Teaching clinical reasoning to medical students

ABSTRACT

Clinical reasoning is often not explicitly addressed in the early medical school curriculum. As a result, students observe the process while on clinical placements with little or no understanding of the complex processes underlying it.

Clinical reasoning has significant implications for patient safety. Medical errors as a consequence of faulty reasoning contribute to patient morbidity and mortality. Educating medical students at an early stage about the processes of clinical reasoning and strategies to avoid associated errors can have positive impacts upon patient safety.

The authors propose that clinical reasoning should be taught as early as the first year of medical school, using frameworks, anatomical knowledge and mnemonics. Using this approach with simulated cases during the pre-clinical years, students will be equipped with an understanding of the clinical reasoning process as it unfolds before them while on clinical placements, enhancing their overall learning experience.

Arguably, clinical reasoning is central to the practice of clinical medicine. By clinical reasoning the authors mean the process by which a diagnosis is reached. In comparison to other areas of the early medical school curriculum, it is often not explicitly addressed. Therefore to the medical student the process may seem somewhat opaque; this is despite our increased understanding of clinical reasoning as a phenomenon.

The clinical reasoning process is complex, comprising both intuitive (type 1) and analytic (type 2) aspects. The type 1 (intuitive) process is typically fast and most often used by experts. It often involves cognitive short-cuts, or heuristics. The type 2 (rational) process is slower and more deliberate and the focus is on hypothesis and deductive reasoning. Repetitive use of the type 2 reasoning process leads to the development of type 1 reasoning (University of Iowa Carver College of Medicine, 2017). Unfortunately, most diagnostic errors are the result of errors in type 1 processing, and in up to 90% of cases, involve premature closure of the diagnosis (Graber et al, 2005).

Table 1. Five of the most common biases affecting diagnostic error

Cognitive bias	Definition	Example
Availability heuristic	Diagnosis of a current patient is biased by the clinician's experience with past cases	A patient presenting with chest pain is incorrectly treated as having a myocardial infarction, despite evidence that an aortic dissection was present
Anchoring heuristic	Initial diagnosis was adhered to despite subsequent contrary information becoming apparent	Positive blood cultures were dismissed as contaminants; later the patient was eventually diagnosed with bacterial endocarditis
Framing effects	The diagnostic decision was unduly and incorrectly biased by collateral information	A patient with a history of heroin addiction who presented with abdominal pain was treated for opiate withdrawal, but proved to have a bowel perforation
Confirmation bias	Over-weighting findings that appear to support the working diagnosis, rather that look for disconfirming evidence to refute it	A patient presents with unilateral throbbing headache, photophobia and nausea. On hearing that there is a family history of migraine, the clinician unconsciously discounts the fact that the patient described the onset as thunderclap
Premature closure	Stopping the search for new information after reaching a diagnostic conclusion	Chest pain is attributed to a broken rib detected on chest X-ray, interrupting the systematic analysis of the image, and subsequently overlooking the presence of a small pulmonary node with ill-defined margins

Adapted from Wellbery (2011)

Within medical education, it has been widely assumed that an understanding of biases at play in type 1 thinking will help make more accurate diagnoses, thereby reducing error rates. Hence, there is interest in when to teach clinical reasoning, and how to avoid biases and errors. Over 100 biases have been identified in the psychology literature but, of these, fewer than ten (*Table 1*) are commonly seen in medical practice (Saposnik et al, 2016).

Why teach clinical reasoning?

Being a safe and effective junior doctor is not only about knowledge. The ability to think, reason and make decisions is arguably a critical component of the role (Cooper

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and Frain, 2016). Clinical reasoning has significant implications for patient safety. In 2015 the US Institute of Medicine reported that one in ten diagnoses were incorrect, and diagnostic errors accounted for 9.6% of all deaths in the United States in 2013 (Makary and Daniel, 2016). The authors contend that clinical reasoning should be a core skill taught by medical schools. However, historically, it has not been explicitly taught; instead it is incorrectly assumed that clinical reasoning can be learnt through observation of expert clinicians during the clinical years (Gay et al, 2013). As a result, most students learn clinical reasoning skills passively with varying quality of supervision in a random manner.

When should we teach clinical reasoning?

There is much debate concerning when to teach clinical reasoning. Some argue that first year medical students do not have enough knowledge to begin clinical reasoning at this very early stage. Arguably, however, the introduction to clinical reasoning starts by looking at reasoning in general, and moves to recognizing the role of content pattern recognition in medicine. Students are carefully selected and generally highly motivated individuals and may bring experience from outside of university settings that is important to clinical reasoning processes. From the authors' experience of graduate entry medical students at Griffith University, Australia it is not uncommon for early first year students with a science background to spontaneously suggest pulmonary embolus and dissecting aneurysm as differential diagnoses for a patient presenting with chest pain. Students with no previous scientific background add value and depth to the discussion by questioning the role of the patient in the clinical reasoning process.

Hence, the authors contend that clinical reasoning should be taught early. Since clinical reasoning may be clouded by the complexity of the case and ambiguity, learning about clinical reasoning at an early stage can introduce core concepts of uncertainty that characterize clinical practice. There is extensive literature regarding the prevalence of uncertainty and ambiguity in medicine, and the detrimental impact it can have upon clinical decision making and hence patient management (Lally and Cantillon, 2014). Put another way, teaching of clinical reasoning can become a tool to deal with such uncertainty.

Introducing students to the concept of human reasoning at an early stage in their studies will enable them to appreciate that, to an extent, pattern recognition is a skill that they already have. In terms of child development, pattern recognition starts as early as infancy when a baby learns to smile, or recognize his/her mother's face. It continues into our daily activities at a subconscious level, getting to work or school, and continues into all aspects of our lives as we grow. Similarly, educating medical students about pattern recognition and its role in the clinical reasoning process early in their medical degree gives them the option to organize their knowledge into packages that develop into illness scripts and become more relevant to making diagnostic decisions.

The act of committing to a working diagnosis and a management plan allows early year one students to examine how they make errors and reflect upon the reasons why. In the authors' experience in Australia, during the final years of a typical medical programme (the clinical years), supervising clinicians have limited time to appropriately break down and teach the clinical reasoning process. By teaching a framework and introducing the theory of clinical reasoning during the pre-clinical years medical students can begin their clinical placements with the tools to not just watch their senior colleagues 'magically' make a diagnosis, but instead use a 'hypothetico-deductive' approach and better understand how the diagnosis was made.

How should we teach clinical reasoning?

Various approaches to teaching clinical reasoning are effective for junior doctors and medical students. As students learn the general principles of history and physical or mental state examination, by concurrently teaching clinical reasoning they can begin the process of selecting which of these questions is relevant to a specific clinical problem. It would be interesting to assess whether potentially less mature, undergraduate medical students would benefit from the same approaches as postgraduate students, or if additional or different approaches would be required. Students naturally lack the knowledge required to be able to synthesize clinical features into meaningful clusters or syndromes. As a result, their clinical reasoning styles are typically characterized by poorly organized knowledge structure. In comparison, expert clinicians reason by 'illness scripts' – organizing and prioritizing syndrome recognition through comparing and contrasting key clinical features in making a diagnosis (Norman, 2006). Illness scripts provide a framework to explain how medical diagnostic knowledge can be organized for diagnostic problem solving.

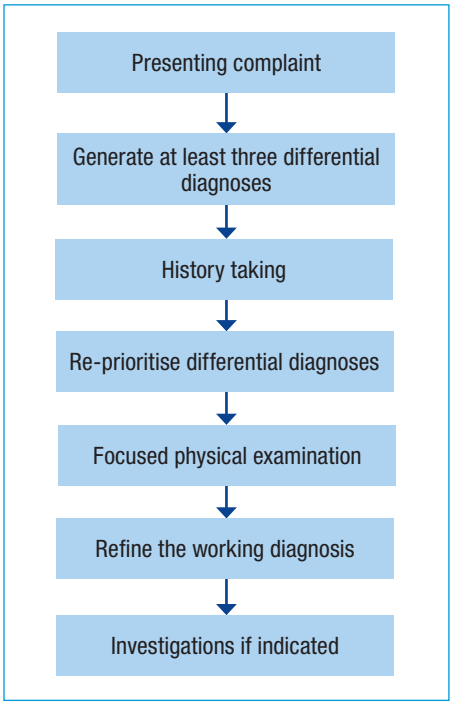
Expert clinicians often use illness scripts in their clinical reasoning approach, applying pattern recognition in an automated approach (type 1 processing) which is more time efficient than using a hypothetico-deductive (type 2) reasoning approach (Charlin et al, 2000).

Three different approaches to teaching clinical reasoning are outlined below:

Teaching clinical reasoning 1: frameworks

By considering clinical reasoning as a skill to be learnt, a structured framework for teaching this skill can be implemented (Linn et al, 2012). The structured approach (*Figure 1*) starts with the patient

Figure 1. A structured framework for teaching clinical reasoning to early medical students.



outlining his/her presenting complaint, at which point the students start to generate differential diagnoses based on the patient's demographics, particularly his/her age and gender. Students are encouraged to generate a minimum of three differential diagnoses, and need to be able to describe the key features and distinguishing features of each. The students are encouraged to think about if and how this information influences their list of differentials, and begin creating a working diagnosis based on the information obtained. At the conclusion of history taking, the working diagnosis should be redefined, shaping and focussing the physical examination to follow. Relevant positive and negative findings should be noted, and will influence and further refine the working diagnosis. If a student feels a particular investigation is required, he/she should be able to explain how its results will confirm or alter the working diagnosis, and if not, explain whether the test is necessary.

Teaching clinical reasoning 2: anatomical approach

Students apply their anatomical knowledge to the generation of differential diagnoses (Gay et al, 2013). This works particularly well if the patient's presenting complaint is one of pain. The student can use the location of pain, and his/her knowledge of the structures and systems located in that region to assist with the development of differential diagnoses which can be further addressed in history taking and physical examination. Typically a student would apply an anatomical approach from the 'outside' inwards. In a patient presenting with chest pain, for example, the students can think through each 'layer' of the anatomy as a potential cause of the pain: the skin, muscle and connective tissue, bones, and internal organs.

Teaching clinical reasoning 3: mnemonics

Applying mnemonics, such as VINDICATE (*Table 2*) (Mutnik and Barone, 2013), to broaden the student's list of differential diagnoses, helps to ensure that systems and rare diagnoses are still considered. This also encourages students to acknowledge life-threatening causes which might have otherwise been overlooked.

Teaching year one and two students a structured approach to dealing with clinical reasoning enables them to recognize when their senior colleagues are using pattern recognition to make a diagnosis, and enables them to think through the outlined approaches to assist in their diagnostic processing.

Table 2. VINDICATE as a mnemonic to assist in the generation of differential diagnoses

V – vascular
I – inflammatory/iatrogenic
N – neoplastic
D – degenerative/deficiency/drugs
I – idiopathic/intoxication
C – congenital
A – autoimmune/allergic
T – traumatic
E – endocrine

Conclusions

Clinical reasoning should be actively taught to medical students as they progress through their medical studies (Linn et al, 2012). The clinical consultations they will observe during their clinical years will often revolve around pattern recognition and hence 'automation' in diagnosis. To an observing student who is unaware of the clinical reasoning framework and alternate approaches, it becomes difficult to grasp this concept and is therefore a barrier to learning. Moreover, if students have a basic understanding of the theoretical concepts behind clinical reasoning, and have used the framework in simulated cases in their pre-clinical years, it will improve their understanding of the process as it unfolds while they are on clinical placements. Despite our increased understanding of clinical reasoning as a phenomenon, there remains a deficit of robust studies looking at the effectiveness of clinical reasoning teaching and learning in medical students.

By applying a structured approach to the teaching of clinical reasoning, and incorporating interesting cases and exercises throughout the medical programme, clinical reasoning can become an essential, fun and integrated component of medical student teachings. This not only provides skills that can be applied in future practice to minimize diagnostic error, but also puts the job of 'being a doctor' into perspective from the beginning of their studies. **BJHM**

KEY POINTS

- Clinical reasoning should be a core skill taught by medical schools.
- Clinical reasoning teaching can have significant educational value even if taught as early as the first year.
- Teaching clinical reasoning by means of frameworks focused on anatomical knowledge and mnemonics is recommended as an effective approach to assist deeper learning.

Conflict of interest: none.

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