Teaching Differential Diagnosis: Tool Box Techniques

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Abstract Differential diagnosis is one of the most challenging skills for a new clinician to learn. Typically, students are first exposed to the process of differential diagnosis in problem-based learning sessions. In general, techniques and tools to use in performing this important task are not universally or consistently taught, so successful clinicians learn this process largely from observing other more experienced clinicians. This article presents effective techniques and assignments that can be used to teach the process of differential diagnosis, enabling novice clinicians to become more accurate and proficient diagnosticians earlier on. Rubrics for evaluation and the theory behind these techniques are also provided.

BACKGROUND

Teaching the Process of Differential Diagnosis

One of the more challenging performance issues that physician assistant (PA), medical, and nurse practitioner students must master is the ability to formulate, prioritize in order of relevance, and justify an accurate differential diagnosis list to guide management. According to Carver and Hipskind,[1] a significant number of medical adverse events occur due to errors in diagnosis. Performing a differential diagnosis is a complex cognitive process that requires a practitioner to possess a fund of medical and experiential knowledge that they can apply to often ill-defined clinical problems. It also involves recall of past experience and how that experience compares or does not compare to the current situation. Ultimately, practitioners make and justify a decision and course of action based on applying and adapting prior knowledge and experience to a new situation. This process is an example of the highest level of learning and cognitive process according to Bloom's Taxonomy.[2]

Formulating a differential from a chief complaint and history and physical actually requires a clinician to recognize patterns in a patient's narrative and to judge how closely they match or do not match classical presentations of illness and, ideally, illnesses that the clinician has seen before, and for which they had a known diagnosis. Context, patient demographic, and duration are also relevant. For example, it would be unlikely for a patient with a 5-day old rash, fever, and malaise to have Rocky Mountain spotted fever if they have never traveled to the endemic area and if they have not been bitten by a tick within the past month. Traditionally, students are not explicitly taught to formulate a differential and to systematically use pattern recognition and compare and contrast processes and algorithms along with considering patient demographic, context, and duration. Generally, these are not consistently linked to any intentional instruction on how to formulate and justify a differential. Astute learners and novice clinicians may begin to do this spontaneously with exposure and experience, even if they are not consciously aware of what they are doing. However, some learners have difficulty developing these techniques. The complexity of the cognitive processes involved in the skill of formulating a differential diagnosis makes teaching differential diagnosis difficult. Attempts at assisting learners in making differentials have been made via the use of mnemonics, such as the VINDICATE (Vascular, Infectious, Neoplastic, Degenerative, Iatrogenic/Intoxication, Congenital, Autoimmune/Allergic, Traumatic, Endocrine)[3] and VITAMIN (Vascular, Infectious, Trauma/Toxic, Autoimmune/Allergy, Metabolic, Iatrogenic/Idiopathic, Neoplasic, Social) mnemonics.[4] The techniques described in this article do not preclude use of these memory tools but presents a systematic process to be applied when the task of differential diagnosis is necessary.

Seller[5] states that the process of differential diagnosis is not specifically taught in medical school curriculum as it relates to chief complaints but only in the context of problem-based learning. The distinction is nuanced but important. Seller[5] developed an instruction for family medicine clerkship students that exposed them to a process of formulating a differential diagnosis based on commonly encountered chief complaints. While Seller's technique could give students improved facility with formulating a differential diagnosis with commonly encountered chief complaints, it does not provide a process for learners to apply systematically with symptoms or chief complaints with which they are not familiar. Stewart[6] notes that students are left to tease out the skill of differential diagnosis on their own. Reinoso et al[7] stated that making the process of differential diagnosis explicit so that learners can apply prior knowledge and integrate new knowledge systematically and consistently poses a particular didactic challenge. A recent informal query of PA educators by the author at the annual Physician Assistant Education Association (PAEA) Education Forum indicated that many educators use no standard technique for teaching the process of differential diagnosis beyond the process of problem-based learning and clinical problem-solving as required by Accreditation Review Commission on Education for the Physician Assistant (ARC-PA) Standard B1.07.[8] Traditionally, differential diagnosis is

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taught as a process grounded almost exclusively in deductive reasoning and hypothesis testing, often in the context of problem-based learning sessions.[9] Yet, techniques that assist learners in developing this skill and making them more efficient can be taught.

Using Advance Organizers in Teaching Differential Diagnosis

As defined by Ausubel, an advance organizer is a tool used to help the learner recall and transfer prior knowledge to new information being presented.[10] The techniques described in this article provide a set of advance organizers intended to help novice clinicians and students organize and access their prior knowledge and obtain and organize new information from a given patient such that they have a schema that they can systematically use in order to formulate a differential diagnosis. The techniques described in this article provide overt and explicit criteria that can be systematically applied to patient complaints and symptoms. This is particularly relevant as PA education is moving toward a more competency-based, stepwise entrustment approach to training where learners are assessed at given points in time for behaviors demonstrating competence in various clinically relevant skills.[11] The ability to accurately perform differential diagnosis effectively is one such assessed skill.

Exploding the Process of Differential Diagnosis

Many experienced clinicians have no conscious awareness of the process that they use to arrive at a diagnosis; however, the work of Heneghan et al[12] reveals that primary care clinicians actually use different techniques at different phases of the diagnostic process and to varying degrees depending on their familiarity with the condition at hand. They divide the process of differential diagnosis into 3 phases: (1) initiation of the diagnosis, (2) refinement, and (3) defining the final diagnosis. According to this work, many clinicians use the techniques of spot diagnosis, self-labeling, and presenting complaint and pattern recognition in stage 1 and use restricted rule outs, stepwise refinement, probabilistic reasoning, pattern recognition fit, and clinical prediction rules in stage 2; only in stage 3, do they label a disease entity, order additional tests, perform a test treatment, and observe response for a finite amount of time in the absence of a definitive diagnosis.[12] Spot diagnosis can be defined as the immediate recognition of a disease entity based on a characteristic appearance.[12] An example of this is recognition of a particular kind of rash based on its appearance. Self-labeling involves the patient presenting and telling the clinician what condition they believe is making them ill. Restricted rule out is a technique that a clinician applies to generate a short list of diagnostic possibilities but includes a few entities that, although unlikely, would have dire medical consequences if they were missed.[12] Probabilistic reasoning and clinical prediction rules rely on prevalence, demographics, context, and medical evidence to varying degrees.[12] It should be noted that the findings in this research demonstrated that few general practitioners formally recognized their use of probabilistic reasoning.[12] Test of time and treatment was used on average for one-quarter of the consultations, despite there being a poor evidence base for informing this process.[12]

Improving How Differential Diagnosis Is Taught

According to the work of Lucey et al,[13] if students are taught to use disease narratives or illness scripts and algorithms, and compare and contrast techniques to organize their clinical knowledge base, they can become more proficient in formulating a differential diagnosis when they move to the clinical setting and examination room, and can more quickly move from novice to a more experienced clinical problem-solver. The work of Lucey et al is consistent with the work of Reinoso et al[7] who stated that the necessity of using inductive and deductive reasoning together in the process of differential diagnosis poses a particular challenge for the novice clinician, who can benefit from being taught to use cognitive tools to facilitate the process of learning and accurately performing a differential diagnosis. According to Lucey et al,[13] knowledge base is not enough alone; organization of that knowledge base so that it can be accessed quickly and in a meaningful way in the clinical setting is key. Diagnostic efficiency and effectiveness is further enhanced when practitioners employ the above techniques in addition to consulting the medical evidence when necessary, while considering demographics, context, and duration of a given patient presentation and how closely in the patient's situation these match conditions that are part of the practitioner's cognitive schema and knowledge base. The risk of this refined diagnostic technique is that clinical students with a paucity of knowledge will latch onto one diagnostic clue that they do recognize and make all subsequent decisions based upon that one clue; they are correct only when they get lucky.[13] A second type of error occurs, according to Lucey et al,[13] when a novice clinician with an adequate but poorly organized knowledge base cannot refine a differential that they can justify to a manageable length. This article proposes that the antidote to these errors and the struggles of the novice clinician to diagnose efficiently and effectively is to create an environment where learners are encouraged to build, organize, and test their knowledge base, and reflect upon the strategies that can be used to make a diagnosis as suggested by the work of Heneghan et al.[12] It is the opinion of the author that this is especially useful for students who struggle with applying medical knowledge in the clinical realm.

METHODS

This paper describes the instructions and rubrics that have been designed, used, and initially assessed in a large, well established, successful PA program to teach PA students the above described skills and processes to assist them in becoming effective and efficient diagnosticians.

The assignments require that the students use consultation of medical databases and a practitioner's/student's growing clinical experience at key decision points of differential diagnosis. This is an application of Bayesian decision-making, shown to increase the accuracy of decisions made in the context of ill-defined and changing conditions.[14]

Assignment 1

The first assignment presented is designed for first-year PA students, and the content is synchronized to the topics that the students are learning in physical diagnosis. In essence, this is a compare and contrast activity (Figure 1). Upon completion of

Assignment #1 Learning Outcome: Formulate a differential diagnosis at a level appropriate for level of training and associated with information obtained from history and physical examination.

Diagnosis, as well as any time that we recognize something for what it is, is actually about recognizing patterns in whatever it is that we are observing. For example, you would recognize a car as a '57 Chevy if it had certain components that are known to belong to a '57 Chevy—a particular bumper style, certain fins, and a particular type of tail light, for example. Taken together, the pattern of all its components lets you know that you are looking at a '57 Chevy and not a '69 Mustang. We recognize diseases in the same way. This exercise is intended to help you fine-tune your ability to recognize the patterns, the appearance, and behavior of certain common illnesses, in other words, the scripts of an illness. If you know the patterns or a script of a given illness, when a patient presents with a clinical "story" that contains those patterns, you are better able to recognize it for what it is and for what it is not. It will also give you a skill set and tools for further independent study that you can apply to learn patterns or illness scripts of other illnesses. Of course, in real life, an illness in a given patient often does not fit 100% with how the illness is described in the literature, but clinical medicine is not an exact science, and the goal in differential diagnosis is to find the closest fit with the known patterns. This is one effective way that you can formulate a differential diagnosis list and rank order the items on that list based on closest match with the theoretical script of the illness that is potentially causing the patient's symptoms.

Please watch: “Teaching Young [Providers] to Think Like Clinicians” by Dr. Catherine Lucey on YouTube.[14] Then complete the assignment and upload your completed product to the assignment drop box.

You may wish to use:

- Dynamed (access your account via the library)
- US Preventive Task Force App (links to an external site)
- CDC (links to an external site)
- or other valid resources that you like

Activity:

Consider a patient presenting with sore throat, fever, and adenopathy as an initial complaint or symptom set over a brief period of time.

Next, **list** 3 to 4 conditions or diseases that cause these in a patient aged 18–40. Remember to consider the common diseases but also one or 2 that may be less likely but that could cause a really poor health outcome if you fail to diagnose it. For example, one of these diseases in this case would most certainly be strep throat.

Once you have you 3 or 4 conditions in mind, **then do some research in valid medical resources and write a narrative or compare and contrast charts** describing the classic presentation of your chosen illnesses or conditions. Consider where the diseases overlap in symptoms or behaviors, and what unique features distinguish one from the other. For the example above, you would probably describe strep throat, viral pharyngitis, mononucleosis, and also perhaps peritonsillar abscess, and even leukemia for the symptom set or complaint of sore throat, fever, and adenopathy. Finally, rank order your diagnoses from most likely to least likely and state why.

Repeat the steps above with the following complaints or symptom sets. The lists below are somewhat nonspecific so that you must consider several diseases that share these symptoms or complaints. It is up to you to accurately flesh out the narratives or compare and contrast charts of the diseases that you list. You may write a narrative for each disease that you decide to script, or you may make compare and contrast charts. Think 57 'Chevy vs. '69 Mustang. What would you write or list to help yourself or someone else distinguish one from the other? **Finally, rank order your chosen diseases from most likely to least likely. Remember to cite one reference that you used to help you write your narratives or compare and contrast charts.**

Symptoms or complaints list:
1. Sore throat, fever, adenopathy in a patient age 18–40 with symptoms being present for one week
2. Tinnitus, impaired balance, and decreased hearing in a 60-year old male
3. Malaise, fever, cough that is sometimes productive, and myalgia in a 55-year old female who has not had health care in 10 years. The symptoms have been present for about 10 days. She has been healthy but does work with the public. It is winter. She is a non-smoker.
4. Child with sore throat, fever, malaise, cervical adenopathy, rash on palms of hands and soles of feet, and mouth ulcers of a few day's duration.

Submit: Submit an assignment consisting of at least 3 sets of the disease narratives or compare and contrast charts that you wrote for each of the 4 symptom lists above. Remember to cite at least one reference.

Figure 1. Differential diagnosis assignment

Table 1. Differential Diagnosis Rubric

Illness Scripts and Differential Diagnosis: 11 Points = Pass				
Criteria	**Ratings**			**Total Possible Points**
Student submitted 3 sets of disease narratives or compare and contrast charts for each of the 4 symptom sets or complaint sets.	5.0 pts Diseases were reasonable choices for the symptom or complaint sets.	3.0 pts Most diseases were reasonable choices for the symptom sets or complaint sets chosen.	0.0 pts Diseases were not reasonable choices for the symptom sets or complaint sets chosen.	5.0
References were cited.	5.0 pts Student cited at least one medically valid reference.		0.0 pts Student cited no medically valid references.	5.0
Diseases were designated most to least likely with justification for the designations.	5.0 pts Diseases in the differential were appropriately designated "most likely" to "least likely" for every symptom set or complaint set, and a justification with a medically accurate and valid rationale was given for the designation.	3.0 pts Diseases in the differential were appropriately designated "most likely" to "least likely" for the symptom sets or complaint sets, and a justification was given for the designation that was adequate but superficial although medically accurate and valid.	0.0 pts Diseases in the differential for each symptom set or complaint set were not designated "most likely" to "least likely" and/or no justification was given.	5.0
Total possible points: 15.0				

https://www.cdc.gov; https://uspreventiveservicestaskforce.org.

the assignment, students will have done this activity for 4 symptom collections. The student products for the assignment are then evaluated by faculty according to the rubric (Table 1). An example of a student product can be seen in Table 2. This first assignment serves as an advanced organizer for the second assignment.

Assignment 2

In the second assignment, cases with symptoms similar to the ones in the first assignment are presented to the students (Figure 2). Students work in groups of 5 or 6 and are asked to state and designate as "most likely" to "least likely" at least 4 entities that could be causing the symptoms in a given case. It is at this time that the concept of using algorithms (clinical decision trees) and 30% match is introduced. According to Lucey et al, if a disease is being considered as a possible cause of the patient's symptoms but the patient's symptoms and presentation match by less than 30% with the classic narrative of the disease—and the demographics, context, and duration do not match—it is unlikely that the suspected disease is the cause of the patient's symptoms.[13,15]

According to McHugh and Lake, time, access to feedback, and self-reflection also lead to improved diagnostic skills.[16] To address the self-reflection issue, students are debriefed in a large group after each small group session. The faculty, who were circulating and interacting with each student group throughout the session, completed the same rubric for assessing each student's performance (Table 3).

Faculty Training and Buy-In

It is essential that faculty using this instruction are thoroughly familiar with its goals. One important goal of these 2 instructional activities is for students to use cognitive tools, such as compare and contrast techniques, to organize their knowledge bases and to be able to better and more quickly differentiate even subtle differences between disease entities. Other goals are for students to use illness narratives; application of the 30% rule; restricted rule out; consideration of context, duration, and demographics; and utilization of databases as relevant to formulate a differential diagnosis and justify it. Faculty must be trained and facile in giving feedback to the students about not only the diagnostic choices that they have made but also their justification for those choices. Faculty also must be willing to spend adequate time and focus evaluating the student products of the first assignment and to give ample feedback. One way to train faculty is to invite them to complete the assignments before using them as instruction.

ASSESSMENT AND DISCUSSION

The author's program reviewed write-in feedback on final preceptor evaluations from 2013 through 2018 and received direct feedback from preceptors and students that the students' skills in differential diagnosis for level of training could be stronger. While most preceptors ultimately scored the students' performance in this area as "satisfactory," their write-in comments implied that they perceived room for improvement. The program's ideal target of learning outcomes is to

Table 2. Student Product for Differential Diagnosis Assignment

DDx	Streptococcal Pharyngitis	Infectious Mononucleosis	Viral URI	Epiglottitis
General	Pharyngitis caused by group-A beta-hemolytic Strep	Primary infection with EBV	Acute viral infection of upper airway	Life-threatening upper airway inflammation and obstruction
Who?	Peak ages 5–15 y	Peaks between ages 5–25 y	Can occur at any age	More common in males, can occur at any age
Risk factors	Age 5–15 y, cold weather, exposure to others with Strep throat, crowded living conditions	Day care centers, settings in which exchange of saliva occurs, poor sanitary conditions	Exposure to sick person, weakened immune system, smoking, cold weather, and stress	Absence of Hib vaccine, weakened immune system, and smoking
History	Sore throat, fever, odynophagia, tender nodes, sudden onset. Unlikely to have rhinorrhea, cough, conjunctivitis	Classic triad of fever, pharyngitis, and adenopathy. Fatigue, headache, and rash also common	Sore throat, fever, congestion, cough, rhinorrhea, and malaise	High fever, severe sore throat, odynophagia with drooling, dyspnea, cough, and cervical adenopathy
Physical	Temperature: 101°–104° F, pharyngeal, tonsillar, and uvular inflammation, exudate, and petechiae on soft palate	Pharyngitis, tonsillitis, lymphadenopathy, splenomegaly, fever, rash	Mild fever, tonsillitis, pharyngitis, cervical adenopathy	Tripod/sniffing position, erythematous throat, neck tenderness, cervical adenopathy
Likelihood (1 = most likely, 4 = least likely)	3, because the age range would not fit perfectly but still possible	2, because the presenting symptoms fit perfectly, but the age range and lack of ability to reoccur makes it less likely	1, because this fits the presentation perfectly and is common among most ages	4, because the incidence of this is very rare due to wide use of the Hib vaccine, and the presentation doesn't match perfectly

DDx, differential diagnosis; URI, upper respiratory infection; EBV, Epstein-Barr virus.

have a significant majority of students exceed expectations for level of training on all assessment criteria on summative clinical evaluations at the end of each rotation. That is why the program decided to implement more intentional instruction specifically on the skills and tools used in differential diagnosis.

Feedback and Outcomes From First-Year PA Students

Feedback from the first-semester first-year PA students in the program's Class of 2020 who completed these assignments was generally positive (n = 75) and suggested that students found the techniques attainable and useful in clinical decision-making and even as a study tool. Less positive feedback was that the process was time-consuming, and that the diseases used in the assignment were not diseases that the students had yet encountered, which a few learners found to be frustrating. It was intentional that, while all diseases would be related to particular organ systems being studied, some would be unfamiliar to the students as disease entities. This was intended to prompt research and acquisition of new medical knowledge and to help replicate the actual clinical setting as much as possible. In the clinical setting, a novice clinician might not immediately recognize a condition from past experience alone, thus prompting the systematic use of the techniques discussed in this article. In the future, the use of the systematic techniques discussed in this article will be pointed out to learners as a learning objective. The program introduced the techniques in the second semester of the didactic year's problem-based learning sessions on diagnosis and management, and faculty was trained to introduce and use the concept of illness narratives as part of teaching differential diagnosis in problem-based learning. When surveyed for faculty feedback on course methodology, 100% (N = 8) found the techniques to be "excellent" (3 respondents) to "very good" (5 respondents).

Feedback and Outcomes From Second-Year PA Students

For clinical year students, data were assessed from the Class of 2015, which had no formal exposure to these techniques, through the Class of 2019, which had the most robust exposure to these techniques but not to the formal assignments used with the Class of 2020. Final clinical preceptor evaluations from the Class of 2015 through the Class of 2019 were compared. No significant difference in student performance in the parameters assessing differential diagnosis were noted when the "satisfactory" Likert scale criteria were assessed. This might be because the exposure these students had was to a less robust version of the above assignments. It may be reflective of preceptors' reluctance to designate "needs improvement" in the actual Likert scale criteria. However, when the final preceptor evaluation data for the Class of 2019 were assessed and compared to prior classes back to the Class of 2015, the data for the Class of 2019 showed more students achieving the "exceeds expectation" Likert criteria in the

Assignment #2 to be completed in class

Objectives:
The objective of this session is to improve students' abilities to manage particular patients with commonly encountered diagnoses in the primary care setting.

Outcomes:

1. Working with a most likely diagnosis in a specific patient, students will develop a medically sound management plan that addresses medical needs, and biopsychosocial needs, of the patient and takes into account the specific patient's values and culture. They will use medically valid resources such as Dynamed, Hippocrates, the MPR app, and the ePSS App.
    - Students will prescribe and suggest referrals to allied health services, provide patient education, address patient questions, and assess patient's ability to adhere to a given plan.
    - Students will consider patient's values, economic situation, home situation, social determinants of health, and cultural background, and discuss how these will likely affect adherence to the given plan.
    - Students will accurately write prescriptions and orders for the above-mentioned interventions and review those of their peers.
    - Students will document and review plans in the program's practice electronic medical record.
2. Students will be able to externalize the thought process that went into choosing the most likely diagnosis and management plan and justify their plan.
3. Students will be able to devise an alternative management plan when relevant.
4. Students will give feedback on a classmate's most likely diagnoses and management plans.
5. Students will adapt their most likely diagnoses and management plans when feedback and data warrant it.

Methods: Students will work in small groups of 6–7 with a faculty facilitator. Cases will be presented in which the most likely diagnosis should be apparent and should be named by students. However, students should still have a short differential in mind. Students may assume up-to-date vaccinations, no known drug allergies, non-pregnant state, and general good health unless told otherwise in the scenario. Pertinent negatives and positives will be stated in the description as they are relevant to a particular case.

Patients and Conditions:

Assume no known drug allergies unless otherwise stated.

1. **18-year old, stable, otherwise healthy non-pregnant female** with sore throat, exudative pharyngitis, tender bilateral cervical adenopathy, headache with no stiff neck, a fever of 100.5 degrees, with insurance and an attentive parent. She has no abdominal pain or adenopathy elsewhere. She is making herself take fluids and is voiding with normal quantity and frequency. She is mildly tachycardic but vitals are stable. She is up to date on age appropriate vaccinations and routine health maintenance. Her symptoms have been waxing and waning, maybe becoming a little worse over the past 2 days. The onset of the sore throat was rapid. **What is the working diagnosis, and why and how do you want to manage this patient?**
2. **70-year old male** with tinnitus, vertigo (how do you distinguish vertigo from dizziness and near syncope?), fluctuating hearing loss that seems to be getting worse in the right ear, a feeling of pressure in the right ear, and impaired balance. Each episode lasts a few hours and the symptoms have been present for a few months. There are no other concerning symptoms. Hint: This is not a catastrophic CNS event or a cardiac event. **What is the working diagnosis and how do you want to manage this patient? Why?**
3. **A 3-year old otherwise well child with an uneventful neonatal and prenatal history who goes to daycare** presents with his mother with sores/ulcers in the front of his mouth, tender cervical adenopathy, and sores on the soles of his feet and the palms of his hands. He has had a fever of 101.5 since yesterday without antipyretics and is taking fluids reluctantly. There are no rashes elsewhere on his body, his lips are not cracked, and the tongue is not swollen. He is voiding a normal amount according to his mother, and he is a little more irritable than usual. He is up to date on his vaccinations. There are no sick household contacts but the mother reports that she heard that one of the children at daycare was sent home with a fever. **What is at the top of your differential? What about the presentation makes you fairly certain that this child does not have Kawasaki Disease? Why? Why is it important, however, to consider Kawasaki Disease? How do you want to manage this patient?**

Figure 2. Interventions and therapeutics assignment

Table 3. Clinical Interventions and Therapeutics Rubric

Clinical Interventions and Therapeutics Session: 24 Points = "Complete" for the Activity				
Criteria	**Ratings**			**Total Points Possible**
Student made meaningful contributions to the class and group work in a respectful manner.	4.0 pts Meets expectations	2.0 pts Needs improvement	0.0 pts Does not meet expectations	4.0 pts
Student demonstrated appropriate use of valid medical and community resources.	4.0 pts Meets expectations	2.0 pts Needs improvement	0.0 pts Does not meet expectations	4.0 pts
Student demonstrated accurate awareness and acknowledgment of content/concept mastery and also gaps in knowledge and understanding.	4.0 pts Meets expectations	2.0 pts Needs improvement	0.0 pts Does not meet expectations	4.0 pts
Student sought to address gaps in knowledge and mastery in a productive manner that did not delay or disrupt group progress.	4.0 pts Meets expectations	2.0 pts Needs improvement	0.0 pts Does not meet expectations	4.0 pts
Student demonstrated on-target content knowledge for level of training.	4.0 pts Meets expectations	2.0 pts Needs improvement	0.0 pts Does not meet expectations	4.0 pts
Student devised a medically valid differential diagnosis and most likely diagnosis.	4.0 pts Meets expectations	2.0 pts Needs improvement	0.0 pts Does not meet expectations	4.0 pts
Student devised a therapeutic plan that involved non-pharmacologic and pharmacologic interventions and, in doing so, took into account patient values, culture, and resources, as appropriate.	4.0 pts Meets expectations	2.0 pts Needs improvement	0.0 pts Does not meet expectations	4.0 pts

differential diagnosis. It should be noted that the data are reflective of data averaged from clinical rotations one to 5 for each class from the Class of 2015 to the Class of 2019. At the time that this article was written, the Class of 2019 had only completed 5 out of 8 rotations. This data did not reach statistical significance, but they do show a trend suggestive of improvement in the desired learning outcome (Table 4). Physician Assistant Clinical Knowledge Rating and Assessment Tool (PACKRAT) and Physician Assistant National Certifying Exam scores of students exposed to these techniques and those not exposed did reveal improvement in parameters related to differential diagnosis and clinical management in the students exposed to the techniques, although the differences were modest and did not reach statistical significance (Table 5). Moreover, other curricular changes were made at the time that this instruction was introduced, so it is difficult to attribute the improved standardized test scores to only the instruction described here.

Table 4. Average Percentage of Students Achieving Expectations by Year* (Clinical Rotations I to V)

2015	45.0% (minimal exposure to techniques described in this article)
2016	50.0%
2017	50.0%
2018	47.0%
2019	55.4% (class with most exposure to techniques described in this article)

*These data do not reach statistical significance.

Table 5. PACKRAT Data by Year

	Year 1	Year 2
Class of 2018 (National)		
Clinical intervention	65.54% (66%)	68.23% (66%)
Clinical therapeutics	65.35% (59%)	59.87% (57%)
Diagnosis	77.45% (70%)	79.21 (74%)
	SD: 18.5 (21.7)	SD: 16.7 (19.1)
Class of 2014 (National)		
Clinical intervention	61.95% (62%)	61.56% (60%)
Clinical therapeutics	52.77% (50%)	65.74% (62%)
Diagnosis	68.95% (65%)	81.65% (75%)
	SD: 17.3 (19.3)	SD: 17.8 (14.8)

PACKRAT, Physician Assistant Clinical Knowledge Rating and Assessment Tool.

It is the goal of the program to provide preceptor education to help ensure preceptors are aware of this technique of teaching differential diagnosis. This didactic method was presented at the 2018 PAEA Education Forum, and most PA educators who participated in the session (n = 19) found that it provided useful content and concepts that they planned to apply to their own teaching and instruction.[17] Several participants suggested that the session should have been longer; this could be interpreted to mean that the concepts are relevant and warrant their time and attention. Further refinements will be made to this instruction based on feedback from learners and faculty and performance data.

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