

Educational strategies to reduce diagnostic error: can you teach this stuff?

Mark L. Graber

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Abstract Diagnostic error typically involves both system-related and cognitive root causes. Educational interventions are proposed to address both of these dimensions: In regard to system-related origins, education should focus on communication skills, including handoffs. In regard to cognitive shortcomings, educators need to consider both normative approaches to decision making, as well as the ‘flesh and blood’ processes used by experienced clinicians. In the long term, the goal of education should be to promote expertise, based on the assumption that experts make the fewest mistakes. In the short term, education should emphasize the importance of reflective practice, and consider use of a checklist for diagnosis to improve reliability.

Keywords Health care quality · Patient safety · Diagnostic error · Education · Expertise

Introduction

According to the best evidence, the rate of diagnostic error in medicine is likely to be in the range of 5–15% (Berner and Graber 2008). The past decade has seen an awakening of interest in these errors, and substantial progress in understanding how they occur. With this understanding comes the hope that appropriate interventions can be considered that would reduce the likelihood of error. This paper considers educational strategies directed at this goal.

Diagnostic errors typically reflect multiple ‘root causes’. In a study involving diagnostic errors in internal medicine, an average of 6 such causes were identified per case (Graber et al. 2005). Roughly two-thirds of these root causes involved system-related factors. For example, coordination of care may be less than ideal, or an abnormal result from a

M. L. Graber (✉)
Medical Service, VAMC Northport, Northport, NY, USA
e-mail: Mark.Graber@med.va.gov

M. L. Graber
Department of Medicine, SUNY at Stony Brook, Stony Brook, NY, USA

diagnostic test is missed by the provider. Similarly, roughly two-thirds of the root causes involved cognitive elements: We did not gather the relevant data optimally or we failed to synthesize the data correctly (the most common problem). Knowledge deficits per se are actually quite unusual in mature clinicians, although medical trainees will obviously be at higher risk in this regard. Both system-related and cognitive errors could potentially be reduced through appropriate education.

Education for system-related error

The obvious target in regard to system-related errors are the communication breakdowns that contribute to diagnostic error. These can involve patient-to-physician communication or communication amongst physicians and other healthcare providers. For medical trainees, especially in the setting of restricted work hours and frequent shift changes, handoffs from one provider to another are critical to ensure reliable diagnosis. To the extent that handoffs are too brief or inaccurate, the opportunity for error increases.

There is substantial evidence that communication skills can be increased through appropriate training, and formal courses have been constructed to develop these skills, such as the physician-directed courses offered by the Bayer Institute for Healthcare Communication (<http://www.healthcarecomm.org/index.php?sec=courses>) or the Institute for Healthcare Improvement (<http://www.ihl.org/IHI/Programs/IHIOpenSchool>). Many new tools to improve communication skills have also recently been developed, such as techniques for improved hand-offs and standardized communication tools such as the SBAR process (Kemp et al. 2008). To the extent that we can incorporate them into our training curricula, these new strategies to improve communication represent a major opportunity to reduce medical error by educational interventions. Team training is a second intervention that improves coordination of care, and might be helpful to explore as an approach to reducing system-related diagnostic error.

Education for cognitive error

The larger challenge is to develop and use educational interventions to reduce cognitive errors in diagnosis. This responsibility clearly falls to schools of medicine and their clinical departments, which exist to develop students, residents and fellows who are highly competent in both diagnosis and management.

Normative approaches

Training programs have traditionally encouraged students to use normative approaches to consider hypotheses and prioritize them (Goss 1996; Kassirer and Kopelman 1991). A normative process refers to how a process should be done ideally. In the context of medical decision making, it refers to an approach that would have the highest probability (but no guarantee) of arriving at the correct diagnosis. The normative approach begins by compiling a list of all the diagnostic possibilities. Trainees are repeatedly exposed to this step in 'morning report' and similar didactic sessions where more senior clinicians help them derive an exhaustive 'differential diagnosis' list. The next step is to find or estimate the likelihood of each diagnostic possibility, and the consequences of making/missing

any one particular diagnosis. The list is then narrowed using appropriate diagnostic tests and Bayesian probability adjustments to determine the diagnosis with the highest probability.

Despite the allure of normative approaches, they are used infrequently in practice. The reasons are many: First, the approach itself is complex. Clinician's eyes glaze over when asked to explain Bayes Theorem. Second, using a normative approach requires definitive data on the base rates of disease in our own population of patients and the characteristics of every diagnostic test we might apply. These data typically are not available. Third, normative techniques work well on cases with a single issue that needs resolution, but as Wears and Croskerry point out in this issue, some clinical cases are just too complicated (Wears 2009; Croskerry 2009). And finally, who would teach it? Even in schools that boast of master diagnosticians, few of these use normative approaches themselves, and so students lack role models to emulate.

Flesh and blood decision making

To the extent that we are knowledgeable and experienced, the likely diagnosis in a given case emerges easily and there is a high likelihood that this diagnosis will be correct (Coderre et al. 2003). The current paradigm of how we arrive at a diagnosis is best described as a *dual-process* model, part automatic and part conscious. (Croskerry (2009), and Norman (2009)) The automatic, subconscious process solves the common problems (System 1), whereas conscious, rational and analytical cognition is available to check on the solutions to these easy problems or as a primary resource for problems that do not lend themselves to automatic solutions (System 2). To reduce the cognitive problems that lead to diagnostic errors, trainees must learn how these 'flesh and blood' decisions are made, the inherent shortcomings that are inevitably involved, and how to overcome these (Hall 2002).

The development of expertise: a framework for considering educational interventions

As medical students learn the basic and clinical sciences, they can use deductive reasoning to solve clinical problems. This is a difficult task, and highly error prone. At the other end of the spectrum are medical experts, with a complete knowledge base and extensive experience. These clinicians typically solve clinical problems with ease and the lowest likelihood of error. Between these two extremes, most clinicians use some combination of System I or System II approaches, with intermediate levels of effort and error propensity. This framework is described in (Fig. 1), which illustrates how reliability improves and effort decreases as medical diagnosticians acquire ever more expert skills. This relationship suggests two possible educational strategies to improve the reliability of medical diagnosis. One approach is to improve diagnostic reliability by improving our expertise, a long-term plan. In the short term, the reliability of medical diagnosis can potentially be improved by invoking the conscious mind, stopping to think. Conscious, reflective review allows a cross-check of the results derived from our subconscious 'cognitive dispositions to respond' (Croskerry 2003a, b). It provides the opportunity to catch errors by consciously considering alternatives, being more comprehensive, and recognizing and addressing the shortcomings of heuristic problem solving. We can now consider these two approaches in more detail:

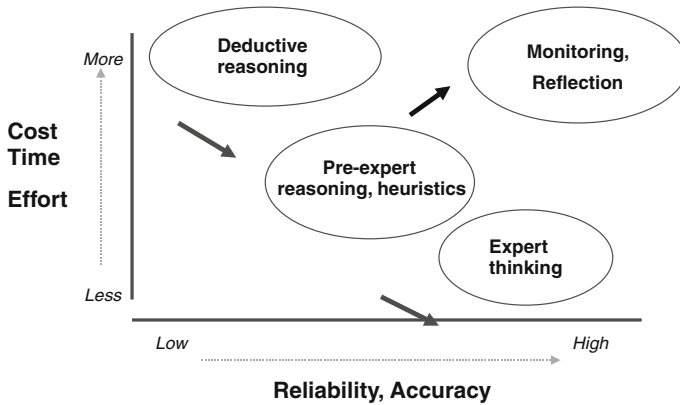


Fig. 1 The relationships between reliability and cost in diagnostic decision making. As clinicians improve their diagnostic competency from beginning level skills (use of deductive reasoning) to intermediate levels (use of heuristics) to expert level skills, reliability and accuracy improve and with *decreased* cost and effort (*descending arrows*). In any given case we can improve diagnostic accuracy by using conscious thought for monitoring, considering alternatives, and other strategies to improve the likelihood of arriving at the correct diagnosis

The long view: improving the reliability of diagnosis by enhancing expertise

Experts, by definition, perform at the highest levels of diagnostic proficiency. Their expertise reflects the acquisition of a complete skill set (for example, interviewing and physical examination skills), and a sizeable base of knowledge and experience (Norman 2006). Diagnosis often depends on recognizing that the key features of a new case resemble patterns from previous cases that the clinician has seen, and experts typically have the largest repertoire of such cases to call upon. Not only do they make the fewest errors, most experts arrive at a diagnosis almost instantaneously with little or no apparent effort.

Efforts to increase expertise therefore hold outstanding potential to reduce diagnostic error in medicine, but such interventions require a long-term investment spanning the many years of medical training:

Undergraduate trainees need to focus on acquiring the knowledge base and skill set to allow reliable diagnosis. To begin with, it is essential that students acquire high levels of competency in obtaining an accurate medical history and performing an informative physical examination. As reviewed below, these competencies are not always attained. These skills, combined with a growing knowledge base, allow them to recognize the patterns of syndromes and illnesses that make up the building blocks of medical diagnosis (Bowen 2006).

Residents and fellows have already acquired a wide range of competencies. The studies of how expertise develops in other fields suggests that further skill development is possible, but requires extensive practice combined with formative feedback (Ericsson 2008). The challenge to medical educators is to apply these principles effectively in postgraduate medical education. Take, for example, the diagnosis of congestive heart failure. How many cases does a trainee need to see to develop expert levels of diagnostic competency? The answer is not known for even this classic example, let alone the many hundreds of other diseases a clinician will encounter. Not only do trainees need exposure to a sufficient

number of ‘classical’ cases, they must also see atypical cases that span the spectrum of disease presentations. A novel approach to meet such ‘rich’ bases of experience would be to supplement actual cases encountered in training with simulated cases. This would be, for example, an ideal way to provide exposure to diseases and syndromes that are not well represented in the clinics or on the inpatient wards (Satish and Streufert 2002; Bond et al. 2004).

Encouraging sub-specialization

Although health economists clamor for more generalists and primary care providers, if one considers diagnostic reliability as a more important goal than access to care, a case can be made for just the opposite. To the extent that subspecialists become ever-more expert in ever-more focused fields, it might be expected that diagnostic error rates could be minimized by directing patients to true experts regarding their particular problem, so long as each patient is sent to the appropriate expert.

What can I do today? Improving the reliability of diagnosis through conscious, reflective thought

General tips on improving diagnostic reliability have recently been offered in the form of “Twelve Tips”, and the “Ten Commandments”—both attached as appendices (Trowbridge 2008). Both of these offer sage advice and incorporate the recommendation to use conscious, reflective review to optimize clinical decision making. Conscious, reflective review offers the best hope of improving diagnostic reliability in the short term, by providing corrective oversight to the automatic processing that underlies so many diagnostic errors. An essential pre-requisite to using reflection effectively is to recognize and understand the most likely diagnostic pitfalls, in particular the many ‘cognitive dispositions to respond’ that characterize our subconscious problem solving (Croskerry 2003a, b).

We suggest that students learn to use a simple checklist for the diagnostic process. (Fig. 2) This incorporates the classical elements (taking a complete history, performing a focused exam, and comprehensive consideration of possible diagnoses) and adds in the key concepts of reflection and establishing a feedback loop (Schiff 2008) to help augment diagnostic reliability and minimize the chance of harm from a diagnostic error. Regular use of a checklist would systematize these practices and help ensure that none of the steps are omitted. Checklists have an established record of improving reliable performance in a wide

- Obtain a **complete** history and use this to generate initial hypotheses
- Perform a comprehensive but focused & purposeful physical examination
- Use a systematic approach to obtain diagnostic possibilities to be considered
- Take time to pause and reflect
- Embark on the plan but acknowledge uncertainty and **ensure pathways for follow up**

Fig. 2 A checklist for reliable diagnosis

variety of professions and settings, and this possibility is worthy of testing in regard to medical diagnosis.

In conclusion, our current understanding of diagnostic error in medicine incorporates both system- and the cognitive-related etiologies. Both of these could potentially be minimized by appropriate educational interventions. Educators should provide training on communication and coordination of care to help minimize the system-related contributions to error. The cognitive contributions are more complex, but in our view can be effectively targeted by teaching the antidotes to our subconscious decision-making tendencies, and incorporating their conscious review as part of a diagnostic check list that also ensures the completion of the other essential steps needed for reliable diagnosis. In the long view, educational interventions that build expertise should also be effective in reducing diagnostic errors.

Appendix: Twelve tips for teaching avoidance of diagnostic errors (Trowbridge 2008)

Robert Trowbridge

1. Explicitly describe heuristics and how they affect clinical reasoning.
2. Promote the use of 'diagnostic timeout's.
3. Promote the practice of 'worst case scenario medicine'.
4. Promote the use of a systematic approach to common problems.
5. Ask why.
6. Teach and emphasize the value of the clinical exam.
7. Teach Bayesian theory as a way to direct the clinical evaluation and avoid premature closure.
8. Acknowledge how the patient makes the clinician feel.
9. Encourage learners to find clinical data that doesn't fit with a provisional diagnosis; Ask "What can't we explain?"
10. Embrace Zebras.
11. Encourage learners to slow down.
12. Admit one's own mistakes.

Ten commandments to reduce cognitive errors

Leo Leonidas MD (Pediatrics, Maine)

1. Thou shalt reflect on how you think and decide.
2. Thou shalt not rely on your memory when making critical decisions.
3. Thou shalt make your working environment information-friendly by using the latest wireless technology such as the Tablet PC and PDA.
4. Thou shalt consider other possibilities even though you are sure of your first diagnosis.
5. Thou shalt know Bayesian probability and the epidemiology of the diseases in your differential diagnosis.
6. Thou shalt mentally rehearse common and serious conditions that you expect to see in your specialty.

7. Thou shalt ask yourself if you are the right person to make the final decision or a specialist after considering the patient's values and wishes.
8. Thou shalt take time to decide and not be pressured by anyone.
9. Thou shalt create accountability procedures and follow up for decisions made.
10. Thou shalt record in a relational data base software your patient's problems and decisions for review and improvement.

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