Teaching and Assessing Clinical Reasoning Skills

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Clinical reasoning is a core competency expected to be acquired by all clinicians. It is the ability to integrate and apply different types of knowledge, weigh evidence critically and reflect upon the process used to arrive at a diagnosis. Problems with clinical reasoning often occur because of inadequate knowledge, flaws in data gathering and improper approach to information processing. Some of the educational strategies which can be used to encourage acquisition of clinical reasoning skills are: exposure to a wide variety of clinical cases, activation of previous knowledge, development of illness scripts, sharing expert strategies to arrive at a diagnosis, forcing students to prioritize differential diagnoses; and encouraging reflection, metacognition, deliberate practice and availability of formative feedback. Assessment of clinical reasoning abilities should be done throughout the training course in diverse settings. Use of scenario based multiple choice questions, key feature test and script concordance test are some ways of theoretically assessing clinical reasoning ability. In the clinical setting, these skills can be tested in most forms of workplace based assessment. We recommend that clinical reasoning must be taught at all levels of medical training as it improves clinician performance and reduces cognitive errors.

Keywords: *Assessment, Clinical problem solving, Clinical reasoning, Diagnostic reasoning, Medical decision-making, Medical education.*

The challenge of medicine lies in its complexity. One of the most important skills that a doctor needs to have is the ability to translate the unorganized information received from the patient into the language of medicine. In a short period of time, physicians are expected to work their way, starting from the presenting symptoms of patients to the diagnosis, and plan of management pertinent to the patient's specific context. They also need to decide about which direction to proceed in, which information to discard, and when to stop looking for more information. This calls for a phenomenal degree of observation, comprehension, recall, alertness and reasoning.

What is Clinical Reasoning?

Clinical reasoning has been defined as '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' [1]. Clinical reasoning has also been defined as 'the ability to integrate and apply different types of knowledge, to weigh evidence, critically think about arguments and to reflect upon the process used to arrive at a diagnosis' [2,3]. The terminology may vary to include terms such as 'clinical/medical problem solving' or 'diagnostic reasoning', but the essence remains that it is a complex cognitive process leading to meaningful interpretation of patients' problems and formulation of an effective management plan.

Experts agree that clinical reasoning is an essential skill that must be developed during the early years in training and further refined during subsequent years of practice. It must be taught at all levels of medical training [4-6]. Over the last few decades, it has been considered a crucial aspect of physician competence and is explicitly included in most medical schools' documents [6]. The Medical Council of India's proposed Graduate Medical Education Regulations (2012) also lists 'effective clinical problem solving' as one of the skills to be developed in medical graduates [7].

Advantages of Learning Clinical Reasoning Skills

Clinical reasoning skills not only help physicians in reaching an appropriate diagnosis, but are also the key to preventing diagnostic errors. Diagnostic errors in medicine may occur in 5-15% of cases [8]; two-thirds of these are cognitive errors which include flaws in diagnostic reasoning, and decision making. Deeper understanding of the processes involved in acquisition of clinical reasoning skills will thus help in reducing cognitive errors.

Process of Clinical Reasoning

Educational psychologists have explored the process of

medical decision making extensively, and these perspectives have changed over time [6, 9]. It is not within the scope of this article to discuss these theories, their evolution or evidence. We shall restrict ourselves to merely mentioning one of the models of clinical reasoning-namely Croskerry's dual processing theory [10, 11].

Dual Processing Theory

Croskerry's model proposes that clinicians use two types of cognitive processes to arrive at a diagnosis: System 1 approaches and System 2 approaches. System 1 approaches are intuitive, draw on past experience, and may be based entirely on pattern recognition or heuristics [10, 11]. On the other hand, System 2 approaches are slower, analytical, more deliberate and involve deeper thinking (**Table I**). The two processes are not mutually exclusive.

Clinicians tend to switch between both approaches depending on the complexity of the case [12]. In the learning phase, one tends to use more of System 2 or analytical approaches, and as expertise sets in there is a tendency to use more of System 1 or pattern recognition approaches. However even when experts encounter challenging cases, they tend to revert to System 2 approaches. During teaching, more emphasis is laid on System 2 processes, but in practice, physicians use System 1 processes more often. Hence there is need to train learners in System 1 approaches right from the beginning.

EDUCATIONAL STRATEGIES TO TEACH CLINICAL REASONING

Problems with clinical reasoning often occur because of inadequate knowledge of the disease, failure to activate prior knowledge, flaws in data gathering and improper approaches to information processing [5]. It is a challenge for clinical educators to diagnose the learner's approach to clinical reasoning and guide them towards correct approaches.

Clinical reasoning is perhaps best taught during the course of a clinical encounter either conducted by the physician-teacher (for demonstration), or preferably during observation of a clinical encounter being carried out by the student. Clinical case presentations, case based discussions/ chart stimulated recall, clinical problem solving exercises and structured case presentation models like SNAPPS (refer Box 1) and One Minute Preceptor (all discussed in detail later) are good settings for teaching clinical reasoning skills.

We enumerate some strategies which when used consciously by educators will encourage students to learn clinical reasoning approaches (**Table II**) [13,14].

Exposure to a wide variety of clinical conditions: Learning is contextual. Success in solving one kind of clinical problem is a poor predictor of success when faced with another clinical situation. A student thus needs exposure to a wide variety and large numbers of clinical cases during training [1, 6]. Students can learn prototypes of different diseases by this approach [15].

Activation of prior knowledge: Asking students for their reasoning based on pathophysiologic knowledge also enables them to recall and contextualize relevant basic sciences concepts [16, 17].

Emphasize forceful features: Many clinical conditions may be recognized by certain 'key features' or 'forceful features' or 'anchor points'. Students must be asked to observe these forceful features that serve as trigger in the memory for recognition of the condition when encountered again [13]. Pattern recognition based on above helps the physicians not only in identification of clinical condition but also in discriminatory thinking processes [9].

TABLE I DUAL PROCESSING THEORY: SYSTEM 1 AND SYSTEM 2 APPROACHES

System 1 approaches	*System 2 approaches*
• Reflex and intuitive (guided by knowledge and experience) • Automatically activated: Results in quick formulation of diagnostic hypothesis • Experiential, pattern recognition, heuristics or 'mental shortcuts' based on information that is readily available (past experiences, knowledge base, earlier feedback) • Dependent on contextual cues, affective state of physician • Common and simple clinical conditions are diagnosed predominantly by this processing	• Slower and deeper analytic thinking; more demanding on cognition • Deliberate, conscious and logical/rational analysis of given clinical scenario • Draws upon gathering of relevant new facts in addition to utilizing the past knowledge base and experience • Strengthens or rules out the initial hypotheses – raises questions; • Complex clinical conditions draw more upon this reasoning approach

TABLE II EDUCATIONAL STRATEGIES TO ENCOURAGE CLINICAL REASONING

Strategy	*Purpose*
• Provide exposure to a rich volume and variety of clinical conditions	• Students learn prototypes of different diseases, are able to compare different contexts: facilitates quick pattern recognition
• Give them enough time to prepare for each case	• Allows students to gather data, process information and reflect on it • Activates prior knowledge
• Encourage students to state possible diagnostic hypotheses early on in case presentations. E.g.: *"What do you think this patient is suffering from?"*	• Early commitment to a possible diagnosis encourages development of System 1 reasoning approaches
• During case discussion, link clinical knowledge to basic science concepts	• Activates prior knowledge and allows students to contextualize basic science concepts
• Emphasize forceful features	• Helps to build context specificity
• Ask students to prioritize differential diagnoses periodically with addition of each new bit of information (history/ physical finding/investigation)	• Helps them proceed in a logical manner • Teaches them to change the diagnostic probability using additional epidemiological and clinical data
• Ask students to compare and contrast various differential diagnoses	• Allows students to reflect, categorize and build illness scripts
• Ask students to explain the reason why any further particular information is being sought, and how they arrived at a particular conclusion. Do so in a non threatening manner	• Allows teacher to understand clinical reasoning approach of the student while making a diagnosis or management plan • Encourages correct reading habits: deep learning rather than rote memorization • Provide formative feedback and time for reflection on feedback
• Provides opportunities for formative feedback	• Encourages deliberate practice • Encourages metacognitive processes
• Teachers to share own logic and analytical process on the given case	• Demonstrates clinical reasoning approaches of experts
• Ask to summarize the case in 2-3 sentences	• Encourages comprehension and synthesis of information
• Give opportunities for repeated practice	• Encourages deliberate practice • Increases confidence in dealing with diverse contexts

Categorization and illness scripts: It is impossible to learn the frequency of every sign and symptom of each disease. One of the basic differences between the approaches of experts and novices is that experts are able to mentally categorize diseases in a logical manner [18]. The expert's mind stores the information pertaining to clinical conditions or diseases in the form of 'illness scripts'– or the predictable details of the condition such as predisposing factors, clinical presentation, complications, etc. [1, 19]. They learn to retrieve and apply this information reflexively.

Students need to be taught or exposed to clinical cases in a manner that they gradually develop these mental prototypes of disease or 'illness scripts'. This can be done by guiding learners' thought processes by way of asking relevant questions. These questions should encourage them to (*a*) propose differential diagnoses based on minimal clinical details; (*b*) modify diagnostic hypothesis as more information is available; and (*c*) justify or refute hypotheses based on their background knowledge or by asking them to compare and contrast most likely differential diagnoses [13,19]. Another way of teaching students to build on their illness scripts is to ask them to reflect on a previous patient with similar findings and compare presentations.

Two models of structured case presentations which encourage building of illness scripts or mental schemata are discussed here –the SNAPPS model, and the One

Minute Preceptor (OMP) model. These can be utilized for teaching as well for formative assessment and are designed for use by the physician-teacher in a busy office or out-patient setting [20].

- SNAPPS model (**Box 1**) can help learners build illness scripts essentially by way of comparing differential diagnoses and clarifications of uncertainties [21]. This method encourages expression of intuitive as well as analytical thinking and promotes self-reflection by the student [20, 21].
- The One Minute Preceptor (OMP) model is another useful model of structured clinical case discussion. In this model, the student presents a case, he/she is then asked to commit to a diagnosis, and is probed for reasoning for the same [22]. The preceptor, now aware of patient as well as student's diagnosis, teaches general rules (e.g. key features, principles of management, effective communication). The final two steps are to reinforce what was done well by the student and to correct the mistakes made. Usually it takes about 10 minutes (arbitrary division of time could be: 6 minutes for case presentation, 3 minutes for questioning and 1 minute for teaching the general rule and feedback) [23]. Despite being a teacher-initiated model, it drives the student to propose and justify the diagnosis, employing appropriate clinical reasoning skills by the learner.

Use of checklists has also been mooted to help in avoiding errors of omission [24].

Formative feedback: The role of providing effective formative feedback to the learner is the single most important feature which affects learning. Both SNAPPS and OMP models have an inherent component of providing feedback to the students.

Encourage learners to use both System 1 and System 2 approaches: There is often a mismatch between what we know about diagnostic reasoning and the way we teach our students. We have already discussed that expert clinicians first make use of intuitive processes, and go to analytical processes only later when the case does not fit our illness scripts. We should make a deliberate effort to promote intuitive thinking by asking the students at periodic intervals during the presentation (i.e. when he still does not have the complete clinical history or physical findings), the various possibilities that can be considered. As each new piece of information is presented as the history or physical finding, this list should change. The knowledge of epidemiology further contributes to speed and accuracy of diagnosis. Students should be trained to utilize the epidemiological data such as seasonal, geographical or demographic variation of disease conditions for narrowing down the diagnosis [25, 26]. Students must learn to prioritize in a list of differential diagnoses in a given context, enumerating points in favor and against each diagnosis. They should be encouraged to explain the reason why any further particular information is being sought, and how they arrived at a particular conclusion [27].

Box 1: SNAPPS MODEL FOR STRUCTURED CASE PRESENTATION

- **S**ummarize the case
- **N**arrow the differential diagnosis
- **A**nalyse the differentials
- **P**robe the preceptor about uncertainties
- **P**lan management for the patient
- **S**elect case related issues for self study

Another method, the Clinical Problem Solving (CPS) exercise serves as a good setting to demonstrate clinical reasoning. An expert physician is presented an unknown case in a stepwise fashion. During the course of an interactive discussion between the expert and the audience, the diagnostic process and its nuances are demonstrated [28].

Reflection and metacognition: Students must be encouraged and provided an opportunity to reflect on their diagnostic approach, and think about what they could be missing. Morbidity and mortality conferences are a good place to do this. Residents can be asked to reflect on their delivery of patient care based on actual case records (case based discussions) or on the discharge papers of patients (chart stimulated recall) [29]. Portfolios may also be useful in achieving this purpose. Such a metacognitive approach may help learners to recognize the need to slow down and avoid errors that occur due to premature closure of reasoning [30].

Deliberate practice: Just like a musician needs to practise again and again to play well, clinicians too need to hone their skills through training activities which are designed to maximize improvement. Ericsson called these activities 'deliberate practice' [31]. Deliberate practice includes finding opportunities for repeated practice, requesting honest feedback on performance at frequent intervals, maximizing learning from each case, reflecting on feedback and errors to improve performance and using mental practice to support clinical experiences. This can be done during regular clinical activities such as, asking students to report back during the morning rounds or after an emergency floor/ call duty.

ASSESSMENT OF CLINICAL REASONING ABILITY

The assessment of clinical reasoning is challenging as these skills are not measurable and must be inferred from behavior. As clinical reasoning is context specific, it has to be assessed across multiple domains, on multiple clinical scenarios, using multiple assessment methods to draw meaningful and valid interpretations. Moreover, these skills should be assessed throughout the course. Learning strategies for developing clinical reasoning rely heavily on feedback and reflection, and this is possible only when continuous ongoing formative assessment is in place.

The assessment of clinical reasoning can be carried out either in an authentic workplace-based clinical setting or outside it. The standardization of assessment, reliability, feasibility and resource efficacy may appear higher for assessments carried out in formal examination settings. However, assessment carried out in authentic clinical settings inherently scores higher in terms of validity and educational impact. Reliability of these assessments can be improved by increasing the number of clinical encounters. The issue of feasibility can also be addressed by structured assessment tools such as the mini clinical evaluation exercise (mini-CEX). Usefulness of some methods in assessment of clinical reasoning ability is discussed below:

1. *Multiple Choice Questions (MCQ)*

A well blueprinted MCQ-based examination has the potential of assessing wide content areas across different contexts in a short time. Simple recall type MCQs contribute little to assessment of medical decision making. However they can be improved to explore clinical problem solving ability by making them contextual. This is done by inserting clinical scenarios (**Box 2**).

Extended matching questions (EMQs) are also good for testing reasoning ability. Here learners have to pick the answers to context-specific clinical scenarios around a single theme from a list of options [32]. An example can be seen in **Box 3**.

2. *Key Feature Test*

These are clinical scenario-based questions that focus on critical steps in diagnosing or managing a particular clinical condition. These test a step in which examinees are most likely to make errors or a challenging aspect of the diagnosis and management in practice. The questions are designed as case scenarios to prompt learners to identify the key clinical feature in a clinical presentation and plan essential steps in diagnostic and management strategies [33]. An example is shown in **Box 4**.

Box 2: CONVERTING A RECALL TYPE MCQ INTO A HIGHER ORDER MCQ

Recall type MCQ:

The commonest cause of childhood anemia in India is:

a) Nutritional anemia b) Thalassemia major

c) Sickle cell disease d) Aplastic anemia

Higher order Scenario-based MCQ:

A two year old boy presents with severe pallor. He has been fed on milk-based diet. Anthropometry revealed weight for length below -3 *Z* score and length for age between -2 to -3 *Z* score. The child also has tachypnea, tachycardia, angular stomatitis, and koilonychia. There is no significant lymphadenopathy. Liver is palpable 5 cm below costal margin. Spleen is not palpable. Rest of the examination is normal. *The most likely cause of anemia in this child is:*

a) Nutritional anemia b) Thalassemia major

c) Sickle cell disease d) Aplastic anemia

Box 3: EXTENDED MATCHING QUESTIONS

Consider the following options

A. Nutritional Anemia

B. Thalassemia minor

C. Thalassemia major

D. Sickle cell trait

E. Sickle cell disease

F. Hookworm infestation

G. Aplastic Anemia

Lead in question: *For each child with anemia, select the most appropriate diagnosis*:

Q. 1: A two-year-old girl presented with severe anemia, icterus, hepatospenomegaly and failure to thrive. Her malar bones were prominent. She has a history of receiving two blood transfusions in the last year.

Key: *C*

Q. 2: A five-year-old boy presents with increasing pallor for 1 month and cutaneous bleeds for 7 days. Child is febrile. There is severe pallor but no lymphadenopathy. Liver and spleen are not enlarged. Child has been consuming 1300 kcal daily including food items from all the four food groups.

Key: *G*

Box 4: KEY FEATURE TEST

An 18-month-old girl presented to emergency with loose stools of 4 days duration. The weight for length of the child was below -3*Z* score. Peripheral pulses were weak and poorly palpable. Extremities and abdomen were cold to touch.

Q1. Provide a list of 2 problems that need immediate attention in this child.

[Score key: *The question carries 2 marks. 1 mark is awarded each for any of the following answers: severe dehydration, shock/septic shock, hypothermia. Any other response (such as diarrhea, dehydration, gastroenteritis, hypoglycemia, electrolyte imbalance, malnutrition) will carry minus 1 mark].*

Q2. Outline the three most important life-saving measures in managing this child.

[Score key: *The question carries 3 marks. 1 mark is awarded for each of the following answers; Warm the child by placing under radiant warmer; Secure IV access and provide bolus fluid (N/2 saline or Ringer lactate); Start systemic (IV) antibiotics. Any other response will carry minus 1 mark].*

3. *Script Concordance Test (SCT)*

This is based on the principle that the steps in the clinical reasoning process can be assessed and compared to the reasoning ability of a panel of experts [34]. The test design conforms to the possible organizational structure of illness scripts in the minds of the experts.

In Step 1, short ill-defined clinical scenario is first provided and the examinee's opinion is sought in terms of diagnostic hypothesis or investigation or judgment. In Step 2, a new piece of information is provided (clinical feature, test result, disease progression etc.). The examinee is then asked how this new piece of information affects their initial judgment. The decision making process of the learners is reflected in their responses at the addition or availability of each new piece of information. Learners' responses are scored using the responses by a panel of experts on the same case as a reference [9, 19, 34]. An example of SCT is shown in **Box 5.**

4. *Oral/ Viva voce Examination*

Despite being resource-intensive, oral examinations are ubiquitous in Indian medical schools. Though they are often reduced to mere recall of facts, they have the potential of being utilized for assessing clinical reasoning and medical decision making. Clinical scenario based questions that probe the analytical skills of the examinee may be utilized. Further, multiple clinical scenarios may be used to assess across subject areas [32].

5. *Long Case Examination*

Long case remains the mainstay of most clinical examinations conducted in our country. Usually the student works-up an allotted case (unobserved) and presents the same to the assessor. The assessor then asks clarifying questions or may ask to demonstrate a clinical sign. Though the long case examination is effort-intensive as well as time-consuming, it provides an oppportunity to the examiner to assess the clinical reasoning process of the learner by asking appropriate questions. Structuring of long case, like in Objective Structured Long Examination Record (OSLER)- may

Box 5: DESIGN AND EXAMPLE OF SCRIPT CONCORDANCE TEST (SCT)

[*Step* 1: Clinical Scenario] A four year old girl presents to the outpatient department with history of fever and sore throat since the last 3 days.

[*Step* 2*:* Diagnostic hypotheses]	**[*Step* 3: Additional information provided]**	**[*Step* 4: Change in clinical judgment]**
If you were thinking:	And then on subsequent interview and examination, you found that:	This diagnosis becomes: (Use the scale below)*
1. Viral pharyngitis	• Fever was high grade; • She had difficulty in swallowing	-2 , -1, 0, +1, +2
2. Streptococcal sore throat	• Recently developed red rash • Neck glands palpable	-2 , -1, 0, +1, +2
3. Diphtheria	• Tonsils enlarged and with a white coating	-2 , -1, 0, +1, +2

**-2 =Ruled out or almost ruled out; -1 = Less likely; 0= Neither more nor less likely; +1 = More likely; +2 = Certain or almost certain*.

improve the reliability of the long case, make it time efficient as well as impart it the valuable formative feedback function [35].

6. *Mini-Clinical Evaluation Exercise (mini-CEX)*

This method involves observing the learner during an actual clinical encounter. This exercise could be observed on an out-patient, inpatient or in an emergency-room setting. The assessor scores the performance of the learner on a standard scoring sheet (global rating) containing items pertaining to seven core clinical skills (medical interviewing, physical examination, professionalism, clinical judgment, counseling, organization/ efficacy and overall clinical competence) [36]. However all skills need not be assessed in a single encounter. The assessor then provides an immediate and contextual feedback. Scores of 'clinical judgment' are likely to reflect clinical reasoning ability.

7. *Portfolios*

These are case logs maintained by the student along with their reflective and narrative writing. They are able to offer rich and authentic evidence of learners' achievements and developments. When used properly, they can be suitable for monitoring and assessing learner competence and growth [29, 37].

FACULTY DEVELOPMENT

Faculty need to be sensitized about their role in facilitating learning and promoting development of clinical reasoning skills in students. Teachers need to consciously share their own clinical problem solving approaches. This guides learners through the developmental phases of this skill acquisition [38]. Additionally, faculty development initiatives are needed to train teachers in assessment of clinical reasoning skills and in giving effective feedback. Designing and conducting assessment to test reasoning ability requires a great deal of team work among experts.

CONCLUSIONS

Clinical reasoning skills are core competencies to be acquired and demonstrated by every physician. Conscious and sustained efforts are needed to encourage training medical graduates in the acquisition of these crucial skills.

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