Developing Clinical Reasoning in Medical Students - A Scoping Review

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Developing Clinical Reasoning in Medical Students - A Scoping Review

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Background

Clinical reasoning (CR) is, perhaps, the most important competence of the physicians' job, or at least a fundamental aspect of medical practice; thus, teaching CR must be in the core of medical curricula (1). Errors in establishing diagnoses or therapeutic plans or prognosis may lead to serious problems for physicians and patients alike, including potentially harmful health care, malpractice lawsuits, or increased health care costs (2, 3). Physicians that have acquired an appropriate aptitude to clinically reason during undergraduate education (being able to not only collect and interpret data but also to consider the situated needs of patients and health systems) are assumed to be successful clinicians in their work (4, 5). Consequently, CR skills are now included as explicit, instead of tacit learning outcomes in many medical curricula across the world (6). Diverse

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curriculum, pedagogical, and assessment strategies (or approaches) are also explicitly incorporated in medical education to achieve these learning outcomes when earlier, it might be supposed that students developed CR as an implicit learning process in clinical rotations (7).

Although developing students' CR skills is an interesting journey, medical educators might also consider this journey as long and frustrating because, apparently, there are no 'quick fixes' to teach CR (8). Some studies on CR learning have exposed that medical students struggle to choose the most relevant data to make accurate diagnoses, and the variety of clinical cases —to which they are exposed to in rotations— appears to be limited in number to acquire high levels of CR skills (9, 10). Moreover, though mainly limited to preclinical or nurse education, previous scoping reviews of empirical research showed that strategies used by teachers aiming to develop students' CR skills are varied and different from one another (11-14). This diversity of teaching approaches might have created a preconceived idea that current practices produce competent physicians; hence, there is no need to change what is working. However, it is still unclear what, how, and why specific practices are better (or not so good) for promoting CR skills, particularly during the last training year in medical school (12).

Aware of the need to have an overview of that issue, which may help to guide the specific queries of clinical teachers in order to transform their educational practice, we conducted a scoping review examining the nature, gaps, and extent of research in this field. Our aims in this review consisted in clarifying: a) what has been investigated about curriculum and pedagogical practices that aim to develop final-year medical students' CR skills, and b) what curriculum and pedagogical practices have been done to develop these students' CR skills. We used this rationale to conduct this review and make decisions about study selection and data charting. It is important to outline that we assumed the assessment of CR skills as part of pedagogical practices.

Propositions of this Review

We started this review with four propositions in mind: a) scoping reviews (15) are broadly accepted as a reliable method to inform practices of clinical teachers; b) The term 'curriculum' means different things to different people (16); therefore, we wanted to look for how these meanings guided the CR training research; c) Diverse theories have framed the concept of CR, for instance,

hypothetic-deductive model, dual process reasoning, illness scripts, knowledge encapsulation or situated cognition theory, among others (4, 17-20), which is why we also wanted to search for how these theories guided the studies we were interested in; and (d) students' CR learning in the context of the last year in medical school is different from that of the previous years because the first ones have acquired more knowledge —and experience— then the other group of students (12). Specifically, since medical students in the last year of training are close to graduating, we assumed that they better represent the kind of physician that medical schools are offering to society in terms of CR skills. Considering the last proposition, we narrowed the scoping review for analyzing studies focused on last-year medical students.

The work conducted by Schmidt and Mamede was, likewise, an important referent when we began this review (12). They undertook a narrative review of the literature on CR teaching approaches in pre-clinical courses up to June 2014. After analyzing 24 studies, the authors found different teaching approaches that they grouped in two categories: a) how case information was delivered to students (i.e., serial-cue approach or whole-case format) and b) what the purpose of the approach was about (i.e., helping students acquire/apply knowledge or develop a way of thinking). Although the authors suggested some strategies to improve CR training in preclinical education based on their findings, they also concluded that the available empirical evidence was insufficient to decide between the approaches used in the reviewed studies.

We recognize the importance of this contribution to advance knowledge on CR training in medical education, but we believe an update of this review (including a different scope) is needed to better understand curriculum concepts and CR theories that informed practices of training medical students' CR skills. This belief is supported by three main reasons. First, studies that described teaching approaches in clinical rotations were excluded in the former review, therefore, limiting the transferability of conclusions to clinical students. The authors justified this decision based on the assumption that learning during rotations is unsatisfactory due to the variable quality of supervision, feedback, and the number of patients available for practice. Second, the field of CR skills training has continued to grow in terms of teaching approaches and publications since Schmidt and Mamede conducted their review. And third, while research has continued to increase, it is still unclear what kind of research has been done about curriculum and pedagogical practices aiming to develop CR skills of final-year medical students.

Review questions

The data obtained from the review will be analyzed and summarized to address the following research questions:

- What has been investigated about curriculum and pedagogical practices that aim to develop final-year medical students' CR skills?
- What curriculum and pedagogical practices have been done to develop these students' CR skills?

Review Protocol

The search strategies

A scoping review is the literature mapping process that allows a researcher to provide an overview of the literature based on a particular question of interest, which can be practical to explore the extent of it, identify boundaries and parameters of the review, and identify the gaps in a body of the literature (21), and convenient when trying to answer broad questions and for gathering information prior to conducting a systematic review (22). These reviews describe existing literature and other sources of information, including findings from a range of different study designs. Scoping reviews require structured searches to maximize the capture of relevant information. Its framework consists of the following steps: 1) identifying the research question and relevant studies, 2) the selection of studies during the gathering and reviewing of information, 3) charting the data to extract the relevant information from the review literature, 4) summarize and report the results through tables and charts presented according to key themes, and 5) invite the stakeholders so they can provide their insight to inform and validate findings (22).

This method can be useful when the information on a subject has not been thoroughly reviewed or is complex and diverse when there is limited literature to inform the research question of interest (21, 22). If there is a limited number of studies of comparable methodology or sufficient quality, a scoping review is a comprehensive and evidence-based methodology useable to answer the broader question (22). Its framework allows the researcher to identify types of existing evidence, clarify essential definitions and characteristics on a given field, survey how research is conducted on a certain topic, and identify knowledge gaps (21). Even if the scoping review is considered more rigorous than a narrative review, it is thought of as less structured than a systematic review because it focuses on the range of content identified rather than synthesizing quantitative data to address a specific research question (22).

The scoping review has several limitations, given the fact that it does not evaluate the quality of evidence nor gathers information from a wide range of studies and methods (21). As a consequence of providing a descriptive account of available information, scoping reviews lead to broad, less defined searches that require additional actions on the part of the authors to synthesize and draw useful conclusions from them (21, 22). In addition, scoping reviews do not

provide a synthesized result or answer to a specific question, but an overview of the available literature, requiring a substantial amount of time to complete due to the wide coverage of the search (1). Finally, this method is at risk of selection bias when it does not identify all available data on a topic, and the resulting descriptive account of the available information is flawed (1).

We conducted a scoping review in August/October 2018 following the protocol proposed by Arksey and O'Malley (15, 23). To search for papers relevant to answer our review questions, considering there are no sources dedicated exclusively to medical education interventions (24), we chose databases that covered pertinent literature on medical and educational sciences. These databases included were Pubmed, Scopus, Proquest Research Library, ERIC, Proquest Dissertations, and Thesis Global. The search was narrowed to papers published from 2014 to 2018. We selected this interval because the last systematic review on this topic was performed until 2014 (12). In this way, we excluded any paper that could have been reviewed before and included those studies that may not have been analyzed yet. We reduced the search to papers published in English, but no geographical limit was applied.

The search terms and syntaxes were borrowed from the work of Schmidt and Mamede, (12), making some changes in keywords related to the educational intervention and intervened population (table 1). Authors JV and PT conducted a search pilot in Pubmed to refine syntaxes and inclusion/exclusion criteria. After the pilot, the search syntaxes were consulted with a librarian at Aalborg University. As a result of this consultation, we modified search syntaxes to adapt them to the requirements of the databases (table 2). Then, we performed the searches in all described databases (on October 4th, 2018) and stored all titles and abstracts found in this process in Endnote 9 to eliminate duplicate references (figure 1). Across three steps, the search strategy shown in table 2 included: subject headings, free text search terms, Boolean operators, truncation symbols, and proximity operators. Specifically, in the first step, terms representing the participants, interventions, and outcomes were combined separately using the 'OR' Boolean command. In the second step, the three combined 'OR' searches were selected and combined with the 'AND' function, and results were limited by timeframe.

To increase the number of relevant results that had not been retrieved using the search syntaxes (i.e., gray literature), we conducted hand-searches across references of key papers and Google Scholar. As shown in figure 1, those studies

cited in key papers or found in Google Scholar that did not appear in database-searches were included for further analysis.

The search strategies described above show that we moved from 'inclusive' towards 'focused' approaches. This means that at the beginning of the process, we were concerned with including all key results, also named as improving the sensitivity of the search (24). However, after performing the pilot review, we identified more than five hundred papers as data sources. Then we were concerned to compromise the specificity of searches, that is, including results irrelevant to our queries (24). In order to address this tension, we assumed that published research on curriculum and pedagogical strategies that aimed to improve CR skills of final-year medical students should have these concepts in the abstract of the paper. Thus, the search strategy was targeted on the abstracts before extracting relevant data from the full papers.

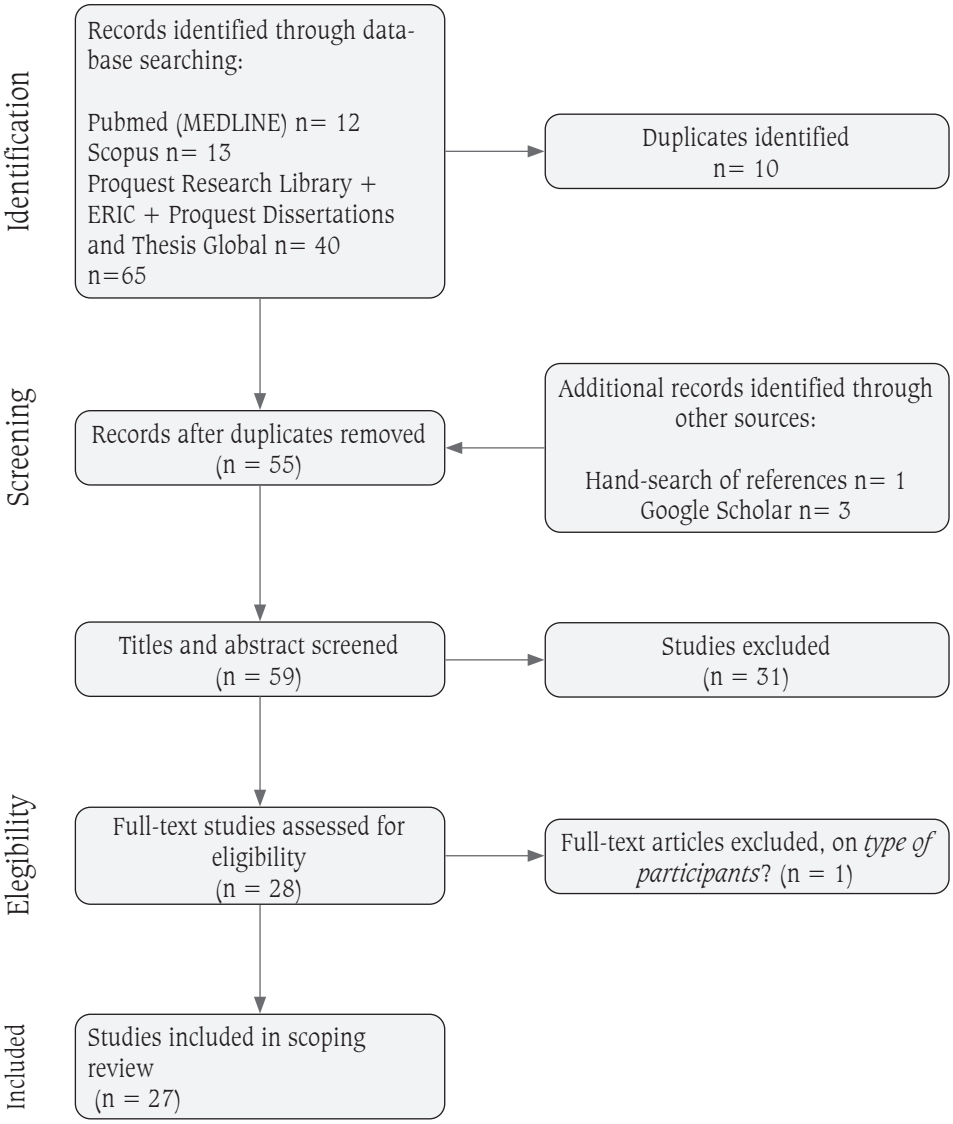
The initial search generated 65 results. The flow of studies through the scoping review is displayed in figure 1. For this process, we followed the PRISMA guidelines (25). In the following third step, to reduce the number of irrelevant references, all stored abstracts were screened independently by two members of the review team (JV and PT) looking for those studies conducted on students different than those immersed in the final year of the medical education program. These studies were excluded (see inclusion/exclusion criteria in Section II). The remaining abstracts were reviewed independently by two group members. After screening abstracts for duplicates and adding records identified through other sources, we obtained a full version of the papers for charting data.

Table 1. Search Strategy

	AND		
OR	Participants (P) "Last year medical Student" "Last year medical Students" "Final year medical Student" "Final year medical Students"	Intervention (I) Teaching Teach Curriculum Training	Outcome (O) "Clinical Reasoning" "Differential diagnosis" "Differential diagnoses" "Diagnostic reasoning" "Medical decision" "Medical decisions"

Table 2. Search Syntaxes

Databases	Search conducted	Syntaxes
Pubmed (MEDLINE)	04.10.2018	((((((“education”[Subheading] OR “education”[All Fields] OR “teaching”[All Fields] OR “teaching”[MeSH Terms])) OR (“education”[Subheading] OR “education”[All Fields] OR “curriculum”[All Fields] OR “curriculum”[MeSH Terms])) OR (“education”[Subheading] OR “education”[All Fields] OR “training”[All Fields] OR “education”[MeSH Terms] OR “training”[All Fields]))) AND ((((“differential diagnosis”[All Fields]) OR “diagnostic reasoning”[All Fields]) OR “clinical reasoning”[All Fields]) OR “medical decision”[All Fields])) AND ((((“final year medical student”[All Fields]) OR “last year medical student”[All Fields])) OR ((“final year medical students”[All Fields]) OR “last year medical students”[All Fields])) Filters: Publication date from 2014/01/01
Scopus (title, abstract, and keywords search)	04.10.2018	(teaching) OR (curriculum) OR (training) OR (teach*) AND (“clinical reasoning”) OR (“differential diagnosis”) OR (“diagnostic reasoning”) OR (“medical decision”) AND (“final year medical student*”) OR (“last year medical student*”) AND LIMIT-TO (PUBYEAR 2014-01-01 – 2018.10.04)
”Proquest Research Library”, ERIC and ”Proquest Dissertations and Thesis Global”	04.10.2018	(teaching OR curriculum OR training) AND (“clinical reasoning” OR “differential diagnosis” OR “diagnostic reasoning” OR “medical decision” OR “differential diagnoses” OR “medical decisions”) AND (“last year medical student” OR “last year medical students” OR “final year medical student” OR “final year medical students”)



Selection Methods

Inclusion/Exclusion Criteria

- Types of Participants: we included studies that investigated medical students during the final year of the medical education program. We

excluded studies that investigated CR on a) medical students in pre-clinical or previous clinical training years, b) health professionals, and c) students from other health professions. Non-human subjects were also excluded from the review.

- Types of Studies: we were interested in theoretical and empirical research, including both quantitative and qualitative studies, published in English. Studies were included if they described a) a curriculum context and b) CR teaching, learning, or assessment strategies. We limited the review from 2014 to 2018. We excluded reviews, dissertations, books, and papers that were not electronically available. Non-English papers were excluded from the review.
- Types of Outcomes: the outcomes of interest were medical students' CR skills. We included other skills related to students' CR skills development, such as communication, leadership, and teamwork skills. Students' satisfaction, attitudes, and behaviors not related to students' CR skills development as intended learning outcomes were excluded.

For studies selection, we had in mind our purpose for identifying research priorities to advance educational practices in CR during the final year of undergraduate medical education. As said above, we conducted a search pilot to refine our inclusion/exclusion criteria. Since the agreement percentage between the two authors that conducted the pilot was 50% (mainly caused by different understandings of what can be considered as "other skills related to students' CR development"), we discussed our comprehensions about this topic, and then 100% agreement between both researchers was achieved.

Data charting

We developed a data-charting form to extract the information we were interested in from full papers, according to our research questions. The charting process was planned during ongoing meetings in which we identified some study characteristics that oriented this process. Before conducting data charting, authors JV, PT, and JH did a pilot with three full papers selected randomly. We read all selected papers at the same time to create and refine categories of the study characteristics. In doing so, we deleted one category (i.e., curriculum perspective) because we found it very unclear to identify this study characteristic explicitly in the manuscripts. Data were charted in the following categories:

- Authors
- Title
- Journal
- Year of publication
- Inclusion/exclusion
- Type of paper (i.e., empirical or theoretical)
- Research paradigm (i.e., quantitative or qualitative)
- Type of study (i.e., descriptive study or experiment)
- Research aim
- Country of the study
- Number of participants
- Course (i.e., Anesthesia or clinical reasoning course)
- Curriculum content (i.e., acute pain or tuberculosis)
- Amount of time of curriculum delivery
- Pedagogical practice (i.e., problem-based learning or simulation)
- Pedagogical aim
- Clinical reasoning assessment and evaluation (i.e., multiple-choice questions or oral examinations)
- Explicit definition of clinical reasoning
- Results
- Conclusions
- Explicit limitations of the study

The characteristics of each full-text paper were extracted by two reviewers (JV and JH) using the Excel® sheet the review team had developed. The 27 reviewed manuscripts included journal papers, conference abstracts, and PhD and Master thesis. One paper was excluded at this phase since reviewers had found it did not meet the inclusion criteria (i.e., 4th year was not the last year of the program). Likewise, three additional studies were included when reviewers identified them through other sources such as hand-search of references and Google Scholar search. The consensus was reached to solve any conflicts between reviewers' data charting.

Journal		Year of Publication		Type of Paper		Research Paradigm		Type of Study	
Journal article	24	2014	2	Empirical	26	Quantitative	21	Systematic review	1
PhD Thesis	2	2015	7			Qualitative	3	Grounded theory	1
Master Thesis	1	2016	6			Mixed methods	1	Assessment - curriculum intervention	1
		2017	6			Unclear	1	Descriptive	6
		2018	3	Theoretical	1			Cross sectional study	9
								Analytical study	5
								Psychometric quality assessment	1
								Quasi-experimental study.	1
								Experimental study	2

Research Aim		Country of the Study		Number of Participants		Course		Curriculum Content		Amount of Time of Curriculum Delivery	
To analyze students' feedback after the educational intervention	1	Germany	4	< 50	11	Specialities*	10	Communication skills and history taking	5	< 20 hours	3
To assess students' learning improvement after the educational intervention	8	UK	4	50-100	3	No information	5	Clinical Reasoning	4	1-10 weeks	10
To determine the psychometric quality of a CR assessment tool	1	Malaysia	3	101-500	9	Clinical reasoning	3	No information	3	1-6 years	5
To develop and implement a clinical reasoning course	1	USA	3	500-1000	1	No course	2	Multiple content+	4	No information	6
To evaluate the educational intervention	1	Singapore	2	> 1000	1	Community and Family Medicine	2	Acute illness or pain management	2	No intervention	3
To examine factors associated with general practice career aspirations	1	Turkey	2	No participants	1	Cognitive biases and debiasing strategies	1	No curriculum content	2		

Research Aim		Country of the Study		Number of Participants		Course		Curriculum Content		Amount of Time of Curriculum Delivery	
To explore differences of competencies	4	Australia	1	No information	1	Palliative care rotation	1	ECG interpretation	1	No intervention	3
To explore learning processes during educational intervention	1	China	1			Simulation programme	1	Emergency Medicine	1		
To explore students' subjective experiences of the educational intervention	4	India	1			Undergraduate medicine(ED consultants)	1	Malaria and tuberculosis	1		
To explore the relationship among various evaluation metrics of medical students and their self-directed learning readiness (SDLR) to assess the extent to which they are related.	1	Israel	1			Repetition module	1	Male circumcision and HIV	1		
To identify deficits in students' competencies	1	Japan	1					Palliative care	1		

Research Aim		Country of the Study		Number of Participants		Course		Curriculum Content		Amount of Time of Curriculum Delivery	
To identify the factos associated with medical students` CR	1	Pakistan	1	No information	1	Repetition module	1	Pneumothorax, trauma, tricyclic antidepressant (TCA) overdose and sepsis/ cardiac arrest	1	No intervention	3
To measure students' feedback	1	Poland	1					Polytrauma	1		
To understand how prepared students are for practice	1	Saudi Arabia	1								
		The Netherlands	1								

* Internal Medicine; Surgery, Pediatrics ; obstetric; Gynecology; Anesthesia; Orthopaedic/Musculo-Skeletal Medicine; Emergency Medicine or Traumatology + Polyarthritis; SLE; Acute coronary syndrome; Left ventricular failure; Acute kidney injury; Chronic kidney injury; Peptic ulcer disease and GORD; Acute or chronic liver disease; Pyrexia of unknown origin; Pneumonia; Carcinoma lung; Chronic obstructive pulmonary disease; Stroke; Seizures or peripheral neuropathy; Diabetes mellitus; Thyroid diseases; Surgery, Pediatrics; obstetrics; Gynecology.

Pedagogical Practice			
Number of pedagogical strategies		Type of pedagogical practice	
A single pedagogical strategy	12	No information	5
Two or more pedagogical strategies	8	Case based discussions facilitated by a tutor	2
No pedagogical practice or no information	7	No pedagogical practice	2
		OSCE assessment of clinical history taking skills	2
		The TWED mnemonic checklist aimed to minimize cognitive errors	2
		Advocacy–inquiry method (Structured debriefing to understand and elicit the deeper assumptions, perceptions and thought processes underlying the learner's actions) and simulation	1
		Consultations	1
		Decision-centered instruction and Student-led Grand Rounds with the senior facilitator and relevant specialty registrar/consultant	1
		eLearning	1
		Interpretation of ECG associated with 16 clinical cases	1
		Lecture case- based discussions through PowerPoint (Microsoft) presentations of cases combined with an associated simulated scenario using SimMan (Laerdal) and interactive PRS voting using an Interwrite handset	1
		Lectures and clinical rotation under the supervision of senior house staff and attending physicians	1
		Lectures, brief didactic talks, and tutorials on real clinical cases	1
		PBL	1
		Seminars (students present a patient case from their ward that is subsequently discussed together with the instructors)	1
		Serious Games and PBL	1
		small- group learning, early immersion in clinical experiences, and dynamic interaction with faculty	1
		Vitual Patients (uses question nodes and feedback via internet)	1
		Workplace based patient encounters, followed by discussions with clinicians (formal bedside teaching round)	1

Data Analysis

To summarize the compiled data, descriptive statistics were calculated by the review team. We used frequencies and percentages to describe nominal data. This summary was challenging, as the nature of the studies was diverse. For example, studies used different research methods, epistemological approaches, CR curriculum content, pedagogical practices, and CR assessments. Several studies showed low-quality methodologies and contradictory results.

Discussion and Conclusions

It is found that the studies relate clinical decision making, communication skills, and patient care with clinical reasoning. Having in common, the use of clinical cases (in various formats) in the pedagogical practices. Likewise, the evaluation and assessment methods seek to establish students' knowledge and how they apply it to adequately answer the tasks. However, a smaller number of studies also evaluated soft skills, specifically the ability to empathize; it could mean a growing interest of Medical Schools for this type of skills beyond technical knowledge. Regardless, there is no clarity on how they influence the clinical reasoning of students.

It is not clear what is understood by CR. There are a few studies with an explicit definition about it, and similarities with the hypotheses shared at the beginning of this paper, as a cognitive process, scripts or diagnostic lists, thought processes related to previous knowledge, among others. However, it is striking that of 27 studies evaluated, ten did not have an explicit and structured definition of what CR is, and eleven did not even mention the term. This allows questioning the objective of pedagogical practices and curriculum regarding the development of clinical reasoning skills. In the same way, the lack of integration and clarity made it difficult to conclude whether there is a specific, conscious, and structured way of teaching CR. This can explain why it is a weakness for medical students and can be seen as an opportunity for improving medical education programs. However, for this to be possible, further studies are needed on the subject, with explicit limitations of CR, because it would allow the authors to have clarity about the objectives and specific needs to achieve them.

This study provides an updated view of what is found in the literature about curriculum and pedagogical practices, and the teaching of CR in the faculties of medicine. Findings support the reports of Schmidt and Mamede, in which it was concluded that the available evidence did not allow establishing a reliable method to address the teaching of CR. As one of the most important skills of a physician, as it is the basis for diagnosis and treatment for a disease, it is urged to continue investigating the better ways for teaching CR. It would also be important to assess students' empathy capacity and its influence in their clinical reasoning; since, if there are variables that influence the CR process not included within the technical knowledge but within the individual soft skills, they could be evaluated and addressed within the medical programs in order to improve the performance of its future graduates.

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