REVIEW ARTICLE

# Teaching clinical reasoning: principles from the literature to help improve instruction from the classroom to the bedside

Steven J. Durning[1,*], Eulho Jung[1,2,*], Do-Hwan Kim[3] and Young-Mee Lee[4]

*[1]Center for Health Professions Education, Uniformed Services University of the Health Sciences, [2]Henry M Jackson Foundation for the Advancement of Military Medicine, Bethesda, MD, USA, [3]Department of Medical Education, Hanyang University College of Medicine, and [4]Department of Medical Education, Korea University College of Medicine, Seoul, Korea*

Clinical reasoning has been characterized as being an essential aspect of being a physician. Despite this, clinical reasoning has a variety of definitions and medical error, which is often attributed to clinical reasoning, has been reported to be a leading cause of death in the United States and abroad. Further, instructors struggle with teaching this essential ability which often does not play a significant role in the curriculum. In this article, we begin with defining clinical reasoning and then discuss four principles from the literature as well as a variety of techniques for teaching these principles to help ground an instructors' understanding in clinical reasoning. We also tackle contemporary challenges in teaching clinical reasoning such as the integration of artificial intelligence and strategies to help with transitions in instruction (e.g., from the classroom to the clinic or from medical school to residency/registrar training) and suggest next steps for research and innovation in clinical reasoning.

***Key Words***: Clinical reasoning, Medical education, Clinical decision-making, Teaching method

## Introduction

Clinical reasoning has been characterized as being an essential aspect of what a physician does [1-4]. Despite this widely held perception of clinical reasoning there are a number of barriers to effective clinical reasoning instruction. For example, prior publications cite clinical reasoning as having a variety of definitions [5-7], faculty do not feel adequately prepared to teach this topic [8] and medical school curricula are not believed to spend ample time on teaching this essential ability [9]. Furthermore, clinical reasoning has been largely absent from competencies in the United States and elsewhere and has been proposed to be a core competency for physicians, e.g., in the United States and Korean Association of Medical Colleges (KAMC) it is subsumed under patient care without needed elaboration. [1,10]. Finally, and perhaps most concerning, medical error (which is commonly attributed to clinical reasoning gone awry) has been reported to be a leading cause of death in the United States and abroad [2,11]. For purposes of this manuscript, we define clinical reasoning as the cognitive and affective steps up to and including arriving at a diagnosis and management plan that

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Corresponding Author: Steven J. Durning (https://orcid.org/0000-0001-5223-1597)
Center for Health Professions Education, Uniformed Services University of the Health Sciences, Bethesda, MD 20814, USA
Tel: +1.301.295.3606 email: steven.durning@usuhs.edu
Corresponding Author: Eulho Jung (https://orcid.org/0000-0001-7102-4243)
Center for Health Professions Education, Uniformed Services University of the Health Sciences, Bethesda, MD 20814, USA
Tel: +1.800.515.5257 Fax: +1.800.515.5257 email: eulho.jung.ctr@usuhs.edu
*These authors contributed equally to this work as corresponding authors.

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is specific to a patient's circumstances and preferences.

So how can a teacher best provide clinical reasoning instruction to learners? While we do not claim to have the answer, we have selected principles from the literature on teaching clinical reasoning to help the teacher. We begin with discussing key findings and theories to inform its teaching and research and then discuss four principles from the literature to help guide instruction. These four principles from the literature were informed by scoping reviews that involved defining clinical reasoning [12] and clinical reasoning assessment methods [13]. With pursuing these scoping reviews and reviewing related papers related to the teaching of clinical reasoning as well as our corporate experience with teaching clinical reasoning and researching this construct, we distilled these four principles. The reader is encouraged to review the search terms, search dates, search engines, and related materials in these prior papers.

We also describe a variety of techniques for teaching these four principles and attempt to tackle contemporary challenges in teaching clinical reasoning such as the integration of artificial intelligence (AI) and how to navigate transitions in instruction (e.g., moving from classroom to the clerkship) to help ground an instructors' understanding and effectiveness in teaching clinical reasoning. Finally, we suggest next steps for research and innovation in clinical reasoning.

## Foundational concepts of clinical reasoning

To be effective with clinical reasoning instruction, there are some foundational concepts to keep in mind such as its definition, theoretical approaches, and selected major findings from the literature. Clinical reasoning has multiple definitions in the literature, over 100 to be more precise [5]. In this article, we take an inclusive view of clinical reasoning that is consistent with contemporary literature on the topic [3,5]. More specifically, and as stated previously, we define clinical reasoning as the cognitive and affective steps up to and including establishing a diagnosis and management plan that is specific to a patient's circumstances and preferences. In other words, clinical reasoning begins as the patient enters the room and ends with the diagnosis and plan from a cognitive and emotional perspective. We include emotion with cognition, as emotion has a powerful impact on cognition, especially with the high-stakes decisions made with clinical reasoning. With this broad definition, it is important to also state what clinical reasoning is not. Clinical reasoning entails cognition and thus while it can weave into various aspects of patient care it is not professionalism, for example.

Key theories that inform clinical reasoning include dual process, cognitive load, deliberate practice, and situativity. We will briefly describe these below for purposes of teaching clinical reasoning and recommend that the reader consider additional references on these topics to further enhance their understanding [14-16]. Dual process theory argues that our thinking entails two broad cognitive processes [17,18], and this theory was popularized in the book "Thinking fast and slow" by Kahnemann [19]. The first process is fast thinking which in clinical reasoning terms is referred to as nonanalytic reasoning. Nonanalytic reasoning is fast, low effort and subconscious. A key strategy of nonanalytic reasoning is pattern recognition. If there is any question about how fast thinking fits these characteristics try to describe, with paragraphs, how a loved one walks, talks, and laughs. While you will have difficulty coming up with precise descriptions (subconscious and low effort) you can immediately and accurately identify the loved one on a busy street while driving by in a car. The second process is slow thinking also known as analytic reasoning which is slow, high effort, and involves actively comparing and contrasting options. An example here would be the thinking used to ascertain the diagnosis of coronavirus disease 2019 at the outbreak of the pandemic when a physician had not been exposed to this condition before. Cognitive load theory refers to our limited cognitive architecture, that we can only hold or process a limited amount of information in our working memory which is critical for learning and performance [15,20]. Given these cognitive limitations we constantly group (or chunk or try to make patterns) information to free up our working memory resources—turning slow thinking to fast thinking and when done well can be highly effective which is referred to as organized knowledge—when this chunking is done well so that an individual can quickly and efficiently use this information to solve problems (e.g., arrive at the diagnosis). Deliberate practice theory argues that to be an expert in an area, one needs to deliberately (effortfully) practice the component parts of the activity, at least initially under the guidance of a mentor or coach [16,21]. Finally, situativity theory is a family of theories that argue that the environment matters with cognition and that cognition entails interactions with other individuals and artifacts when thinking, learning, and acting (e.g., using the electronic health record's point of care resource and speaking with colleagues to help manage a patient in the hospital) [22]. All of these theories have important implications for teaching clinical reasoning as we outline below. We highlight some key concepts through a brief illustrative case.

> A 36-year-old woman presents to the clinic with the onset of pain, swelling, and tenderness of her hands and wrists. She also reports stiffness in the morning lasting over an hour and after sitting long periods of time. Additionally, she reports fatigue and changes to her finger joints and wrists.

## Four principles for teaching clinical reasoning

### 1. Principle 1: Clinical reasoning requires rich content-specific, organized knowledge.

A key principle is the notion that clinical reasoning is content (or case) specific. What this means is that knowledge about a condition is inextricably tied to reasoning about it. Thus, many experts in clinical reasoning do not refer to it as a skill which suggests that it is broadly generalizable. Indeed, studies have repeatedly found that clinical reasoning is not broadly generalizable (is highly dependent upon the content of the case) [23,24] and content specificity helps explain why we have specialties in medicine (and why you do not want your internal medicine physician to care for your infant with a rare condition). Thus, to be effective at clinical reasoning one needs a broad and deep fund of knowledge of the conditions and their treatment in practice. Medical education across the continuum should continue to place acquiring a broad and deep fund of knowledge as a core element of medical education to foster clinical reasoning. An appropriate question is how to effectively probe a learner's fund of knowledge.

In the below Box 1, we outline teaching strategies that can be used for this first principle. Here we advocate for finding common ground with the learner's fund of knowledge about the condition being discussed. This could be at the vocabulary level (semantic competence, e.g., recognizing chest pain as pleuritic), the problem list, the syndrome (e.g., septic shock or nephrotic syndrome), the differential diagnosis or the diagnosis. Teachers should learn how to probe at these different levels so that they can help to improve the learner's knowledge chuck. One can also ask the learner to diagram their thinking (e.g., with a concept map). Also, be mindful of the learner's cognitive load with providing instruction. Contemporary theory suggests we can hold up to four pieces of information in working memory. Therefore, be mindful of feedback to help the learner grow—if more than three pieces of advice, write them down for the learner. This first principle could be renamed as making the implicit explicit.

Returning to our case, if a medical learner lists only osteoarthritis on the differential an appropriate discussion (finding common ground) would be pointing out the difference between inflammatory and degenerative arthritis as well as the pathophysiology, sematic qualifiers (e.g., synovitis), and causes of each category of arthritis as this is likely where the learner's clinical reasoning diverges from the preceptor's. This could be done through several ways including a concept map, comparing, and contrasting related diagnoses, asking what if questions where you change features in the presentation and/or probing for common ground in your thinking and theirs (e.g., does the learner understand the difference between inflammation and degeneration)?

## 2. Principle 2: Clinical reasoning requires multiple strategies, flexibility in strategy use, and prolonged effort.

Returning to dual process theory, there are multiple strategies that one can use for each of the two processes. Nonanalytic reasoning (fast thinking) strategies include pattern recognition and heuristics that can be defined as useful rules of thumb—for example, consider arthrocentesis in a patient that presents with acute monoarticular arthritis. Analytic reasoning (slow thinking) strategies are more numerous and include ruling out the worst-case scenario, key feature approach (focusing on a feature with a limited differential diagnosis to generate the patient's diagnosis), using a schematic (algorithm) such as for low back pain, among many others [25]. What has been found in the literature is that we often use multiple strategies at the same time (we do not think purely fast or slow most of the time). For example, a patient presents to the emergency room with substernal chest pain and the emergency room physician may consider using pattern recognition, ruling out worst case scenario and focusing on a key feature. What the literature suggests is that faculty teach multiple strategies as flexibility in strategy use is

Box 1. Principle 1 and Selected Strategies for Teaching Clinical Reasoning

**Principle 1. Clinical reasoning requires rich content-specific, organized knowledge.**

**[Strategies]**

- Find "common ground" and point of "departure" in your learner's thinking
- Discuss intermediate steps: e.g., syndrome, problem lists, summary statement, encapsulations, and semantic qualifiers
- Have learners compare and contrast conditions
- Create prototypic patient assignments (How would a patient with condition X typically present?)
- Change key features in presentation ("What if" questions)
- Create algorithms/flowcharts/concept maps
- Give learner time to think (intentional pauses)
- Discuss essential concepts multiple times and via different ways
- Utilize near peer instruction at times (e.g., senior medical students teaching more junior students)
- Optimize cognitive load (facilitates effective chunking)
  - Provide worked examples (e.g., "solved" cases)
  - Start with common (classic) cases and gradually increase complexity
  - Do not overwhelm learners with too much feedback at once

Box 2. Principle 2 and Selected Strategies for Teaching Clinical Reasoning

**Principle 2. Clinical reasoning requires several strategies, flexibility, and prolonged effort.**

[Strategies]

- Encourage both processes (nonanalytic & analytic), multiple strategies, flexibility with strategy use
- Emphasize common causes and big picture concepts (e.g., focus on horses, not zebras)
- Think out loud (pretend like you have no frontal lobe and let the learner hear how you put the patient's presentation together leading to a diagnosis and management plan)
- Longitudinal mentoring (e.g., over months to years or more versus isolated events)
- Tell learners which activities to practice (context/situation dependent)
  - Teach: relevant from irrelevant, typical from atypical presentations
- Provide frequent, specific, focused feedback over time (if more than three suggestions, have the learner write them down)
- Other resources that may be helpful for this principle include:

One-minute preceptor [26]: teacher uses five micro skills

1. Get a commitment
   (e.g., so, what do you think is going on in this case)
2. Probe for supporting evidence (uncover basis for learner's decision)
   (e.g., what factors in the history support this diagnosis?)
3. Reinforce what was done well
4. Correct mistakes
5. Teach a general principle
   (e.g., when to consider performing arthrocentesis in a patient with arthritis)

SNAPPS [27]: a learner centered approach standing for:

- Summarize (briefly the presenting findings)
- Narrow (the differential to 2–3 options)
- Analyze (the differential diagnosis comparing and contrasting options)
- Probe (the preceptor by asking questions about uncertainty, difficulties, and so forth)
- Plan (management for the patient's presentation)
- Select (a next case for continued learning)

IDEA [28]: a learner centered approach standing for:

- Interpretive (summary of the patient's presentation)
- Differential (diagnosis)
- Explanation (of clinical reasoning)
- Alternatives

more likely to result in diagnostic success. The specific terms for each strategy are not key from our perspective, teaching the multiple approaches to a clinical problem (the strategies) are key. Clinical reasoning also requires prolonged effort (e.g., deliberate practice). In terms of deliberate practice, focusing on big picture concepts, common versus uncommon presentations and diseases, and so forth, is recommended. See Box 2 below for suggestions for teaching this principle which includes learner centered approaches where the student can explicitly practice this and elements of other principles with engagement with their teachers.

Returning to our case, asking the learner what conditions they would be worried about (rule out worst case scenario), what would be the differential diagnosis for wrist synovitis (key feature approach), thinking out loud on how you approach the patient's presentation and pointing out how inflammatory arthritis differs from degenerative arthritis as well as giving the patient an article to read or another practice case would represent ways to put this second principle into action with this case.

### 3. Principle 3: Clinical reasoning is impacted by motivation and emotion.

This principle reflects that we are not computers taking care of inanimate objects. We are thinking and feeling beings that care of those individuals who seek our help and may have a life-threatening condition. This principle reflects the inherent complexity of human cognition and behavior in medical settings, underscoring that clinical reasoning extends beyond pure logic and cognitive processes, incorporating the emotional and motivational dimensions intrinsic to human interactions, particularly in the context of patient care [29-31]. Attention to motivation (e.g., enhancing the willingness or desire to do something such as optimizing the learning climate) and/or emotions (e.g., feelings that can enhance learning and/or performance such as achievement emotions can enhance clinical reasoning instruction. For example, telling patient stories, enabling independence with patient care tasks (when ready), and celebrating successes in patient care as well as discussing when patient care goes awry. Making it clear why a learner is being instructed on a topic and giving appropriate autonomy are also key. See Box 3 for additional recommendations.

Returning to our case, giving the learner the opportunity to lead aspects of the care to include discussion of the condition, risks/benefits of treatment and or help with any planned office procedures (e.g., help with arthrocentesis or interpretation of X-ray findings) would help enhance both motivation and emotion connected to learning clinical reasoning in this scenario. The interplay between cognition, emotion, and motivation has implications for clinical practice and education [32].

### 4. Principle 4: Clinical reasoning is context specific.

An important emerging finding is that clinical reasoning is also context (or situation) specific. This refers to the phenomenon of a physician seeing two patients with the same presenting symptoms, findings, and diagnosis and yet the physician comes to two different diagnostic decisions.

Box 3. Principle 3 and Selected Strategies for Teaching Clinical Reasoning

Principle 3. Clinical reasoning is impacted by motivation & emotion.

[Strategies]
- Optimize learning environment
- Optimize engaging, relevant work activities (with appropriate support)
  - Encourage progressive independence (increasing responsibility when the learner is ready such as providing patient education)
- Capitalize on emotion with learning (limbic valence; tell meaningful "story" such as actual cases where things went well or poorly and what was learned)
  - Encourage learners to commit to diagnosis and therapy (without interruption)

Box 4. Principle 4 and Selected Strategies for Teaching Clinical Reasoning

Principle 4. Clinical reasoning is context specific.

[Strategies]
- All three prior lessons matter (review the strategies)!
- Do not assume an "expert" will display expert performance on every case
- Consider how to better optimize the system:
  - Adequate time, effective point of care resources
  - Robust, timely, specific feedback on performance
  - Enhance teamwork (e.g., on clinical team and inter-professionally)

Early work suggests that cognitive load and emotion may play a role and thus our incorporation of emotion into the definition of clinical reasoning and discussion of cognitive load with its teaching. Strategies to assist with principle 4 are listed below in Box 4.

Returning to our case, the teacher could enhance instruction of clinical reasoning by showing the learner appropriate point of care resources (e.g., UpToDate), extending the time in the case by asking the learner to present to the attending their thoughts on the management of this patient after having time to review the literature and put together their thinking and to contemplate how other members of the team (e.g., consultants and other health professionals) could facilitate effective clinical reasoning diagnosis and/or management.

This principle highlights the importance of the situational elements in which clinical reasoning occurs. This principle recognizes that clinical reasoning is not an isolated activity occurring inside the physician's head but is deeply embedded within a system that includes teamwork, resources, and feedback mechanisms. Situativity theorists do not deny the existence of cognitive structures—they embrace them. However, they do argue that cognitive processes not only take place "inside the head" but also "in the world." In other words, external factors (such as the electronic health record, time for the appointment, availability of support staff) are not just noise but are important elements of the cognitive process, and that there is a non-linear relationship between the input and output of the process [33]. Research in medical education, specifically on context specificity, supports the notion that clinical reasoning cannot be entirely separated from the context in which it takes place [34,35].

Studies collectively highlight the intricate relationship between clinical reasoning and the context in which it occurs, advocating for a more nuanced understanding and teaching of clinical reasoning that incorporates the dynamic and situational aspects of medical practice [36,37]. Patient care is a team sport performed within a larger system and things such as adequate time, appropriate point of care resources, enhancing teamwork and designing systems to provide timely and robust feedback will help instruction of clinical reasoning across the continuum. This lesson argues that all prior lessons are also important.

## Contemporary challenges

AI is changing how we work and arguably think. At the heart of AI and clinical reasoning includes can the resource be trusted for accurate information (much like many questioned UpToDate when it first emerged) and the speed of AI. The latter refers to could AI, like GPS (Global Positioning System) has become, for example, bolster (or replace) fast thinking that is critical to a physician's practice. If AI can support nonanalytic reasoning, it could revolutionize clinical reasoning instruction and performance. As AI technologies, such as deep learning and machine learning algorithms become more integrated into healthcare, they have the potential to support or even augment not only analytic reasoning but also potentially nonanalytic reasoning in a physician's practice. This evolution could lead to a revolution in clinical reasoning instruction and performance, offering more informed and meaningful discussions among learners, physicians, and patients [38].

Clearly AI will help support patients and may lead to more effective and meaningful discussions with learners and physicians (e.g., more informed about what may be occurring with their health). There are also opportunities for AI to provide timely and specific feedback to learners (e.g., could help development of clinical reasoning chunks for conditions) without the time dependence of teachers speaking with learners about each specific patient [39].

The integration of AI into clinical reasoning presents both challenges and opportunities for modern healthcare. Recent literature highlights the advancements and considerations in applying AI within healthcare contexts. For example, Koulaouzidis et al. [40] discuss the integration of AI in cardiology, emphasizing its role in clinical decision support systems and the challenges of implementing these technologies in practice. Similarly, Segato et al. [41] in 2020 explore AI applications in brain disease analysis, highlighting the technology's potential to enhance diagnosis and treatment planning through advanced data analysis.

Furthermore, the transition from classroom to clinical settings poses challenges for learners, as context specificity becomes increasingly complex and rarely discussed by teachers. Instruction that is authentic and considers learners' readiness and the specific clinical reasoning tasks being learned is crucial for navigating these transitions effectively [42]. Recent literature underscores the need for a symbiotic approach to learning clinical reasoning, integrating AI into the curriculum to navigate the benefits and potential issues of AI in clinical diagnosis [42,43]. This approach acknowledges the evolving relationship between clinicians and AI, emphasizing trust, ethical use, and the complementary strengths of human and AI. We argue that instruction should be as authentic as possible for the learner (taking in account their readiness and the clinical reasoning task being learned) as context specificity can be challenging when learners move from the classroom to the clinic.

We believe these four principles and selected strategies can be used in sessions for teaching clinical reasoning from the classroom to the bedside. We acknowledge that our findings are limited by the literature that we were able to review and given the diverse terminology, for example, and multiple health professions, there may be additional principles that we did not uncover with this work. Potential future research directions include enhancing our understanding of what leads to context specificity which should enable improved clinical reasoning instruction, exploring nonanalytic reasoning and how to enhance both the acquisition and maintenance of organized knowledge, clarifying the role of emotion in teaching and learning clinical reasoning to leverage curricula for the future as well as enhancing our understanding of contemporary challenges described below.

# Conclusion

We identified four essential principles for teaching clinical reasoning. First, a solid and broad organized knowledge base is crucial for success and teachers should try to make what is implicit explicit. Second, versatility in reasoning—strategies enabling nonanalytic and analytic reasoning—is key. Third, the influence of emotions and motivation on reasoning should be recognized and integrated into teaching methods. Fourth, clinical reasoning is context-dependent, and instruction should be authentic and take into account what is going on in the specific care encounter, reflecting the realities of diverse clinical environments. Our insights aim to guide the evolution of medical education to better prepare clinicians for the dynamic nature of patient care.

**ORCID:**
Steven J. Durning: https://orcid.org/0000-0001-5223-1597;
Eulho Jung: https://orcid.org/0000-0001-7102-4243;
Do-Hwan Kim: https://orcid.org/0000-0003-4137-7130;
Young-Mee Lee: https://orcid.org/0000-0002-4685-9465
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