The theory and practice of clinical decision-making

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THERE is a story about a philosopher and a psychologist having a drink. The philosopher asks: why did the chicken really cross the road? The psychologist replied: well, as the chicken lacks any formal reasoning or decision-making capabilities, it seems unlikely that its action was spurred by any conscious motivation, so I'd say it was instinct.

The exchange brings out some salient points for the present discussion on clinical decision-making in anesthesiology. Firstly, we generally assume that all human behaviour with the exception of reflexes is driven by some motivating influence. Motives in turn lead to decision-making which characterizes human behaviour. The first decision of the day, getting out of bed, arises from a complex of motivators which may include: vocation, making a living, hunger, a sense of duty, threat, guilt and others. Once that first decision is made, the rest of the day consists of a series of decisions and actions, one after the other, some in parallel, of lesser or greater complexity. If the environment is predictable and routine, some decisions and actions can be relegated to an almost automatic level, such as driving. In contrast, when there is uncertainty a sustained level of vigilance and attention may be required. At the highest level of cognitive function we can make a decision to monitor our decision-making - this is metacognition.

Good problem solving, sound judgement, and effective clinical decision-making are considered among the highest attributes of physicians, yet this topic has been actively researched for only about 35 years. Norman has provided a broad overview of the main issues.[1] The spectrum of decision-making in medicine runs from simple to complex and is related to the level of uncertainty; there are a variety of tasks with varying degrees of certainty. In some settings such as a dermatology clinic, the problem set is limited, the level of uncertainty generally low, and emergencies rare. In contrast, in a trauma unit the potential problem set is large, uncertainty high, and a there is frequent requirement for expediency. In anesthesiology, there is a variable problem set due to the variety of settings in which anesthesiologists work: preoperative clinics, the operating room (OR), recovery room, labour and delivery, the hospital wards, acute and chronic pain clinics, out-patient departments, intensive care units (ICU), trauma units, emergency departments (ED) and others. There are differing levels of uncertainty in each setting. Anesthesiologists often face added uncertainty and task complexity that results from working in more tightly coupled teams, as well as from the influence of external organizational factors.[2]

The cognitive continuum of decision-making runs from informal/intuition at one end to calculation/analytical at the other,[3,4] (Table I) and the nature of tasks runs from simple to complex. The trick lies in matching the appropriate cognitive activity to the particular task.

Decision-making in anesthesia generally falls into the category of 'human factors', or more specifically 'non-technical skills'[5] in which the majority of errors are believed to occur.[6] Importantly, these non-technical skills constitute a major proportion of the qualities on which competence in anesthesiologists' practice is based.[7]

TABLE I Characteristics of intuitive *vs* analytical approaches in decision-making

	Intuitive	*Analytical*
Cognitive style	Heuristic	Systematic
Cognitive awareness	Low	High
Conscious control	Low	High
Automaticity	High	Low
Rate	Fast	Slow
Reliability	Low	High
Errors	Normative distribution	Few but large
Compliance	High for answer Low for method	Low for answer High for method
Effort	Low	High
Predictive power	Low	High
Emotional valence	High	Low
Detail on judgement process	Low	High
Scientific rigour	Low	High

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An anesthesiologist is covering the ICU of a community hospital and is called to the ED to see an elderly patient in septic shock. She has a history of recurrent urinary tract infections, and was brought in by her daughter following some 'bladder pain', back pain, nausea, vomiting and syncope. Blood and blood cultures were drawn, and a urine sample obtained shortly after arriving in the ED showed many leukocytes. She has since become hypotensive and was receiving fluid resuscitation when the anesthesiologist arrived in the ED. He noted the history and proceeded to examine the patient finding local swelling and tenderness in the left inguinal area. Radiology was called to do a bedside ultrasound which showed an iliac artery aneurysm. She was immediately transferred to the OR.

This case illustrates a good match between the task and the level of cognitive activity. The anesthesiologist recognizes the uncertainty and potential complexity of the case and steers his way around a variety of cognitive biases (see below), principal among which is premature diagnostic closure, to make the correct diagnosis. This is highly calibrated decision-making.

An anesthesiologist is finishing up a busy morning in an outpatient pain clinic. He has not yet had lunch and has just been paged with a reminder that he is due in the OR in 20 min. The last patient is a 29-yr-old male with low back pain whom he has seen in the past. The patient has a past medical history of degenerative disc disease and scoliosis. The clinic nurse's note says that the pain has increased over the last two days and that he has been seen recently at the ED of the local hospital. The clinic has accessed a copy of the ED chart in which the patient was described as a 'chronic management problem' at triage. The emergency physician comments in his notes that the patient has 'intractable pain' and that he was requesting to see a neurosurgeon. He also raises a concern that the patient might be 'drug-seeking'. After an examination, the anesthesiologist ordered an *im* injection of meperidine and dimenhydrinate and discharged the patient on oral analgesics. The patient presented later the same day to a tertiary care center where he was found to have saddle anesthesia and incontinence. He stated that he had been experiencing these symptoms since the previous day. He was diagnosed with cauda equina syndrome and taken to the OR where he underwent L4 laminectomy and L4-5 discectomy. However, saddle anesthesia persisted and he developed both neurogenic bladder and bowels, as well as neuropathic pain and a gait disturbance.

In contrast to the first case, there is an apparent mismatch here between the cognitive activity of the anesthesiologist and the task. Cognition and affect are covert activities and we can only guess at what the anesthesiologist was thinking and feeling. Clinical impressions may have been formed on the basis of this and previous exchanges with the patient, but these were not recorded on the chart. Perhaps he was influenced by the ED note and suspected malingering and drug seeking behaviour, or perhaps was disaffected with the patient for other reasons. Perhaps he had seen a series of patients with back pain and this case looked no more remarkable than the others. Perhaps he felt that the patient was being adequately monitored by his family physician, or had been adequately worked up at the recent ED visit. Perhaps he felt irritable and impatient at having missed lunch, or hurried by his need to get to the OR. Whatever the explanation, critical developments in the patient's condition appear to have been overlooked resulting in delayed treatment, and the patient's life was forever changed.

Optimal situational awareness occurs when physicians find the appropriate fit between cognitive level and task complexity - this in turn leads to good decision-making. When they achieve this they are referred to as well-calibrated and as having clinical acumen. Good decisions translate into safe care. However, in the area of patient safety the importance of clinical decision-making has received insufficient attention. To improve patient safety and maintain a high quality of care we need as many well-calibrated physicians as possible, and therefore need to find ways of optimizing clinical decision-making. How might we achieve this and what are the impediments?

Works in practice not in theory?

One thing we do know about decision-making is that experienced clinicians perform better than novices i.e., practice at clinical decision-making appears to improve performance. This fits with what we know about error type and provider proficiency. Over time there are progressively fewer knowledge-based errors (Figure). After an appropriate learning period, usually in the order of about five to ten years, rule acquisition is optimal and thereafter rule-based errors go into decline. The downside of becoming an expert is that skill-based errors gradually increase to a greater or lesser extent.

The most reasonable explanation for the improvements that we see over time is experience per se i.e., it does not appear that the decision-making of experienced clinicians improves because they have been reading about, or taking courses on critical thinking or decision-making. In fact, there is very little emphasis in medical training on decision-making, and precious few postgraduate or Continuing Medical Education

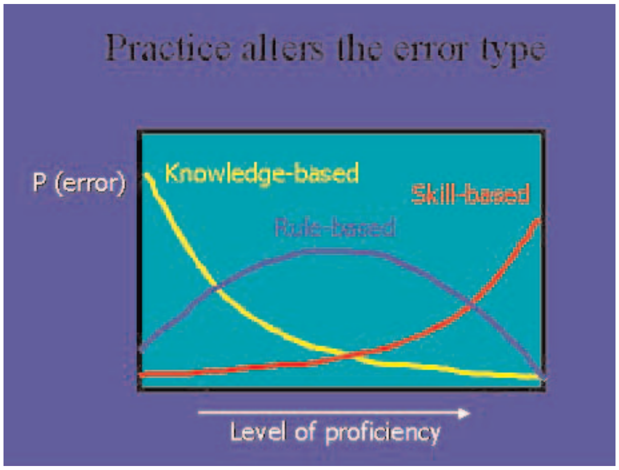

FIGURE The relationship between errors and provider proficiency according to error type. Reproduced with permission from Reason J: Overview of unsafe acts. Presented at the Second Halifax Symposium on Healthcare Error, October 2002, Dalhousie University, Halifax, Nova Scotia, Canada.

courses on the topic. Most clinicians have never taken such courses, and only a handful ever read articles on decision-making. For example, I recently conducted a three-question survey of 30 career emergency medicine physicians who work in a setting where decision density and level of uncertainty are arguably the highest in medicine. The survey asked about the last time they read a journal article or book explicitly on decision-making, if they read the journal Medical Decisionmaking, and how important they thought decision-making was in their practice. The response rate was 100%. Responses to the first question were: 1) within the last six months: 0%, 2) within the last year: 0%, 4) within the last five years: 20%, 5) not since residency training: 80%. For the second, the responses were: 1) yes: 3%, 2) no: 97%. For the third: 1) not very important: 0%, 2) moderately important: 0%, 3) very important: 100%.

There is a major disparity here. Despite an overwhelming consensus that clinical decision-making is important, there is little or no pursuit of the topic at an academic, or theoretical level. This is also evident in research. Over 60% of the lead authors for the 51 articles published in Medical Decisionmaking in 2004 were not physicians.

Olympians *vs* lesser mortals

Part of the explanation presumably resides in the models of decision-making that still prevail. Despite various caveats,[8,9] the academic/research position still appears to retain a statistical, formalized, quantitative notion of how people make decisions i.e., that they use quantitative formulas and techniques dispassionately, objectively, rationally, carefully weighing all the best evidence, in an environment where there is no lack of resources, no throughput pressures, no interruptions or distraction, optimal workplace ergonomics, good information technology, and when they are rested and well slept. This is an Olympian ideal that departs significantly from the cognitive reality. The lot of frontline clinicians is a more bounded rationality that is often far removed from what it is medical decision-making researchers think they do. Human factors engineers could have a field day in many clinical settings.[10]

The quantitative approach has detractors other than clinicians. One contrasting view is that thinking and decision-making is an adaptive process and that it is misleading to use the quantitative tools of the trade of scientific decision-making (logic, mathematics, and statistics) as models for thought. Instead, the effort should be directed at the adaptive function of thought and the effective use of heuristics.[11–14]

This polarization between quantitative and clinical approaches was addressed nearly 30 years ago,[15] and several times since, yet little appears to have changed. In fact, despite a growing awareness and assimilation of the importance of psychological factors in medicine by clinicians, there has been little corresponding acknowledgement by medical decision theorists. A variety of studies in the clinical setting have repeatedly demonstrated the importance of heuristics and biases in information processing and in establishing a diagnosis. Heuristics are rules of thumb, intuitions, abbreviations, simple judgements and short cuts. They are particularly prominent in the dynamic decision-making that characterizes the work of anesthesiologists, and are described in Gaba's cognitive model of anesthesiologists decision-making.[16] For example, if a patient becomes hypotensive during surgery the event can be heuristically categorized as a generic problem that leads to a generic action from a set of precompiled responses, even though the exact diagnosis may be unknown.[17] This approximation strategy allows a decision to be made and a corrective response to the patient's needs without invoking formal Bayesian reasoning.

Generally, such heuristics are effective but occasionally they fail. A patient undergoing a laparotomy, for example, became hypotensive with tachycardia. Despite there being no significant blood loss, the

TABLE II CDRs that may influence clinical decision-making

Aggregate bias	Gambler's fallacy	Premature closure
Anchoring	Gender bias	Psych-out error
Anticipated regret	Hindsight bias	Representativeness restraint
Ascertainment bias	Ignoring negative evidence	Search satisfying
Availability	Multiple alternatives bias	Sutton's slip
Base-rate neglect	Omission bias	Triage-cueing
Commission bias	Order effects	Unpacking principle
Confirmation bias	Outcome bias	Vertical line failure
Diagnosis momentum	Overconfidence bias	Visceral bias
Ego bias	Playing the odds	Ying-Yang out
Fundamental attribution error	Posterior probability error	Zebra retreat

Cognitive dispositions to respond (CDR) that may influence clinical decision-making. Many are derived from the three meta-heuristics: representativeness, availability, and adjustment and anchoring.[18] For further details see Croskerry.[20]

heuristic response was to give her fluids and a pressor agent, but her condition worsened. Consultation with a colleague drew attention to the fact that the patient had moderate aortic stenosis. 'Counter-intuitively' she was subsequently given a beta blocker, which, far from worsening her hypotension, instead lowered her heart rate, increased ventricular emptying, and improved her condition.[A]

Heuristics may be influenced by a variety of cognitive biases. For example, the fixation errors, a form of anchoring bias, have been well described in anesthesiologists.[17] Following the pioneer work of Tversky and Kahneman 30 years ago,[18] there has been a steady increase in the number of heuristics and biases acknowledged by clinicians to influence medical decision-making. Eight were described in 1987,[19] and by 2002 there were over 30.[20] Recently, the term cognitive disposition to respond (CDR) has been proposed to circumvent the negative associations of bias, sanction, fallacy, error, and other terms.[20,21] These are summarized in Table II.

The compendium does not include four further categories of bias that may arise in the course of diagnostic test evaluation: verification or work-up bias, diagnostic review bias, test review bias and incorporation bias,[3] nor does it include a number of affective biases that have been described.[22,23] Collectively, these known cognitive/affective and other biases in the diagnostic process would currently yield a total in excess of 40, and there are probably more.

A This case example was provided by Dr. Norman Buckley of the Department of Anesthesia at McMaster University, Hamilton, Ontario, Canada.

Clinical relevance *vs* scientific rigour

Despite the increasing relevance of these psychological phenomena to clinicians, they have been less than enthusiastically received, largely it seems because the underlying theory has been found lacking in rigour. Elstein's original clinical-statistical polarization[15] has been re-framed recently as one of clinical relevance *vs* scientific rigour i.e., without quantification and statistics there can be no scientific worth. A recent commentary observes: 'The broader community of medical decision-making researchers has not embraced the topic of heuristics and biases approach with sustained enthusiasm.'[24] More specifically, failure of the theory of heuristic strategies has been attributed to its weak predictive power, its inability to describe the judgement process in sufficient detail or to explain individual differences, and to its failure to assist physicians in improving their decision-making.[25] Thus, in the hands of those who might be best positioned to develop a robust theory and application of heuristic strategies, the work appears to have stalled.

Unfortunately, a similar inertia and pessimism also appears to have developed towards ways in which the undesirable effects of these cognitive biases might be undone i.e., debiasing strategies.[21,26] Again, this bind was articulated some time ago: '…the more it is insisted that a clinical situation cannot be analyzed in terms of risks and likelihoods, estimated however roughly, the more investigation in these terms is discouraged'.[15] Clinicians would appear to have inherited the worst of both worlds; not only are these issues not deemed worthy of study, but they could not be fixed anyway.

The discussion of limitations of heuristic theory is almost as though physicians have chosen this cognitive style out of scientific indolence or obtuseness. Instead, the tradition of heuristics in medicine was bred out of necessity. Before there was ever any evidence for any-thing in medicine, heuristics were all that guided the ancient practitioner. But even presently, there are often too many variables or unknowns in the clinical situation, too many ethical and financial restrictions, or too many other resource limitations to ever allow a simple quantitative approach to guide each clinical decision[27,28] - actuarial models simply cannot be applied in many clinical situations. For example, the safety and efficacy of approximately one third of all pediatric medications in use have not been established in children.[29] Where information is incomplete, where prospective, randomized, double- blind, multicentre clinical trials do not exist, or where the data may not be readily fitted to a Markov model or Monte Carlo assessment, the clinical imperative to diagnose and treat always remains.

The hard wiring problem

We turn now to the last part of the chicken story. As if the heuristics and biases problem didn't make the prospect of a comprehensive theory of clinical decision-making gloomy enough, several other considerations are beginning to further compound the issue. The first concerns instinctive behaviour. Instincts, in the ethological sense, are hard-wired chunks of inherited behaviour, and while it is readily accepted that animals have such inherited behaviour patterns, there is a palpable reluctance to accept the same of humans.

Yet, there are persuasive arguments that we may be hard-wired to respond to certain features of our environment as well as to processing information in predictable ways. Cognitive dispositions to respond appear to be widespread; they are not the sole proclivity of clinicians and are found in all walks of life. Their universality, indeed, suggests that the structure and function of the human brain has been as subject to Darwinian pressures of natural selection as other anatomical features - this is the central thesis of the burgeoning discipline of evolutionary psychology.[30] In effect, it says that we have innate cognitive dispositions to respond to elements in the environment in predictable ways, just as human factors engineers find that our physical bodies predictably interact with our immediate environment. If there is any feature of cognitive activity that might influence whether or not our genes get into the next generation, decision-making would appear to be a good bet - presumably good decision-makers have a higher rate of survival. Evolutionary success may then be a reflection of adaptive thinking.[11–14] Over 20 years ago, in a discussion of decision-making and the factorability of separate problems in the environment (hunger, fatigue, shelter, etc.) the Nobel prize-winner Herbert Simon offered this view on the descent of rationality.[8]

'If this factorability is not wholly descriptive of the world we live in today - and I will express some reservations about that - it certainly describes the world in which human rationality evolved: the world of the caveman's ancestors, and of the cavemen themselves. In that world, very little was happening most of the time, but periodically action had to be taken to deal with hunger, or to flee danger, or to secure protection against the coming winter. Rationality could focus on dealing with one or a few problems at a time, with the expectation that when other problems arose there would be time to deal with those too.'

Compelling evidence for the inheritance of behaviour is already in. For example, identical twins are similar to each other in virtually all measurable traits, including personality, whether reared together or apart.[31] In the general population, all five of the major personality dimensions (neurotiscism, extraversion, openness to experience, agreeableness, and conscientiousness) are inheritable, with about 50% of the variation in a typical population explained by differences in genes.[31] Personality variables have been shown to be important in such qualities as leadership, job performance, and career success,[32] all presumably depending upon effective decision-making. It has long been recognized that medical specialties are associated with personality differences.[33–36] As a group, anesthesiologists were found to be shy, withdrawn, inhibited, and cold, whereas surgeons were confident, domineering, aggressive, egotistical, arrogant and meticulous.[33] In a recent study, anesthesiologists scored significantly higher on the dimension of vigilance (suspiciousness and skepticism) than surgeons, whereas surgeons scored significantly higher than anesthesiologists on tough-mindedness (less open to other viewpoints, decisive, aloof, enterprising, resilient).[36] Notwithstanding the occasional brawl or homicide in the OR,[37] it would be surprising if such differences in personality were not associated with different styles of decision-making. Surveys have described coercive pressure from surgeons to proceed with surgery even when the anesthesiologist has deemed it to be unsafe,[38] and surgeons are less likely than anesthesiologists to accept that stress, fatigue or personal problems have an impact on decision-making and performance.[39] In another study, warping of probability estimations was attributed to ego bias in surgeons.[40]

Another major variable typically not factored into quantitative decision theory is physician gender. In one study, female physicians were found to have more apprehension, less self-assurance, and worried more than their male counterparts.[36] Physician gender is associated with different personality characteristics,[41,42] either innate or learned, and several studies have pointed towards a gender impact on decision-making.[43–46] Gender is generally associated with risk-taking behaviour[47] which may explain the finding that missed diagnosis of an acute coronary syndrome in the ED is more likely to happen with a male physician than a female.[48]

If we come to accept that certain CDRs are, indeed, hard-wired, there are important implications for medical decision-making researchers and educationists. If heuristic strategies are the stuff upon which cognition evolved, the current view of medical decision-making theorists that the theory is of insufficient scientific rigour becomes increasingly untenable. Further, it places an even stronger imperative on the need for research into de-biasing strategies - finding ways of undoing our innate tendencies that evolved in simpler times and which now may be counter productive in modern medicine. A variety of cognitive de-biasing strategies has been described,[21] and renewed vigour and imagination is required to systematically explore these options. Some recent initiatives are encouraging. For example, it appears that even something as basic as opinion surveys can be preened of bias with relatively little effort - a simple Bayesian maneuver providing greater reliability in subjective responses.[49] Another promising development has been the use of simulation training to teach residents cognitive forcing strategies[26] to avoid common cognitive pitfalls.[50] Affective forcing strategies might similarly be trained to avoid predictable affective pitfalls. Simulation is not clinical experience, but it may be vicariously sufficient to shorten the road to clinical acumen.

In the meantime, there is the pressing problem of lack of insight and awareness of CDRs in medicine. Even experienced clinicians often register surprise when they are pointed out to them. Therefore, there is an ongoing need to educate medical students and postgraduates about CDRs to give them insight into their decision-making. These educational initiatives are underway[20,51,52] but are not yet sufficiently widespread.

Towards a universal theory of decision-making

It is clear that in the field of medical decision-making, one approach does not fit all. Certain tasks will require more or less of an intuitive or an analytical approach. There will always be a gradient of decision-making that parallels the degree of uncertainty associated with the wide variety of patient conditions, and which are to some extent discipline-specific. Oncologists, for example, are not found in EDs waiting to diagnose the very occasional colon cancer that might come through the doors as an undifferentiated abdominal pain. In their world, much of the uncertainty about diagnosis has already been removed by the time they see the patient, and decision-making is about staging the disease and choice of appropriate treatment. In contrast, anesthesiologists engage in a variety of domains, the degree of uncertainty varying considerably across the various settings in which they practice. Uncertainty will generally be lower in the OR than in the ED. The successful decision-maker will be one who has an ergonomically optimized workplace, is well rested and well slept, is not driven by throughput pressures, is aware of the various cognitive and affective biases, and is able to safely blend cognitive intuitive and analytical styles according to the particular task at hand. This last is especially important. It invokes the concept of situational awareness - knowing what has gone before, what is happening now, anticipating what is coming, and then having one's cognitive engine in the right gear. Occasionally, it may have to be metacognitively kicked up a notch to match the situation.

Conclusion

Decision-making is a critical area in anesthesia and important in all disciplines in medicine. Besides basic training in formal decision-making we need to ensure that undergraduates and postgraduates have adequate training in critical thinking, problem solving, and a working understanding of the multiple cognitive and affective biases to which they might be vulnerable. Medical decision theorists, for their part, need to reevaluate their models to take greater cognizance of non-actuarial factors in clinical judgement. What is required at the end of the day is a closer, collaborative approach. To be clinically real and relevant, a multidisciplinary effort is required involving clinicians, medical decision-making researchers, human factors engineers, cognitive, social, and evolutionary psychologists, psychiatrists and others.

Acknowledgements

The author is indebted to Sherri Lamont at the Emergency Department, Dartmouth General Hospital for technical assistance. Support through a Senior Clinical Fellowship from Dalhousie University is gratefully acknowledged.

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