Errors in clinical reasoning: causes and remedial strategies

Everyone makes mistakes, but greater awareness of the causes would help clinicians to avoid many of them, as **Ian Scott** explains

Most errors in clinical reasoning are not due to incompetence or inadequate knowledge but to frailty of human thinking under conditions of complexity, uncertainty, and pressure of time. To minimise such cognitive error we need to understand its prevalence and causes. In this article I discuss why errors occur and describe strategies that may help avoid them.

Prevalence of reasoning error

The first step to optimal care is making the correct diagnosis, which is missed or delayed in between 5% and 14% of acute hospital admissions.[1 2] Autopsy studies confirm diagnostic error rates of 10-20%,[3 4] with autopsy disclosing previously undiagnosed problems in up to 25% of cases.[3] Even if the diagnosis is correct, up to 45% of patients with acute or chronic medical conditions do not receive recommended evidence based care,[5] while between 20% and 30% of administered investigations and drugs are potentially unnecessary.[6] Clinicians are sometimes less willing to adopt new beneficial interventions than to abandon old ineffective ones.[7]

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The extent to which these deficits relate directly to reasoning error by clinicians, rather than environmental determinants beyond their control, remains uncertain, although recent studies of adverse events in hospital patients may give some indication.[8 9] A third of the identified adverse events involved errors of execution (slips, lapses, or oversights in carrying out appropriate management in correctly diagnosed patients), but almost half involved errors of reasoning or decision quality (failure to elicit, synthesise, decide, or act on clinical information). Such reasoning errors led to death or permanent disability in at least 25% of cases, and at least three quarters were deemed highly preventable.[9]

Of some concern is the discrepancy between prevalence of reasoning error and clinicians' appreciation of the scale and causes of the problem. For example, no more than 10% of clinicians admit, when asked, to any error in diagnosis over the past year,[10] and 40% of diagnoses about which clinicians were certain were proved wrong at autopsy.[11] Clinicians often stay wedded to an incorrect diagnosis, even if the correct one is suggested by colleagues or by decision support tools.[12] In terms of management, no correlation exists between actual rates of guideline concordance and how closely clinicians perceive themselves as adhering to guidelines.[13 14] Being an older and presumably more experienced clinician also does not guarantee better quality care[w1] or lower risk of reasoning error.[w2]

Cognitive psychology of clinical reasoning

More research has focused on diagnostic reasoning than on management (or treatment) reasoning,[w3] but the cognitive psychology of both share common properties. Diagnosis begins with acquisition of data through history taking and clinical examination. Clinicians use these data, almost subconsciously, to frame or contextualise the patient's problem as a clinically meaningful representation. They then use various semantic or abstract linkages[w4] to transform individual clinical findings into coherent clinical syndromes or schemes that then inductively trigger one or more diagnostic ideas. For many previously encountered problems, experienced clinicians then proceed in a non-analytical fashion, relying on pattern recognition—selecting the best match from a large mental library of example cases.[w5] The diagnosis is then verified quickly through a small number of confirmatory inquiries.

In more novel, ambiguous, or complex situations, clinicians switch to a more analytical mode of reasoning. Several diagnostic ideas are iteratively tested by slower, deliberate, and selective gathering of additional data that, by a process of deduction, narrows the list of possibilities towards the provisional diagnosis.[w6] Diagnosis is then verified according to whether the observed natural course, results of investigations, or initial response to treatment corresponds to what is expected for the assumed diagnosis. Novice clinicians may complement this

Box 1 | Commonly stated explanations for decision errors

Errors in diagnosis

- It (the correct diagnosis) never crossed my mind
- I paid too much attention to one finding, especially laboratory results
- I did not listen enough to the patient's story
- I was in too much of a hurry
- I didn't know enough about the disease
- I let the consultant or specialist convince me
- I didn't reassess the situation when things didn't fit
- The patient had too many problems at once
- I was overly influenced by a similar case
- I failed to convince the patient to have further investigations
- I was in denial of an upsetting diagnosis

Errors in management

- The treatment seemed to work well on the last patient who had the same problem
- Most of my colleagues were very keen on this new drug so I used it too
- I was too concerned about possible side effects and underestimated the potential benefit of treating with drug x.
- I thought I should be seen to be doing something, even though I knew the treatment had little chance of success
- I had so many therapeutic options to choose from, and as I wasn't sure which one would work best, I stuck with the one I was most familiar with
- I did not fully appreciate how difficult it would be for the patient to stick to my advice
- I wasn't as aggressive as I should have been in treating this patient's hypertension and hyperlipidaemia as I didn't appreciate just how high his risk was of an adverse outcome

method with other types of reasoning based on pathophysiological principles or algorithmic approaches.[w7]

Management reasoning can be similarly conceptualised. A diagnosis will lead the clinician to frame or contextualise basic management goals with the aim of controlling symptoms, avoiding clinical complications, or simply reassuring and monitoring the patient. For common, straightforward diagnoses for which there are well known effective treatments, the appropriate management options will come quickly and intuitively from imprinted care patterns or "mindlines."[w8] But if the disease is unfamiliar to the clinician or there are competing treatment risks or comorbidities, selection of management options will proceed more analytically, with explicit weighing up of the pros and cons of different treatments in light of the patient's circumstances and preferences.[w9 w10]

Sources of cognitive error

Irrespective of whether diagnosis or management is the focus, or whether analytical or non-analytical reasoning modes predominate, all decision making is vulnerable to different forms of cognitive and affective (emotional) bias or error.[w11-w13] With the benefit of hindsight, clinicians will offer various explanations for wrong decisions (box 1),[w13 w14] many of which relate to embedded ways of thinking, including the use of mental heuristics (maxims, shortcuts, rules of thumb). These heuristics are very efficient and accurate in many situations (box 2) but can sometimes predispose to wrong decisions.[15]

Other forms of bias can be internal to the clinician (such as value bias based on the clinician's beliefs and values,[w15] expectation bias based on what the clinician expects of the patient-doctor relationship,[w16] agency bias in which clinicians put their interests ahead of those of the patient,[w17] and affective bias arising from clinicians' emotions and personality[w18]), or external (such as social bias contingent on past professional socialisation and influence of peer opinion,[w19] and externality bias due to constraints of time, resources, and skill[w20]). Also highly relevant is the presence or absence of ill health, fatigue, interruptions, and time pressure, which can blunt attention span and fracture cognitive integrity.[w21] The successful decision maker has to reconcile these, at times, dissonant internal and external worlds and select the most appropriate form of reasoning for the decision requirements at the time.

Box 2 | Commonly used heuristics

- If it looks like a duck, sounds like a duck, and walks like a duck, it is a duck
- Common conditions occur commonly (including their atypical variants): "If you hear hoof beats, don't think zebras"
- Look for a single diagnosis that can explain all the findings (Occam's razor)
- Favour a diagnosis (or choose diagnostic investigations) that explains the clinical findings (or are most likely to verify the diagnosis)—go where the money is (Sutton's law)
- The best medicine may be to do nothing—first do no harm
- Treat the patient, not the numbers

Types and examples of reasoning error

More than 40 forms of cognitive error have now been described,[16] and several texts and articles explore these in depth using narrative case studies.[w22-w24] Tables 1 and 2 (see bmj.com) define the commonest errors in diagnostic[w25-w30] and management[w9 w10 w31-w37] reasoning and provide examples. Many error types are inter-related, and more than one can feature in a patient's care. Importantly, deficiencies in medical knowledge are rarely responsible for diagnostic errors, with premature acceptance of the most favoured diagnosis being highly prevalent (up to 90%) and independent of level of expertise.[w29] Similarly, cognitive resistance to altering past habits and mindsets has a much more prominent role than ignorance in errors of management reasoning.[w37 w38]

Strategies for preventing reasoning error

At the system level several interventions can improve decision quality:

- Good training and ongoing professional development programmes that expand clinical expertise, using both didactic and experiential teaching
- Collegiate ethos of seeking second opinions and advice without fear of ridicule
- Educational outreach by respected and seasoned peers[w39]
- Clinical decision support systems that remind and prompt clinicians to consider evidence based recommendations and clinical decision rules[w40]
- Robust handover and information

Examples of errors in diagnostic and management reasoning

Cognitive error	Description and effects	Example	Debiasing strategy[15 16 w21-w23]
Diagnostic			
Availability heuristic[w25]	Tendency to accept a diagnosis because of ease in recalling a past similar case rather than on the basis of prevalence or probability	Clinician sees a 40 year old woman with left calf pain which is ultimately diagnosed as secondary to myosarcoma. He subsequently evaluates all patients with calf pain for myosarcoma because of the vividness of recall of the previous case	Verify prevalence based on proper statistics; pay attention to base rates
Anchoring heuristic[w27]	Tendency to fixate on first impressions—selected symptoms or signs or simple investigation results as predictors of specific diagnosis	A 72 year old woman with back pain has compression vertebral fracture diagnosed on plain radiography. Her normocytic anaemia is attributed to myelodysplastic syndrome. These diagnoses based on first impressions inhibit consideration of an alternative and ultimately correct diagnosis of multiple myeloma with bony involvement	Think beyond the most favoured; reconsider in light of new data or unexpected course of illness that challenges initial diagnosis
Premature closure[w29]	Acceptance of a diagnosis before it has been fully verified by considering alternative diagnoses and searching for data that challenge the provisional diagnosis	A 55 year old heavy smoker with poorly controlled diabetes presents with protracted vomiting. His clinician, suspecting diabetic gastroparesis, requests abdominal radiography, which shows a large gastric air bubble. Considering the diagnosis confirmed, he fails to consider neurological causes of vomiting and misses findings of bilateral papilloedema and central ataxia. Subsequent computed tomography of the head shows multiple enhancing lesions in the posterior fossa	Reconsider the case when refreshed and less distracted; consider extremes or "red flags": "What's the diagnosis I don't want to miss?"
Management			
Framing effect[w30]	Tendency for benefits and risks to be perceived differently if expressed in relative versus absolute terms or death versus survival	A drug company representative tells a receptive clinician that his new antihypertensive drug, in mild to moderate hypertension, can reduce the risk of stroke by 30% compared with current therapies, but fails to add that this represents an absolute risk reduction of only 1% over 5 years, which means 100 people would need to be treated for 5 years to prevent one stroke	Consider both relative and absolute risk reduction and number needed to treat
Commission bias[w32]	Tendency to do something (or seen to be doing something) even if intended actions are not supported by robust evidence and may in fact do harm	An 18 year old girl is brought to hospital by her worried parents with severe headache, fever, and rhinorrhoea. Physical examination shows no evidence of meningitis and routine blood tests give normal results with no neutrophilia. Her parents are keen for a lumbar puncture to exclude meningococcal disease. Reluctantly, the clinician accedes to their wish but analysis gives normal results. Subsequently the patient develops severe post-lumbar puncture headache and has to stay in hospital for another four days, requiring an epidural blood patch to relieve symptoms	Consider evidence for prescribing all treatments (including non-drug, non-device treatments): "Am I treating the patient or myself?"
Extrapolation error[w36]	Tendency to generalise treatment experiences and clinical trial results to groups of patients in whom the treatment has not been properly evaluated	A 70 year old patient with ischaemic cardiomyopathy (ejection fraction 35%) and chronic renal failure (serum creatinine 350 mmol/l), is prescribed spironolactone in addition to an angiotensin converting enzyme inhibitor and β blocker on the basis of trials showing its survival benefit in heart failure. He presents two weeks later with cardiac arrest secondary to hyperkalaemia, an adverse effect not disclosed in the original trials, which had excluded patients with renal insufficiency or ejection fractions over 30%	Ensure treatments have been evaluated in different patient subgroups

systems providing seamless transmission of patient data and clinician reasoning from one individual clinician or team to another[w41]

- Feedback in the form of clinical audits, mortality and morbidity reviews, and sentinel event analyses in which causes and consequences of faulty decisions can be discussed openly and dispassionately.[w42]

Feedback is especially important given observations that clinicians are not good at assessing their own performance.[w43]

At the level of the individual clinician, maintaining continuity of care with individual patients over the long term ensures awareness of past mistakes that take time to emerge.[w44] Another strategy is for clinicians to develop an understanding of basic error theory and skills in meta-cognition—that is, thinking about their thinking.[w45-w47] Being able to critique your own reasoning, particularly in circumstances where error is more likely to occur (situational awareness) and to activate thought processes that make decisions less susceptible to bias and error (debiasing strategies) are valuable skills. Croskerry has proposed cognitive approaches that can be generic (being familiar with major types of reasoning error and the debiasing strategies that may be applied) and specific (being aware of specific clinical scenarios in which classic errors are more predictably made and selecting the most appropriate debiasing strategy in response).[15]

Common clinical scenarios associated with increased risk of diagnostic error include back pain in presence of known malignancy, wherein anchoring may cause osteoarthritis and other common causes of mechanical back pain to be considered over metastatic spinal disease; and patients with dyspnoea, raised jugular venous pressure, and hypotension for whom systolic heart failure is prematurely accepted as the diagnosis when pulmonary thromboembolism and cardiac tamponade can present with similar features. Similarly, for management error patients with atrial fibrillation may have anticoagulant therapy withheld because of overestimation of bleeding risk (omission bias, regret bias) or inconvenience to the patient or doctor from long term monitoring (contextual error, clinical inertia); and patients with end stage heart failure or lung disease may receive inappropriately aggressive treatment (commission bias) when end of life supportive care may be more suitable. Box 3 (see bmj.com) gives further examples.

Croskerry[15 16] and others[w22 w24] have developed several corrective (or debiasing) strategies for minimising errors of reasoning (table). Although this approach has face validity and is being adopted in think aloud simulation exercises,[w48] clinical coaching,[w49] and hypothetical vignettes,[w50] its effectiveness in preventing error is yet to be evaluated and unintended consequences are possible. These include decisional delays ("paralysis by analysis" or

constant second guessing), increase in unnecessary investigations in response to expanded lists of differential diagnoses, patient anxiety arising from clinicians' expressions of uncertainty, and more errors as more investigative and treatment options have to be considered.[w51] More effort may also be needed to deal with negative emotions and cognitive impairment arising from work stress and personal predispositions that cause clinicians to jump to wrong decisions.[w52]

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Implications for clinical training

It is important that experienced clinicians act as role models in good clinical reasoning and explicitly discuss how they arrive at the decisions they have made. This requires "thinking out loud" as they grapple with clinical problems in real time, articulating problem representations, highlighting pivotal or key features in diagnosis and management, and explaining the pros and cons of different courses of action.[17-19] The approach should be used not only for cases solved successfully but for cases characterised by blind alleys and false starts.

Students should learn about how cognitive biases can mislead and be taught simple corrective maxims to lessen their effects, including judicious application of evidence based medicine and clinical decision support. Novice clinicians need to be encouraged to think and question using a democratic (not authoritarian) style and to have their reasoning heard and appraised with specific, timely, and constructive feedback that avoids harsh judgments based on hindsight. Finally patients, families, and carers need to be encouraged to help improve decision quality by being aware of circumstances pertaining to themselves (such as a tendency towards hypochondriasis) or to the environment (busy emergency department where staff may be overworked) which predispose to clinician error, to participate in decision making and sound the warning bell if they feel at risk,[20] and accept a certain level of uncertainty when the right course of action is not immediately obvious.

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ANSWERS TO ENDGAMES, p 55. For long answers use advanced search at bmj.com and enter question details

PICTURE QUIZ

Fast and furious

1 Figure 1 shows a supraventricular arrhythmia that could, on the basis of the adenosine test, be either atrial flutter or a focal atrial tachycardia. The adenosine test revealed regular organised atrial activity, which is actually flutter waves occurring at a rate of approximately 250 per min. This activity constitutes atrial flutter with 1:1 conduction. There is also intermittent atrioventricular block with the adenosine, although the rapid ventricular response rate eventually resumes.

2 The use of flecainide—alone, without a rate limiting drug such as a β blocker or calcium channel blocker—to treat this patient's atrial fibrillation could be responsible for his presentation. Flecainide to treat atrial fibrillation raises the risk of atrial flutter and can also increase the ventricular response rate to atrial activity during the arrhythmia. The regular atrial activity shown by the adenosine test rules out atrial fibrillation in this patient. The results of the adenosine test also make atrioventricular re-entrant tachycardia or atrioventricular nodal re-entrant tachycardia much less likely, as these arrhythmias incorporate the atrioventricular node as part of the circuit and so tend to terminate when the atrioventricular node is blocked. Atrial flutter and focal atrial tachycardia are thus the main differential diagnoses. The fact that the patient had been taking flecainide for his atrial fibrillation makes it more likely that the arrhythmia is actually atrial flutter.

STATISTICAL QUESTION

Correlation

None