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TWELVE TIPS

Twelve tips for teaching expertise in clinical reasoning

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Abstract

Background: Clinical reasoning is one of the most critical skills to teach to medical learners, yet clinician educators rarely receive adequate training on how to teach this topic.

Aims: To enhance clinician educators' ability to teach clinical reasoning.

Methods: I conducted a review of cognitive, medical decision making, and expertise theory literature to develop practical tips that could be applied to typical teaching encounters.

Results: Through the literature review, twelve tips were designed to provide a blueprint for teaching clinical reasoning on the wards or in the clinics.

Conclusions: Teaching clinical reasoning is important and feasible. Teachers who explicitly teach problem solving and decision making may help learners to improve their diagnostic accuracy and treatment choices.

Background

Clinical reasoning has been defined as the 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" (Eva 2007). This article provides a practical primer on teaching expertise in clinical reasoning, drawing from the literature on cognition, medical decision making, and expertise. The first eight tips focus on practices that learners (medical students and residents) can adopt to improve their clinical reasoning skills. Teachers can encourage learners to develop these skills and integrate them into daily practice. The last four tips describe specific techniques that clinical educators can apply to incorporate a greater focus on clinical reasoning into their teaching.

Learning behaviors

Tip 1

Maximize learning from each patient encounter

The fast pace of modern medicine and reliance on modern diagnostic technology has reduced the amount of time that learners spend with an individual patient, but these encounters provide the flesh on the bones of their anatomic and pathophysiologic knowledge. Learners' prototypes of specific diseases derive from the history, physical examination and natural history discovered through them (Bordage 2007). In order to recognize these essential patterns of diseases, learners need time to build history taking and exam skills, as well as time to process the large amounts of clinical data obtained.

Clinician educators can aid this process in three ways. First, allow learners to prepare for an encounter. Throwing learners into an encounter without a chance to activate their previous knowledge has limited clinical value and likely reduces knowledge gains. Second, give learners ample time to perform the evaluation. Accurate data collection is critical to diagnosis. Third, allow learners to read and reflect on the data, ideally, through writing their assessment and plan prior to seeing another patient. Learners process clinical data in a slower, analytic way as compared with experienced clinicians (Schmidt & Rikers 2007). On the wards, students can admit less sick patients early in their rotations and present to clinician educators the following day. Alternatively, they can see sick patients after the initial evaluation and orders have been completed. As long as they do not review the chart, they can still have an excellent learning experience. In the clinic setting, the wave model, which uses a similar approach, has been successfully employed in the ambulatory setting (Ferenchick et al. 1997).

Tip 2

Minimize omission errors through active information seeking

Performing a rote history and examination increases the probability of missing key clinical findings, because the eye does not see what the mind does not seek. By actively processing clinical data related to the patient's presentation, learners are more prepared to consciously register a subtle abnormal finding, which may be the clue to solving a

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diagnostic puzzle (Norman et al. 1996; Hatala et al. 1999; Norman et al. 2000).

Clinician educators can encourage learners to think through each step of the evaluation by stressing early hypothesis generation with active confirmation or rejection strategies incorporated into history taking and physical examination (Kassirer et al. 2009). Prior to the evaluation of a patient with acute dyspnea, for example, a teacher can ask the learner to list the differential diagnosis. The learner who verbalizes a hypothesis of pulmonary embolism will be more likely to seek a history of oral contraceptive use and a loud P2, thereby reducing the likelihood of missing a potentially deadly diagnosis.

Another practical approach to avoiding errors of omission is to apply a checklist approach (Gawande 2009). Careful reflection on the diagnostic process can be encouraged through use of a mnemonic checklist, such as SEA TOW (Is a Second opinion needed? Is this a "Eureka"/pattern recognition diagnosis? Is there Anti-evidence that refutes my diagnosis? Did I Think over my thinking (metacognition)? Am I Overconfident? What else could I be missing?) (Williams 2010). Such a metacognitive approach may help learners to recognize the need to slow down and avoid premature closure errors (Moulton et al. 2007).

Tip 3

Capitalize on pathophysiologic knowledge to make diagnoses

Inexperienced learners have more biomedical than clinical knowledge. Application of pathophysiologic knowledge to understand clinical findings enables students to better recall and apply the knowledge that they do have (Woods 2007; Woods et al. 2007).

To help learners attack more challenging diagnostic situations, clinician educators can ask students to explain the relationship of the clinical presentation to the underlying pathophysiology of the disorder when applicable (Woods et al. 2007). For example, imagine the case of a patient with bilateral lower extremity edema but no evidence of heart failure or cirrhosis. The student who can recall Starling's equation might consider the mechanism of decreased intracapillary oncotic pressure, and this may help introduce a third potential diagnosis of nephrotic syndrome into the differential diagnosis. For a medical student with limited clinical experience, this type of pathophysiologic knowledge is more readily recalled than the list of the differential for bilateral lower extremity edema (Schmidt & Rikers 2007). Learners can also apply pathophysiologic knowledge to confirm or reject diagnostic hypotheses through causal reasoning.

Tip 4

Utilize epidemiology

Diagnostic accuracy requires knowledge of epidemiology (e.g., demographics and risk factors). Knowledge that seasonal flu occurs only in winter allows advanced learners to exclude that diagnosis from their differentials in a summertime illness, while causal reasoning alone might lead to a misdiagnosis. Several studies have supported the idea that knowledge of epidemiology may be critical in distinguishing experts from non-expert physicians (Custers et al. 1996, 1998; Van Schaik et al. 2005). However, epidemiology is still a relatively minor part of the pre-clinical curriculum. In addition, trying to remember an epidemiological fact, such as the bimodal peak in prevalence of inflammatory bowel disease (IBD), is challenging, because: (1) it is a rather dull fact if one has never seen a patient with IBD and (2) it lacks a physiologic or conceptual framework which allows for recall. Learners' clinical experiences, however, bring the epidemiology of diseases to life.

When seeing a patient, clinician educators can highlight the relevant epidemiology of a potential diagnosis, specifically discussing prevalence, as well as comparing and contrasting it with the textbook presentation. This method is used commonly in conditions such as acute coronary syndrome and Clostridium difficile infections. It would not be difficult to extend these principles to other illnesses. Epidemiologic data generally begin any chapter on a particular disease and can be quickly found in a general textbook or an available internet resource. Helping learners develop a strong epidemiologic foundation may reduce their risk of inaccurate base rate (e.g., pre-test probability) estimations.

Tip 5

Explicitly compare diagnostic possibilities

Categorization is the fundamental task of diagnosis. A focus on the important distinguishing features of a group of different objects increases the reliability of accurate category assessment as compared with learning all the characteristics of a set of objects (Proctor & Vu 2006). Experienced clinicians often categorize diseases in such a manner, given the impossibility of learning the frequency of every symptom and sign for a given illness (Wigton 1988). These categories, or "illness scripts," serve as mental prototypes that physicians compare with the patient's presentation until they find one that fits (Eva 2007). When a patient's presentation fits an illness script well, an experienced clinician rapidly recognizes the disease in a rapid, unconscious, non-analytic way (i.e., pattern recognition).

For many diseases, learners may not have formed strong or accurate illness scripts (Schmidt & Rikers 2007). Clinician educators can help learners' build illness scripts by asking them to compare and contrast the most likely diagnostic possibilities in the differential (Bowen 2006). Practically, they can ask learners to employ the SNAPPS oral presentation model: Summarize the history and findings, Narrow the differential, Analyze the differential, Probe preceptor about uncertainties, Plan management, and Select case-related issues for self-study (Wolpaw et al. 2009). This model has been shown to increase the number and the comparison of diagnoses discussed, as well as the justification for their inclusion. Clinician teachers can also stress careful analysis of

the differential diagnosis in written documentation. Rigorously evaluating and providing feedback on the clinical reasoning within learners' notes may help them to refine their illness scripts and distinguish diseases more accurately. Finally, when a student admits a patient with the same symptom as a previous patient, the clinician educator can explicitly ask the student to reflect back on the previous patient and compare the presentations. If the patient has the same diagnosis, the student can expand his illness script for that disease based on the new patient; if a new diagnosis, he can use contrast to learn how to distinguish the two diseases.

Tip 6

Be flexible when reasoning diagnostically

In many cases, pattern recognition is a rapid and accurate way to make diagnoses, even for students (Norman & Eva 2009). However, every physician has had experiences where over-reliance on pattern recognition has led to a diagnostic error. On the other hand, research has demonstrated that excessive analytic reasoning can paradoxically lead to less diagnostic accuracy (Norman & Eva 2009). This may be due to the presence of excess stress ("cognitive overload") on working memory, which can process only small amounts of data at any one time. Most physicians move freely between pattern recognition and analytic reasoning as a given case necessitates (Eva 2007). No one diagnostic strategy is appropriate for every case.

The diagnostic literature supports the use of pattern recognition by learners but demonstrates reduced accuracy as compared with experts (Norman & Eva 2009). Because of this fact, it may be appropriate that learners complete a quick analytic "cross-check" to search for clinical findings that don't fit the pattern and deadly diagnoses that cannot be missed. For example, learners can employ pathophysiology or use a mnemonic, such as SEA TOW, to analyze the accuracy of a working diagnosis that emerged from pattern recognition (Kassirer et al. 2009; Williams 2010). Support for such a combined non-analytic and analytic approach to clinical reasoning can be found in two studies that have demonstrated improved diagnostic accuracy (Eva et al. 2007; Mamede et al. 2007).

Tip 7

Encourage learners to make commitments

Whenever possible, encourage learners to imagine that they are the only doctor taking care of the patient and that their decision is the final one. Ideally, this will strengthen their resolve to grapple with difficult decisions rather than deferring to their resident or clinician educator. Only through active engagement in these challenging decisions will learners begin the process of actual practice that can lead to expertise (Bowen 2006).

Once learners have selected a working diagnosis, the clinical teacher can ask them if they want to continue to test (e.g., order more studies to increase diagnostic certainty) or choose treatment (e.g., diagnostic certainty is high enough to treat given the benefits and risks associated with therapy). Practical questions to ask would include: "What difference will that test make in your management?" or "Do you think the benefits outweigh the harms in your treatment approach?" When differences of opinion arise, the clinical educator can think aloud to help the student understand why a specific decision was made.

This becomes particularly relevant when teaching about patients with complicated, ill-defined, or multiple medical problems. When a more challenging patient presents the attending can encourage learners to take their best shot and then guide them through a discussion of the pros and cons of various options through step-wise questioning. In the case of the patient with multiple issues or conflicting management goals, the clinician educator can ask the student to prioritize the management strategy and facilitate the process with key questions. For example, in the treatment of a patient with congestive heart failure and acute kidney injury, the teacher might ask a learner, "Using the data available to you to defend your answer, tell me what you think our top treatment priority should be: the heart failure or the kidney failure?" One way to help students and house officers to make commitments, even in these complex cases, is to create a mini-courtroom drama on rounds. The clinical teacher can ask learners to imagine themselves lawyers proving the guilt or innocence of the highly likely diagnoses and/or justifying their management plans. This sort of practice can build skill and confidence in tackling cases that are not clear-cut.

Tip 8

Practice deliberately

The challenges of developing expertise in clinical reasoning result in part from the fact that practice opportunities are limited. Unlike musicians who can pick up their instruments at any time, medical students and residents can only truly practice while in a clinical environment. In addition, musicians can play the same piece repeatedly, while the practice of medical learners hinges on chance exposure to diseases. Reading about various diseases to supplement the unpredictable nature of the ward experience may improve knowledge without necessarily improving clinical skills. In this setting, clinical teachers can stress the application of deliberate practice (Ericsson 2007). Deliberate practice includes:

(1) Requesting honest feedback on performance frequently
(2) Maximizing learning from each case
(3) Reflecting on feedback and errors in depth to improve performance
(4) Using mental practice frequently

Clinician educators can promote these behaviors during daily interactions with learners by providing regular formative feedback. Furthermore, they can stress additional learning objectives for students to help expand their clinical experiences (e.g., bring the student to the bedside to carefully examine the joints of a patient with rheumatoid arthritis although the patient was admitted for chest pain). Finally,

because practice opportunities are limited, clinician educators should encourage learners to use mental practice to supplement their hands-on clinical experiences. For example, though learners may not have seen a case of pulmonary embolism, they can mentally practice with a made-up case or a clinical problem solving exercise (available in journals such as NEJM and JGIM). Through these cases, they can consider the approach to the patient with acute shortness of breath (e.g., "What historical questions should I ask? What is my differential? What tests should I order? What would I do if the patient became hypotensive?"). In addition, group-based clinical reasoning practice exists in most educational settings in the form of case-based conferences (e.g., morning report and morbidity and mortality conference), and learners can participate in these (Kassirer 2010). Repeated individual and group mental practice in this fashion is likely to strengthen retention and recall, thus preparing learners for an actual patient encounter. Simulation-based learning will likely become a significant component of a technological solution to the deliberate practice problem in medicine, because learners will be able to practice both mental and procedural skills in hands-on, realistic clinical scenarios. Basic simulations, such as web-based cardiac auscultation and videos of patients, are readily accessible to most students and can be used for practice sessions. More advanced simulation technologies are now being employed within medical schools for teaching clinical skills; however, a detailed discussion of this topic is not within the purview of this article (McGaghie et al. 2010).

Teaching techniques

Tip 9

Bring Bayesian reasoning to life

Because values are often not available, clinician educators often describe diagnoses as "common," "rare," or "not uncommon," and tests as "good," "fair," or "poor." For learners, however, these somewhat amorphous terms may make decision making seem mysterious at best or arbitrary at worst. Mathematical approaches have the particular merit of demonstrating the key elements of the decision-making process. Introducing Bayes theorem (pre-test odds for a disease × likelihood ratio = post-test odds for a disease) to students reinforces the value of determining the probability for a given disease prior to testing, as well as the likelihood ratio for a test, to understand its utility for a specific patient's case (Deeks & Altman 2004).

Although many physicians find such mathematical approaches unfamiliar, they use these processes intuitively and can develop some faculty in their explicit use with a little practice. Though physicians may be inaccurate at determining pre-test probability based on clinical gestalt, many can be readily found within the literature, including prediction rules such as the Wells, FRAX, and Framingham risk scores (Richardson et al. 2003). Using a likelihood ratio nomogram, which can easily be found on the internet, eliminates the need for actual calculation (CEBM 2009). A search engine (e.g., Google™ Scholar) or library resources, such as ACP PIER®, DynaMed, or JAMA®'s Rational Clinical exam series, can quickly locate likelihood ratios for various studies and clinical findings. Searching for these numbers can be a student's or house officer's job on rounds or in clinic, because most learners are adept at internet searches. This process could allow a statement such as, "The negative d-dimer makes pulmonary embolism pretty unlikely in this patient," to be transformed into, "The negative d-dimer in our patient with a pre-test probability of 37.5% based on the Wells' score reduces her post-test probability to about 5%, essentially ruling out pulmonary embolism." Clinician teachers should use Bayesian analysis selectively because it has limited value in straightforward pattern recognition diagnoses, can be time-consuming, and numbers for the calculations may not be available. However, Bayesian principles can be reinforced by asking learners to define the probabilities of their diagnoses in all their patient assessments and to comment on how a positive or negative result for their requested studies will change management plans.

Tip 10

Emphasize evidence-based decision making

Role modeling an evidence-based approach is an important part of teaching clinical reasoning. Without data, well-founded diagnoses and management decisions are difficult to make and may become anecdotal exercises, which can leave students puzzled by the decision making process. Discussing the evidence for a decision encourages learners to seek out and assess the medical literature.

Doing quick, highly focused literature searches with internet-based resources or compiled evidence reviews (e.g., BMJ Clinical Evidence Handbook) while seeing a patient in clinic demonstrates to learners that rapidly accessing relevant medical literature is both feasible and valuable. After role-modeling this approach, clinical teachers can encourage learners to research their own patient-related questions and present them. This exercise can improve students' research skills and make them feel valued. Learners, as well as the clinician teacher, could also present a brief answer to a clinical question once a week. When evidence does not exist or a patient's preferences determine a certain decision, clinician educators should feel comfortable stating that informed clinical

Table 1. Reasons for incorrect diagnoses.

1. Lack of or inaccurate hypothesis generation
   a. Limited or inaccurate illness scripts
2. Inaccurate problem or context representation
   a. Data gathering failure
      i. Lack of or inaccurate history and/or physical examination
      ii. Failure to obtain necessary lab or radiologic studies
   b. Data processing failure
      i. Faulty verification (e.g., premature closure)
      ii. Faulty hypothesis generation
      iii. Faulty estimation of disease prevalence (base rate error)
      iv. Faulty interpretation of a test result
      v. Faulty causal model
      vi. Overreliance on a clinical axiom

Source: Adapted from Kassirer et al. (2009).

judgment, rather than a body of research, dictated the choice. They can also remind learners that a patient's informed opinion supersedes even the best evidence.

Tip 11

Diagnose the learners, not just the patient

Clinical reasoning failures usually occur either because of inadequate knowledge of diseases or inaccurate representation of the patient's problem due to data gathering or processing failure (Kassirer et al. 2009). By asking probing questions to assess the learner's knowledge gaps, clinical skills, and interpretation of patient data, clinical teachers can identify and address the cause of a diagnostic error. Table 1 lists some selected causes of diagnostic errors. A detailed description of diagnosing clinical reasoning errors in learners is beyond the scope of this article, but a recent review describes these techniques and addresses how they can be applied in a non-threatening manner (Bowen 2006).

Tip 12

Be a coach

Though few physician teachers think of themselves as "coaches," the expertise literature suggests that this may be the most important role of clinical teachers. Experts in various fields have nearly always had coaches that pushed them to greater heights through motivation and feedback (Ericsson 2007). Great physician coaches can have a powerful impact on learners (Weise 2010). Coaching can be broken down into three areas: role modeling, motivation, and feedback. All of the clinical reasoning tips presented here can be role-modeled by the teacher, so the remainder of this discussion will focus on motivation and feedback.

Because learners differ in skill, the first step in motivating them is to set achievable yet challenging expectations and goals for each one. Most learners will strive for the bar set for them, so setting high personalized expectations for each learner and expressing confidence that they can meet such expectations will help them to achieve expertise in clinical reasoning. In a practical sense, teachers can make expectations explicit and state them on day one. For an early student, one might say, "By the end of this month in clinic, I expect you to be able to obtain a thorough history and physical and present a clear and concise assessment of the patient's problems." For a student later in training, the teacher might specify that the assessment provide clinical findings for or against the most likely diagnoses and evidence for the plan. Expectations are equally important in terms of professional behaviors such as including communication, critical self-reflection, and life-long learning skills.

Setting expectations lays the groundwork for the most critical aspect of coaching: feedback. Practice without external feedback may lead to some improvement in skill acquisition, but learners are generally poor at self-assessment so external feedback is essential (Eva & Regehr 2008). Like a personal trainer, clinical teachers should push their learners to achieve a higher performance than they think possible, by giving feedback on their history taking, physical exam, and clinical reasoning skills. When errors occur, receipt of constructive feedback in an appropriate manner and setting may serve as a powerful learning experience for students (Eva 2009). How, when, and where feedback is given significantly influences its efficacy. Helpful reviews have been written on this topic (Ende 1983; Archer 2010; Kluger & Van Dijk 2010).

Finally, clinical educators must provide the learners with the appropriate autonomy to achieve their expectations. Otherwise, the goals become meaningless. The violin teacher who plays the concerto for the student but does not allow the student to practice would quickly be replaced, yet in medicine, some teachers still have their learners primarily "shadow" them. This lack of autonomy prevents learners from actively practicing clinical reasoning skills, which is essential to improvement.

Conclusion

A major goal of the medical educator is to promote the development of expert clinical reasoning in a learner. The first eight tips can be summarized as encouraging students to actively engage in the evaluation and management of patients, seek a deep understanding of diseases, and reflect critically on their performance. Using the final four tips can aid clinician educators in explicitly teaching clinical reasoning concepts. Nothing can replace the exposure of learners to a wide variety of cases, which provide the foundation for the development of clinical skills and knowledge of syndromes/illness scripts. However, these teaching tips provide clinician educators with methods to help learners maximize these experiences as they travel on the path toward expertise in clinical reasoning.

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