Using Web-based Video to Enhance Physical Examination Skills in Medical Students

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Background and Objectives: Physical examination (PE) skills among US medical students have been shown to be deficient. This study examines the effect of a Web-based physical examination curriculum on first-year medical student PE skills. Methods: Web-based video clips, consisting of instruction in 77 elements of the physical examination, were created using Microsoft Windows Moviemaker software. Medical students' PE skills were evaluated by standardized patients before and after implementation of the Internet-based video. Results: Following implementation of this curriculum, there was a higher level of competency (from 87% in 2002–2003 to 91% in 2004–2005), and poor performances on standardized patient PE exams substantially diminished (from a 14%–22% failure rate in 2002–2003, to 4% in 2004–2005. Conclusions: A significant improvement in first-year medical student performance on the adult PE occurred after implementing Web-based instructional video.

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Physical examination skills among US medical students have been shown to be deficient.\textsuperscript{1,5} It appears that traditional methods for teaching physical examination skills (eg, lecture, demonstration, peer-to-peer practice, and practice with both standardized and actual patients) are not producing competency.\textsuperscript{6}

Several innovative education interventions have been undertaken by medical schools in the United States to strengthen students' physical examination skills.\textsuperscript{7,10} For example, several schools have introduced Web-based "encounters" and compared them to the use of standardized patients to teach clinical diagnosis skills,\textsuperscript{9,12} with positive results.

At our institution, we were faced with significant challenges in teaching physical examination skills. While some consider the diversity of the faculty to be a major strength of our institution, it also presents a significant challenge. Including community preceptors, nearly 300 faculty members are involved in teaching basic physical examination skills to our medical students. Predictably, this results in a wide range of teaching styles, with varying approaches to the physical examination. For the purpose of medical student education and evaluation, we believed that it was important to provide a consistent, uniform, and standardized approach to physical examination content and technique.

To improve the consistency and quality of instruction on physical examination skills, we developed a Web-based curriculum consisting of 77 video vignettes that supported teaching of the physical exam during our Principles of Clinical Medicine (PCM) course. We hypothesized that this curricular enhancement would have a positive effect on our students' physical examination skills when assessed at end of the first year of medical school. This study’s purpose was to measure changes in first-year students’ performance of physical examinations on standardized patients after implementation of this Web-based curriculum.

Methods

Study Participants

All 319 medical students at the University of Connecticut School of Medicine entering their first year of training in 2002, 2003, 2004, and 2005 were participants in this study. Our Institutional Review Board granted the study an exemption from formal review.
Students were assigned to a class cohort corresponding to their entering year. The first-year medical student classes entering training in 2002 and 2003 classes did not have the Web-based video vignettes to use as part of the curriculum. The 2004 and 2005 classes received the new curriculum that included the video vignettes.

The demographics of the two cohorts were similar to one another, with most students beginning medical school in their early 20s and all groups comprised of more than 60% women. The main criteria for medical school admission, which included university grades, performance on standardized exams, and a personal interview, did not change during the study time frame (Table 1). Core faculty teaching the PCM course also remained largely unchanged during the study time frame; of 20 core faculty members teaching the course, turnover totaled no more than two (and sometimes fewer) faculty members each year.

**Program Development**

**Background.** The PCM course meets one afternoon per week in small-group seminars during the first 2 years of medical school. Each group is facilitated by two faculty members, one of whom is a physician and the other a nonphysician health professional. Through a combination of lectures, small-group discussions, and practice sessions, students learn the basic components of the history and physical examination. A new body system is introduced each week and every 4 weeks is punctuated by a formative clinical skills assessment (CSA) session. During CSA sessions, students received formative feedback from trained standardized patients about their performance on physical exam techniques taught to date.

Concomitant with the PCM course, students participate in Student Continuity Practice (SCP), which is a 3-year curriculum that emphasizes ambulatory care and early exposure to generalist approaches to medicine. Students spend 1 half day per week with physician preceptors who are primary care community physicians in the fields of internal medicine, pediatrics, and family medicine. This community-based experience provides students with an opportunity to put their physical examination skills to practice.

Given the size and heterogeneous nature of our faculty, we conceptualized a Web-based physical examination curriculum that could be uniformly referenced by all course participants (including faculty, medical students, and standardized patients). This online curriculum could be accessed in both a synchronous (during instruction) and asynchronous manner.

**The Video Vignettes.** We created 77 short video vignettes consisting of downloadable video files to match the 77 maneuvers on our physical examination checklist (Figure 1). Before videotaping began, we reviewed the evidence-based literature on some of the more controversial aspects of physical examination techniques. Our multidisciplinary faculty leadership agreed that while many acceptable variations exist for a particular organ system (eg, thyroid exam), we would try to eliminate some of the variations in technique by suggesting only those that were most supported by evidence. Where supportive evidence did not exist, faculty consensus was used to make decisions about physical exam technique.

Filming sessions took place in CSA, in which a standardized patient served as the physical exam model. Course faculty members were used as instructors in the video, while others served as moderators in reading a prepared script. Approximately 16 hours of videotaped instruction was edited to identify the 77 unique maneuvers. Video was downloaded in .mpg format, and Microsoft Moviemaker was used for video editing. Editing consisted of truncating, combining, dubbing, and title overlays for each video segment. Clips range in length from 30 to 240 seconds, highlighting important aspects of physical exam maneuvers and fully demonstrating a particular exam technique in its entirety. In some cases, different viewing angles were added to enhance clarity.

All together, the final vignettes comprise nearly 90 minutes of video. Editing was conducted by one individual and took approximately 50 hours of effort. Video clips were subsequently reviewed by course faculty, CSA faculty and trainers, standardized patients, and selected medical students. Based on feedback, clips were retaped or reedited for additional clarity and emphasis.

### Table 1

<table>
<thead>
<tr>
<th></th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent female</td>
<td>64</td>
<td>66</td>
<td>63</td>
<td>71</td>
</tr>
<tr>
<td>Average age (years)</td>
<td>24</td>
<td>24</td>
<td>24</td>
<td>24</td>
</tr>
<tr>
<td>MCAT</td>
<td>29.7</td>
<td>30.5</td>
<td>30.8</td>
<td>30.2</td>
</tr>
<tr>
<td><strong>Ethnicity</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% URM</td>
<td>15</td>
<td>16</td>
<td>22</td>
<td>23</td>
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<tr>
<td>% Asian</td>
<td>17</td>
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<tr>
<td>% White</td>
<td>68</td>
<td>68</td>
<td>72</td>
<td>63</td>
</tr>
<tr>
<td>GPA undergraduate</td>
<td>3.60</td>
<td>3.66</td>
<td>3.66</td>
<td>3.66</td>
</tr>
</tbody>
</table>

MCAT—Medical College Admissions Test
URM—underrepresented minorities
GPA—grade-point average
Introducing the New Curriculum. The Web-based resource of video clips was then demonstrated to faculty and first-year medical students (class entering in 2004) in January 2005 at the outset of physical examination instruction in the second semester of curriculum. Faculty members giving lectures or conducting small group sessions were encouraged to reference the video clips directly in their presentations. Medical students were actively encouraged to access the Web page and download PE clips at any time. To further encourage use of the videos, students were informed that the Web page format was precisely that of their summative assessment in clinical skills. In fact, a Web page was designed to mimic the CSA physical examination checklist, which also serves as the final summative evaluation form. Clips were hyperlinked to the checklist for ease of downloading. The Web page was maintained on an institutional server for both Intranet and Internet access. This made access simple for all course participants and instructors and did not require use of the medical library.

Program Evaluation
At the conclusion of the PCM course, a final summative CSA occurs; students are expected to perform a complete adult physical examination on a standardized patient. This remained unchanged during the study time frame.

Each student’s performance was assessed by standardized patients using two sets of measures: a percent correct score on the 77-item physical exam checklist (PE checklist) and a mean score on a four-item physical exam process instrument (PE process) that used a Likert scale, with 1 indicating poor and 5 indicating excellent. The PE process score was a sum score of four items: (1) attention to patient comfort, (2) efficiency of exam, (3) draping technique, and (4) overall skills level.

Data Analysis
Student data were de-identified and presented in aggregate. Data analysis included calculation of the mean percentage of correct items on the PE checklist and mean value for the PE process items for each cohort. T test analysis and repeated measures ANOVA were used to determine statistical significance of pre-implementation (2002–2003) and post-implementation (2004–2005) performance of medical students on the adult physical examination of standardized patients. Analyses were performed using SPSS 11.5, 2004 software (SPSS, Inc, Chicago).

Results
The mean score on the PE checklist showed a statistically significant increase for students in the cohorts that had access to the Web-based curriculum (Table 2). Mean PE checklist performance scores rose from 87%
Auscultate femoral bruits

Auscultate abdomen for bowel sounds

Palpate femoral pulses

Percuss liver span and spleen

Muscle strength—lower extremities

Palpate abdominal aorta

Joint inspection and joint ROM upper extremities

- CN V—motor and sensory—three branches/side

Inspect lower extremities

- Joint inspection and joint ROM upper extremities

- Joint inspection and joint ROM lower extremities

- CN VII—forehead, frown/ smile

- CN IX, X—(agh)

Muscle strength—upper extremities

Muscle strength—lower extremities

Sensory—sharp touch

Vibration—toes

Proprioception—toes

DTRs—biceps, triceps, knee, ankle

Babinski reflex

Cerebellar—FTN or RAM

Cerebellar—heel-to-shin (HTS)

Gait—normal, tandem, walk on heels and toes

Romberg

Pronator drift

Back mobility—six directions

Mental status—orientation

General Assessment

Attention to patient comfort:

<table>
<thead>
<tr>
<th>Excellent</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 4 3 2 1</td>
<td></td>
</tr>
</tbody>
</table>

Efficiency of exam:

<table>
<thead>
<tr>
<th>Excellent</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 4 3 2 1</td>
<td></td>
</tr>
</tbody>
</table>

Draping:

<table>
<thead>
<tr>
<th>Excellent</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 4 3 2 1</td>
<td></td>
</tr>
</tbody>
</table>

Overall skills level:

<table>
<thead>
<tr>
<th>Excellent</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 4 3 2 1</td>
<td></td>
</tr>
</tbody>
</table>

Washed Hands _Y_ _N

Figure 1 (continued)

in 2002–2003, to 91% in 2004–2005 ($P<.05$). There was also a decline in the standard deviation of those scores (Table 2) and a significant drop in the percentage of students scoring below 80%, which has been designated as the minimum passing score (Figure 2). The repeated measures ANOVA indicated that the overall increase in PE checklist score was statistically significant ($P<.01$) between the years prior to and following implementation of the new curriculum. The PE process scores did not change during the study time frame.

Discussion

This study demonstrates a positive and statistically significant benefit in first-year medical students’ performance after implementing our Web-based curricular innovation. Although prior to the introduction of these 77 video vignettes most students succeeded in passing the threshold score of 80%, a sizeable number did not (22% in 2002 and 14% in 2003). Following implementation of this curricular enhancement, there was a substantial and consistent decrease in the percentage of students who did not pass: 4% in both 2004 and 2005. Arguably, this is perhaps our most important result, since our primary objective was to have all students perform at a higher competency level than before the curricular innovation. This diminution of the “tail” of marginal or substandard performance is an important step toward ensuring competency of all first year students in these skills.

We believe that introducing the reference video enhanced the uniformity of both instruction and learning. Multidisciplinary instructors at all levels of the course were given a reference, or standard, from which to teach. Standardized patients, who used the videos for their own reference purposes, may have contributed to improved accuracy of their evaluative feedback to learners. Medical students, the primary recipients of this instruction, had a reference and standard from which to learn. In effect, we believe that this teaching tool reduced the variance inherent in physical exam instruction that is common in many medical school curricula.

Further, these standardized video demonstrations served to eliminate much of the controversy regarding students’ final summative evaluation. Students had a clearer understanding of precisely how they would be evaluated a priori and could prepare more efficiently for their performance-based adult physical exam at the course conclusion.

Given the complexity and scope of teaching physical examination skills in our setting, we feel that our results likely can be generalized to other medical education settings. Without a reference or standard for physical examination instruction, many curricula create unnecessary “noise” and variance in instruction; even textbooks do little to harmonize instruction in examination.
technique. Standardized Web-based video provides a unique instructional framework for both teacher and pupil that reduces variance and enhances competency. By providing a classroom and outside-the-classroom reference that is available whenever desired, we have augmented the performance of the entire medical student class, as well as the performance of marginal performers.

The availability of our online curricula has had far-reaching effects in our health care setting. Based on informal discussion, multidisciplinary Clinical Medicine Course faculty members have expressed appreciation for a reference standard from which to teach. Standardized patients have described these videos as a valuable resource, particularly for those with limited experience/knowledge in medical education and those in primary occupations other than health care. On a larger scale, the curriculum has been used by nursing students, advanced-practice nurses in training, and medical students at another state medical school.

**Limitations**

We acknowledge several limitations of our study. First, we initially did not anticipate studying the effectiveness of this innovative tool; as such, we did not directly measure or track actual utilization of the video clip Web site by students, teachers, or patient instructors. This might easily have been facilitated by a Web page counter device, which we subsequently added in 2006. However, we have no reason to doubt the use of this Web-based video, given the favorable feedback from all users.

Second, this tool was implemented at a single medical school. Because of the unique undergraduate curriculum that interfaces with this tool, the results may have some limits in applicability to the curriculum of some other medical schools.

Third, our study used a retrospective design that was not blinded. All study participants in each study year either did (2002, 2003) or did not (2004, 2005) receive the study intervention. In retrospect, it might have been useful to have each year of medical students randomized into groups using the curricular intervention and those using only the conventional curriculum. A prospective, randomized, placebo-control study design would have more accurately revealed the effects of our curricular intervention.

Lastly, we acknowledge that these improved performance results may not have a lasting effect on more senior medical students’ competence in physical examination skills. Future research may examine test results from these same medical student classes to see if better performance in the first year of training is sustained throughout all years of undergraduate medical education.

**Conclusions**

This study demonstrated a measurable improvement in first-year medical students’ physical examination skills following implementation of a Web-based curriculum consisting of 77 instructional video vignettes that provided students with a demonstration of acceptable physi-

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**Table 2**

Physical Exam (PE) Performance in Four Classes of Medical Students*

<table>
<thead>
<tr>
<th>Class (Entering Year)</th>
<th>PE Checklist</th>
<th>PE Process</th>
<th>Percent Scoring Below 80% on Checklist</th>
<th>Percent Scoring Below 3.5 on Process</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002 n=81</td>
<td>87±8</td>
<td>4.0±0.6</td>
<td>22</td>
<td>17</td>
</tr>
<tr>
<td>2003 n=80</td>
<td>87±7</td>
<td>3.9±0.8</td>
<td>14</td>
<td>34</td>
</tr>
<tr>
<td>2004 n=81</td>
<td>91±6</td>
<td>4.2±0.6</td>
<td>4</td>
<td>15</td>
</tr>
<tr>
<td>2005 n=77</td>
<td>91±5</td>
<td>3.9±0.6</td>
<td>4</td>
<td>26</td>
</tr>
</tbody>
</table>


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**Figure 2**

Percent of Students Scoring Below the Mean Physical Exam Checklist Score of 80% Before and After Implementation of the Web-based Curriculum (P<.05)
17. http://fitsweb.uchc.edu/PCMLogin/login.asp. (Note: users must register with a username, password, and working e-mail address for free access).