Title :

Medical intuition: is there an assessment tool? A critical analysis of the literature.

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Introduction: Intuition is a core component of clinical reasoning. It is essential to early generation of hypothesis and accuracy for the final diagnosis. Expert physicians solve clinical cases by using intuitive reasoning based on their experience. Clinical reasoning poses many difficulties for students and residents. We hypothesized that tools for learning and assessing clinical reasoning focus only on analytical reasoning and omit intuitive reasoning. The purpose of this study was to critically analyze clinical reasoning assessment tools and determine whether they contribute to exploring intuitive reasoning.

Methods: In order to determine whether an assessment tool can explore intuitive reasoning, its characteristics must be precisely defined, distinguishing it from analytical reasoning. We identified these characteristics by analyzing the scientific literature and how researchers who have been interested in intuition have explored it in their studies. We will use these characteristics to set up indicators of whether an assessment tool is suitable for exploring intuitive reasoning. We will finally apply these indicators to all clinical reasoning tools and develop a score to determine how well they assess the intuition.

Results: Of all the clinical reasoning assessment tools identified, none appears to fully address the two criteria identified as essential for exploring a student's intuitive reasoning.

The tools most willing to do this in their current version seem to be the full-scale simulation, the written notes, the think aloud and the self-regulated microanalysis.

Discussion: Future studies on this topic should focus on the development of an assessment tool that satisfactorily addresses both criteria for measuring intuition. It would allow teachers to improve medical students training as well as reflecting on expert physicians practices in a continuing education approach.

INTRODUCTION

Numerous studies on the origin of adverse events associated with care establish that 74% to 96% of them are attributed to errors in clinical reasoning, and particularly to diagnostic errors (1–5).

Expert physicians solve clinical cases by responding faster than residents and with greater accuracy, using intuitive reasoning based on their experience (6). Yet, they use the same process of hypothesis generation and testing than medical students (7,8). Thus, expertise is not tied to a particular reasoning process, but rather depends on a clinician's ability to access knowledge from past experience to intuitively generate relevant diagnoses (9).

It also appears that context plays a key role in the decision process and that the risk of diagnostic error may be exacerbated by fatigue, mental (over)load, interruptions, ambient noise, sleep deprivation, stress, resource limitations and other environmental factors specific to each workplace (10). Furthermore, malpractice is a fear that leads some physicians to develop defense mechanisms resulting in a greater propensity to hospitalize patients and over-prescribe additional tests (11). In addition to improving the ability of a physician in training to make a diagnosis, there is therefore an economic and crowding reduction issue of hospital services in understanding and learning the cognitive mechanisms and mechanisms of diagnostic error among students and physicians.

Since 2008, researchers have adopted a relatively consensual approach to the cognitive functioning of clinical reasoning, based on the *"dual process theory", i*.e. an analytical approach to systematically testing intuitively generated diagnostic hypotheses (12,13). It is now accepted that clinical reasoning is therefore based on two distinct cognitive processes of information treatment: the first, intuitive, is based on experience and the recognition of similarities past

events, without any conscious effort and extremely rapidly. The second, analytical, consists of consciously processing the information, for example, to collect data, including those related to complementary examinations, and which aims to confirm or refute the intuitively generated hypotheses. Studies using functional magnetic resonance imaging have shown that these two processes involve distinct brain areas and have different glucose requirements (14,15). Regarding intuitive reasoning, functional MRI has also shown that novices and expert clinicians share a common neural network, but that experts have more neural activation in regions such as the prefrontal cortex, which is involved in cognitive control of memory, task switching, and integration of past events, among other things (16).

A comparative study artificially attempted to exclusively solicit analytical reasoning processes in one group of residents and intuitive processes in another group (17). The results showed that the use of purely analytical reasoning led to a slowing down of the clinical reasoning process by about 30%, with considerable consumption of cognitive resources. In another study, the use of purely intuitive or purely analytical strategies leaded to a decrease in diagnostic performance compared to the use of strategies combining both processes (18).

According to Norman, errors can be related to both intuitive and analytical processes (19). Thus the best level of performance is obtained by adequately combining the two processes. Medical intuition development and assessment in medical students is therefore essential to help them generate early and relevant hypotheses and, subsequently, to reach and accurate the final diagnosis (20).

Among the skills that the Royal College of Physicians and Sergeants of Canada (CANMEDS, 2015) believes every physician should develop, clinical reasoning and clinical decision making are explicitly included through a set of resources: the ability to "prioritize the issues to be addressed in a patient encounter" or to "perform timely clinical assessments with

recommendations that are presented in an organized manner" (21) ; in other words, resources that systematically involve the intuitive and then the analytical phase of clinical reasoning.

Clinical reasoning poses many difficulties for students and residents. Between 10% and 15% of learners encounter reasoning difficulties during their training (22). These difficulties are often identified at the end of the curriculum and remedial measures are then taken too late to be effective (23). It is therefore essential to promote the development of clinical reasoning and to identify students with difficulties as early as possible.

The tools used in formative, summative or certifying assessment significantly influence student learning and how their knowledge is organized in long-term memory (24). In order to foster the development of students' reasoning according to the "*dual process theory"*, tools are needed to assess both the analytical and intuitive dimensions of clinical reasoning.

Because intuition has received more recent attention than analytical processes, our hypothesis is that tools for learning and assessing clinical reasoning, most of which were developed in the 1980s to 2000s, focus only on analytical reasoning and omit intuition.

The purpose of this study was to critically analyze clinical reasoning assessment tools and determine whether they contribute to exploring intuition.

METHODS

In order to determine whether an assessment tool can explores intuition, the characteristics of intuition must be precisely defined, and distinguished from those of analytical reasoning. We will identify these characteristics on the basis of converging data in the literature on how intuition is described, but also by analyzing how researchers who have been interested in intuition have explored it in their studies. We will use these characteristics to set up indicators of whether an assessment tool is suitable for exploring intuitive reasoning. We will finally apply

these indicators to all clinical reasoning tools and develop a score to determine how well they assess the intuition.

What are the characteristics of intuition?

In the course of his intuitive reasoning, the clinician calls upon the recognition of situations experienced in the past, which he/she associates without conscious effort with the current situation. This recognition is made possible by prototypes, i.e. an association of a few typical clinical and contextual signs, stored in long-term memory, which is mobilized very quickly each time the physician is confronted with a new clinical situation (25). A prototype contains on average three clinical and contextual data. For example, the prototype for pulmonary embolism would be "dyspnea - unilateral calf pain - context of prolonged immobilization." Thus, each time a physician identifies these three elements in a given clinical situation, he or she will immediately and without conscious effort evoke the hypothesis of pulmonary embolism. These prototypes will be enriched and become more and more relevant with experience.

Intuition allows the physician to generate initially one to three diagnostic hypotheses, but also, for example, to determine whether the patient is ill or not, requires hospitalization or not, or needs resuscitation, all in less than one minute (26,27). This process is based on immediately available data, and therefore mostly visual, but it also occurs, for example, when reading a medical record or talking to another health professional, even in the absence of the patient (28). Physicians are therefore able to diagnose effectively and accurately using very little clinical data (29). Subsequently, during their meeting with the patient, they will again collect clinical and anamnestic data and data related to the results of complementary examinations, enabling him or her to revise or confirm his or her initial hypotheses, or to generate new ones ((27).

Based on these considerations, we have identified three main characteristics of intuition, which we describe in Table 1.

How is intuition explored in research?

In order to determine whether an assessment tool explores a student intuition, we also wanted to determine how researchers who were specifically interested in intuition explored these processes in their studies.

To explore intuition, Norman et al. instructed students: "*You must make your diagnosis ... as quickly and accurately as possible*" (17). Sherbino et al. asked subjects to: "*work as quickly as possible without sacrificing accuracy*" (30). In these two studies, subjects were given an average of 59 to 72 seconds to solve a case. By asking this same type of question, Mamede et al. sought to encourage subjects to reason intuitively through the activation of prototypes, thereby minimizing the chances of engaging in elaborate analysis of the clinical case (31). By asking participants to quickly give their first impression of a clinical case, they were encouraged to use their intuition (32).

Ilgen et al. explored another way of eliciting intuition by instructing, "*This clinical case may look like things you have seen before. Trust your sense of familiarity*" (33). Ark et al. refer to this approach as "similarity-based" reasoning (18).

Characteristics of a teaching tool to explore intuition

The description of intuition in the scientific literature as well as the way in which researchers explore intuition in students has allowed us to identify two indicators corresponding to the fundamental characteristics of a teaching tool aimed at exploring a learner's intuition (see Table 2).

Clinical reasoning assessment tools and score assigning

A recent literature review sought to identify which of the learning assessment tools commonly used in medicine assess clinical reasoning, without distinguishing whether these tools assess the intuitive and/or analytical dimension of clinical reasoning (34).

The tools were described according to their ability to explore clinical reasoning in seven pre-established stages: Information gathering - Hypothesis generation - Problem representation - Differential diagnosis - Diagnostic exploration - Diagnostic justification - Treatment and Management. A group of experts assigned a score for each assessment tool (0 to 2). A tool was considered "good" (to assess clinical reasoning) with a score of 1.1 out of 2. Of the nineteen assessment tools, we therefore analyzed only those with an overall mean ≥ 1.1.

We have thus retained :

Four tools used in academic settings: short and long answer questions, Modified Essay Questions (MEQs), Patient Management Problems (PMPs), and oral exams.

Two assessment tools used in simulated environments: the Objective Structured Clinical Examination (OSCE) and the Full Scale Simulation (FSS)

Seven assessment tools used in the health care setting: direct observation (via the mini-clinical evaluation exercise), global assessment, oral case presentation, written notes (Post-Encounter Forms, the Interpretive summary, Differential diagnosis, Explanation of reasoning, and Alternatives assessment tool), Chart-stimulated recall interview, Think-aloud, and Self-regulated learning microanalysis.

In this study, we therefore evaluated thirteen tools that were considered "good" or "very good" for exploring medical students' clinical reasoning.

Each tool was scored based on its ability to assess intuition, thereby answering the research question.

This score was based on the two measurement indicators we previously identified.

For each tool and each indicator, we have associated one of the following three features:

✓ Planned *by the current design of the tool.*

Partially *planned and requiring minor changes.*

✗ Absent *or requiring complete redesign of the tool, thus no longer ensuring its validity.*

This scoring has been done separately by each of the two authors of this study. Then results were shared among them. In case of initial disagreement on a scoring, a consensus was find on the final scoring.

RESULTS (35–60)

Table 3 summarizes the score obtained by each of the thirteen clinical reasoning assessment tools according to their ability to explore a student's intuition. See additional file for a brief description of each assessment tool.

No clinical reasoning assessment tool fully satisfies the two essential indicators for assessing medical students' intuition.

Apart from the oral assessment, all the tools used in the academic environment do not meet either of the two indicators. Of the tools used in the simulated environment, only the full scale simulation partially meets both indicators and requires adaptations in the way the debriefing should be conducted to explore the student's intuition.

The tools used in the care setting seem to better address both indicators. In particular the written notes, the think-aloud and the self-regulated microanalysis. In contrast, the global assessment, the oral case presentation and the chart stimulation recall interview do not meet any of the indicators for exploring a student's intuition.

DISCUSSION

For decades, medical intuition has been considered as a "mystical" ability, not accessible to consciousness and which should never prevail over analytical and rational judgment (12).

The purpose of this study was to bring together recent scientific discoveries related to intuition and the way students' clinical reasoning is trained and assessed, to determine whether the clinical reasoning assessment tools currently in use are capable of exploring intuition and to enrich knowledge in a prolific field of research in medical education.

Of all the clinical reasoning assessment tools identified, none appears to fully address the two criteria identified as essential for exploring a student's intuition.

The tools most willing to do this in their current version are the full-scale simulation (within a simulated environment) and the written notes, the think aloud and the self-regulated microanalysis (within care settings), i.e. tools where the environment is either the closest to reality or the reality itself. These results are in line with the study by Daniel et al. where the above-mentioned tools also had the best scores for assessing clinical reasoning in its entirety (34). Conversely, academic assessment tools do not explore a student's intuition. Yet they are currently the most widely used tools for certifying medical students at any point in their education (61).

This study addresses some limitations. One of the main limitations is the lack of systematic reviewing of the literature. The two indicators we have identified emerged from the analysis of the main studies we found on the subject. A thorough analysis of the literature, using the systematic method of searching for articles in a meta-analysis, would ensure that no articles were missed which could enrich the indicators already found. Another limitation concerns how the tools have been scored. Only the two authors participated in that assessing. There would have been greater precision if there were several assessors. However, because of the

identification of the two indicators, each teacher is in a position to judge whether an assessment tool sufficiently addresses them or not.

CONCLUSION

It is now widely recognized by the scientific community in medical education that intuition is at the heart of an expert's reasoning and therefore conditions the adequate management of a patient (11,62). There is therefore an urgent need to assess medical students on their intuition in both formative and summative ways.

Future studies on this topic should therefore focus on the development of tools that satisfactorily address both criteria for assessing intuition in medical students. Focusing on a tool to assess intuitive reasoning would allow teachers to improve medical students training as well as reflecting on expert physicians practices in a continuing education approach.

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