Original Publication

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Pituitary Gland: Normal Function and Assessment

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Abstract

Introduction: This computer-based, interactive module introduces preclinical medical students to normal pituitary function and outlines its assessment. Solid understanding of these topics is requisite to learning clinical disorders of the pituitary. Existing resources largely target learners at earlier or later stages of training; thus, we created this resource to address needs of medical students during a first- or second-year endocrine course. **Methods:** A module format was selected to promote interactive, independent learning. Two cohorts of medical students completed the 40-minute module: 172 second-year students who had completed a year of basic sciences in the traditional curriculum and 180 foundation-phase students in a three-semester combined basic and clinical sciences curriculum (due to a change in the medical school curriculum at our institution). In both instances, the module was completed before start of clinical pituitary content. A static set of PowerPoint slides accompanied the module to facilitate note taking. Test Your Knowledge slides were inserted to ensure grasp of key terms/concepts before moving to subsequent slides. A short question-and-answer session was held following module completion to clarify points of confusion. **Results:** Students rated effectiveness of the module as 4.6 out of 5, commenting on its clarity, organization, high-yield nature, and utility in preparing for clinical material. Faculty noted greater understanding of foundational pituitary principles and more engaging discussions. The percentage of pituitary-related questions answered correctly on the midterm exam increased. **Discussion:** The success of the pituitary module prompted development of adrenal, thyroid, and parathyroid modules that now comprise the Endocrine Organs Introduction Series in our curriculum.

Appendices

- A. Normal Pituitary Function and Assessment folder
- B. Normal Pituitary Function and Assessment PowerPoint Slides.pptx

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

Keywords

Module, Endocrinology, Preclinical Medical Education, Endocrine, Pituitary

Educational Objectives

After completing this module, the learner will be able to:

1. Describe the normal function and regulation of the pituitary gland, including names and actions of the anterior and posterior pituitary hormones.
2. Understand the basic approach to laboratory assessment of the pituitary.
3. Differentiate between anterior and posterior pituitary origin, function, and regulation.
4. List the hormones produced by the pituitary gland.
5. Discuss for each pituitary hormone: hypothalamic stimulating/inhibiting factors and their clinical uses, basic physiologic function, and regulation (feedback loop).
6. Describe factors that affect growth hormone levels.
7. Understand the tests for growth hormone excess and deficiency.
8. Define a primary versus secondary endocrine disorder.

Introduction

Teaching foundational aspects of basic and clinical endocrinology to medical or health professional students poses unique challenges compared to teaching other organ systems. The endocrine system is not a group of physically connected organs (such as the gastrointestinal system), nor is it composed of a few discrete organs whose function can be studied in detail (such as the nervous system) during a fast-paced, several-weeks-long organ systems block. Rather, several organs with distinct cell types, structure, hormonal products, function, feedback, and laboratory assessment must be covered within a compressed

time frame. At minimum, for adequate boards and clerkship preparation, students must possess a good understanding of the pituitary, adrenal, parathyroid, and thyroid glands and the endocrine pancreas.

During several years of teaching and subsequently codirecting a second-year medical student endocrine block and serving as chief curriculum support for this block, we found that students experienced difficulty transitioning from one organ to the next, even with weekly overviews and consistent lecture and small-group formats. Moreover, because instructors typically included introductory slides about their organ of interest before discussing a particular clinical or pathologic entity, the initial portions of lectures were often repetitive and at times presented conflicting information. The challenges, then, were to centralize the necessary foundational information about each endocrine organ before introducing the relevant clinical and pathologic content, provide an interactive and self-directed format for students to learn this information, and disseminate the resource to block faculty to ensure consistency of messaging.

In preparing to develop our resource, we met with student focus groups and reviewed end-of-block evaluations. We also researched available materials—in print, online, and on websites/forums dedicated to medical teaching or endocrinology—but found none that provided a detailed yet straightforward overview of endocrine organs in an interactive format. Existing resources either were too simplistic (geared towards the educated public, undergraduates, or medical students preparing for the United States Medical Licensing Examination [USMLE] Step 1) or targeted audiences at more advanced/detailed stages of study (such as residents, endocrine fellows, or basic science graduate students).

We aimed to create a resource tailored to the needs of preclinical medical students but adaptable for students in nurse practitioner or physician assistant programs or nursing, pharmacy, or allied health fields. We had received positive feedback from a previous module that covered the synthesis, structure, regulation, and function of insulin; we therefore structured our Endocrine Organs Introduction Series as a similar set of interactive modules. Each module follows a two-part format, with part one covering the endocrine organs' function and part two reviewing the key principles of laboratory assessment. A series of PowerPoint slides is set to informal audio narration—purposefully avoiding a written script to maintain audience interest—and then animated such that elements of each slide appear in conjunction with relevant portions of the narration. The pituitary module was created using Articulate Storyline 2 with PowerPoint as the storyboard for the initial creation. We maintain the same narrator and animator throughout the series for consistency. Test Your Knowledge slides are inserted periodically in the modules and require a correct answer for the learner to advance to the next slide. A summary slide at the end of each module revisits key information.

The pituitary module was vetted with several fourth-year medical students. We made modifications for clarity and relevance based on their feedback. A similar process was followed for subsequent modules. The entire series was completed over the course of 2 years, with the pituitary, adrenal, and thyroid modules introduced in the first year and the parathyroid module in the second year. The pituitary module was selected for initial submission because it is the initial module in the series and serves as the prototype for the remaining modules.

Self-directed computer-based or web-based modules promote retention and learning in preclinical medical education, as measured by pre- and posttest results and standardized exams, and demonstrate high rates of learner satisfaction.¹ Trends towards higher quiz scores compared to traditional learning methods have been shown in some studies,² as have improvements in knowledge, attitude, intended behavior, and self-efficacy related to assigned content.³ At least one study noted that perceived concept difficulty was significantly reduced among a group of medical students who studied with modules compared to peers who studied with traditional lecture notes and textbooks and that the number of hours spent studying the concepts was significantly increased in the group that used modules. The authors interpreted these findings to suggest that medical students may learn more effectively and feel less intimidated by difficult concepts when interactive modules supplement traditional instruction.²

In the field of endocrinology, while computer-based or web-based modules are available through organizations for residents, fellows, or practicing physicians, there is a paucity of such resources for medical students and in particular for preclinical students. Medical schools that have developed their own computer-based or online endocrine modules have not made them accessible to students outside their respective institutions.

Therefore, our submission builds upon the knowledge that computer-based modules are effective tools to complement more traditional learning methodologies and addresses a gap in the availability of such materials for the field of endocrinology.

Several pituitary concepts emerged as recurring challenges during 13 years of teaching and 2 years of codirecting a preclinical medical student endocrine course. The problematic areas included the distinction between the anterior and posterior pituitary; the relationship between the hypothalamic, pituitary, and end organ hormones; the unique regulation and assessment of growth hormone; and the critical difference between primary and secondary disorders of glands regulated by the pituitary. These areas were targeted in the module.

Likewise, key features of a successful module became apparent after several years of providing curriculum support and developing digital learning tools for first- and second-year medical student blocks. The most effective modules were clearly organized, judiciously animated, moderately paced, and accompanied by a static PowerPoint for students to annotate. Effective modules also provided immediate feedback on fact/concept recall in the form of interactive questions spaced throughout.

Methods

The module includes the interactive pituitary module (Appendix A) and the corresponding PowerPoint slides (Appendix B)—with the answers to Test Your Knowledge questions removed—for students to annotate if they wish while completing the pituitary module. We adhered to and recommend the following steps for optimal implementation of the module. Students should independently complete the interactive pituitary module prior to exposure to clinical and pathologic material related to the pituitary gland. The module may be posted in a learning management system such as Sakai or Blackboard or on a server that allows direct access to learners. Slides may be replayed as needed, and at any time during the module, students may revisit a previous slide for reference. A glossary is provided on the left-hand sidebar of the module for easy reference of new terms.

The Test Your Knowledge slides must be correctly answered to proceed. If the first answer selected is incorrect, additional opportunities are given to select the correct response before proceeding. If the module is delivered through a learning management system with sharable content object reference model (SCORM) capabilities, students' performance on Test Your Knowledge questions can be tracked and/or graded.

The PowerPoint slides should be posted simultaneously in the same location to facilitate note taking while viewing the module and for reference afterwards as needed.

A link to relevant textbook chapters may be included for reference if desired. For example, we provided a link to an electronic copy of an endocrine textbook⁴ available through our institution's health sciences library. Specifically, we noted that chapter 4, sections 2-4, of this edition⁵ covered material relevant to the pituitary module.

Session length or run time of this module is approximately 40 minutes. From our experience and from student feedback, the average time for a preclinical first- or second-year student to complete the module—allowing for pauses, re-review of information, and answering Test Your Knowledge questions—is approximately 60 minutes. This time will vary based on the individual learner. The run times for the subsequent modules in our Endocrine Organs Introduction Series range from 25-30 minutes each.

We encourage course directors to allow adequate time within the footprint of a course to complete the module and to incorporate the module into the final course grade in some fashion (we assigned 1% credit for completing the module on time, but even making the module a required component to pass the course would be sufficient per student feedback). This approach facilitates timely completion of the module and assigns its content equal weight with other scheduled activities such as lectures, small-group sessions, or laboratory sessions. However, if time is limited, the pituitary module may be assigned as homework for completion prior the start of a pituitary section.

Results

Medical students across several cohorts provided overwhelmingly positive feedback regarding the clarity and effectiveness of the module. Feedback was obtained through student focus groups during each block and through end-of-block evaluation forms.

Quantitative ratings from end-of block student evaluations are shown in the [Table](#). The score for course materials improved between Spring 2014, prior to introduction of the module, and Spring 2015, after the introduction of the module. The same trend was noted in the subcategory of self-directed materials. Between Spring 2015 and Fall 2015, the evaluation categories for the endocrine block changed (coincident with change in the medical school curriculum to an integrated basic and clinical sciences curriculum), but a high score for course materials was preserved, and an even higher score of 4.6 was noted in the new subcategory of modules.

Table. Mean Scores for Course Materials and Subcategories in the Endocrine Block
(Scale of 1-5)

Materials	Spring 2014	Spring 2015	Fall 2015
Course materials	3.9	4.4	4.2
Self-directed materials or modules ^a	4	4.3	4.6

^aSelf-directed materials were a subcategory of course materials in Spring 2014 and Spring 2015. Modules were a subcategory in Fall 2015.

Qualitative student comments that specifically mentioned modules are included below. Note that no comments were required on the end-of-block evaluation form; that is, all comments were voluntary. Of 22 total unsolicited comments regarding block methods and/or materials in Fall 2015, 10 specifically referenced the block modules. Further, there were no negative comments about the pituitary module or the related modules in class cohorts of 172-180 students.

Qualitative comments in response to the prompt “Which methods and/or materials were most helpful? What could have been more helpful? How? Please be as specific as possible” included the following:

- “I really liked the required modules—they were just the right amount of material and were not bothersome to do before class.”
- “I really liked the modules required to be done before class. It helped me stay disciplined and come to class prepared and keep up with the material.”
- “Totally appropriate amounts of info to be presented in module format.”
- “Clear, helpful, and I enjoyed being able to do them multiple times throughout block.”
- “Excellent . . . not that long, but still covered all the important information.”
- “Very well done, actually super helpful to get them done by the assigned date.”
- “Best modules we have had so far. Incredibly organized and well placed within the block to correlate with lecture/small group material.”

Faculty who had taught in the block for many years commented that students were more prepared for the pituitary clinical lectures and small-group sessions after module implementation. Because students better understood basic aspects of pituitary function and regulation, there was less need for faculty to revisit or

explain foundational information. Consequently, questions posed in lectures addressed higher level concepts, and small-group discussions became more engaging.

Similar percentages of pituitary-related questions (75%-76%) were answered correctly on the midterm exam before module implementation and in the first year the module was used. However, the percentage of correctly answered pituitary-related questions increased to 86% in the second academic year that the module was used, even though no questions covering only module content were included. Questions continued to be framed in a clinical context and introduced by a multisentence vignette to simulate USMLE-style questions and promote synthesis of information over simple fact recall. It is difficult to know the exact contribution of the pituitary module to the higher percentage of correct answers. However, as the lectures, small groups, practice questions, and exam questions remained largely unchanged, it is reasonable to conclude the module may have contributed to some degree. Medical students in the latter cohort also were more accustomed to modules in general, due to increased use of this learning tool in other blocks, which might have promoted greater impact from our module.

The outcome of this module prompted introduction of additional endocrine modules (adrenal, thyroid, and parathyroid). The additional modules met with similar success and are now known as the Endocrine Organ Introduction Series within our endocrine block.

Discussion

Based on our experience teaching endocrinology to preclinical medical students, we identified a need for a clear, concise introduction to each endocrine organ before proceeding to a study of clinical/pathologic disorders. The pituitary, as the initial organ covered in most endocrine courses, was the logical starting point. We deliberately avoided a lecture or small-group format, as both would have been time intensive on the part of the faculty and the students; moreover, introductory material could lend itself well to independent learning. We also decided against assigning prereading from a textbook or similar source, because students in other courses where prereading was assigned as the first pass at new material found it difficult to identify key concepts on their own, often becoming distracted by minutia, and because a passive learning format was less likely to promote retention.

A computer- or web-based module had the advantage of being interactive, associated with a high rate of learner satisfaction and retention per existing literature, and adaptable to many settings. We successfully used the pituitary module to teach second-year medical students in a traditional curriculum that covered basic sciences in the first year and clinical sciences in the second year (Spring 2015), as well as in the foundational phase of a combined basic science/clinical science curriculum (Fall 2015). Likewise, the module could be incorporated into preclinical courses for nurse practitioners or physician assistants or with minimal modification into pharmacy, nursing, and allied health programs.

In addition to the steps outlined in the Methods section for optimal implementation of the module, we learned that the module was most effective when fully integrated into the larger block content. To maximize integration, we suggest that course directors do the following:

- Introduce or signpost the module at the start of the block as a critical component to understanding subsequent pituitary content.
- Reserve time for a question-and-answer session regarding module content or a quick review session of the highlights. We used just 10 minutes the morning after the module completion deadline, prior to the start of formal lectures, which proved worthwhile and sufficient per student feedback. Students were encouraged to e-mail questions about the module the night before, and the most common points of confusion were addressed.
- Request that faculty review the module or at least the PowerPoint slides before they deliver lectures, small groups, or lab sessions related to the pituitary gland.

- Identify instances in lectures or case-based discussions in which a slide or figure from the pituitary module could be reused. This serves to reinforce concepts from the module and reassures students that a new point covered by instructors in a clinical or pathology lecture builds upon a foundational concept from the pituitary module. For example, when discussing dopamine antagonists as a cause of hyperprolactinemia, a lecturer could reference slide 22 of the module to explain the underlying pathophysiology.

We faced several challenges in the implementation of the module. One was the excess focus that some students devoted to details. For example, the information about the hypothalamic releasing hormones CRH and TRH (slides 9 and 11, respectively) was intended to illustrate general aspects of the hypothalamic-pituitary relationship. However, several students thought that an in-depth understanding of these hormones' use in specific clinical situations was required. In the module's second iteration, we conveyed exactly how the module should be used, citing which information was historical or would be revisited later in the block. This approach resulted in fewer questions/concerns from students and allowed them to focus on the module as intended. Other course directors who adopt this module should identify areas to emphasize or deemphasize, as needed, based on their block's specific learning objectives.

It is also important to convey to fellow instructors that the Test Your Knowledge questions interspersed throughout the module are intentionally straightforward, to assess knowledge of key facts and fundamental concepts before moving on to the next slide. Successful completion of the module does not indicate advanced understanding of pituitary function or ensure the ability to interpret pituitary laboratory measurements in complex clinical scenarios. This limitation should be overcome via lectures, small groups, and lab sessions designed specifically for more advanced competencies.

In the future, with our learning management system becoming SCORM compliant, we plan for students to submit the module for a formal grade, based on percentage of questions answered correctly on the first attempt, rather than awarding credit for module completion alone. Some adopters of the module may already have the necessary software to do this. Alternatively, if more formal assessment of knowledge from the pituitary module is desired, the Test Your Knowledge questions may be removed from the module and grouped into a set of quiz questions to be taken after module completion in a secure manner for a grade.

As mentioned previously, we built upon this pituitary module to create the Endocrine Organs Introduction Series with four modules altogether. These modules have been useful for students during our block and, per preliminary feedback, have been revisited by the same students during their USMLE Step 1 preparation and clerkships.

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Ethical Approval

Reported as not applicable.

References

1. Chumley-Jones HS, Dobbie A, Alford CL. Web-based learning: sound educational method or hype? A review of the evaluation literature. *Acad Med*. 2002;77(10)(suppl):S86-S93. <http://dx.doi.org/10.1097/00001888-200210001-00028>
 2. Bryner BS, Saddawi-Konefka D, Gest TR. The impact of interactive, computerized educational modules on preclinical medical education. *Anat Sci Educ*. 2008;1(6):247-251. <http://dx.doi.org/10.1002/ase.55>
 3. Metcalf MP, Tanner TB, Buchanan A. Effectiveness of an online curriculum for medical students on genetics, genetic testing and counseling. *Med Educ Online*. 2010;15:4856. <http://dx.doi.org/10.3402/meo.v15i0.4856>
 4. Gardner DG, Shoback D, eds. *Greenspan's Basic & Clinical Endocrinology*. 9th ed. New York, NY: McGraw-Hill; 2011.
 5. Javorsky BR, Aron DC, Findling JW, Tyrrell JB. Hypothalamus & pituitary gland. In: Gardner DG, Shoback D, eds. *Greenspan's Basic & Clinical Endocrinology*. 9th ed. New York, NY: McGraw-Hill; 2011:65-114.
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