

# A Novel Preclinical Course in Ophthalmology and Ophthalmic Virtual Surgery

Jennifer J. Yong, BS, Michael E. Migliori, MD, and Paul B. Greenberg, MD

**THE LIASON COMMITTEE ON MEDICAL** Education provides guidelines for medical school curricula, but these guidelines lack requirements for teaching ophthalmology.<sup>1</sup> Due to the vast amount of information taught to preclinical medical students, more time is devoted to fundamental subjects and less on specialties like ophthalmology.<sup>2</sup> There has been a significant decline in the number of schools requiring an official clinical rotation in ophthalmology.<sup>3</sup> In addition, although the number of hours of undergraduate ophthalmology instruction may meet the International Council of Ophthalmology Task Force recommendations, data indicates that residents in primary care are uncomfortable in assessing and managing common ophthalmic conditions.<sup>4</sup> These studies highlight the need for improved ophthalmic instruction in medical school to avoid overlooking eye conditions that may result in irreversible damage if left untreated.

Ophthalmology is of interest to medical students for several reasons: it is disproportionately concerned with the care of the fastest growing segment of the United States population, the elderly; it is connected to many important systemic diseases; it has a major impact on daily functioning and quality of life; finally, it provides insight into an unusual specialty that is strongly linked to both medicine and surgery. To this end, we designed a preclinical elective course in ophthalmology at the Alpert Medical School of Brown University.

Taking a previous Alpert Medical School preclinical elective on cataract surgery as our starting point,<sup>5</sup> our course, titled *Adventures in*

*Ophthalmology and Virtual Surgery*, introduces preclinical medical students to ophthalmology through multiple diverse approaches.<sup>6</sup> The course's multifaceted method of instruction is innovative because it accommodates different learning styles, allows flexibility of schedule, and helps students to learn interactively with virtual surgery technology to consolidate concepts of anatomy, pathology, and treatment of the eye.

## METHODS

### Course Design and Implementation

The elective was designed in three parts: (1) independent study of web-based didactics; (2) participation in conducting a vision screening; and (3) training with a virtual eye surgery simulator.

The first section of the course was designed as a web-based curriculum to be completed independently. This portion was divided into five learning blocks, one for each of the eye conditions examined: cataracts, open-angle glaucoma, age-related macular degeneration, diabetic retinopathy, and thyroid eye disease. These specific eye conditions were chosen to provide students with a well-rounded understanding of how disease can impact key components of the eye.

The first learning block (cataracts) was taken from the predecessor course offered at Alpert Medical School in 2009-2010.<sup>5</sup> The remaining four learning blocks were created specifically for this initiative. Each learning block is composed of a didactic curriculum, a supplementary video, and a short quiz. The didactic curriculum consists of three PowerPoint slide modules, focusing on topics of epidemiology, pathophysiology, and treatment for the particular eye condition. The learning objectives for this curriculum were based on the American Academy of Ophthalmology guidelines.<sup>8-11</sup> A web-link was included in each block, directing to a digital video on the surgical treatment of the particular disease. A ten-question, investigator-generated multiple-choice quiz was created for each learning block; each quiz was administered before starting and after completing each block to assess the students' progress. Course materials were uploaded onto our institution's online course management system.

The second section of the course was designed to bring the didactic portion of the course to life in a clinical setting. Arrangements were made for pairs of students to participate in a three-hour glaucoma screening session at the Rhode

**Table 1. Selected results from the pre-course survey**

Statement (n=17)	Average Rating	Standard Deviation	Question Style
Is the ophthalmology content provided in your medical school classes limited?	3.67	0.94	Likert
Does the multifaceted nature of the course (online learning, clinic screening, virtual surgery) interest you?	4.18	0.51	Likert
Did the online nature of the didactic modules attract you to enroll in the course?	3.65	1.03	Likert
Are you interested in ophthalmology as a possible career choice?	3.76	1.00	Likert
Do you have experience working with virtual surgery simulators?	No (16 of 17)		Yes/No
Do you have experience using ophthalmic diagnostic equipment?	No (12 of 17)		Yes/No

Average Rating was calculated by assigning a numeric value to each response (Strongly disagree=1, Disagree=2, Neither agree nor disagree=3, Agree=4, Strongly agree=5), and obtaining a weighted average of all the responses.

**Table 2. Selected results from the post-course survey**

Statement (n=17)	Average Rating	Standard Deviation	Question Style
Course content was at a level of difficulty appropriate to first and second year med students.	4.69	0.46	Likert
The virtual surgery simulator helped me in understanding ocular anatomy.	4.00	0.79	Likert
I would be interested in more experience with the virtual surgery simulator.	4.56	0.61	Likert
I feel more comfortable with using ophthalmic diagnostic equipment.	4.19	0.53	Likert
Participating in the glaucoma screening session helped me understand the importance of early diagnosis for glaucoma.	4.31	0.68	Likert
I am interested in ophthalmology as a career.	3.88	0.78	Likert
The course increased my awareness of ocular signs and symptoms in patients.	4.56	0.50	Likert
Please provide additional feedback and suggestions you may have about the virtual surgery session.	Interested in more experience (15 of 17)		Free response

Average Rating was calculated by assigning a numeric value to each response (Strongly disagree=1, Disagree=2, Neither agree nor disagree=3, Agree=4, Strongly agree=5), and obtaining a weighted average of all the responses.

Island Free Clinic (RIFC) with the members of a medical student-organized community vision screening initiative.<sup>7</sup> The student organization provided instruction for operating the automated perimetry and automated visual acuity screening machines prior to the start of the session.

The third portion of the course was designed to use virtual surgery technology to foster a more complete mastery of the academic topics of the course. From the five cataract modules available on the EyeSi® (*VRmagic*, Mannheim, Germany), six tasks of difficulty levels thought to be appropriate for first and second year medical students were selected. Each student was assigned a three-hour individual block of time to complete the virtual surgery session with EyeSi® ophthalmic-surgical simulator housed at the Providence VA Medical Center Eye Clinic. In the virtual surgery suite, the student followed a detailed instruction manual (first created for the predecessor cataract course, and then edited for the purposes of this course) explaining the step-by-step use of the simulator to allow the student to work independently.<sup>5</sup> As our goal was for students to attain a holistic understanding of the eye and to provide an introduction to ocular surgery, the students were allowed

to repeat individual tasks of the virtual surgery as many times as needed in the three-hour session.

The entire web-based didactic course and the virtual surgery instruction manual can be accessed online at mycourses.brown.edu. Visitors can login as a guest and click on the title of the elective (*Alpert Medical School – Adventures in Ophthalmology and Virtual Surgery*) to be directed to the course website.

**Course Evaluation**

The elective was offered on a pass/fail basis at the Warren Alpert Medical School for the 2011–2012 academic year. Students were assessed with five online quizzes (50 questions total) that tested the content presented in the web-based didactic modules. Requirements to pass the course were: grades of 70% correct on each of the five content-based quizzes, participation in the vision screening, and participation in the virtual surgery session.

Students were asked to complete anonymous surveys before and after the course to validate educational content and determine how the elective can be improved in the future. These pre- and post-course surveys specifically measured students’ motivation for enrolling in

the course, students’ knowledge of ophthalmology before and after the course, students’ perceptions of eye diseases as a manifestation of other systemic diseases, students’ interests in pursuing a career in ophthalmology, and students’ evaluations of the didactic and practical portions of the course. The pre-course survey consisted of four Likert-style questions, three multiple-choice questions, and one free response question. The post-course survey consisted of 17 Likert-style questions and three free response questions. Five response choices were given for each of the Likert-style questions: “strongly agree,” “agree,” “neither agree nor disagree,” “disagree,” and “strongly disagree.”<sup>12</sup> The free response sections expanded on the quantitative aspects of the surveys by asking students to provide feedback and suggestions about the individual components of the course.

The Institutional Review Board (IRB) of the Providence VA Medical Center (PVAMC) concluded that this course evaluation did not meet the definition of research and thus IRB approval was not required.

**RESULTS**

Twenty-three of the 205 first and second year students (11%) enrolled in

the preclinical elective, making it the most popular elective in the 2011–2012 academic year. This paper reports the pre- and post-course survey results from the 17 students enrolled in the elective during the 2011 fall semester. The mean score of the content-based quizzes administered before the course was 49%. The mean score of the same quizzes administered after completion of the didactic portion of the course was 94%. All 17 students achieved a passing score of 70% or greater in the course.

### Pre-Course Survey

Selected results from the pre-course survey are included in Table 1. This survey indicated that the elective attracted students interested in ophthalmology: 13 (76%) enrolled medical students were interested in pursuing ophthalmology as a career, and 100% of the students reported in the free response section that “interest” in the topic of ophthalmology was their primary reason for enrolling in the course.

Though students exhibited desire to expand their exposure to ophthalmology, they were most attracted by the multifaceted nature (web-based, clinical, virtual surgery components) of the elective: only one student (6%) disagreed when asked if the ophthalmology content in medical school classes were limited whereas none of the students disagreed when asked if the multifaceted nature of the course interested them. Most students had no prior experience working with virtual surgery simulators (16/17; 94%) and ophthalmic diagnostic equipment (12/17; 71%).

### Post-course Survey

Selected results from the post-course survey are included in Table 2. This survey indicated that the web-based component of the course was well received. All enrolled medical students responded “strongly agree” or “agree” to the following: the course was easy to access and navigate, the course could be completed in a reasonable amount of time, and course content was at a level of difficulty appropriate to first and second year medical students. Most (15/17; 88%) agreed that the quiz questions were an appropriate test of the material covered in the didactic modules and that the surgical videos were helpful in understanding the treatment

of the diseases studied. In terms of constructive feedback, three students (18%) indicated that the web-based curriculum could be expanded to include information on more eye conditions.

Students expressed a high level of satisfaction with the vision screening session: 15 (88%) reported feeling more comfortable using ophthalmic diagnostic equipment after the session and 14 (82%) reported that screening vision first-hand helped them understand the importance of early diagnosis of eye diseases. In the free response section, four students (24%) suggested that additional instruction regarding operation of the screening machines would have been useful in preparing them to give the patients the most benefit. In particular, three of these four students stated that a written guide or protocol would have been helpful.

The feedback from the free responses indicated that the virtual surgery session was a positive educational experience. Most students (15/17; 88%) indicated an interest in gaining more experience with the virtual surgery simulator; five students (29%) found navigating the machine to be challenging.

With respect to the combined impact of the three components of the course, all students agreed that the course helped increase their awareness of ocular signs and symptoms in patients.

## DISCUSSION

This course was successful in supplementing gaps in the ophthalmology curriculum by providing academic, clinical, and surgical experience to preclinical students. Using the tools of virtual surgery simulation technology to help consolidate the concepts learned in the web-based and clinical components, this elective was well received and highly effective in increasing awareness of the impact of eye conditions on the quality of life. Moreover, the unique learning modalities of this course allow for the possibility of the elective holding a sustainable spot in the medical curriculum; course offerings will not need to depend on the availability of lecturing instructors, and the materials can be easily passed on and updated from semester-to-semester based on feedback from post-course surveys.

This study has several limitations. First, the sample size of students was small

and inadequately powered, increasing risk for biased results. Second, this project was susceptible to selection bias: enrolled students may have had a predilection for surgery, ophthalmology or other surgical specialties. Thirdly, the clinical and virtual surgery components of the course were graded on participation, not on competency or performance. Use of the EyeSI® simulator has been shown as a reliable quantifiable performance analysis tool,<sup>13</sup> but further work is needed to develop a method of assessing skill improvement specific and appropriate to the level of preclinical students. Though the goal of this course is not acquisition of microsurgical performance, a more definitive method of assessing learning would be helpful to evaluate the efficacy of virtual surgery in preclinical medical education.

This preclinical elective course in ophthalmology suggests that with a relatively small investment of time, students can learn the epidemiology, pathophysiology, and treatment of common eye conditions with the tools of web-based instruction, clinic participation, and virtual surgery. Ophthalmology is a field acknowledged for creative innovation and technological advancement. Applying these attributes to our educational mission, an elective of this nature provides a unique opportunity to introduce this subspecialty as a possible career choice to future doctors early in their careers. Using a similar strategy, representatives from other fields can integrate their specialty into their institution’s medical curriculum to maximize exposure to the necessary field-specific knowledge all medical students should attain before graduating.

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*Jennifer J. Yong, BS, is a third year student at the Warren Alpert Medical School of Brown University.*

*Michael E. Migliori, MD, is a Clinical Associate Professor of Surgery (Ophthalmology) at the Alpert Medical School of Brown University and Ophthalmologist-in-Chief at Rhode Island Hospital.*

*Paul B. Greenberg, MD, is a Clinical Associate Professor of Surgery (Ophthalmology) at the Alpert Medical School of Brown University, Chief of Ophthalmology at the Providence Veterans Affairs Medical Center, and Associate Director of the Brown/Rhode Island Hospital Ophthalmology Residency Program.*

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#### **CORRESPONDENCE**

Paul B. Greenberg, MD  
 Section of Ophthalmology  
 VA Medical Center  
 830 Chalkstone Avenue  
 Providence, RI 02908  
 phone: (401) 273-7100 x1500  
 e-mail: paul\_greenberg@brown.edu

