



Improving the competency of medical students in clinical breast examination through a standardized simulation and multimedia-based curriculum

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Abstract

Purpose Clinical breast examination (CBE) is an important step in the assessment of patients with breast-related complaints. We developed a standardized simulation and multimedia-based (SSMBI) curriculum using current evidenced-based recommendations. This study aimed to determine if SSMBI training resulted in better performance (examination scores and detection of abnormal findings) than the traditional teaching method.

Methods Novice fourth-year medical students were exposed to the SSMBI curriculum ($n = 68$) or traditional ($n = 52$) training. The traditional group was taught by a lecture and attending weekly clinics where they had hands-on experience. The SSMBI group underwent a structured lecture followed by an instructional video and dedicated simulated teaching. Both groups were assessed through a written knowledge exam and an objective structured clinical examination (OSCE). Student's t test and χ^2 tests were used to assess differences in CBE technique and knowledge.

Results Students who underwent SSMBI training had significantly higher numbers of correct answers describing the different steps and justifications of CBE. OSCE performance was significantly higher in the SSMBI group. SSMBI-trained students were more likely to complete all the necessary CBE steps compared to traditionally-trained students (88.2% vs. 28.2%, $p < 0.00001$). The SSMBI group was also more systematic and more likely to perform adequate inspection, palpation, examination of the nipple-areolar complex, and identify and characterize a palpable lesion ($p < 0.05$).

Conclusions Formal SSMBI training is an important asset when teaching medical students how to perform a CBE. Real clinical experience is still necessary to refine this skill and the physician–patient interaction.

Keywords Clinical breast examination · Breast disease · Breast cancer · Breast

Abbreviations

CBE	Clinical breast examination
OSCE	Objective structured clinical examinations
SSMBI	Standardized simulation and multimedia-based

Introduction

Clinical breast examination (CBE) is an important step in the assessment of patients with breast-related complaints [1, 2]. The aim is to detect abnormalities and evaluate patient-reported symptoms in the hopes of finding a cause such as a palpable breast mass, nipple or skin changes, or lymphadenopathy [2]. For some women, CBE can complement mammography in the early detection of breast cancer. CBE detects some breast cancers (4–17%) not found by mammography, although the magnitude of its contribution to the early detection of breast cancers among asymptomatic women is relatively small [2–6]. Additionally, in some settings CBE provides an important screening tool for women in whom mammography is not recommended or who do not receive high-quality screening mammography according to recommended guidelines [2]. CBE also provides important clinical

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information in routine breast cancer follow-up, particularly when evaluating for locoregional recurrence [7].

Although proficiency in CBE is critical, studies have well-documented clinicians' lack of confidence and knowledge. For example, in a multi-site survey of physicians and nurse practitioners, 43% of respondents felt their CBE was impacted by a lack of confidence and exposure to patients with breast lumps [8]. Approximately one-third of physicians reported that their CBE training in medical school was inadequate [9]. Lack of confidence in CBE is frequently reported to impact physicians' willingness to perform CBE [10].

Simulation training is a commonly employed technique that improves clinicians' proficiency and competency in physical examination skills [11, 12]. Studies emphasize the importance of having a formal lecture complimented by a hands-on component [13]. The use of silicone breast models can significantly improve the rate of true positives in students exposed to practice models [13, 14]. Additionally, the setting and format of teaching also determines the success of students learning. Clinicians prefer practicing on standardized patients because it is more effective than attempting new invasive skills in a clinical setting [15]. Objective structured clinical examinations (OSCE) have also been incorporated into medical education because they help assess clinical knowledge and performance [16]. An educational model that combines structured teaching, simulated and didactic training, and an OSCE has been shown to make trainees more proficient at identifying physical exam abnormalities than those who do not receive this training [17].

Based on the need to improve our medical student's education, we developed a standardized simulation and multimedia-based (SSMBI) curriculum using current recommendations. The primary aim of this study was to determine whether teaching CBE using SSMBI training resulted in better performance measures (detection of abnormal findings and examination scores) than the traditional teaching method.

Methodology

Study design

This was a single observation, performance assessment study [18]. Ethics approval was obtained by the review board from the Pontificia Universidad Javeriana School of Medicine in Bogota, Colombia.

Participants

A convenience sample of fourth-year medical students was recruited from the Pontificia Universidad Javeriana School

of Medicine. The target population was students who had not completed their breast surgery rotation. Involvement in the study was voluntary and students had the opportunity to opt out at any time. There were no incentives. Students were randomly allocated to two groups: traditional and SSBI training. Both groups completed the same written evaluation test and OSCE.

Traditional CBE training

Historically, fourth-year medical students learn about CBE through a lecture in their pre-clinical courses. Their technique is further refined during their breast surgery rotation, which is a standard component of the 3-month general surgery core rotation. During their breast rotation, medical students attend weekly benign disease and breast cancer clinics with one of two academic breast surgeons (MT, LT). In clinic, they have hands-on experience with real patients.

Standardized simulation and multimedia-based instruction (SSMBI)

Students allocated to SSMBI training completed a multi-step curriculum taught by two academic attending breast surgeons (MT, LT). Students were divided into groups of 4 or 5 and attended a didactic objective-based 1-h lecture in which they reviewed three key topics. First, normal anatomy was reviewed using illustrations and photographs of the relevant soft tissue structures and lymphatic drainage of the breast and axilla. Three physical models of healthy breasts were presented to allow students to appreciate a variety of normal breast densities. Second, benign and malignant breast pathology was reviewed by exposing students to a spectrum of lesions along with their typical exam findings. A variety of interchangeable materials in silicone breast models were used to simulate pathologies such as fibroadenomas, cysts, and malignant tumors. Students were instructed on how to report these findings. Third, an overview of the CBE technique was instructed by means of a 10-min instructional video [19]. This video was created by several of the authors (FAA, SAA, MT, LT) to teach a standardized approach adhering to current recommendations [20]. In brief, the video uses visual aids, animations, and a real clinical scenario to showcase the current recommendations for performing CBE including [20]: (1) visual inspection of breast symmetry, nipple-areolar complex, and skin changes'; (2) use of "vertical strip" search pattern; (3) use of the pads of the middle three fingers in a circular motion; (4) use of increasing levels of palpation pressure (light, medium, and deep) to assess three levels of depth (subcutaneous, midlevel, and chest wall); and (5) use of an examination of 3 min per breast.

Students then underwent individual teaching sessions with one of two breast surgeons. Instruction was carried out over 1 hour using a silicone breast model. Students were allowed to repeat the process as many times as needed. The breast surgeon observed students during practice, and provided feedback and correction on technique elements when indicated. Students were then given an opportunity to practice on their own prior to the OSCE.

Written evaluation and objective structured clinical examination (OSCE)

Prior to the OSCE, students completed a written test that assessed their knowledge through multiple choice and open answer questions. Also included were questions using a Likert scale addressing satisfaction with their training and comfort level performing CBE.

OSCEs were performed under direct supervision via closed-circuit broadcasting of the assessment room to the separate examiners room. The testing sessions took place during the surgical clerkship on a day set aside for didactic and simulator education. Two attending breast surgeons and one chief resident served as evaluators. Once inside the examination room, students were given a clinical vignette and asked to perform a CBE using a breast simulator that contained a solitary, deep, hard mass two centimeters in size, with subtle skin changes. The evaluator observing the examination marked each part of the examination performed by the student on a scoring checklist, which was developed by two breast surgeons (MT, LT). Although not validated externally, the checklist was compared systematically with other previously published checklists used to evaluate the CBE skills of health care professionals, and was found to be similar [21]. It was also consistent with the guidelines published by the American Cancer Society [20]. Students were not explicitly aware of the contents of the checklist; however, the teaching objectives of the training for both groups were reflected in the checklist items.

The OSCE checklist contained the following criteria: (1) performs the steps prior to beginning CBE, including washing hands, explaining what the exam consists of, offers chaperone, obtaining verbal consent, and appropriate draping; (2) performs CBE in a systematic manner; (3) positions the patient in an adequate manner for inspection and palpation of lymph nodes and the breast; (4) carries out a visual inspection noting symmetry, contour, dermatologic signs of disease; (5) performs the exam within an appropriate anatomical perimeter; (6) uses a “vertical strip” search pattern; (7) uses 50% of the pads of three fingers for palpation; (8) uses “circular rubbing” while palpating the breast; (9) performs palpation at three levels of pressure; (10) uses two active hands together; (11) performs inspection and palpation of the nipple-areolar complex; (12) performs palpation

of the lymph nodes in the neck, supra/infraclavicular fossa, and axilla; and (13) identifies and adequately characterizes the palpable breast lesion using appropriate medical terminology. Students were also assessed in terms of their systematic approach, search pattern, search technique, number of hands used, number of fingers used, and whether the lymph nodes and nipple-areolar complex were included.

Students received an overall score which was calculated using the number of adequately completed items divided by the total number of tested items. After the testing, students were given individual feedback and their overall score.

Definitions

Systematic refers to performing the CBE in a predictable, ordered, and methodical manner. Search pattern was defined as the direction of palpation relative to the breast. Search technique was defined as the finger movements of the participant, independent of the search pattern used. Hand number assessed the number of active hands used during the exam.

Data analysis

Results were transferred from the grading sheets and stored in an Excel data base (Microsoft Co, USA). The mean simulator examination summary score was compared between groups overall and within experience levels using a 2-sample *t* test. For continuous variables, a Pearson χ^2 test was used for comparison.

Results

The study consisted of 120 participants of whom 52 and 68 were in the traditional and SSMBI groups, respectively (Fig. 1).

CBE knowledge results

Table 1 summarizes the results of the CBE knowledge evaluation. Students who underwent SSMBI training had a significantly higher number of correct answers describing the different steps and justifications of CBE.

OSCE performance

Table 2 summarizes the results of the OSCE results by group. Overall, the SSMBI group performed a physical exam more consistent with recommendations than the traditional group. The percentage of students who adequately completed all 13 items was significantly higher in the SSMBI group (88.2% vs. 28.2%, $p < 0.00001$). Students in the SSMBI group were more systematic in their approach

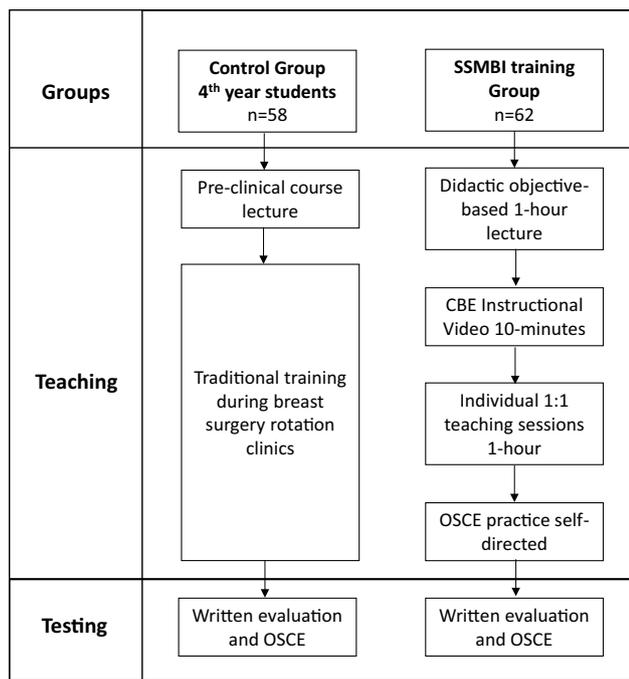


Fig. 1 Flow chart of research and data collection

Table 1 Summary of clinical breast examination knowledge (CBE) knowledge results

Item	Traditional (n=52)	SSMBI (n=68)	p value
Mean number of adequately described steps, n	1	4	0.00001
Inspection, n (%)	31 (59.6)	66 (97.1)	0.0001
Position, n (%)	30 (57.7)	59 (86.8)	0.0001
Palpation, n (%)	36 (69.2)	67 (98.5)	0.0001
Pressure, n (%)	17 (32.7)	42 (61.8)	0.0001
Axilla, n (%)	18 (34.6)	60 (88.2)	0.0001
Justifications, n	1.2	4.3	0.00001

SSMBI standardized simulation and multimedia-based instruction

to the CBE compared to the traditional group (92.6% vs. 13.5%, $p=0.0001$). Compared to the traditional group, the SSMBI group was more likely to visually inspect; perform palpation with an adequate search pattern, search technique, pressure levels, and use of finger pads; examine the nipple-areolar complex; and adequately identify and characterize a palpable lesion ($p=0.00001$).

Confidence and satisfaction with training

When participants were asked to rate how confident they felt performing CBE at the end of their training, participants who underwent SSMBI felt significantly more confident than those with traditional training. SSMBI-trained students were

more frequently “very confident” than traditionally trained students (97.1% vs. 9.6%, $p=0.00001$). Satisfaction with training was significantly higher in students who underwent SSMBI compared to traditional training (88.2% vs. 19.2%, $p=0.00001$).

Discussion

The results of this study demonstrate that formal training in CBE technique can improve the knowledge, proficiency, and confidence of medical students in detecting breast masses. Students exposed to our SSMBI curriculum performed better than traditionally-trained students in all domains. CBE technique significantly improved in SSMBI-trained students in all tested areas. Significant differences were noted in visual inspection, palpation search pattern and technique, examination of the nipple-areolar complex, and identification and characterization of a palpable lesion.

In agreement with our results, previous studies examining teaching strategies that included standardized, evidence-based CBE technique, and high-fidelity silicone models showed improvements in trainee and patient performance. An early clinical trial by Pilgrim et al. randomized medical students to receive either a lecture alone or an experimental group containing teaching with feedback, silicone models, and women volunteers. Students in the experimental group used more standardized techniques and found more simulated lumps in a silicone model [13]. A study by Nathwani et al. examined medical student performance after exposure to a structured CBE curriculum including instruction on anatomy, pathology, and technique, using models [22]. One year later during OSCE assessments, the experimental group performed examinations that were significantly more consistent with guidelines and were more likely to use two hands in a systematic fashion. While still showing statistical significance, some studies have not shown the level of significance found in our study [23]. There are several factors that could explain this disparity. In some designs, the control group also received dedicated teaching on CBE including a didactic lecture or ambulatory clinic teaching sessions [23]. Study populations have also examined more experienced practitioners such as fully trained physicians, motivated medical students attending a national conference, or resident physicians [17].

In contrast to the above interventions, Goodson et al. tested whether an attention-focusing device in the form of a standardized questionnaire inquiring about the specifics of patients’ CBE would improve lesion detection [24]. They used call rate as a surrogate marker for abnormality detection and found clinicians using the form were more likely to find an abnormality than during a historical control period. They suggest that this strategy is more practical

Table 2 Clinical breast examination (CBE) objective structured clinical examination (OSCE) results

Item, <i>n</i> (%)	Traditional (<i>n</i> =52)	SSMBI (<i>n</i> =68)	<i>p</i> value
Performs steps prior to beginning CBE, including washes hands, explains exam, offers chaperone, obtains verbal consent, and appropriately drapes patients	44 (84.6)	61 (89.7)	0.2
Performs CBE in a systematic approach	7 (13.5)	63 (92.6)	0.00001
Positions the patient in an adequate manner for inspection and palpation of lymph nodes and the breast	42 (80.8)	65 (95.6)	0.1
Carries out a visual inspection noting symmetry, contour and dermatologic signs of disease	10 (19.2)	63 (92.6)	0.00001
Performs the exam within an appropriate anatomical perimeter	42 (80.8)	65 (95.6)	0.1
Uses a “vertical strip” search pattern	3 (5.8)	66 (97.1)	0.00001
Uses 50% of the pads of three fingers for palpation	3 (5.8)	66 (97.1)	0.00001
Uses “circular rubbing” while palpating the breast	3 (5.8)	66 (97.1)	0.00001
Performs palpation at three levels of pressure	10 (19.2)	60 (88.2)	0.00001
Uses two active hands together	47 (90.4)	63 (92.6)	0.7
Performs inspection and palpation of the nipple-areolar complex	3 (5.8)	66 (97.1)	0.00001
Performs palpation of the lymph nodes in the neck, supra/infraclavicular fossa, and axilla	50 (96.2)	66 (97)	0.8
Identifies and adequately characterizes the palpable breast lesion using appropriate medical terminology	3 (5.8)	66 (97.1)	0.00001

CBE clinical breast examination, SSMBI standardized simulation, and multimedia-based instruction

than retraining practitioners with more elaborate techniques. However, this study group consisted of clinicians with an average of 10 years of postgraduate experience. While these findings are interesting and potentially easier to implement, our results strongly suggest a more focussed and interactive learning experience leads to the greatest gains in proficiency for novice examiners.

A strength of our study is that it draws attention to the inadequacy of traditional clinical exposure to CBE. Despite having a dedicated breast surgery rotation nested within a 3-month general surgery rotation, our students did not perform adequate numbers of CBEs to feel confident or appropriately perform in an OSCE. Many medical schools do not have dedicated breast surgery rotations and it is unlikely that administrators can rely on organic clinical scenarios to prepare their students. Additionally, our results show a high level of significance, suggesting SSMBI is a very effective tool for improving medical student performance compared to traditional techniques that rely on opportunistic clinical exposure and pre-clinical teaching sessions.

A potential weakness of our study is the use of OSCE scores as a measurement of CBE performance. It is possible that higher OSCE scores in our students would not translate into superior CBE in later clinical practice and therefore better lesion detection. However, OSCE-type environments have been rigorously tested and validated during the development of national standardized clinical skills examinations [25]. Assessments during medical school, including OSCEs, have been significantly correlated to clinical performance in internship, even when adjusted for pre-medical school exam scores [26]. It is also the responsibility of medical schools to adequately prepare their students for these high-stakes

examinations. In response to increased emphasis placed on clinical skills during national examinations, North American medical schools have increased the use of standardized patients, simulation learning, and direct observation of real patients [27].

Debate has questioned the contributions of CBE to the detection of breast cancer in asymptomatic women and to improving survival and reducing cancer-specific mortality rates. Apart from the general observation that smaller breast cancers have better prognosis than larger ones [28], the impact of CBE in a screening capacity to improve survival and/or reduce breast cancer mortality is limited. In a large Canadian trial, long-term follow-up did not demonstrate any benefit to screening physical examination over mammography [29]. Given the overall level of uncertainty, most screening guidelines either recommend CBE as a complement to mammography or do not recommend for or against its use [30–33]. Nonetheless, competency in CBE is relevant as it may contribute to the earlier detection of breast cancer in women who are outside the screening age groups, for whom mammography is not recommended, in women who are not adherent to recommended screening guidelines, and among women who participate in regular screening [2]. For example, a small subset of breast cancers can be identified on exam. CBE can detect up to 5% of breast cancers not immediately identified on mammography [2, 34]. Additionally, when used as part of breast cancer surveillance in the follow-up care of breast cancer patients, CBE can detect up to half of all breast recurrences and two-thirds of axillary recurrences [35].

The role of CBE in detecting breast cancer seems to be decreasing, with both the U.S Preventative Services Task

Force and the American Cancer Society recommending against CBE as a screening modality [32, 33]. As this trend continues, medical students' exposure to CBE will increasingly come from specialized rotations and we must ensure competency in this important clinical exam for all trainees. Updated guideline recommendations should not discount the potential value of CBE in low- and medium-resource settings where mammography screening may not be feasible. CBE alone has been suggested as a screening method in countries with limited resources [36]. An India-based study by Okonkwo et al. estimated that annual CBE achieves nearly the same number of life-years saved as biennial mammography, but at approximately half the cost [37]. Besides screening, CBE is still a standard part of the assessment of patients with breast masses and complaints [1]. CBE improves accuracy in preoperative assessment of breast cancer and is used in follow-up after breast cancer treatment [38].

Given the importance of a well-performed CBE, our results support the delivery of an SSBMI-based curriculum to improve competency in medical students. This is in agreement with existing literature that a multi-modal approach consisting of didactic teaching sessions, hands-on coaching with content experts, exposure to standardized CBE techniques, and the use of high-fidelity models will improve learning. Training programs responsible for teaching CBE may consider revising their curricula to incorporate these methods and should be wary of relying on usual clinical experiences to provide CBE instruction. Future studies should focus on testing CBE competence of medical students on real patients and the role of SSBMI in improving higher-level skills such as patient–physician interaction and preoperative evaluation of breast lesions.

Conclusion

For medical students with limited clinical exposure to CBE, learning through a structured curriculum guided by evidenced-based practice leads to higher quality performance. Medical students exposed to a structured curriculum consistently performed the CBE according to standard recommendations. While teaching students with formalized CBE sessions does improve proficiency, this educational tool should complement actual clinical experiences during clerkship rotations. SSBMI training offers students the advantage of having a structured approach to performing a physical examination on patients with breast complaints, thereby allowing them to hone their skills and bedside manner.

Compliance with ethical standards

Conflict of interest All authors declare that they have no conflicts of interest.

Ethical approval Ethics approval was obtained by the review board from the Pontificia Universidad Javeriana School of Medicine in Bogota, Colombia.

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