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Four Web-Based Interactive Endocrine Case Studies for Use in Undergraduate Medical Education

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Abstract

Introduction: This resource is a collection of four case-based exercises intended to provide medical students with structured and focused opportunities to link basic science with clinical application. The cases are designed to help students self-evaluate their knowledge and develop a robust and well-integrated understanding of endocrine physiology and pathophysiology in the context of a representative range of endocrine disorders involving adrenal cortical, thyroid, and reproductive function. Although these cases were designed for, and used by, first-year students, they are also suitable for more advanced students. **Methods:** Each case opens with a brief vignette containing a patient presentation and a history of present illness. The student first formulates a differential diagnosis and then sequentially narrows the differential by selecting from lists of diagnostic tests; correct answers with feedback are provided at each step. A diagnosis is ultimately required, and the student may be prompted to propose a treatment plan. **Results:** End-of-course survey results from 128 first-year medical students suggest that the use of these interactive case studies was considered to be a worthwhile use of study time, and that knowledge gained in the correlate endocrine course was required to work through the cases. Students indicated that the levels of case and task complexity, along with feedback, were appropriate and helpful. **Discussion:** These cases provide a resource for meeting the need for clinically relevant scenarios in the preclerkship years.

Keywords

Physiology, Pathophysiology, Case-Based Learning, Hypogonadism, Endocrinology, Cushing's Syndrome, Addison's Disease, Hypothyroidism

Educational Objectives

By the end of this session, learners will be able to:

1. Describe the predominant signs and symptoms of Cushing's syndrome, hypothyroidism, male hypogonadism, and Addison's disease.
2. Utilize the information provided in a focused patient presentation and history to develop a differential diagnosis.
3. Explain the rationale for the most useful tests that will aid in narrowing the differential diagnosis, drawing upon relevant endocrine physiology and pathophysiology concepts commonly taught in preclerkship medical school curricula.
4. Explain the contribution of particular physical exam and diagnostic test data to a final diagnosis, utilizing relevant endocrine physiology and pathophysiology concepts commonly taught in preclerkship medical school curricula.
5. Propose an appropriate treatment plan for the purpose of restoring the normal physiologic state.

Introduction

Given the widespread adoption of integrated curricula across medical schools worldwide,¹ it is increasingly imperative to implement specific teaching resources and approaches that help learners link basic science and clinical application in meaningful and timely ways. Medical schools often invest much time and effort in juxtaposing basic and clinical science content, but are not always as consistent in creating specific

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Appendices

- A. Case 1 folder
- B. Case 2 folder
- C. Case 3 folder
- D. Case 4 folder

All appendices are peer reviewed as integral parts of the Original Publication.

learning experiences that are “conducive to teaching the content. . . to ensure that the material creates explicit and discernible linkages for students.”² The online interactive cases presented here are designed to help students develop a robust and well integrated understanding of endocrine physiology and pathophysiology in the context of a representative range of endocrine disorders. Although these cases were designed for, and used by, first-year medical students as part of the first-year Renal, Endocrine, and Reproductive Systems course at Robert Wood Johnson Medical School, they are also suitable for more advanced students seeking to strengthen and revisit basic science knowledge in clinical contexts.

Each case opens with a brief vignette containing a patient presentation and a history of present illness. The student must first formulate a differential diagnosis by choosing from a provided list of diagnoses. Next, the student sequentially narrows the differential by selecting from lists of diagnostic tests; correct answers with feedback and causal explanations are provided at each step. A diagnosis is ultimately required and the student may be prompted to propose a treatment plan. The cases are encountered online, individually, and at the student’s own pace.

We developed the cases in this fashion partly in response to observed needs among our students. Observation of our students revealed that many were using internally prepared and commercially available questions to self-evaluate as they worked their way through our integrated curriculum. We have found that many students tend to rely almost exclusively on this method. For all the strengths of these questions in helping students build recognition of common presentations, students can become too comfortable with item-stem content and similar answer choices across resources. In addition, an insufficient number of the commonly used questions are application-oriented, and they do not fully tap into knowledge of integrated concepts. We thus observed a mismatch between the level at which we were teaching and the resources students were using for practice and self-assessment.

In addition, our use of cases and questions was informed by the unique potentialities of case-based learning as a means for helping students move from surface to deep learning, and as a complementary opportunity to retrieve and apply facts and concepts from lecture and independent study.³ The sequential, step-wise approach we adopted is meant to capitalize on the balance of structured inquiry intrinsic to some of the positive outcomes of case-based learning, and achieve a desirable level of difficulty⁴ and feedback that can help students engage in the advanced elements of these cases without being overwhelmed.

We could not identify similar web-based interactive exercises based upon internet searches. Again, the vast majority of so called self-evaluation resources are in the form of question banks, the limitations of which have been previously discussed. This suggests that this interactive endocrine-based self-study tool is unique, and it thus offers an exciting and challenging addition to the existing materials.

Methods

This interactive exercise has been designed to provide first-year medical students with an application-based method to self-evaluate their competency in endocrine physiology and pathophysiology. The exercise was made available to students via the course website as part of the Robert Wood Johnson Medical School first-year Renal, Endocrine, and Reproductive Systems course. Students may access the exercise at any time during the course; however, they are encouraged to use this exercise for self-evaluation once the endocrine and reproductive physiology sections have been completed.

This exercise is comprised of four case studies, collectively representing a range of endocrine disorders, which are tested in the Robert Wood Johnson Medical School internal end-of-course exam, and likely represent high-yield concepts within the USMLE Step 1 exam. Importantly, since these cases do not represent obscure pathologies, any long-term retention of this information has the potential benefit of assisting students with clinical reasoning skills well beyond their preclinical education.

Cases

Case one features a 35-year-old woman with menstrual irregularities, weight gain, and hirsutism. The diagnosis is Cushing’s syndrome. Case two features a 40-year-old woman with oligomenorrhea,

amenorrhea, and fatigue. The diagnosis in this case is hypothyroidism. Case three features a 52-year-old man with decreased libido, decreased muscle strength, and fatigue. The diagnosis is hypergonadotropic hypogonadism. Finally, case four features a 29-year-old woman with long-standing weakness, lightheadedness, nausea, and vomiting. The diagnosis for this case is Addison's disease.

Technical Aspects

To use the cases, first extract the case .zip folders. Select a case by opening the case folder and clicking on the index.html file. If prompted, choose a Web browser to view the file. Begin the case by clicking the "Start" link at the bottom of the first page. Navigate through the entire case by clicking the "Next," "Previous," or "Start Over" links on each subsequent page.

Running the Exercise

Each case study begins with a short vignette containing the initial patient presentation and a history of the present illness. The information provided in this first section is typical given the final diagnosis. However, as is the case with these pathologies, many of the signs and symptoms overlap among numerous endocrine and nonendocrine disease states. Thus, the consideration of numerous physiologic and pathophysiologic mechanisms of action is critical in order to form the differential diagnosis, which is the first step in this exercise. To accomplish this, a list of several pathologies is provided, and the learner is prompted to choose, by checking boxes, "Which of the following should be included as part of your differential diagnosis?" The question and answer portion of each case is interactive. The choices have radio buttons next to each. The correct answers and the incorrect answers are displayed when the user clicks on the "Check Answers" button. A "Try Again" button refreshes the individual page and removes all user responses, which allows the user to repeat the same question. Once the student is ready to proceed, a second screen appears showing the correct answers with feedback describing why the listed correct answer choices are the best answers and why the incorrect answers are not.

By clicking on "Next" at the bottom of the screen, a subsequent screen appears which, when appropriate, may include some initial diagnostic test results, and prompts the selection of one or more diagnostic tests that will best aid in narrowing the differential diagnosis. Once this is complete, the "Check Answers" button is clicked, and the next screen appears, showing diagnostic results that will aid in further narrowing the differential as well as the best answers with feedback. This process continues, ultimately leading to a screen which asks for the selection of the most accurate diagnosis. Once the diagnosis is established, the student may be asked to choose the most appropriate treatment plan.

In addition to feedback, in some cases, additional enrichment is also included. Certain sections prompt the student to provide short answer responses. At all points throughout each case, the student has the option to move to the next screen, return to the previous screen, try again, or start over.

Results

The following subset of items were included within the end-of-course survey which was made available to the students following the Robert Wood Johnson Medical School first-year Renal, Endocrine, and Reproductive Systems course. One hundred and twenty eight out of the 188 first-year medical students who completed this course also completed the following survey, items of which are based upon a 5-point Likert scale with one indicating strong disagreement, five indicating strong agreement.

Item one stated, "I found the online interactive endocrine cases a worthwhile use of my self-study time." On average, students rated this statement on the Likert scale as a 4.2, with 86% either agreeing or strongly agreeing, 2% disagreeing, and 1% strongly disagreeing.

Item two stated "I was required to utilize the knowledge obtained in this course to work through these cases." On average, students rated this statement on the Likert scale as a 4.28, with 84% either agreeing or strongly agreeing, 1% disagreeing, and 0.5% strongly disagreeing.

Item three stated "The content of these cases was at an appropriate level to reinforce and/or extend course content." On average, students rated this statement on the Likert scale as a 4.07, with 80% either agreeing or strongly agreeing, 4% disagreeing, and no students strongly disagreeing.

An opportunity to provide written comments was also provided. Feedback from the written comments represented a wide range of opinions, but was overwhelmingly supportive of this exercise as being a useful learning mechanism.

The following are direct quotes from a representative sampling of survey comments in response to the question of “What did you find was/were the MOST useful aspect(s) of the cases?”

- “Having to actually narrow down the differential diagnosis, as well as walking through multiple different tests. Actually getting some kind of results back from tests helps to cement the information in our minds.”
- “Content of these cases accurately reflected the course content’s level of difficulty.”
- “I think they may have sometimes just slightly pushed the boundaries into what I expect M2 year will be about, but other than that they were great.”
- “The integrated nature and the real-life applicability - seeing how the diseases we learned about in class would present in the clinic, as well as how to go about diagnosing and treating them.”
- “The explanations for why a diagnosis or potential symptom was unlikely/incorrect were very helpful.”
- “I found the answer explanations to be most useful (although somewhat incomplete since they did not explain every one of the answer choices) - especially why the wrong answers were considered incorrect. I liked how the cases were broken up into steps and required application of many different concepts learned throughout the block.”
- “Good to see the cases reflect real world situations!”
- “Starting to make a differential, and what labs to order. . . helps you to think through what’s wrong, how it presents and start to work toward acting like a real doctor.”
- “The most useful aspects were synthesizing knowledge/information to solve a problem.”

The following are direct quotes from a representative sampling of survey comments in response to the question of “What did you find was/were the LEAST useful aspect(s) of the cases?”

- “There were a lot of details I wasn’t sure we needed to know. When the cases were so vague that anything and everything could be the cause of the vague symptoms, but I know [you] did that for learning purposes...I’m just someone who likes clear cut answers.”
- “The first few questions of each case had way too many right answers. I prefer shorter practice questions that are more similar to the format of questions on exams. The cases that were presented online were very similar to what we do in lecture, and I felt that they were redundant. However, I could see how they would be useful for other students who prefer practicing questions in that format.”
- “Sometimes the explanation for why certain choices were incorrect were lacking.”
- “More of the wrong answers could have been explained, there were a few answers that I got wrong that the explanation wasn’t long.”
- “Addressed too much material in each individual question.”
- “The length of time it took to go through each one.”

Students were asked to estimate the amount of time that they devoted to completing the case studies. Sixty-four percent of the students spent 20 minutes or less using this exercise. Approximately 28% spent between 20 and 60 minutes. Seven percent spent 60 minutes or greater.

Discussion

We developed this case-based exercises in order to provide first-year medical students with an early, structured, and focused opportunity to link basic science with clinical application. Our initial motivation for doing so was to meet student demand for self-evaluation resources by providing practice materials that corresponded more closely to the manner in which we were teaching. However, we also saw these cases as learning experiences in and of themselves.

The challenges we faced were how to achieve appropriate levels of case and task complexity and a beneficial balance of structure, inquiry, and feedback. One index of success in meeting these challenges is whether students found the cases to be useful and acceptable. End-of-course survey results strongly suggest that the use of interactive case studies was well received by the students. The majority of survey respondents posted positive comments regarding the usefulness of the cases. The time needed to complete the cases was not excessive and perhaps contributed to the high level of agreement indicated by students regarding whether the cases were a worthwhile use of their time.

On a more specific level, students indicated that the levels of case and task complexity were appropriate and helpful. Student comments reflected their appreciation for the “real-world” feeling of the cases and the authenticity of the step-wise progression from differential diagnosis to treatment plan. Many students indicated that they felt they were able to engage in thinking through the case, and therefore synthesize knowledge from class and self-study to make decisions and explain findings. In particular, many found the greatest value in the explanations provided for incorrect answers. This is further evidence that the advanced clinical elements of these cases were framed and supported in ways that did not overwhelm the majority of students. Our choice to prompt students to choose among options, rather than asking them to generate diagnostic possibilities, tests, and treatment plans was helpful in this regard.

Nonetheless, some students did find that some aspects of these cases were too advanced for them. This is true to a limited degree (at least based upon our curriculum). However, the intent was to allow students to work through real endocrine cases that were not artificially simplified. The advanced nature of the cases is by design so as to challenge students to apply and integrate physiologic concepts and pathophysiologic mechanisms, rather than having them rely upon rote memorization of facts and figures. As several students indicated, there are those who preferred “clear-cut answers” or fewer “right answers.” There is inherent uncertainty in a case-based approach that raises complex topics and not all students will resonate with this, perhaps because of differences in prior knowledge or orientation toward learning.³ Still, other students were comfortable with the complexity of the cases, but sought more and/or fuller explanations.

The primary limitation to our evaluation of these exercises is that the feedback that we received was based upon student perceptions of whether or not they found this exercise useful. Limitations of this feedback have to be considered in that, at our institution, we currently have no way of tracking how many actually used the exercise, nor to what extent; and of those who used the exercise, how many completed the evaluation. Future studies are being considered in which more definitive outcomes data can be analyzed, such as a study comparing exam item performance on those areas testing thyroid, adrenal cortical, and reproductive endocrine function between students who completed the activity and those who did not. But again, this would rely upon accurate reporting by students regarding to what extent the case studies were utilized.

We believe that these online interactive cases in their current form can help students embrace the fact that a firm understanding of physiology is essential in clinical practice. Student feedback supports this rationale. Although we used these cases with first-year medical students, we believe these same cases can be used across the undergraduate medical education continuum. The advanced elements of the cases would be easily recognizable to clerkship students, but would provoke them into revisiting and reviving the casual mechanisms they learned in their preclerkship years in a timely and context-specific manner.

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Ethical Approval

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