Title: A Pilot Study to Integrate an Immersive Virtual Patient with a Breast Complaint and Breast Exam Simulator into a Surgery Clerkship

Article Type: ASE Manuscripts

Keywords: Virtual patients; clinical breast examination; mannequin-based simulators

Abstract: Background: We determine if an immersive virtual patient (VP) with a breast complaint and a breast mannequin prepare 3rd year medical students for history-taking (HT) and clinical breast exam (CBE) on a real patient (RP). Methods: Following standardized instruction in breast HT and CBE, students (N=21) were randomized to either an interaction with a VP (experimental) or to no VP interaction (control) before seeing an RP with a breast complaint. Participants completed baseline and exit surveys to assess confidence and anxiety regarding their HT and CBE skills. Results: Students reported greater confidence in their HT (Δ-value = 1.05 ± 1.28, p<0.05) and CBE skills (Δ-value = 1.14 ± 0.91, p<0.05) and less anxiety when performing CBE (Δ-value = -0.76 ± 1.10, p<0.05). The VP intervention group had a significantly higher mean HT confidence than the control group at the conclusion of the study (4.27 ± 0.47 vs. 3.50 ± 0.71 p<0.05). Conclusions: A single interaction with a VP with a breast complaint and breast mannequin improves student confidence in breast history-taking during a surgery clerkship.
July 7, 2008

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American Journal of Surgery
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Re: Conflict of Interest Disclosure

Dear Dr. Bland,

Please find enclosed a manuscript entitled: A PILOT STUDY TO INTEGRATE AN IMMERSIVE VIRTUAL PATIENT WITH A BREAST COMPLAINT AND BREAST EXAM SIMULATOR INTO A SURGERY CLERKSHIP. This work was presented at the Association for Surgical Education meeting on Saturday, April 19, 2008, in Toronto, Ontario, Canada.

There are presently no financial relationships related to this work.

Sincerely,

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July 7, 2008

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Sincerely,

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A Pilot Study to Integrate an Immersive Virtual Patient with a Breast Complaint and Breast Exam Simulator into a Surgery Clerkship

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Submission: Presented at the Association for Surgical Education Meeting on Saturday, April 19, 2008, Toronto, Ontario, Canada.
Abstract

**Background:** We determine if an immersive virtual patient (VP) with a breast complaint and a breast mannequin prepare 3rd year medical students for history-taking (HT) and clinical breast exam (CBE) on a real patient (RP). **Methods:** Following standardized instruction in breast HT and CBE, students (N=21) were randomized to either an interaction with a VP (experimental) or to no VP interaction (control) before seeing an RP with a breast complaint. Participants completed baseline and exit surveys to assess confidence regarding their HT and CBE skills.

**Results:** Students reported greater confidence in their HT (Δ-value = 1.05 ± 1.28, p<0.05) and CBE skills (Δ-value = 1.14 ± 0.91, p<0.05) and less anxiety when performing CBE (Δ-value = -0.76 ± 1.10, p<0.05). The VP intervention group had a significantly higher mean HT confidence than the control group at the conclusion of the study (4.27 ± 0.47 vs. 3.50 ± 0.71, respectively, p<0.05). **Conclusions:** A single interaction with a VP with a breast complaint and breast mannequin improves student confidence in breast history-taking during a surgery clerkship.
Summary:

Increasingly virtual reality and other forms of simulation are being used as educational tools to teach and assess clinical skills. We demonstrate that a brief curriculum delivered during the third year surgery clerkship incorporating a virtual scenario and a simulated breast mannequin is a useful adjunct in teaching breast history taking and examination skills.

Key Words:

Virtual patients, clinical breast examination, mannequin-based simulators
Introduction

Effective history-taking and breast examination skills are essential to optimize outcomes for women presenting with a breast complaint. Ineffective communication contributes to delays in diagnosis and malpractice litigation, while proficient information exchange between practitioners and patients improves health care outcomes.¹ Early detection, including the use of screening modalities such as mammography and clinical breast exam (CBE), has contributed significantly to improvements in breast cancer outcomes.²,³ The American Cancer Society recommends CBE as a part of a periodic health exam every three years for women 20 to 39 years of age and annually for women 40 years of age and older.² Thus, from a public health perspective, it is imperative that all health care professionals that care for women are competent in ascertaining a complete breast history and performing a thorough breast examination.

Unfortunately, many women report difficulties communicating with their providers and many physicians receive little formal training in communication skills. Furthermore, many health professions students express fear regarding missing a breast abnormality on breast examination and even practicing clinicians report they need additional training in this important skill.⁴-⁷ Traditionally, health professions students have learned these skills through a series of “hit or miss” clinical encounters with real patients. However, faculty seldom assess students’ performance of these important skills directly. As a result, at many institutions, students learn breast history taking and physical exam skills through the use of standardized patients (SP). However, SPs can only portray a limited set of physical symptoms and the personal nature of intimate examinations further limits their use for teaching pelvic and breast examination. Furthermore, the use of SPs to teach and test clinical skills is both time and resource intensive and therefore there is a strong need for innovative ways to augment traditional methods of
clinical skill acquisition. An ideal time to teach breast history and physical examination skills is during the third-year surgery clerkship when medical students interview and examine patients with breast complaints.

Computer simulation and virtual reality may enhance traditional methods in medical education. Virtual patients (VPs), or computerized representations of patients, have the potential to provide medical students a safe learning environment, the opportunity for extensive repetitive practice, and real-time feedback. Moreover, VPs could facilitate the learning of anxiety-provoking tasks such as breast history-taking and examination before interacting with a real or standardized patient. The purpose of this study was to determine if a curriculum during the third-year surgery clerkship to teach breast history-taking (HT) and CBE can prepare a medical student for an interaction with a real patient (RP). More specifically, we wanted to determine if an interaction with a VP improves confidence and reduces anxiety in performing the history and exam in the context of such a curriculum.
Methods

Study Population

Study participants consisted of 29 third-year medical students at the Medical College of Georgia (MCG) assigned to the first two rotations of the 8-week surgery clerkship in the 2007-2008 academic year. Students rotating in surgery at off-site affiliated institutions were excluded from the study because of difficulties coordinating their participation in the breast curriculum. The study was approved by the MCG Human Assurance Committee and fully informed consent was obtained from all students participating in the virtual interaction.

Curriculum

Instruction for all students related to breast history-taking and examination skills during the surgery clerkship contained three components. At the outset of the rotation, students received a one-hour didactic lecture from surgical oncology faculty regarding the presentation, diagnosis, and surgical treatment of common breast complaints (e.g., breast mass, nipple discharge, breast pain etc.). This didactic component was complemented by a small group session (3-5 students per group) lasting approximately one-hour led by a surgical resident, who reviewed pertinent points of breast history-taking and demonstrated CBE following established guidelines using a simulated breast model with implantable lesions (Figure 1). The simulated breast mannequin consists of a foam rubber breast (Limb & Things, Inc., Savannah, GA) overlaying a silicone insert in which a variety of materials are placed to represent the feel and texture of a real breast. Modules have been developed to represent a “normal” breast, a fibrocystic breast, as well as various masses (e.g., cysts, fibroadenomas, and adenocarcinomas). The breast mannequin uses sensors that detect the force applied as the breast is being examined and has the ability to record and display learner performance. Following the CBE demonstration, students practiced CBE
using the mannequin breast model for as long as they wished with instructor feedback. Finally, each student was required to attend the surgical oncology clinic for one day during the surgery rotation to interview and examine a patient who presented with a breast complaint. Following the interaction with a patient with a breast complaint, students then presented their patient findings to a faculty member.

**Virtual Patient Intervention**

Students were randomized by lottery to experimental (N=15) and control groups (N=14). Students in the experimental group conducted a 10-minute interaction with a VP with a complaint of a breast mass (Figure 2). Within one week of the VP interaction all students (experimental and control groups) performed a history and breast exam on a RP in the surgical oncology clinic. In the virtual scenario, subjects converse with a life-sized avatar projected on the wall of an exam room via a commercially available speech recognition engine (Dragon Naturally Speaking 9.0; Nuance Communications, Burlington, MA). The audio is processed through the speech recognition and the utterances are parsed by a weighted keyword matching algorithm. This system enables the student to talk to the VP naturally within the scope of the scenario and the VP responds with speech pre-recorded audio. The virtual system consists of two networked personal computers, a data projector, two web cameras, infrared LEDs to track user body movements, and a wireless microphone as described previously.9

The control group of students did not interact with the VP prior to the clinic experience. To ensure equality of educational experience across all groups, students in control group were given the opportunity to interact with the VP after data collection was complete.
**Data Collection and Analysis**

Participants completed baseline and exit surveys to assess confidence and anxiety regarding HT and CBE, our primary outcomes of interest, and were asked to rate the educational value of the curriculum using a Likert-type scale (1=least confident; 5=most confident and 1=least anxious; 5=most anxious). Baseline information was also collected on the number of previous experiences interviewing and examining patients (SP or RP). In addition, an exit survey assessed the total number of patients seen during the breast clinic experience. Group means were analyzed using paired and Student’s t-tests (reported as mean ± standard deviation). Comparison of proportions was done using Fisher’s exact test. All analyses were conducted using SAS for Windows, version 9.1 (SAS Institute, Cary, NC).
Results

Of the 29 students enrolled in the surgery clerkship during the study period, 21 (72%) participated in the study. Six students were excluded from the study because they were assigned to off-site rotations at affiliated hospitals. One student in the intervention group was unable to complete the virtual interaction due to technical difficulties. Another student from the control group was unable to complete the curriculum as assigned. These students were excluded from analysis. Prior to the study, only one student in each group had ever interviewed and examined an SP with a breast complaint (Experimental: 9% vs. Control: 10%, p=0.999). Experience with RPs was also limited and similar between the two groups (Experimental: 9% vs. Control: 20%, p=0.587).

Most students felt that the required components of the breast curriculum were educationally valuable: faculty lecture–89%; small group interaction–89%; breast clinic experience–100%. Students interviewed and examined an average of two patients during the clinic experience; this did not differ significantly by group (Experimental: 2.45 ± 1.81 vs. Control: 1.70 ± 0.95, p=0.253). As a group, the students’ confidence in history-taking and CBE significantly improved (Table 1). The overall change in confidence score for HT and CBE were 1.05 ± 1.28 (p<0.05) and 1.14 ± 0.91 (p<0.05), respectively. While there was a significant reduction in anxiety level with regard to CBE (-0.76 ± 1.10, p<0.05), this was not seen for the HT anxiety measure.

When compared by group, the VP intervention group had a significantly higher mean HT confidence score than the control group at the conclusion of the study (Figure 3: 4.27 ± 0.47 vs. 3.50 ± 0.71, respectively, p<0.05). There were no significant differences between the two groups in the CBE confidence measure or the HT and CBE anxiety measures. Exit measures were also
compared by gender. There were no significant differences in the HT and CBE confidence and anxiety measures between male and female subjects (Table 2).
Comments

This work is part of a multidisciplinary collaboration of computer scientists, educators, clinicians, and students to create, validate and integrate VP scenarios in health professions education. We have previously reported our initial interdisciplinary efforts to create and evaluate a highly immersive interaction with a virtual patient with abdominal pain as a method to teach medical students basic communication skills. Previous studies have also shown that VPs can be used to assess content related to student history taking skills and that students respond empathetically to a VP.\textsuperscript{8-11} This study represents our initial effort to integrate an immersive, interactive virtual patient with a breast complaint and a CBE simulator into a surgery clerkship to augment traditional learning methods. These innovative educational tools may prepare students with limited clinical experience for interactions with women with a breast complaint.

In this study, a VP with a breast mass was combined with a CBE simulator to teach breast history-taking and examination skills. Taking a thorough breast history and performing a complete breast exam are important components of the armamentarium to reduce morbidity and mortality from breast cancer.\textsuperscript{2} Thus, competence in eliciting a complete breast history and in performing CBE among all physicians is of utmost importance. The Association of American Medical Colleges (AAMC) has identified CBE as an important clinical skill that should be taught as part of undergraduate medical curricula.\textsuperscript{12} Despite its significance, students feel they need additional training in CBE and fear missing a lesion, which causes a significant amount of anxiety when performing the exam.\textsuperscript{4,13} Kann and colleagues found that graduating medical students, while demonstrating significantly better knowledge on breast cancer screening practices than first year students, still felt they needed further instruction in CBE.\textsuperscript{4} In addition, students have limited exposure to intimate examinations such as pelvic, prostate and breast
examination. If completely left to chance patient encounters on the clinical wards, students would undoubtedly finish their undergraduate training with disparate experiences in learning these skills. In order to address these issues, SPs have been used to teach breast history-taking skills and CBE. A study by Sachdeva and colleagues demonstrated that a single, structured SP intervention was successful in improving performance of CBE and professionalism during the exam among third-year medical students. However, the use of SPs in medical education can be time and resource intensive, requiring efforts to train and schedule lay persons to teach these skills. Furthermore, SPs can only portray a limited set of physical symptoms and the personal nature of intimate examinations further limits their use for teaching pelvic and breast examination. In addition, Chalabian and Dunnington found a limited relationship between correct performance of breast examination on an SP and the ability to detect a mass in a breast mannequin, raising concerns about the reliance on SPs alone for instruction in breast physical examination skills. Thus, there is a strong need to provide standardized instruction and assessment of breast history taking and CBE skills.

Mannequin trainers are useful adjuncts to teaching procedural and examination skills. Artificial breast models have been shown to improve CBE skills and increase sensitivity in finding breast abnormalities. Many of these breast models evaluate a learner’s tactile skill, which cannot be duplicated in SPs without a breast abnormality. Also, Pugh and Salud found that use of simulated breast models can improve student comfort levels and facilitate learning CBE. Therefore, a number of tools can be employed to teach breast history and examination skills.

With this background, the third year surgery clerkship at MCG was modified to include a module to teach critical elements of the breast history and CBE. Overall, students felt that the breast curriculum was educational and they demonstrated a significant increase in confidence in
breast history-taking and CBE with a decrease in anxiety when performing CBE. When compared by group, students who interacted with the VP prior to the clinic experience had a significantly higher mean confidence score than the group who did not interact with the VP before they saw a real patient. Interestingly, student anxiety in breast history-taking was not reduced significantly by the educational intervention, perhaps because baseline student anxiety levels were not as high for taking a breast history as they were for performing a breast exam. Students that interacted with a VP prior to a RP demonstrated increased confidence in breast history-taking over those students with no VP interaction but once again there was no change in anxiety level related to history-taking. No difference was seen between the control and experimental groups in student confidence and anxiety related to CBE because our experimental intervention did not involve an additional opportunity to practice CBE. Subsequent efforts have focused on merging the VP and breast mannequin to create a mixed-reality interaction that integrates the computer graphics of the VP with the passive haptics of the mannequin breast simulator to allow students to speak to the VP while conducting the physical exam.

While our results suggest that a single practice interaction with a VP might make students more confident in their history-taking skills, there are a number of limitations to our study. Our sample size limited our ability to control for confounding variables that may have impacted the confidence and anxiety measures at the exit survey, such as previous experience with breast patients and the number of patients seen in the breast clinic during the clerkship. Subject gender may have had an influence on the confidence and anxiety measures; however, no difference was detected in the exit measures when compared by gender. Student reports regarding the value of our educational interventions could also have been influenced by student fears that negative responses might lead to repercussions about their grade for the surgical rotation. In addition, our
measures of anxiety and confidence were self-reported and may not correlate with actual student levels of confidence and anxiety in these clinical skills. Our study lacked objective measures of student performance in history-taking and CBE and, thus, we were unable to determine if the educational intervention actually improved their clinical skills. This study served primarily as a pilot investigation to assess the feasibility of implementing a novel technology into a surgery clerkship. The ability to impact student skill acquisition and retention through repetitive practice with these novel educational technologies will be examined in a future educational research study.
References


**Figure Legends**

**Fig. 1.** Students perform clinical breast exam using a novel simulator designed to provide tactile and real-time objective feedback (photo courtesy of Ellen Soo, Northwestern University).

**Fig. 2.** DIANA (DIgital ANimated Avatar) is a life-sized, fully interactive virtual patient. The avatar can be modified to represent different ages, races, and constellation of symptoms.

**Fig. 3.** Comparison of exit confidence and anxiety scores by group with level of emotion quantified using Likert-type scales (1 = least confident / anxious; 5 = most confident / anxious).

*The intervention group expressed greater mean confidence in their breast history-taking skills compared to controls (Student’s t-test; p<0.05). HT = breast history-taking; CBE = clinical breast exam; VP = virtual patient; RP = real patient.*
Abstract

**Background:** We determine if an immersive virtual patient (VP) with a breast complaint and a breast mannequin prepare 3rd year medical students for history-taking (HT) and clinical breast exam (CBE) on a real patient (RP). **Methods:** Following standardized instruction in breast HT and CBE, students (N=21) were randomized to either an interaction with a VP (experimental) or to no VP interaction (control) before seeing an RP with a breast complaint. Participants completed baseline and exit surveys to assess confidence regarding their HT and CBE skills.

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图3

- VP to RP (Experimental)
- RP Only (Control)

<table>
<thead>
<tr>
<th></th>
<th>Confidence HT</th>
<th>Confidence CBE</th>
<th>Anxiety HT</th>
<th>Anxiety CBE</th>
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<tbody>
<tr>
<td>Experimental</td>
<td>4.3</td>
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<td>Control</td>
<td>1.9</td>
<td>2.3</td>
<td>2.5</td>
<td>2.3</td>
</tr>
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### Table 1

Comparison of baseline and exit measures (N = 21)

<table>
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<th>Measure</th>
<th>Baseline</th>
<th>Exit</th>
<th>Δ-value**</th>
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<tbody>
<tr>
<td>HT confidence†</td>
<td>2.86 ± 1.01</td>
<td>3.90 ± 0.70</td>
<td>1.05 ± 1.28‡</td>
</tr>
<tr>
<td>HT anxiety†</td>
<td>2.52 ± 0.75</td>
<td>2.10 ± 0.77</td>
<td>-0.42 ± 0.98</td>
</tr>
<tr>
<td>BE confidence*</td>
<td>2.52 ± 0.87</td>
<td>3.67 ± 0.80</td>
<td>1.14 ± 0.91‡</td>
</tr>
<tr>
<td>BE anxiety†</td>
<td>3.14 ± 1.06</td>
<td>2.38 ± 0.74</td>
<td>-0.76 ± 1.10‡</td>
</tr>
</tbody>
</table>

* Likert-type scale (1 = least confident; 5 = most confident).
† Likert-type scale (1 = least anxious; 5 = most anxious).
** Paired t-test comparing baseline and exit measures (alpha = 0.05).
‡ p < 0.05
Table 2

Comparison of exit measures by gender

<table>
<thead>
<tr>
<th>Measure</th>
<th>Male (N=13)</th>
<th>Female (N=8)</th>
<th>p-value**</th>
</tr>
</thead>
<tbody>
<tr>
<td>HT confidence*</td>
<td>4.00 ± 0.58</td>
<td>3.75 ± 0.89</td>
<td>NS‡</td>
</tr>
<tr>
<td>HT anxiety†</td>
<td>2.08 ± 0.64</td>
<td>2.13 ± 0.99</td>
<td>NS</td>
</tr>
<tr>
<td>BE confidence*</td>
<td>3.62 ± 0.87</td>
<td>3.75 ± 0.71</td>
<td>NS</td>
</tr>
<tr>
<td>BE anxiety†</td>
<td>2.38 ± 0.65</td>
<td>2.38 ± 0.92</td>
<td>NS</td>
</tr>
</tbody>
</table>

* Likert-type scale (1 = least confident; 5 = most confident).

† Likert-type scale (1 = least anxious; 5 = most anxious).

** Student’s t-test comparing exit measures by gender (alpha = 0.05).

‡ NS = p-value not significant