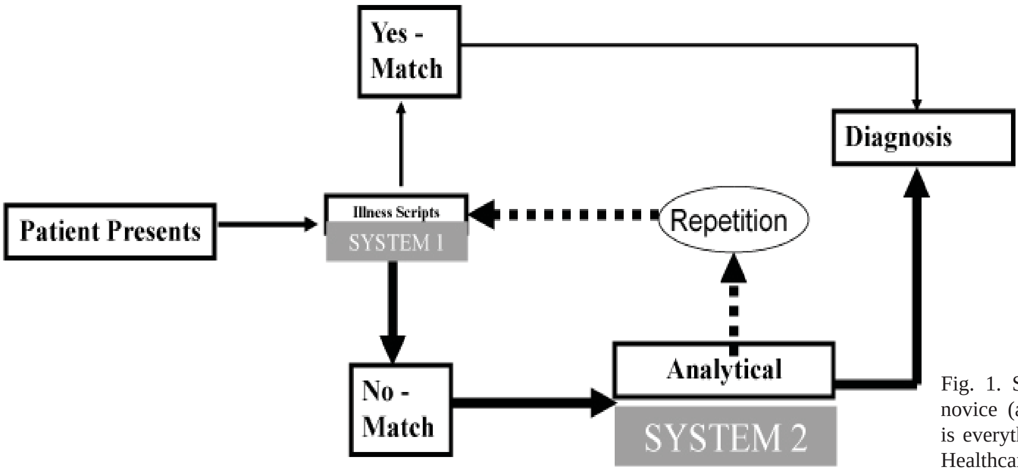

Fig. 1. Schematic of decision-making of a novice (adapted from Croskerry P. Context is everything or how could I be that stupid? Healthcare Quarterly 2009;12:177-7).

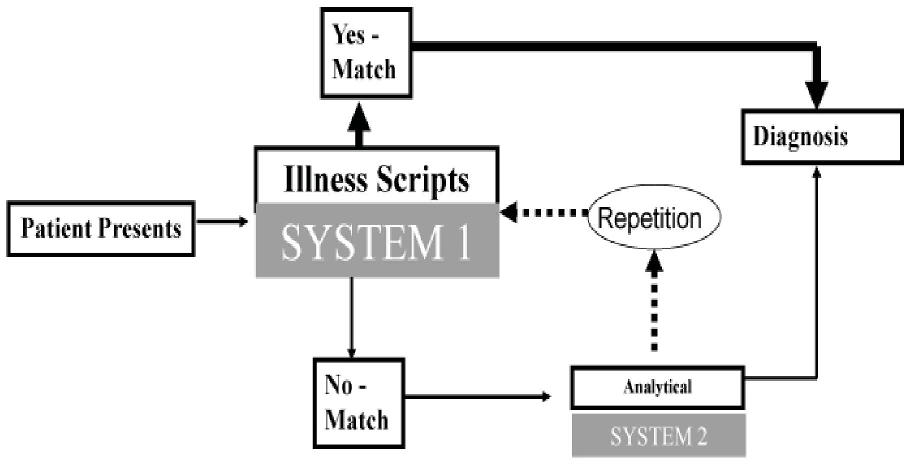

Fig. 2. Schematic of decision-making of an expert (adapted from Croskerry P. Context is everything or how could I be that stupid? Healthcare Quarterly 2009;12:177-7).

System 1 evolved because it tends to yield better outcomes than careful rational process.[29,30] Still, others point out that errors and bias can occur in both systems of reasoning,[16,31] and that there is no evidence to suggest whether System 1 or 2 generate more errors.[17] In fact, there are also studies that demonstrate superiority of System 1 diagnostic accuracy[32] or that the use of combined reasoning (Systems 1 and 2) produces better results.[33]

There is no evidence to suggest clinicians use a single mode of reasoning during an encounter; some authors argue that clinicians use a combination of both modes of reasoning in a given situation.[3,34] Norman and Eva[31] believe that teaching clinicians to apply combined reasoning can lead to better results in diagnostic accuracy;[33] simply avoiding System 1 reasoning may lead clinicians to commit too much cognitive resources in making diagnoses.[25] There is no current consensus of how clinicians should approach both systems of reasoning.

Other methods of making clinical diagnoses have been described.[24] These include using algorithm in diagnosing pulmonary embolism, or using strategies to rule out life threatening or important diagnoses, or to investigate an exhaustive list of differential diagnoses.[3]

Cognitive Biases and Affective Influences

A clinician's clinical diagnoses tend to be correct when there is a higher rate of concordance with other clinicians and when the correct diagnoses appear early during consultation.[5] These may be explained by these clinical diagnoses being easy to make, hence there is a higher rate of concordance with other physicians as well as the early appearance of the diagnoses. Research has also shown that the probability of making a correct diagnosis is not correlated with the length of consultation or the amount of information gathered by the clinicians.[5,17] Findings also suggest that clinicians tend to come to a conclusion when they gathered about 60% to 70% of the information.[17]

Diagnostic errors have been described in both System 1 and 2 reasoning, with System 1 being more prone to premature conclusion, and System 2 being more prone to faulty hypothesis generation.[3] Some authors argue that System 2 errors can be more consequential as more confidence is put into the diagnosis.[18] Factors shown to result in higher diagnostic error rates include high patient load, fatigue, sleep deprivation and overconfidence.[18] Evidence also suggests that errors occur in both high and low workload environment with the difference being that in high workload environment, the ability to detect errors is reduced and the chance of error completion is higher.[13]

Garber[1] classified diagnostic errors into 3 categories: no fault errors (errors arising form silent diseases, atypical presentations, imperfect current knowledge or patient's non-compliance), systemic errors and cognitive errors.[1,35] Norman and Eva[31] further explained that cognitive errors can arise from 3 sources: knowledge deficits, cognitive biases and attitudinal problems of the clinician.

There are evidences to suggest that poor knowledge appear to lead to poor performance.[36] Cognitive biases are very well described as they have been the subjects of intense investigations since Tversky and Kahneman[37] first described heuristic and biases in 1974. Attitudinal problems of the clinician are such attributes as overconfidence. Crosskerry[38] differentiates biases into cognitive biases and affective issues and suggests that these components do interact to form the final outcome.

Table 2. Cognitive Factors in Diagnostic Errors

Sources of Cognitive Errors	**Subcategories**	**Examples**
Cognitive Biases	Gathering of Data	Premature closure Primacy effect Recency effect Search satisficing Confirmation bias Diagnostic momentum Triage cuing
	Data Interpretation	Representativeness Gambler's fallacy Anchoring Under-adjustment Confirmation bias Overconfidence
	Probability Assessment	Availability Hindsight Outcome bias Sunk cost
Affective Influences	Transitory Affective States	Environmental irritation Sleep deprivation Stress Fatigue
	Clinical Situational-induced	Fundamental attribution error Counter transference
	Endogenous Disorders	Mood variation Mood disorders
Knowledge Deficits		

Adapted from:

1. Norman GR, Eva KW. Diagnostic error and clinical reasoning. Med Educ 2010;44:94-100.
2. Bornstein BH, Emler AC. Rationality in medical decision making: a review of the literature on doctors' decision-making biases. J Eval Clin Pract 2001;7:97-107.

Heuristics are mental shortcuts used in reasoning and is almost always seen in System 1 thinking, however they may also influence System 2 thinking. Cognitive biases are heuristics that result in faulty decisions. Because System 1 reasoning is intuitive and relies heavily on heuristics, it tends to be more prone to biases.[9,39]

Biases can be classified in various ways.[14,40-42] One schema categorises them based on the stages of decision-making: gathering of data, during interpretation of data, and during probability assessment; biases may also occur when deciding the course of action.[40] Some biases are more commonly encountered than others. Croskerry[39] identified up to 30 different types of biases seen in clinical practice; some of the more common biases that can adversely affect the clinician are summarised in Table 2.

Types of Cognitive Biases

A basic heuristic is availability. This is when the probability of a diagnosis is influenced by the ease of recollection of possible diagnoses.[27,39,42,43] Recent encounters, prominent cases, frequently encountered diagnoses or diagnoses that are easily searchable are likely to influence the final selection of diagnosis. Returning to our example at the start, ischaemic heart disease is a more frequent cause of chest pain compared to pulmonary embolism. Hence, it is more "available" to our young registrar when he encountered Madam Sumar. This is a generally sound strategy as more commonly encountered diseases should be considered first. This heuristic will however fail when a clinician encounters a rare disease or when a disease presents atypically.

Anchoring and under-adjustment occurs when clinicians anchor their diagnoses on initial information too early in the diagnostic process. Under-adjustment is the failure to revise their diagnoses based on subsequent information.[10,39,42] This bias is related to premature closure, where the clinician concludes the case before all information are obtained.[39] These biases are important heuristic failures and most commonly blamed for diagnostic errors in the study of misdiagnosis.[1] Clinicians may show bias towards initial information (primacy effect) or towards information that was last obtained (recency effect)[42] or modify the interpretation of subsequent information to suit their initial prediction (confirmation bias).[1] These biases appear to afflict medical students, residents and faculties frequently and equally,[44] and also our young registrar when he failed to adjust for Madam Sumar's complaint of leg pain.

The representativeness heuristic describes people judging probabilities by similarity.[42] Hence clinicians choose a diagnosis based on how well the case matches characteristics of representatives (illness scripts) of that particular diagnosis.[39] But such similarities may be misleading, and studies have shown that people can be misled by information that is described in detail even though they are irrelevant.[37,42,45] Hence, this heuristic fails when clinicians are misled by unreliable information of the case, or when the base rate of diseases is not appreciated.[42] Testing with clinical vignettes do show that residents can fail to appreciate the base rate of diseases.[46] Clinicians then tend to miss a disease when it presents atypically, as it does not conform well to the typical illness script.

A related bias is called the Gambler's fallacy.[42] This arises when clinicians fail to appreciate that cases are inherently unrelated (unless there is an outbreak). This bias takes its name from gambling where a gambler, after observing a long consecutive series of heads in a coin toss, reasoned that the next toss should produce a tail,[39] in effect not appreciating that each coin toss is independent. This fallacy arises because people tend to think that a sequence of coin tosses should be representative of a random sequence, and that the typical random sequence does not have consecutive heads. A primary care physician may palpate a rectal tumour during per-rectal examination in a patient presenting with constipation. He or she then attends to another patient presenting with constipation. The physician may then reason that on any given day, there would not be 2 cases of rectal tumour, hence he or she may omit the per-rectal examination in the second patient, though in fact, the second patient may also have a rectal tumour.

Search satisficing is a tendency to call off the search for possible diagnoses once an abnormality is found.[39] This may lead to clinical error when the abnormality detected is not the cause of the problem. Groopman[47] relates his account of how several orthopaedic surgeons stopped searching for the cause of his painful wrist once they found bone cysts in his wrist X-rays, hence failing to come to the right diagnosis of ligamental laxity.

Clinicians are also affected by prior decisions or labels placed on a patient. This can result in diagnostic momentum,[39] hence an initial opinion by a lay person or the patient, or diagnoses made by other clinicians becomes more established through a series of intermediaries. For example, our young registrar's initial diagnosis may have been reinforced by diagnostic momentum—after all, his colleagues were concerned that Madam Sumar had ischaemic heart disease. Another similar bias is triage cuing. Patients triaged higher are subjected to more investigations with more serious diagnoses being considered, while patients who are triaged lower have less serious diagnoses being considered.[39]

Sunk-cost effect is when a clinician's earlier commitment of resources to a particular diagnosis compels him or her to continue pursuing that diagnosis, despite later information that suggest other possibilities.[42] One possible explanation for this effect is that people are averse to waste or loss,[42] hence the clinician is unwilling to "waste" the earlier resources committed by looking at other possibilities.

Outcome bias occurs when a clinician underestimates the probability of a bad outcome and overestimates the probability of a good outcome.[14,39] A clinician may thus underestimate the likelihood of bacteraemia in a sick febrile patient as the outcome of bacteraemia is more severe.

Hindsight bias is prevalent and difficult to adjust for; this is especially so when clinicians are asked to judge the performance of fellow clinicians. When people are made aware of an outcome, they judge the probability of the outcome or the ability to predict that outcome based on initial information given as more likely.[42] Similarly, clinicians' perception of the probability of a diagnosis increases when the final diagnosis or final outcome (for example, death) is known.[23,40,48] Hence, when a clinician is asked to evaluate a colleague's diagnostic error during mortality and morbidity round, the clinician's opinion would be influenced by his or her knowledge of the outcome of the case.

Overconfidence is commonly recognised as a source of errors.[29,42,49-51] A study showed that 94% of academic professionals rate themselves in the top half of their profession.[49] Such overconfidence may afflict medical professionals too. Friedman et al[51] gave synopses of diagnostically challenging medical cases to medical students, residents and faculties. They found that residents tend to be more overconfident of their diagnoses than faculty (41% versus 36%), while medical students showed the least overconfidence (25%). However, other authors have cautioned that expertise can exacerbate overconfidence.[42]

Affective Influences

Affective influences on making clinical diagnoses are less well described.[21,38] Croskerry et al[38] divides them into 3 types: transitory affective states, clinical situational-induced and endogenous disorders (Table 2). Most clinicians would have encountered consultations that made them uncomfortable, perhaps an intoxicated patient, a manipulative patient, angry relatives, over familiar patient behaviour, or drug seeking behaviour. Some of these feelings are what Croskerry[38] termed as negative counter-transferance. Such consultations provoke discomfort and the desire to shorten the consultation, and can therefore lead to clinicians jumping to conclusions and diagnostic errors.[52] We believe that clinicians should be aware of the particular type of patients that trigger disagreeable feelings in themselves so that such diagnostic errors due to affective influence can be avoided.

Fundamental attribution error is an affective influence that causes a clinician to attribute blame to the patient when something goes wrong rather then blaming the circumstance.[39] Our young registrar attributed Madam Sumar's complaints of feeling faint and pain in her leg to her tendency to complain rather than reassessing the possibility of other diagnoses.

Anticipated regrets can also influence a clinician diagnosis.[23,40,53] When a clinician anticipates more regret if he or she misses a particular diagnosis, he or she tends to overestimate the probabilities of the occurrence of the diagnosis.[42] Dawson[54] cited an example of a young man presenting with atypical chest pain, where a clinician would anticipate missing the diagnosis of ischaemic heart disease with regret. He or she would hence overestimate the possibility of ischaemic heart disease in this young man, resulting in unnecessary over-investigation.

Making Ourselves Better Diagnosticians

The contribution of cognitive factors to diagnostic errors are thought to be substantial.[1,2] However, the actual magnitude of contribution, or how to systematically study the effect size is not known.[31,48] There is only sparse evidence to suggest strategies by which we can make clinicians better diagnosticians. Most recommendations by authors appear to be based on personal opinions and experiences.

A key element in making clinicians better diagnosticians is to train them to model expert clinicians. The problem then arises of how we should define an expert—should he or she be defined by postgraduate training, years of practice, seniority in rank, academic publications or track record in diagnosing various ailments?

Table 3. Some Proposed Methods to Debias Clinicians

Level of Intervention	Interventions
System Level	Simplify tasks Decrease reliance on memory Decrease time stress Decrease fatigue Use of guidelines Use of algorithms Publish disease statistics Computer base support system
Individual Level	Increase knowledge • Medical knowledge • Evidence-based medicine • Cognitive factors in diagnostic errors Strategies to review diagnoses • Diagnostic timeouts • Second opinion • Review working diagnoses Feedback and recalibration Awareness technique – mindful, reflective, metacognition

Most authors agree that expertise is content specific.[16,55] There is no reason to imagine that a cardiologist subspecialising in electrophysiology would be just as skilful in diagnosing diastolic heart failure as a cardiologist who manages heart failure on a daily basis. Some authors also point out that an expert displays sophisticated reasoning processes as compared to a novice, although these processes can be case specific.[55] Therefore, we can conclude that the expert clinician has at least both mastery of the reasoning process and an accumulation of experience and knowledge.[34]

The accumulation of experience and knowledge in medical practice is arguably a much easier process than refining clinical reasoning. The process starts with medical school, through internship and residency and continues with the lifetime of a clinician's practice. Scholarly knowledge is supplemented with real experience once a clinician starts practising.

The task of refining clinical reasoning processes appears more arduous. Cognitive biases and affective influences appear difficult to correct even when clinicians are aware of them.[14] Strategies to overcome them include methods that can be applied on a system level or at the individual clinician level (Table 3).

On a system level, suggestions include implementing ways to simplify a clinician's task (such as reducing the number of forms to fill), decreasing reliance on the clinician's memory (allowing internet assess for information or easy assess to textbooks), decreasing time stress of clinicians (allowing more time for consultation), decreasing fatigue of clinicians (ensuring adequate rest time), use of guidelines and algorithms, and making local disease statistics available. While computer based support systems for diagnoses have been explored,[49,56] they are still far from delivering a difference to actual clinical practice.[16] All these implementations require extra time and impose additional costs to the system, for example employing more clinicians to allow for longer consultations or more rest days between shifts. The benefit in these system level interventions in improving diagnostic accuracy is still unknown.

At the individual clinician level, debiasing techniques have been advocated. This include teaching clinicians evidence-based medicine. Some authors argue that clinicians with such training are more likely to use a normative model in reasoning,[40] but others point out that such training has turned out to be less useful in overcoming cognitive biases than has been hoped for.[16] Clinicians are also advised to use diagnostic timeouts to review working diagnoses,[43] or they may adopt an active process of getting colleagues to review their cases.[16] Again, such strategies consume resources and there is no data to indicate how much benefit can be derived.

Seeking feedback on outcome and diagnostic accuracy is advocated as an important means for clinicians to improve their diagnostic accuracy.[57] Feedback allows clinicians to recalibrate themselves when there are negative outcomes.[58] Immediate feedback and more detailed feedback are felt to help clinicians to recalibrate themselves.[12] However, authors cautioned that means of feedback like mortality and morbidity rounds can inflate estimate of true base rates of diseases resulting in clinicians over-investigating subsequent patients.[58]

Teaching medical students and clinicians about the role and types of cognitive biases has also been advocated as a way of debiasing.[40] Studies suggest that students and clinicians who are made aware of biases are less susceptible to them.[23,40] However, critics point out that efforts to reduce biases by raising awareness have been discouraging.[14,31,59] Heuristics are often not consciously applied; knowing that biases exist may still be insufficient to adjust for them.[31]

Thinking Better

Many authors advocate the use of "awareness" as a means to overcome cognitive biases and affective influences.[1,9,10,15,16,18,35,49,57,60,61] Different terms—mindful practice, reflective practice and metacognition—have been used to describe this practice. Although they are usually discussed interchangeably and their concepts appear to be similar, there are usually some subtle differences in what the authors mean.

Mindful practice refers to the presence of the mind to be able to attend to one's own actions, from moment to moment.[60] Epstein[60] further characterised it as having the willingness to observe and improve one's own behaviour, willingness to set aside categories and prejudices, having critical curiosity and open mindedness, openness to uncertainties, and tolerance to one's own incompetence. He further suggested the use of meditation, keeping journals, reviewing videotaped sessions and the use of evaluation forms to cultivate mindfulness.[60]

Reflective practice is defined by Mamede[61] as the capability to critically reflect upon one's own reasoning and decisions during professional activities. This implies a thought process that occurs simultaneously during consultation.[15,49] Other authors understand it as a post-hoc activity to reflect on issues that have surfaced.[57]

In a study of primary care physicians, 5 aspects of reflective practice were identified: a tendency to search for alternative explanations (deliberate induction), a tendency to explore consequences of alternative hypothesis (deliberate deduction), a willingness to test hypothesis against data generated (testing and synthesis), an attitude of openness to reflection (openness to reflection) and a capacity to reflect on one's own thinking, conclusions, assumptions and beliefs (meta-reasoning).[62] Mamede et al[27] have shown that reflective practice can be used to adjust for availability bias.

Favell[63] described metacognition as one's knowledge of one's own cognitive process and products of or anything related to them. He further described it as active monitoring and regulation and orchestration of information processing in relation to the cognitive objects or data.[63] He gave examples of metacognition as when a person becomes aware that he is having more trouble learning A than B (and not just learning A and B) or becomes aware that he should double check C before accepting it as a fact (and not just accepting C) or making a note of D in case he later forgets it (and not just knowing D).[63]

Croskerry[18] and Gallagher[10] describe metacognition in clinical practice as a process of stepping back to examine one's own reasoning process, thereby forcing critical examination of one's own reasoning in an effort to reduce diagnostic errors, like identifying which system of thinking one is using and the relative benefit of switching the mode of reasoning.

The 3 entities described above, though subtly different, appear to refer to a method of heightened mental awareness that oversees our mental processes during decision-making in the hope of avoiding the trap of cognitive biases or affective influences. Some authors have argued that this approach represents the best chance for clinicians to overcome their cognitive and affective shortcomings.[15,61]

Again, there is sparse evidence to suggest that clinicians can avoid cognitive errors by applying them conscientiously in clinical practice.[61] Despite appeals for us to use these methods, there are concerns that they may not be as effective as we had hoped for.[16] Sceptics rightly point out that the cognitive process is complicated. Asking clinicians to be hyper alert at all times may not be reasonable; directing more mental energy to making diagnoses may be detrimental, resulting in unexpected consequences such as overly cautious clinicians, over-investigation and delay of treatment.[29] A practical approach would be to apply such awareness selectively, but the question of just when remains unanswered.[30]

Conclusion

We believe that some basic knowledge of our cognitive processes in decision-making and awareness of our susceptibility to various cognitive biases and affective influences will bring some benefit to a clinician's practice and patient care. Most clinicians would accept that obtaining feedback, recalibrating oneself and being reflective of one's practice is generally considered a virtue in clinical practice and essential in the cultivation of humility as a clinician.

It is unlikely that human errors can be fully eliminated; similarly cognitive biases and affective influences will continue to cause diagnostic errors. However, we should be able to mitigate some of these errors so that they do not propagate towards a negative patient outcome.[13] Progress has been made. We have delineated a dual process theory of reasoning. We understand how and why heuristics, biases and affective influences affect our reasoning, and how selected strategies may perhaps overcome these shortcomings. Many questions remain unanswered; there is hope that new research in this novel frontier of medicine will allow us to make more accurate clinical diagnoses and improve patient outcomes.

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