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Diagnostic Reasoning as a Medium for Promoting Patient Safety

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ABSTRACT

Introduction: Diagnostic reasoning is a key skill practised by clinicians. It is a process by which correct clinical diagnosis is reached. Learning theories offer some guidance on how this cognitive skill is best taught; what curriculum best supports it and how it is learned and used by expert and novice learners. Novice and expert learners have different needs when it comes to developing this skill. This paper aims to explore the unique role of the medical educator; exploring how they facilitate diagnostic reasoning amongst learners with an emphasis on improving patient safety.

Materials and Methods: The bibliography assembled for this literature review includes original articles, quantitative and qualitative papers, narrative review articles, editorials and other documents identified through PubMed, Scopus, ERIC, Australian Education Index, British Education Index and Google Scholar Database searches.

Results: Medical educators employ a variety of teaching strategies including 'thinking aloud' techniques and hypothesis generation. There is some dispute in the literature as to which teaching strategies and which curricula best support the learning of diagnostic reasoning. The contribution of good diagnostic reasoning skills in reducing clinical error and maintaining patient safety is clear.

Conclusion: It is important to continue to encourage the teaching of diagnostic reasoning with an emphasis on patient safety and its role in reducing clinical error and adverse events for patients.

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Background - What is diagnostic reasoning?

"It is every doctor's measure of his own abilities; it is the most important ingredient in his professional self-image" (1). This quotation marks the introduction to a paper by Pat Croskerry (2) whereby he describes a model that may provide a universal approach to diagnostic reasoning.

The cognitive process by which a medical student, novice clinician or experienced clinician reaches a decision on what may be the correct diagnosis for their patient (s) is a process known as diagnostic or clinical reasoning. Clinical reasoning is the ability to 'sort through a cluster of features presented by a patient and accurately assign a diagnostic label, with the development of an appropriate treatment strategy as the end goal' (3). This is a complex system that often seems a mystery to both teachers and learners (4). Experts or experienced clinicians are considered to be better at using this technique than novices – this is thought to be a reflection of how information is stored and retrieved from their semantic networks rather than necessarily because experts have a more extensive knowledge base than novices (5).

Given the risks for the patient that is associated with reaching an incorrect clinical diagnosis this diagnostic reasoning process has

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been referred to as 'the next frontier' in terms of patient safety (6). Research has shown that in 5% of post mortems it has been demonstrated that errors in diagnostic reasoning have lead to lethal complications that would have been avoided had the correct diagnosis been made (7).

The aims of this study were to review the most up to date literature giving consideration to how diagnostic reasoning is taught in an undergraduate medical curriculum and why it is important in the promotion of patient safety.

Theories of diagnostic reasoning

There are a number of theories which are believed to underpin this process and Croskerry (8) summarises two of these. The intuitive or 'fast' system is thought to rely heavily on past experience and this past experience is thought to strongly influence how any new information is presented and interpreted. This system is effective much of the time as it is highly dependent on context. However, because it is based extensively on pattern recognition a problem can arise if a patient were to present with an atypical combination of signs and symptoms. This cognitive system can also be responsible for mental heuristics or short cuts and intuitions which can at times result in negative consequences (8). This intuitive system is thought to be used by expert or experienced clinicians but it has been argued that the strategy used by experienced and novice learners has been indistinguishable suggesting that both groups use this non-analytical or intuitive approach (9).

The alternative analytical approach to diagnostic reasoning is thought to be a slower, resource intensive and more deliberate system based on logical reasoning and critical thinking (10). It is employed when the patient's presentation does not appear to fit with any previously recognised pattern of signs and symptoms. It is thought to be less prone to error than system one and is employed by novice clinicians. However it tends to work best when the clinician is in optimum condition i.e. well rested, calm, focused and free from distraction which is often rare in clinical practice (11). This hypothetico-deductive method involves the clinician mentally proposing a list of possible diagnoses and either verifying or rejecting them based on consideration of previous learned signs and symptoms of disease (12).

In a quantitative study by Coderre and colleagues in 2003 the authors attempted to assess the success rates of reaching a correct diagnosis by comparing hypothetico-deductive methods of diagnostic reasoning (analytic reasoning) with pattern recognition and scheme inductive reasoning (non analytical methods) (13). Scheme inductive reasoning is another theory based on non analytical methods which is thought to represent the way in which knowledge is arranged or 'chunked' in the mind of experts. The authors concluded that when pattern recognition and scheme inductive reasoning methods were used the odds of reaching a correct diagnosis were greater than when analytic methods were used by clinicians. This is in contrast to previous beliefs that the analytic system resulted in fewer diagnostic errors (2). Pattern recognition is often considered unsuitable for use by medical students given their limited prior knowledge and experience. However in this study both experts and novices demonstrated an appropriate use of non-analytic methods of diagnostic reasoning. A limitation of this study is small sample size (n=40) which may affect generalisability.

How errors can occur

Cognitive heuristics and biases can often occur as 'mental shortcuts' and can result in the incorrect clinical diagnosis being reached. These are summarised below (14) –

- Representative heuristic where a clinical diagnosis is reached without considering the prevalence of a disease e.g. hypertension, sweating and headaches indicate phaeochromocytoma.
- Availability heuristic leads the physician to diagnosis a condition based on recent experience of said condition e.g. a brain tumour was diagnosed on routine scanning in dementia and therefore in all future dementia work up investigations the physician will consider brain malignancy
- Anchoring heuristic occurs when the doctor continues to believe in the original proposed diagnosis and fails to give evidence contradicting this diagnosis any credence.
- Premature closure occurs when a diagnosis is reached without giving consideration to all available evidence.
- Confirmation bias is the tendency to look for evidence to support a working hypothesis, ignore contradictory evidence, and misinterpret ambiguous evidence as supporting your initial diagnosis.

Teaching diagnostic reasoning

If the above is thought to form the basis for how clinicians make diagnostic decisions, how then can these skills be best taught to medical students? In a review paper by Bowen the author points out that "clinicians often unconsciously use multiple combined strategies to solve problems, suggesting a high degree of mental

flexibility and adaptability in clinical reasoning" (15). Norman suggests that this is not surprising given the range of experience and knowledge that medical professionals possess and use on a daily basis (16). He also illustrates that clinicians can have difficulty describing to others e.g. medical students how they actually arrived at their working diagnosis and argues against Bowen, stating that it is impossible to be fully accurate about how one uses this complex cognitive system to generate an accurate diagnosis. Bowen outlines some differences that she has observed in how experienced and novice clinicians use their diagnostic reasoning abilities by comparing the two cognitive processes. She goes on to give recommendations to medical educators on how they can help their students to arrive at the correct clinical diagnosis. Extensive contact with patients is thought to develop pattern recognition, analytic reasoning and illness scripts (3). Assisting the students to organise their knowledge of a clinical case by asking them to use abstract terms to create clinical summaries is thought to assist them in creating their own illness scripts – this 'thinking aloud' technique is also useful when the student is encouraged to provide justification for each diagnosis from their list of differentials. Medical students should be encouraged to take histories and carry out clinical examinations of common medical presentations. These repeated exposures are thought to form the basis of a semantic network which the student can then refer back to when confronted with future similar clinical presentations. Norman (16) also encourages the use of open-ended questions by the medical teacher in helping to assess the learner's clinical reasoning ability. The use of feedback for the learner is also considered important. This feedback needs to be relevant by highlighting diagnostically helpful information and identifying less helpful information. The advantages of feedback in medical education have long been established (17).

Kevin W Eva (3) likens clinical reasoning to solving a "whodunit" mystery. The author goes on to describe the merits of using and teaching both systems of diagnostic reasoning and that instead of considering one as being superior and distinct to another he suggests that these two systems are best used and taught in a complementary manner as recent research suggests (18). This type of interactive process between analytic and non-analytic reasoning has been suggested to occur in both experts and novices (19). Context specificity and teaching around examples has been recommended in order to provide multiple opportunities for students to develop their own prior knowledge and database of similar cases (20). Expert clinicians are thought to be able to slow their thinking down in situations whereby they shift from non – analytic to analytic methods of reasoning. Diagnostic experts are considered able to realise when either system is required – having a sense when intuitive or analytic reasoning is called for (21).

A qualitative study conducted by Delany and Golding (22) used action research as a means of attempting to make diagnostic reasoning more explicit and visible for students. They argue that this process is often considered invisible and highly complex for students. By holding a number of focus groups and attempting to complete some diagnostic reasoning tasks the participants (expert clinicians) were able to examine in detail the content of their own thinking process by writing down and reflecting upon how they go about this. They then attempted to use this information in teaching their own medical students. Despite the acceptance that this cognitive process is often subconscious and invisible the clinical educators in this study were satisfied that they were able to make this process more conscious and visible for students by reflecting on some of the cognitive steps taken when they carry out diagnostic reasoning tasks. Unfortunately the transferability of this study is limited in that medical educators gave their views on how students' learning changed but opinions of students themselves were not sought.

Role of medical curriculum

In recent times there has been a shift in medical curricula design moving from a more traditional curriculum (TC) where the emphasis was on a basic science foundation to a more interactive, student- centred Problem Based Learning (PBL) approach which is considered a better approach to teaching problem solving skills (23). PBL curricula were cited as being best suited to providing opportunities for medical students to refine their clinical reasoning skills (24). However, Patel et al argue that a PBL curriculum limits the students' exposure to the basic sciences and may result in students lacking this strong biomedical foundation (25). In a quantitative study by Goss et al in 2011 the authors compared diagnostic reasoning abilities of students from a traditional curriculum with students from a PBL curriculum and concluded that students from the TC appeared to have better diagnostic reasoning skills (26). However this study relied on self report questionnaires which may be subject to response bias. A thought provoking opinion piece written by a medical student promotes the advantages of combining

the effective components of both curricular types. The author feels that lecture based teaching of the basic sciences should not be undermined or forgotten (27). The author is in agreement with Fyrenius et al. (28) who promote the amalgamation of the two curricula.

Medical students tend to store information in a manner based on how it was learned via the curriculum. If information is learned and stored in the format of case presentations then it is considered that this information is more readily available and clinically relevant when it comes to retrieving it in a clinical context (29, 30).

Defining a core curriculum is a challenging task for medical schools. In *Tomorrow's Doctors,* the GMC in Britain (31) created a framework to ensure doctors are competent and reflective practitioners. A number of 'index clinical situations' have been identified in the University of Manchester for which a newly graduated doctor should have competencies (32). The GMC has advocated the integration of basic sciences with clinical medicine which provides opportunities for learning diagnostic reasoning. In a recent progress report by the Irish Medical Council (33) they also recommend an" integrated, systems-based approach to curriculum design and development with emphasis on developing students' communication, team-working and interpersonal skills (case-based / problem-based learning approaches can be helpful here) and development of early (i.e. first-year) patient-contact programmes". They also promote further teaching and training to be made available to staff as well as incentives to encourages medical teachers to remain in the profession of medical education.

Reducing clinical error

In a narrative review by Graber (34) the author reports that medical error as a result of diagnostic error is unacceptably high in the range of 10-15% which is in keeping with the current body of literature reviewing diagnostic error. In a review by Monteiro and Norman (35), the authors suggest that medical error as a result of diagnostic error can be addressed by using strategies targeted at increasing the application of relevant knowledge in the learner or clinician. Strategies suggested include the use of simulation based training and deliberate practice which optimises the role of experiential learning. This deliberate practice involves actively seeking out learning opportunities which may enhance one's clinical skills and achieve one's maximum potential e.g. reading about clinical cases (36). Metacognition or thinking about thinking is also considered a way in which clinicians can reduce diagnostic error. Croskerry (37) suggests that clinicians who are aware of their own mental short-cuts or heuristics can use cognitive *forcing strategies* as a way to prevent error.

Ely et al (38) have proposed a checklisting approach in order to reduce cognitive error. This checklisting involves the basic clinical history taking, physical examination, investigations and differential diagnoses but also includes two additional steps – 'a diagnostic timeout' which gives the clinician an opportunity to reflect upon potential heuristics and cognitive errors and then an amended more informed follow up/treatment plan is reached.

Conclusion

This article has considered the complexities and varying perspectives on diagnostic reasoning, including the importance for medical students to become competent diagnosticians in order to progress their training; the various, and somewhat contradictory strategies recommended for teaching this "invisible" skill and the varying perspectives on how or which curriculum model is best suited to promoting competent clinical diagnosticians. It appears that one of the core drivers for facilitating the learning of this essential cognitive skill should be the awareness that it is paramount to reducing clinical error and promoting patient safety. The authors feel that this specific role for the development of good diagnostic reasoning skills should be further incorporated into undergraduate medical curricula.

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