A lesson in clinical reasoning for the pharmacy preceptor

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Purpose. In this article, the pharmacy preceptor is introduced to the core components of the clinical reasoning process. Teaching strategies based on script theory and experiential educational theory are described to aid the pharmacy preceptor in facilitating the development of clinical reasoning in novice practitioners.

Summary. The development of clinical reasoning skills is essential for all healthcare providers. Clinical reasoning involves the integration of analytic and nonanalytic reasoning while minimizing the occurrence of cognitive error or bias. Such skills are needed to make diagnoses, formulate treatment plans, and solve clinical problems relating to all facets of healthcare. Teaching strategies by which to facilitate the development of clinical reasoning in physicians, nurses, and other healthcare providers have been described. To date, the topic of clinical reasoning has not been adequately addressed in the pharmacy education or practice literature.

Conclusion. Clinical reasoning is fundamental to clinical pharmacy practice. Instruction and modeling of this process by preceptors facilitate the development of advanced practitioners.

Keywords: clinical reasoning, experiential education, preceptor, script theory

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As pharmacists, we know when we are witnessing the use of clinical reasoning. We also hold firmly to the conviction that we use clinical reasoning each day to solve medication-related problems. However, when asked to describe clinical reasoning, few pharmacists involved in teaching can articulate the key components of this process, and far fewer can share how they facilitate the development of clinical reasoning in their pharmacy students and residents. Overall, we know it when we see it, we believe that we use it, but we struggle to teach it to others. As such, the primary purpose of this article is to review the fundamental components of clinical reasoning. Teaching strategies that promote the development of clinical reasoning based on script theory and experiential educational theory will also be described.

Please read the patient case scenario (Box) before proceeding.

Key components of clinical reasoning

Clinical reasoning is defined as “higher order thinking in which the health care provider, guided by best evidence or theory, observes and relates concepts and phenomena to develop an understanding of their significance.”¹ In practical terms, clinical reasoning involves the use of both analytic and nonanalytic thought processes to make a diagnosis and formulate a treatment plan. Sound clinical reasoning has 3 primary components: (1) pattern recognition/nonanalytic reasoning, (2) analytic reasoning, and (3) prevention of cognitive error.²

To understand the components of clinical reasoning, refer to the patient case scenario (Box) and ask yourself if you would have been able to quickly recognize the evidence supporting
the diagnosis of tacrolimus-associated hyperkalemia. The seasoned practitioner, particularly one who has practiced in the area of solid organ transplantation for years, would be able to rather quickly identify the supportive evidence. A pattern of evidence would emerge. This pattern involves a series of associations that are made between theoretical concepts, the clinical findings, and key features of the case (e.g., current medications, aspects of past medical or social history, and the timing of related events). In this scenario, an association would also be made between the treatments for hyperkalemia employed to date and the treatment outcomes. Patterns would be identified subconsciously by the practitioner, and he or she would be able to rather quickly generate a hypothesis regarding the case.2 In some situations, the hypothesis would actually emerge from the evidence via intuition rather than being actively formulated. Following the generation of a hypothesis, the practitioner would reexamine the data and findings, and possibly gather or request additional information, to either accept or refute the hypothesis. This ability to quickly recognize patterns and associations involving concepts and evidence heavily relies on experience.3 Overall, pattern recognition is a sub-conscious process initiated by verbal and nonverbal cues stemming from past experiences with a patient population or populations.3 This process also involves the recognition of when a previously identified pattern does not fit or apply to the current scenario.

If you were not able to readily recognize a pattern relating to this scenario, you would typically begin your investigation by organizing the available data. You would compile a list of the subjective and objective findings, formulate a problem list, conduct a literature search to identify common causes of hyperkalemia, and then generate a hypothesis or hypotheses regarding causality. To test each hypothesis, you would revisit the case and the evidence multiple times before drawing a plausible explanation for the phenomenon being observed. In this regard, you would rely more heavily on analytic reasoning skills than on pattern recognition for clinical reasoning. Analytic reasoning is a slow, arduous, deliberate, and conscious process, and it is the primary form of reasoning employed by the novice practitioner.2 Compared to pattern recognition, an intuitive process gained from experience, analytic reasoning focuses on the acquisition of knowledge and the applications of logic and inference.4 The analytic reasoning process is controlled, relying heavily on the organization of thought and the application of science.3,4

The third component involved in clinical reasoning is the consideration and prevention of cognitive error.

Box. Patient case scenario

As part of a multidisciplinary inpatient care team, a pharmacist listens to a case of a patient who recently underwent orthotopic heart transplantation. Three weeks post–orthotopic heart transplantation, the patient’s primary problem is chronic asymptomatic hyperkalemia. For the past week, the patient’s serum potassium concentrations ranged from 5.7 to 6.2 meq/L, serum creatinine concentrations have been stable (1.4–1.47 mg/dL) and serum glucose concentrations ranged from 110 to 200 mg/dL. Additional laboratory test values include serum sodium and carbon dioxide concentrations of 128 to 130 meq/L and 16 to 19 meq/L, respectively. The patient’s medications are tacrolimus 2 mg orally twice daily, mycophenolate mofetil 1,000 mg orally twice daily, prednisone 20 mg orally once daily, nystatin 500,000 units (swish and swallow) 4 times daily, atovaquone 1,500 mg orally once daily, valganciclovir 450 mg orally once daily, aspirin 81 mg orally once daily, pravastatin 20 mg orally once daily, and patiromer 16.8 g orally once daily. The tacrolimus dose has been adjusted daily to achieve a target whole-blood drug concentration of 10 to 12 ng/mL; the current tacrolimus concentration is 7.8 ng/mL. During the past weekend, use of i.v. calcium gluconate, i.v. insulin, and 50% dextrose in water was ineffective in lowering the serum potassium concentration, and additional doses of patiromer plus sodium polystyrene sulfonate were required. After hearing the case presented on rounds on a Monday morning, the pharmacist suggests that tacrolimus is the likely cause of the hyperkalemia in association with a renal tubular acidosis. The pharmacist describes a plan for management of this probable adverse drug reaction and explains why the current treatment approach using i.v. calcium, insulin, and 50% dextrose in water has been largely ineffective. This intervention, including review of the case and provision of a recommendation, is achieved in less than 15 minutes.
and bias. A variety of errors may be committed, or biases introduced, at various phases in the reasoning process. Overconfidence in the ability to recognize patterns may lead to the disregard of other plausible hypotheses. Error may result from premature closure of the analytic process or failure to collect all pertinent data that may influence decision making. Confirmation bias may be introduced when one relies heavily on evidence that confirms a hypothesis while ignoring evidence that suggests an alternative causation. Consideration also needs to be given to base rate neglect, the disregard of an event’s true rate of occurrence. For example, in our scenario, one must consider that renal tubular acidosis is a relatively uncommon occurrence associated with tacrolimus; all other hypotheses must be carefully considered before attributing causality to tacrolimus. Availability bias is introduced when one overestimates the likelihood of an event because of recent prior exposure to that event. Such bias may occur because the prior event was particularly memorable to the decision maker from an emotional perspective or because the event was dramatic in presentation. Additional cognitive errors may be committed because of lack of knowledge, misinterpretation of the available data, and inaccurate extrapolation of published evidence to the clinical situation. Awareness of the types of cognitive errors and biases, and awareness of self (i.e., one’s strengths and limitations as a problem solver), are needed to prevent errors from occurring.

Overall, clinical reasoning requires the use of analytic reasoning skills, the ability to recognize patterns and make meaningful associations, and the ability to recognize and minimize cognitive errors and biases. Keep in mind that analytic and nonanalytic reasoning are not mutually exclusive processes. In an attempt to simplify this concept, clinical reasoning may be described using an equation adapted from the work of Eva (shown above).

Teaching clinical reasoning

In 1990, a Delphi research project involving 46 theoreticians led to the identification of the core cognitive skills and dispositions involved in critical thinking. These elements can also be used to describe one who possesses clinical reasoning skills (Table 1). Before attempting to teach the process of clinical reasoning, it is important to be aware of these characteristics. Next, it is important to reflect on your learner.

As preceptor, the following questions should be asked and answered about your learner:

- What is the extent of experience of the learner? Is the learner a pharmacy student, postgraduate year (PGY) 1 resident, PGY2 resident, or entry-level practitioner with residency training?
- Is the learner aware of his or her strengths and areas of needed improvement? What does his or her self-inventory of practice skills reveal?
- Is the learner organized in his or her delivery of information?
- Can the learner retrieve information in a timely manner?
- What is the quality of the information retrieved from the literature or patient record?

Table 1. Cognitive Skills and Dispositions Important for Critical Thinking and Clinical Reasoning

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
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<tbody>
<tr>
<td>Interpretation</td>
<td>Comprehend and express the meaning or significance of a wide variety of experiences</td>
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<tr>
<td>Analysis</td>
<td>Identify relationships among statements, questions, and concepts; identify unstated assumptions</td>
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<tr>
<td>Evaluation</td>
<td>Assess the credibility of statements</td>
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<tr>
<td>Explanation</td>
<td>State and justify one’s reasoning</td>
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<tr>
<td>Self-regulation</td>
<td>Self-consciously monitor one’s cognitive skills; self-police</td>
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<tr>
<td>Dispositions</td>
<td>Inquisitiveness: Display a desire for learning and self-learning, even when the application of knowledge is not readily apparent</td>
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<td></td>
<td>Systematicity: Organized, orderly, focused, and diligent in inquiry</td>
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<td></td>
<td>Analyticity: Apply reasoning and use evidence to solve problems</td>
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<td></td>
<td>Truth-seeking: Eager to seek the best knowledge in a given context; courageous about asking questions; honest and objective in pursuing inquiry</td>
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<td>Open-mindedness: Tolerant of divergent views</td>
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<td>Self-confidence: Trusting in the soundness of one’s judgments</td>
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<tr>
<td></td>
<td>Maturity: Judicious in one’s decision making</td>
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• What is the extent of the learner’s knowledge, as demonstrated in daily problem solving?

By aligning the cognitive skills and dispositions toward clinical reasoning in Table 1 with information obtained about the learner, an initial teaching and learning plan can be developed. As an example, consider a learner who is a PGY1 resident with a strong entry-level knowledge base. While working with her, you observe that she is quite organized and adept at retrieving pertinent patient-specific information, but she is hesitant to draw conclusions and formulate a treatment plan. This resident appears highly motivated and aware of her limitations. Alignment of these findings with the cognitive skills associated with clinical reasoning suggests that this resident would most benefit from continued modeling of the decision-making process by the preceptor; continued immersion in patient experiences that have real consequences to build pattern recognition; and instructional activities that focus on the ability to make meaningful associations between theoretical concepts, patient findings, and published evidence. In contrast, a PGY1 resident with a weaker knowledge base and poorly organized presentations of patient information would best benefit from an educational plan directed at building and organizing knowledge from which to improve analytic reasoning skills.

In general, the novice practitioner is most apt to rely on previously acquired knowledge as the foundation for clinical reasoning. Although a vast amount of information may be stored in long-term memory, higher-level thinking requires the extraction and discrimination of information relative to a specific patient situation. Moreover, a knowledge base cannot remain static; new information gained from discovery, experience, and literature review must be incorporated and organized into current knowledge. To incorporate newly acquired information into long-term memory, connections or associations must be made between observations, theory, and previously stored information. One must also acquire the ability to determine when an association cannot be made or a pattern does not fit. To meet these ends and foster the development of clinical reasoning in the novice practitioner, preceptsing in the experiential setting should be focused on the following:

• Assisting the learner in further building his or her knowledge base;
• Assisting the learner in retrieving pertinent information from his or her knowledge base by asking questions that build associations between observations, knowledge, and evidence; and
• Immersing the learner in patient experiences that have real consequences in order to build skills in pattern recognition, time-efficiency, hypothesis generation, and hypothesis testing.

Teaching strategies in the experiential setting

A number of teaching strategies can be employed to facilitate the development of clinical reasoning. Three strategies that focus on particular areas of the learner’s development will be discussed.

Building the knowledge base: Application of script theory. Experts on clinical reasoning remind us that the ability to reason is contingent on a well-developed knowledge base. As such, we need to continually build our knowledge base while also fostering the development of our learner’s knowledge base. To do so, consideration should be given to script theory. This theory is based on the premise that memories and knowledge are organized in our brain as structures, or scripts. When confronted with a situation, retrieved memory in the form of a script allows us to interpret that situation, identify missing pieces of information specific to the situation, and make predictions about specific aspects of the situation. As an example, consider an upcoming medical appointment at a doctor’s office. Your mental script for this visit has been built from your previous encounters as a patient. The script would typically include the check-in process, the taking of vital signs, medication reconciliation, a review of your medical history, and then a physical examination performed by your physician. This mental script allows you to set expectations for the current encounter and identify any deviations or missing elements. Should you be ordered additional laboratory tests or referred to a specialty practitioner, your predictions about the encounter would change, and these new elements would be incorporated and organized into your prior script. Script theory contends that we interpret current events by relating them to previously constructed scripts containing bundled knowledge, sets of related experiences, and assumptions. Scripts are versatile and flexible structures that allow for incorporation of new knowledge and new experiences. Relating this theory to the field of medicine, illness scripts are defined as structured mental summaries of a provider’s knowledge about diseases. When confronted with a patient-specific query or encounter, the provider draws from previously stored knowledge in the form of illness scripts to guide reasoning. As such, illness scripts serve as the foundation of clinical reasoning, and their content varies depending on the provider’s knowledge and experiences.

Medical educators advocate the development of illness scripts as building blocks for clinical reasoning. To illustrate the application of script theory, return to our original scenario regarding the patient with hyperkalemia (Box). When confronted with this case, a series of illness scripts would “open” in the mind of the seasoned practitioner. Each preidentified illness would be associated with hyperkalemia. Notice the structure and organization of these scripts, as described in Table 2. This mental schema is developed and organized over time in the long-term
memory of the seasoned practitioner, and the contents are based on the practitioner’s unique experiences, prior instruction, and self-learning. Features of the current case (i.e., onset, other presenting symptoms, epidemiology, and responses to current and previous treatments) would be examined against each of the scripts. Networking of the scripts would lead to the identification of commonalities and discrepancies between the new case and stored knowledge. A pattern would likely emerge between features of the new case and one of these illnesses, ultimately leading to a hypothesis. In other words, application of an organized body of knowledge and experiences, or scripts, would guide clinical reasoning.

In the field of medicine, the networking of illness scripts is a core feature in the clinical reasoning process, hypothesis testing, and decision making. In the field of pharmacy, illness scripts also serve as a key component in the problem identification process; however, richly developed medication scripts (i.e., mental files that compare and contrast related features of medications) are most instrumental in decision making relative to drug-related problems. As a preceptor, one must appreciate learners’ challenges in first building these mental files, then developing the ability to navigate through both illness and medication scripts to generate sound hypotheses regarding drug-related problems.

The mental schema that you, the preceptor, have developed over time cannot be borrowed or transferred to your student. Instead, the preceptor needs to aid learners in developing and refining their own illness and medication scripts. How do we do so? In the classroom, use of concept mapping promotes the networking or bundling of concepts and data, thereby promoting the development of illness and medication scripts. Problem-based learning (PBL) also aligns well with the tenets of script theory. PBL involves learning through the investigation of real-world problems; it promotes self-investigation and self-discovery. In a PBL environment,
scripts are developed through the sharing of observations aloud (i.e., development of verbal cues) and through the active process of relating newly discovered information into existing knowledge. In the experiential setting, most would contend that informal discussions about commonly encountered diseases allow for the refinement of illness and medication scripts. However, such topic discussions are typically focused on a single illness or disease, not on the differentiating features of related conditions or related medications. To promote the development and refinement of illness and medication scripts in the experiential setting, the following strategies may be considered:

- Focus discussions on illnesses that the learner has encountered or is most likely to encounter during the specific clinical experience, not those that may be encountered. For example, in a cardiology rotation, discussions on heart failure and acute coronary syndrome should have higher priority than discussions on myocarditis or pericarditis.
- Relate the discussions to encountered patients to build pattern recognition. Compare and contrast the discriminating features between illnesses and between medications. For example, how did edema present in the patient with heart failure versus the patient with nephrotic syndrome? How did you determine, based on laboratory test values, that your patient had a drug-induced prerenal azotemia versus an acute tubular necrosis?
- Use the whiteboard or chalkboard to physically construct illness or medication scripts. For example, after observing the effects of a loop diuretic in a patient with heart failure, ask the learner to develop a medication script that compares 3 loop diuretics—bumetanide, furosemide, and torsemide—in terms of initial dose, onset of effect, oral bioavailability, and duration of effect. In a patient with a rash that is suspected to be caused by a cephalosporin, ask the learner to develop an illness script differentiating maculopapular rash, urticaria, and fixed drug eruption based on incidence, type of lesion, body distribution, onset, and recommended treatment.

After the scripts have been drafted on the whiteboard, aid the learner in identifying knowledge gaps for self-investigation.

Application of script theory can allow for the refinement and further development of the learner’s knowledge base. By building illness and medication scripts, the learner enhances the foundation of clinical reasoning from which nonanalytic and analytic processes can evolve.

**Making associations and building skills at pattern recognition: The art of the question**

While building and refining the knowledge base, the learner must also develop the ability to recognize patterns between stored evidence and current encounters. This ability is largely dependent on experience, but it can also be enhanced through effective questioning. A valuable exercise for preceptors is to reflect on one’s manner of questioning the learner. As part of this reflection, it is important to ask oneself the following questions:

1. Do I typically pose open-ended (divergent) or closed (convergent) questions?
2. Do I grill the learner with questions or do I typically use Socratic questioning?
3. When a learner does not know the answer to a question, how do I respond?
4. Do I relate the questions to the patient encounter or are the questions more general in nature?
5. Do I ask the learner to summarize what he or she has learned following my questioning?
6. Do I ask the learner what he or she will self-investigate?

Effective questioning has been described as a powerful device to promote critical thinking and reasoning. Questions can be used to measure knowledge, to gauge how the learner supports a hypothesis or a proposed treatment plan, to explore nonanalytic and analytic reasoning, and to examine metacognitive knowledge (i.e., an awareness of one’s cognition). Overall, the type of questioning heavily influences the development of information networking and mental schema. To promote the transfer of knowledge into long-term memory, associations, or links, between data, experiences, and concepts must be made. To illustrate the impact of questioning on the development of mental schema, refer back to the patient case scenario (Box). Assume in this scenario that the learner was not able to recognize the pattern of evidence supporting an association between tacrolimus and hyperkalemia. Instead, the learner hypothesized that the patient’s rising potassium concentration was related to impaired renal function in the setting of elevated blood glucose concentrations. To promote the development of associations between knowledge and observations, the following questions could be entertained:

- When i.v. calcium, insulin, and 50% dextrose injection in water were administered, the patient’s potassium concentration remained elevated. How does this finding affect your hypothesis?
- If the patient responded better to a cation-exchange resin, how would this finding affect your hypothesis?
- If the patient’s creatinine clearance was calculated as only 10 mL/min lower than baseline, how would this affect your hypothesis?

Questions that facilitate the development of associations will ask the learner to relate their impressions and prior knowledge to their current observations. Presenting a battery of questions to the learner, often
described as “grilling,” does not typically promote the development of associations for incorporation of information into long-term memory. Convergent questions (e.g., Does tacrolimus cause hyperkalemia? What is the mechanism by which this occurs? Why did you overlook tacrolimus as the cause in this case?) can be perceived as confrontational by the learner, thereby shutting down the learning process. The use of “If …, then …” questions allows for relationships to be made between concepts and observations, thereby facilitating pattern recognition.

**Maximizing the clinical experience: Applying experiential educational theory**

Immersion of the learner in clinical experiences that have real consequences is essential for the development of clinical reasoning. However, immersion alone is not effective. The preceptor needs to actively engage in the 4 roles of precepting (i.e., instructing, modeling, coaching, and facilitating) with the learner. The need for modeling cannot be overstated. In this role, the preceptor demonstrates clinical reasoning by sharing observations aloud and explaining one’s thought process. As stated by Dhaliwal in his article “The Mechanics of Reasoning,” “students learn reasoning by listening to others reason.” Modeling involves explaining associations and describing observed patterns, missing information, and discrepancies. The learner cannot borrow the preceptor’s mental schema, but the preceptor can facilitate the development of the learner’s networking of scripts by modeling how data are prioritized and organized for decision making. Effective modeling will empower the learner, allowing for a distancing of the preceptor into the roles of coach and facilitator of learning.

Experts in experiential education such as Kolb (1984, 1985) remind us that interaction, continuity, reflection, and independent learning are the most important features of effective experiences. Kolb describes the process of experiential education as a 4-phase cycle, with the 4 phases being immersion in a concrete experience (e.g., patient encounter), reflective observation, abstract conceptualization, and active experimentation. As a simplification of this model, consider the 3 phases of do (i.e., go forth and have a patient encounter), review (i.e., analyze what transpired and identify what learning opportunities were gained from the experience), and plan (i.e., identify how the current experience and the knowledge gained from it will influence future encounters). Involvement in each of these phases of experiential learning promotes the development of clinical reasoning.

To aid the learner in the organization of thought and the development of a time-sensitive practice, preceptors should consider employing elements of the One-Minute Preceptor Technique. This teaching method, originally described for use in ambulatory care clinics, largely focuses on maximizing the preceptor’s time with a learner by providing effective clinical questioning and feedback.

The One-Minute Preceptor model involves the following 5 steps in the precepting process:

1. **Get a commitment.** After the learner has had a concrete experience, ask the learner for his or her thoughts on the case. In particular, request a “one liner,” a brief summary of the patient encounter. For example, “The patient is 3 weeks post-orthotopic heart transplantation and has chronic asymptomatic hyperkalemia, with potassium concentrations ranging from 5.7 to 6.2 meq/L, in the setting of stable renal function and high-normal serum glucose concentrations.”

2. **Probe for supporting evidence.** Ask probing questions to identify the evidence that the learner is using to support his or her position on the case. In this step, the goal is to identify the learner’s reasoning skills. What data (i.e., evidence, observations, and concepts) are being relied on by the learner to form a hypothesis?

3. **Reinforce what was done well.** Provide positive feedback to encourage the learner. Was the learner organized in his or her presentation of the case? Was there attention to detail and to the timeliness of the situation?

4. **Give guidance about errors and omissions.** Correct mistakes. Misinterpretations of data, inappropriate extrapolation of information to the case, and other cognitive errors need to be corrected. Offer constructive comments that challenge the learner’s assumptions and that identify biases or errors so that the learner may develop self-policing behaviors.

5. **Teach a general principle.** Almost every case illustrates a general concept or principle that can be applied to future cases. Identify one teaching point illustrative of this case. Keep in mind that your choice of a teaching point may have substantial implications on the learner’s development or refinement of mental schema. The teaching point may be specific not only to medications or illnesses but also to the method by which the learner prioritized, processed, organized, or analyzed information in the case.

**Conclusion**

Clinical reasoning involves higher-level thinking and is dependent on the development of mental constructs or organized bundles of knowledge obtained from observation, experience, and self-investigation. A number of teaching strategies can be used to assist the pharmacy preceptor in promoting the development of clinical reasoning in the experiential setting.
Disclosures
The author has declared no potential conflicts of interest.

References