ENDOCRINE PHYSIOLOGY
IN A PATIENT-CENTERED LEARNING CURRICULUM

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The medical curriculum at the University of North Dakota School of Medicine and Health Sciences has recently been redesigned into a problem-based/traditional hybrid model that utilizes an integrated organ systems-based approach to teach basic and clinical sciences. The number of lecture hours in general has been greatly reduced, and, in particular, lecture hours in physiology have been reduced by 65%. Students learn basic science in small groups led by a faculty facilitator, and students are responsible for a great deal of their own teaching and learning. The curriculum is centered around patient cases and is called patient-centered learning (PCL). The curriculum includes traditional lectures and laboratories supporting faculty-generated learning objectives. Endocrine physiology is taught in year one, utilizing four weeks of patient cases that emphasize normal structure and function of endocrine systems. Endocrine physiology is revisited in year two, which is primarily focused on pathobiology. The PCL curriculum, with emphasis on the endocrine component, is described in detail along with key portions of an endocrine case.


Key words: introduction to patient care; endocrine cases

INTRODUCTION AND BACKGROUND

The University of North Dakota School of Medicine and Health Sciences (UNDSDMSHS) is a fully accredited four-year medical school, with the first two years located on the University of North Dakota main campus in Grand Forks, North Dakota. The third and fourth years of medical school (clinical clerkships) are distributed among four primary sites [Grand Forks, Fargo, Bismarck, and Minot, which are considerably scattered across the state (Fig. 1)]. A unique third-year program, Rural Opportunities in Medical Education, utilizes four to six rural sites throughout the state for an intensive eight-month clinical experience for selected third-year students. There are 35 tenure-track plus 13 nontenure-track basic science faculty and 7 clinical faculty on the Grand Forks campus. The typical entering medical class size is 57 and is primarily composed of students from North Dakota, Minnesota, Montana, Wyoming, and the Indians into Medicine..
Program, which includes Native American participants from across the country. UNDSMHS implemented a renewed medical curriculum in August, 1998. The new patient-centered learning (PCL) curriculum implementation followed several years of planning by specific task forces and committees composed of interdisciplinary faculty from both the clinical and basic sciences. The planning groups proposed principles to which the new curriculum should adhere. These are listed in Table 1. The curriculum is governed by faculty appointed and elected to the Medical School Education Council, which is responsible for policy decisions via recommendations to the dean. Implementation is under the direction of the independently budgeted Office of Medical Education (OME) and is accomplished by the coordinated effort of several participants, including block directors, multidisciplinary block design teams, an overall basic science director (PCL director), Introduction to Patient Care (IPC) directors, and traditional basic science and clinical departmental chairs. The block design teams are responsible for construction and revision of a given block. These teams determine the block objectives and then organize the approach to the content by writing cases that include faculty-generated case objectives and suggesting lecture and lab topics to the departments for scheduling. The block director is critical in finalizing the schedule by enlisting faculty, via consultation with departmental chairs, to participate in lectures and labs and by enlisting physicians to participate in the case wrap-up experiences, as described later. Centralized student assessment, program evaluation, and faculty development are also performed and supported by faculty and staff in OME (4).

**TABLE 1**

Principles of the PCL medical curriculum at UNDSMHS

<table>
<thead>
<tr>
<th>Principle</th>
<th>Description</th>
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<tbody>
<tr>
<td>Curriculum planned by interdisciplinary teams (clinicians and basic scientists)</td>
<td>Reduction in time spent in passive learning (didactic lectures)</td>
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<tr>
<td>Life-long learning emphasized; skills acquired</td>
<td>Early introduction of clinical concepts and skills (year one)</td>
</tr>
<tr>
<td>Longitudinal threads throughout all 4 years (geriatrics, nutrition, etc.)</td>
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<tr>
<td>Basic sciences revisited in clinical rotations (years three and four)</td>
<td>PCL cases used as focal points for student learning (years one and two)</td>
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<tr>
<td>Student teamwork and collaboration emphasized over competition</td>
<td>Centralized management of curriculum and assessment</td>
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<tr>
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<td>Assessment covering multiple domains of student learning:</td>
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<tr>
<td>Acquisition and integration of knowledge</td>
<td>Peer teaching and communication skills</td>
</tr>
<tr>
<td>Professionalism</td>
<td>Centralized management of curriculum and assessment</td>
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</table>

PCL, patient-centered learning; UNDSMHS, University of North Dakota School of Medicine.

**CURRICULUM DESCRIPTION**

The PCL curriculum at UNDSMHS is a problem-based learning/traditional hybrid model with the basic sciences integrated across disciplines and organized around organ systems. The curriculum was modeled closely after the University of Missouri-Columbia Medical School. The medical education faculty and staff at Missouri provided our faculty with mentorship and guidance throughout our change process (1, 2). In addition, several of our curriculum leaders received training in problem-based learning and small group facilitation from the University of New Mexico (3, 5). These contributions by our colleagues from other universities have been critical to our successful renewal. The curriculum is divided into four (10-wk) blocks each year with year one focused on normal structure and function and year two dedicated to pathobiology. The major themes and subthemes for each block in year one are presented in Fig. 2. The content of year two chronologically parallels that of year one in terms of organ systems.

During the first eight week of a given block, students are learning basic sciences, clinical reasoning, and hypotheses formation by focusing on the selected patient case of the week. The students are divided into small groups of seven to eight students, assigned to a faculty facilitator for the block, and placed in a...
PCL classroom equipped to meet their learning needs. Each room is designed for active learning with computers, monitors, several white boards and flip-charts, study carrels, etc. The faculty facilitators come to these rooms for the PCL sessions. Students are rotated to new groups after each block and assigned a different facilitator. Facilitators participate in a faculty development program, organized by OME, that initially has each faculty member complete a hands-on PCL training session for certification before facilitating a block. These sessions are patterned after workshops presented by the faculty at the University of New Mexico (3, 5) and involve faculty training in small group facilitation and feedback techniques utilizing a training facility (2-way mirrors), students, and patient cases. Facilitators are also required to observe actual PCL sessions in progress for at least a week before they are given a group of their own. The faculty development program is under the direction of the PCL director, who also is responsible for facilitator assignments throughout the year.

A typical weekly schedule is presented in Fig. 3. In the mornings, the small groups meet three times per week in their PCL classrooms. In addition, students attend lectures and labs designed to support the themes and subthemes of the block and support the basic science objectives of the case of the week. Didactic contact time is standardized to nine lectures and five traditional lab hours per week. This has resulted in a 65% reduction in lecture hours in physiology compared with the traditional curriculum at UNDSMHS before 1998.

On Monday mornings during PCL, the students in each group receive the same patient case and begin to analyze the patient presentation in an attempt to eventually make a diagnosis. The case unfolds in a progressive manner modeling the clinical scenario of patient presentation (history, physical exam, laboratory test results, etc.). By the end of the session on Monday, the students will identify basic science learning issues for each member of the group to research and present at the next PCL session on Wednesday. After the learning issue presentations on Wednesday, the students progress further into the case. At the end of this session, the students are given faculty-generated learning objectives, written into the case by the authors and block director. Between Wednesday and Friday, the students refine their own learning objectives and incorporate the faculty learning objectives into their presentations. After the Friday PCL session,
the whole class is assembled in a lecture hall, and the case of the week is presented by a physician. This session, called the “case wrap-up,” includes discussion and interaction with an actual patient with the disease studied by the students that particular week.

In the afternoons during the week, students attend the IPC component of the curriculum. The major themes of these sessions focus on clinical medicine. The themes for year one are presented in Fig. 2 and include interviewing and professionalism, the physical exam, and human life cycle I and II. The IPC sessions on Friday afternoons have been used to integrate clinical content and concepts related not only to the IPC themes of the block but also to the PCL case of the week. Two afternoons each week are left as unscheduled time in order for students to study and prepare PCL learning issues derived from their case work.

During week 9 of the block, students are given a battery of exams that include a United States Medical Licensing Examination (USMLE)-type multiple choice knowledge-based exam, a case-based written short answer essay exam, and an IPC-based clinical skills exam. The students are also evaluated during the 8 wk of case study by their PCL facilitator in the domains of acquisition and integration of knowledge, peer teaching and communication skills, and professionalism. Formative evaluation on these domains is given to the students in written form by their facilitator at midblock, with a summative evaluation at the end of each block. The students must receive a satisfactory grade on these end-of-block evaluations as well as each of the week 9 assessment tools to proceed to the next block.

Week 10 is “Special Studies Week,” which the students use for vacation, research, or to possibly remediate deficiencies in academic performance during the preceding block.

**ENDOCRINE PHYSIOLOGY**

Endocrine physiology is emphasized in block 3 of year one. The other disciplines covered in this period...
include gastrointestinal and renal physiology. Four weeks of block 3 are devoted to endocrine biology; the cases used for these weeks are listed in Table 2. The first endocrine case is focused on multiple endocrine neoplasia syndrome, type 1, and occurs in week four of the block. This is a rare, autosomal dominant disorder characterized by tumors involving the parathyroid gland, pituitary gland, and pancreas. Patients inherit a defect in the tumor suppressor gene menin. Tumors develop when cells sustain a somatic mutation in the remaining allele, causing enhanced growth. Case objectives are designed for the students to gain an understanding of signal transduction in endocrine tissues, the functional and anatomical relationship of the hypothalamus and pituitary, the genetic basis for the lack of expression of menin in various tissues, regulation of prolactin secretion, and the function of parathyroid hormone on various target tissues. The students are also directed to review acid secretion by the stomach and pancreatic hormone secretion. Lectures and labs this week are focused on the anatomy, histology, and embryology of the hypothalamic-pituitary axis. In addition, the development and morphology of endocrine organs is explored. Lectures on the physiology of calcium metab-

### TABLE 2
Endocrine cases in PCL

<table>
<thead>
<tr>
<th>Year One, Objectives Focused on Normal Structure and Function</th>
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<tbody>
<tr>
<td>Multiple endocrine neoplasia syndrome, type 1</td>
</tr>
<tr>
<td>Amenorrhea</td>
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<tr>
<td>Postmenopausal bleeding</td>
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<td>Infertile couple</td>
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<table>
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<tr>
<th>Year Two, Objectives Focused on Pathobiology</th>
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<tbody>
<tr>
<td>Endometrial hyperplasia</td>
</tr>
<tr>
<td>Prostate cancer</td>
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<tr>
<td>Diabetes—chronic renal failure</td>
</tr>
<tr>
<td>Herpes hepatitis</td>
</tr>
<tr>
<td>Breast cancer</td>
</tr>
<tr>
<td>Hashimoto’s thyroiditis</td>
</tr>
<tr>
<td>Cushing’s syndrome</td>
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<tr>
<td>Osteoporosis</td>
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</tbody>
</table>

Mrs. Olson
Case for Week 7, Block 3, Year 1

Author: William Mann, M.D.

Block 3 Design Committee:
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Mrs. Olson
Facilitator Guide

This very straightforward case is an example of uterine bleeding in a postmenopausal woman. The case will be used to drive learning about the female reproductive system, especially to changes that occur at menopause. Next week’s case will feature a couple experiencing difficulty in conception. During that week students will focus on reproductive biology of both the male and female.

Postmenopausal bleeding may occur from any part of the reproductive tract including uterus, cervix, vagina, vulva, and may be heavy or light. Causes could include:
- Luteolytic (def. Unfavorable response to medication or treatment, here, as a result of estrogen replacement therapy)
- Infection
- Atrophy
- Tumors (benign or malignant, endometrial carcinoma is the cause of 1/3 of all cases of postmenopausal bleeding)
- Polyps (Mrs. Olson has a benign uterine polyp which is removed.)
- Adnexal pathology
- Due to the Monday holiday, PCL groups will meet Tuesday, Wednesday, and Friday mornings. Students may go through page 5 on Tuesday.

FIG. 4.
Face page of a typical case used in PCL. Left indicates the interdisciplinary nature of the block 3 design team. Right demonstrates an example of the facilitator guide that is provided to faculty.
olism are also presented this week. Students begin dissection of the pelvis in the gross anatomy lab to begin exploration of male and female reproductive anatomy.

The second endocrine case is focused on a 32-yr-old female who presents with a fairly typical history of secondary amenorrhea. Case objectives for the students include gaining an understanding of the pathway for synthesis, release, transport, and mechanisms of action of cortisol and aldosterone; the molecular biology of hyperpigmentation in patients with primary adrenal cortical insufficiency; the structure, function, and development of the adrenal medulla and cortex; and the regulation of blood glucose under stress. Lecture topics this week include growth and development, thyroid function, principles of signaling, mechanisms of hormone action, adrenal function, and a review of glucose, lipid, and protein metabolism. Gross dissection of the male and female reproductive tract continues.

Mrs. Olson
Case for Week 7, Block 3, Year 1

Mrs. Olson, age 65, has been a patient in your family medicine practice for almost 20 years. You last saw her for a physical examination one year ago. Today she expresses concern about vaginal bleeding, which she has experienced over the past two months. She notes that she is under some stress because her father, who is 96, has come to live with her family, and there is a tense relationship between her father and her husband. Her two children live in Grand Forks; one child is a quadriplegic as a result of a driving accident. Mrs. Olson is active in her local church and maintains a supportive relationship with her children.

Construct a problem list for Mrs. Olson.

First page of this PCL case represents a description of the patient presentation followed by a task for the students to perform.

The third endocrine case involves a 65-yr-old female with postmenopausal bleeding. Students will learn, via case objectives, about the histological changes observed in the endometrium during the normal menstrual cycle, the anatomy of the female reproductive tract, the effects of aging on the female reproductive system, and the appearance of the endometrium and uterus during menopause, and relate these changes to hormonal effects, the effects of estrogen replacement therapy on tissues outside of the reproductive system, and the pharmacodynamics of progesterone. Lectures are focused on development and histology of the female reproductive tract, menopause and andropause, and hormone replacement therapy. Portions of the endocrine PCL case involving the patient with postmenopausal bleeding are presented in more detail in Figs. 4–8, which illustrate sequentially the progressive unfolding of the case, a facilitator guide, and a list of faculty-generated case objectives.

The final endocrine case completes the block and is focused on a couple in their early 30s who present...
Mrs. Olson
Case for Week 7, Block 3, Year 1
Physical Exam:
Mrs. Olson is alert, neatly groomed, and mildly anxious. She is moderately obese.
Vital Signs:
- Pulse: 70 bpm
- Temperature: 37.2°C
- Blood pressure: 110/80 mmHg
- Height: 5'4"
- Respiratory Rate: 18/min
- Weight: 173 lbs.
The mucosa of the oral pharynx is well hydrated and free from ulceration. The conjunctiva are well injected and the sclera free from icterus. No enlargement of the thyroid is noted. There is no supraclavicular cervical adenopathy. The lungs are clear. There is no jugular venous distension. The precordium and heart sounds are nornodynamic. The abdomen is moderately obese, and the previous surgical scars are noted. There is no visceromegaly, and no palpable masses. The bowel sounds are normal.
Pelvic Exam:
- External Genitalia: Atrophic
- Vagina: Moderate relaxation with moderate cystocele and mild rectocele
- Cervix: Nabothian cyst and slightly stenotic os
- Uterus: Examination was imprecise due to obesity; the uterus was felt to be immobile.
- Adnexae: No palpable masses
- Rectovaginal: Confirmed above findings

What test(s) are indicated?

FIG. 7.

Next sequential page of this PCL case presents information obtained from the physical exam with a prompt for consideration of appropriate laboratory tests.

Mrs. Olson
Case for Week 7, Block 3, Year 1
Case Objectives
1. Discuss the histological changes observed in the endometrium during the normal menstrual cycle.
2. Understand the anatomy of the female reproductive tract.
3. Describe the effect of aging on the female reproductive system.
4. Describe the appearance of the endometrium of the uterus during the normal menstrual cycle.
5. Describe the appearance of the endometrium of the uterus during menopause. What is the effect of exogenous hormones on these tissues?
6. Describe the effects of estrogen replacement therapy on tissues outside the reproductive system. Include the skeletal, nervous, and cardiovascular systems and the mammary glands.
7. Outline the use of the Papincolaou Smear as a screening test for cancer. How does it provide a window to reproductive status?
8. Discuss the pharmacodynamics of progesterone with respect to therapeutic range and effective dose. Give consideration to potential drug-drug interactions.

FIG. 8.
Final page of this PCL case demonstrates examples of faculty-derived case objectives that the students should understand from working with this case this week.
with problems of infertility. The case unfolds as the students pursue numerous possible etiologies of infertility. Case objectives are focused on male and female reproductive anatomy, embryology, spermatogenesis, semen formation, autonomic regulation of erection and ejaculation, hormonal regulation of the menstrual cycle, follicular development, ovulation, corpus luteum formation, fertilization and implantation, and the physiological effects of prolactin. Lecture topics include development and microanatomy of the male reproductive system, puberty, pregnancy, parturition, lactation, and a review of the gonadotropin control of steroidogenesis.

Endocrine physiology objectives are revisited throughout year two, which is focused primarily on pathobiology. These cases are listed in Table 2.

SUMMARY AND CONCLUSION
Since the renewal of the medical curriculum in 1998, the teaching of endocrine physiology has become integrated by using an organ systems-based approach. The students are more energetic and responsive to this type of learning environment. Based on feedback from clinical preceptors in the third-year clerkships, students are better equipped to analyze clinical problems, find and apply appropriate basic science knowledge, and present their patients than was true for students from the earlier, more traditional curriculum. Although we have only limited objective performance data at the current time, we are encouraged by the fact that the first cohort scored comparably on USMLE Step 1 (mean = 209, national mean 215) to previous classes enrolled in the traditional curriculum. Additionally, the individual discipline analysis of the exam did not uncover any major gaps of knowledge of basic sciences for students completing the PCL curriculum. The key to successful continuation of this program will involve the careful balancing of faculty time and efforts between teaching and research as well as the need to reward faculty who significantly contribute to the medical education mission of the school.

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REFERENCES