Hybrid Simulation in Teaching Clinical Breast Examination

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Abstract

Problem: Clinical Breast Examination (CBE) is traditionally taught to third year medical students using a lecture and a table-top breast model. The opportunity to clinically practice CBE depends on patient availability and willingness to be examined by students, especially in culturally sensitive environments.

Intervention: We employed hybrid simulation of the breast and aimed to investigate its effectiveness as an educational tool for teaching CBE to medical students. The hybrid simulation model consists of a standardized patient (SP) wearing a silicone breast simulator jacket.

Context: We compared the use of this tool to the traditional method using a blinded randomized controlled design. Medical students (N=82, 48.8% male) were randomized into teaching activities: hybrid simulation and control. Both groups received didactic teaching followed by a practical session. The control group practiced on the table-top model traditionally used while the intervention group practiced on the hybrid model (SP+breast jacket). Next, all students were assessed on their technical and communication skills in an Objective Structured Clinical Examination (OSCE) that included three SP stations. SPs were trained to act according to specified cultural roles: a liberal woman, a veiled woman and a moderately modest woman. Assessment employed a variety of simulated lesions.

Outcomes: The hypothesized outcomes consisted of a more complete acquisition of CBE skills, improved lesion detection and better communication skills. CBE completeness scores did not differ between the two groups (p=0.889). Hybrid simulation improved lesion identification grades (p<0.001) without increasing false positives. Communication skills were worse in the hybrid simulation group as graded by the SP (p<0.001), but not as reported by the students (p=0.346). We commented on the students’ comfort during OSCE. Hybrid simulation relieved the fear of missing a lesion on CBE (p=0.043) and increased satisfaction with the teaching method among students (p=0.002).

Lessons Learned: As a novel educational tool, hybrid simulation improves the sensitivity of CBE done by medical
students without affecting its specificity. Although it might not necessarily improve their communication or sensitivity to cultural aspects of CBE, hybrid simulation might have a role in increasing the self-confidence of medical students during CBE.

**Keywords:** Hybrid Simulation; Clinical Breast Examination; Medical Education; Standardized Patients

**Introduction and Background**

Breast cancer remains the most common cancer among women worldwide (Miller, 2010). Globally, preventive efforts are targeted towards early detection. The evidence to support the benefit of breast examination in terms of reducing breast cancer morbidity and mortality via early breast cancer detection is not well established (Saslow et al, 2004). Clinical Breast Examination (CBE) is extensively practiced in countries like the United States and is considered part of the regular health exam every 3 years in the third and fourth decades of a woman’s life and every year as of the fifth decade (Saslow et al, 2004). In addition, CBE remains a basic required skill for physicians in training and offers health-care providers the capacity to educate women on breast health.

Our goal in this paper is to study Hybrid Simulation as a tool for teaching CBE in a culturally diverse nation. Hybrid Simulation involves a patient actress, also referred to as Standardized Patient (SP), wearing a breast simulator jacket. Lebanon is characterized by a spectrum of cultural beliefs among women, ranging from extremely religious and conservative (veiled or covered) to extremely liberal. On account of the culturally sensitive setting of Lebanon, we hypothesize that the combination of breast simulators and standardized patients in a single encounter is an effective method for teaching CBE.

The Middle Eastern countries around Lebanon vary in terms of CBE screening programs (13% to 31%) (Alkhasawneh, 2007; Bener et al, 2009; Bener, Alwash, Miller, Denic and Dunn, 2001; Donnelly et al, 2012), although these are especially recommended by the World Health Organization (WHO) in the setting of insufficient resources and unavailable mammography (Miller, 2010). This is multi-factorial in origin and is namely affected by the educational level of women (Bener et al, 2000; Donnelly et al, 2012), the health services and social support available, perceptions, beliefs, attitudes as well as knowledge about breast cancer (Bener et al, 2002). However, the single behavior with the most significant negative effect on perception of breast examination is shyness and modesty (Naghibi, Shojaizadeh, Montazeri and Yazdani, 2015). The barrier to breast examination may include not only the woman’s concerns of modesty but also her husband’s (Facione and Kasapodi, 2000). The preference for a female doctor to perform CBE in 97% of Arab women in the UAE clearly reflects physician gender as a barrier (Bener et al, 2001). This suggests the existence of cultural barriers to CBE, in addition to the religious ones (Montazeri, Haji-Mahmood and Jarvandi, 2003).

Based on numbers from the Lebanese National Cancer Registry, Lebanese women rank among the highest worldwide in rates of breast cancer at younger ages (Lakis, Adis, Osman, Musharafieh and Hamadeh, 2010). Over the past 12 years concerted public health efforts have adopted aggressive screening strategies and targeted promoting and facilitating mammography screening in Lebanon; however, Lebanese women’s religious beliefs and cultural views being polarized on both ends of the spectrum, made it imperative for medical education leaders to ensure that physicians-in-training are not only proficient in CBE, but also cognizant of the cultural and religious diversity.

According to the American College of Surgeons, overcoming the barriers to CBE performance starts with proper training. Didactic presentations, visual demonstrations and practical sessions that provide feedback all constitute the components of proper training (Saslow et al, 2004). Standardized patients alone have been even proven efficacious in
instructing CBE to health-care providers (Coleman et al, 2004; Costanza et al, 1999). Also, it was found that simulators could have a role in relieving any performance anxiety among physicians in training (Pugh and Salud, 2007). In another study, adding a standardized patient component to the pelvic examination simulation model, but leaving each as a separate encounter, was found to improve learning outcomes (Dilaveri, Szostek, Wang and Cook, 2013). Two independent trials found that the CBE Simulator produced significant gains in clinical breast examination skills suggesting that this technology may improve the accuracy and quality of breast cancer screening (Goldstein et al, 2012).

Our primary aim is to study the use of hybrid simulation (breast exam jacket and SP) in CBE teaching in terms of lesion detection and identification. Our secondary aim is to evaluate the cultural sensitivity of students while dealing with women of different cultural backgrounds and compare that to their own self-evaluation of cultural competence.

Materials and Methods

This is a randomized controlled blinded behavioral trial that aimed to assess the efficacy of hybrid simulation of CBE as an educational tool. It was approved by the IRB at the American University of Beirut.

Study aims:

Third year medical students were group-randomized into the hybrid simulation arm or the control arm. Both arms received the traditional educational methods for teaching CBE: a lecture on breast pathology and examination given by JN, followed by didactic videos on the technique of CBE (1 hour total) (Bikley, 2005) as well as principles and tips for culturally-sensitive communication skills (15-20 minutes) (UMichDent@YouTube). Learning objectives of the practical session were explicitly outlined and distributed to the students before the practical session and 2 to 3 weeks prior to the assessment (supplemental material: appendix A). In addition to these activities, the control group participated in a practical session using a low fidelity breast simulator consisting of a table-top breast model (MammaCare), while the hybrid simulation session consisted of a clinical breast examination of a standardized patient wearing a breast simulator jacket from Limbs & Things (Bristol, UK). The control group practiced for an hour on the breast model in the presence of JN and received direct feedback, and they had the option of performing deliberate practice afterwards. The hybrid simulation encounter lasted around an hour in the presence of JN and the students received direct feedback as well. The feedback given to both groups was based on the grading rubric later used by the SP’s in the assessment. In both training models, the lesions presented were fibrocystic disease and carcinomas. Each of the students got to perform a full CBE. In the 2-3 weeks between practice and assessment, the 2 groups rotated together in the OBGYN department and saw patients in the inpatient and outpatient settings and in the operating room. None of the students got a chance to witness or perform a CBE on a patient during that time period.

Study outcomes:

The primary outcomes of CBE proficiency were CBE completeness, lesion identification, and communication competence. Secondary outcomes included self-reported performance and attitude during the CBE Objective Structured Clinical Examination (OSCE), including the student’s reported unease during CBE and its perceived causes. Assessment of outcomes took place two to three weeks after the educational activities through an OSCE-like setting that did not contribute to the student’s evaluation outside the study. The OSCE consisted of 3 stations with three SPs with distinct backgrounds.
Human research participants:

1. Study subjects: medical students

This study followed a pragmatic convenient sampling approach therefore, all (90) third year medical students enrolled at the American University of Beirut were approached, and 91.1% of them (n=82) consented to participate in this study. There were no exclusion criteria. The study period was one year.

a. Randomization:
   The ninety students had been previously divided, as part of the curriculum, into six random rotation groups of fifteen. As part of this study, the groups themselves were then randomized as clusters into the hybrid simulation arm or the control arm. Group-randomization (or cluster-randomization) was adopted, not only because the rotation groups were administratively convenient and a priori adequately randomized, but also for the following methodological reasons. The didactic interventions, namely lectures and simulation laboratory sessions, are naturally delivered to groups of learners rather than single individuals. When applied to individuals who readily interact within a pre-formed group, such didactic interventions are likely to "leak" or spread within the group (22). Peer-effects are also likely to occur when an individual's behavior – such as compliance, attitude, or response – is affected by the changes in behaviors of other individuals within the group. Such potential group contaminations were avoided through the use of group-randomization.

b. Group allocation:
   The intervention-to-control allocation ratio was 2:1. In the design phase of the study, the total sample size had been set as 90 based on the maximum number of third year students that could be recruited. However, since sample size and power calculations required an estimation of the effect but was not available at the beginning of the study, the ratio was arbitrarily set to 1:1. Later, the expected difference in the primary outcome of lesion identification between groups was estimated from an interim analysis. As previously reported, it was based on the first 42 participants (El-Hage Sleiman, Nassif, Nassar, Naamani, Sharara-Chami, 2015). Based on a sample size calculation for a conservative 85% power, in order to detect the estimated expected effect, a ratio of 2:1 or 1:2 would be sufficient. Otherwise, a ratio of 1:1 would give more power than necessary. While a ratio of 1:2 would involve a larger number of students being denied the new intervention. While the old teaching methods were not unethical, a ratio of 2:1 constituted a more ethical choice and was adopted for randomization throughout the remainder of the study.

2. Standardized Patients

The use of SPs for teaching, assessment and research purposes is widespread, however in order for readers to judge the quality of research and the validity of findings, specific standards for reporting SP use in research had been developed (Howley et al, 2008). This study followed the categorization of Howely et al. with regards to the SPs:

a. SP characteristics:
   SPs are defined as individuals instructed to simulate patients in specific scenarios in order to evaluate the learner's clinical and communication skills. In our study, the three SPs, blinded to student randomization, represented middle-aged women seen in the Lebanese society and their cultural or religious values. The moderately modest SP was shy to expose her chest. The extremely conservative and reserved SP refused to consent to CBE for religious reasons (regardless of the examiner’s gender). The extremely liberal SP asked for a form of personal contact with the physician outside of the clinical context (regardless of the examiner’s gender).

b. Encounter characteristics:
The SP in each station was equipped with a breast simulator jacket. Based on her designated role and preset cultural or religious values, she was expected to refuse the breast examination. The SP consented to CBE only if the participating student presented a culturally-sensitive argument relevant to her specific cultural background or if the participant failed 3 times to consent her after asking her permission to proceed to the CBE. The estimated encounter time in each station was approximately 15 minutes.

c. Training:

SPs were trained by the investigators (JN, AKS and SN) on (1) their individual role in each station, (2) how to assess breast palpation on the simulator jacket and (3) how to fill the grading rubric about the student's communication skills. The training was performed for few hours 3 times a week for 2 weeks. During the OSCEs, another rater (SN) randomly audited the sessions and rated the adequacy of the SP's acting and grading process to assess consistency in routine across stations and with different students. Refresher trainings followed for 30 minutes after select OSCEs.

Measures and Variables:

In the OSCE evaluation of students, at the end of each encounter, the SP graded the participant's CBE performance by filling out a checklist on CBE completeness and communication competence. The first part of the checklist included items on the technique of examination, in both its visual inspection and palpation aspects. The second part included items on communication skills and cultural sensitivity. SPs were blinded to the study arms. CBE performance scores were calculated by summing the individual items on the SP's scoring checklist for each encounter (supplemental material - table 1S).

At the end of each encounter, the participating medical student filled an in-clinic note and a self-reported performance survey (in addition to the SP's report). The note addressed items pertaining to their findings on the CBE. The in-clinic note was later graded, (AKS) blinded to participant and study arm assignment, in order to assess for lesion identification or the ability of the participant to correctly identify the breast lesion and describe its pathological features. In addition to the self-reported performance survey, at the end of the OSCE, students filled out a survey on their attitude, specifically regarding comfort and unease during CBE (supplemental material - table 2S). Prior to the OSCE, students have had answered a survey on their satisfaction with the teaching activity (lecture, video and practical session). Because of the possibility for differences in comfort levels and aptitude between female and male doctors, gender of students was collected.

Numerical measures of outcomes consisted of scores and grades averaged from all three OSCE stations for each student. Although averaging total scores across cases (SPs) might arguably lead to compensation of one case for the other, the rationale behind the averaging was to disregard possible inter-rater variability and to minimize potential differences between the SPs in terms of reliability of grading. Statistical analysis was done blinded to the study arms and using SPSS 20.0 from IBM (Armonk, New York, USA). Normal distribution of scores was rejected by the Shapiro-Wilk test. Accordingly, scores were reported as medians and ranges. Distributions were compared using the Mann-Whitney test. Mean Ranks are reported only to indicate the direction of the effect where the distributions are significantly different (p<0.05).

Results and Discussion

Participating students in the two arms did not differ in terms of gender distribution. In the hybrid simulation group (N=56) and the control group (N=26), 50.0% and 46.2% were male respectively (Pearson's chi-square p-
value = 0.747). Items graded for the participating student’s performance and proficiency were averaged from all three stations. Each item was also given a weight-point for its contribution to the composite scores of CBE completeness, visual inspection, palpation, communication competence, communication skills, cultural sensitivity and lesion identification. Our results show that hybrid simulation and the traditional teaching method were not significantly different in terms of overall CBE completeness (p=0.889), including the visual inspection (p=0.996) and palpation (p=0.885) parts of the examination (table 1). However, as hypothesized, hybrid simulation was associated with a significantly higher lesion identification grade (p<0.001), specifically in lesion reporting, identification of malignant features, and accurate location identification as compared to the traditional teaching method (table 2).

To our surprise, significantly lower communication skills score (p=0.033) and culturally sensitive communication score (p=0.002) were observed in the hybrid simulation group (table 3). The composite score for communication competence was also significantly poorer in the hybrid simulation group (p<0.001).

None of the students included had previously encountered a patient requiring CBE. The students’ self-reported communication efficacy and their reported comfort during OSCE were inclined towards numerically higher proportions in the individual survey items and higher composite summary scores in the hybrid simulation group (table 4). No statistically significant differences between the two groups were observed in the distributions of these two scores (p=0.346 and p=0.172 respectively) or in the frequencies of the individual survey items constituting the scores. Also, the score for causes of unease during CBE (p=0.249) as well as the proportions of single individual causes of unease were numerically lower in the hybrid simulation group (table 4). Fear of missing a lesion on CBE was the only cause of unease that reached statistical significance in the hybrid simulation group (p=0.043). As compared to the control arm, students in the hybrid simulation group agreed more on three of the satisfaction survey items (table 5): (1) They were more likely to recommend it as a regular part of the medical school curriculum (p=0.004), (2) The hybrid simulation teaching activity helped students develop confidence in the clinical setting (p=0.017) and (3) better integrate theory and practice (p=0.029). These three items drove the composite score of satisfaction with the teaching activity to be significantly higher with hybrid simulation than with the control teaching activity (p=0.002).

Based on our results, we hypothesize that the use of hybrid simulation in teaching CBE to medical students might result in improved proficiency in performing the examination and identifying the lesion, and increasing the students’ confidence level when performing a CBE.

Lesion identification had been previously proven to be similar in students who learned on standardized patients (real breast tissue) as compared to those who learned on a simulated model (Shubert et al, 2012). In that regard, we found that combining both modalities by employing hybrid simulation, resulted in a cumulative augmented effect on lesion identification skills. Hybrid simulation had an added value over low-fidelity simulation and non-guaranteed real patient encounters. Despite the fact that hybrid simulation improved the sensitivity of detecting and the accuracy of identifying a lesion, the rate of false positive findings did not increase from that of the control group. Accordingly, our findings also implied that the specificity of the CBE is not negatively affected by hybrid simulation.

Unlike what we expected, the hybrid simulation group was not more effective in communication skills and was less culturally sensitive to the patients’ concerns regarding the examination. The results showed that hybrid simulation negatively affected the communication competence of students while performing CBE as graded by the standardized patients. However, in terms of the students’ self-reported attitude, students who learned CBE in a hybrid simulation setting tended to feel more comfortable while performing CBE and probably perceived their communication as more effective and more culturally sensitive. This finding is paralleled by a tendency towards smaller proportions of CBE-related fears in the hybrid simulation group.
With hybrid simulation, the tendency towards less unease, more comfort and improved communication as perceived by the student, suggests that this teaching method might boost the students' self-confidence in their ability to communicate with their patients during CBE. However, combined with worse communication as perceived by the Standardized Patient, these statistically non-significant trends suggest that hybrid simulation could possibly be contributing to a falsely inflated self-confidence in medical students. Such possible relations remain unconfirmed, and require further targeted examination in future studies. A major cause of CBE-related discomfort in medical students had been found to be the fear of missing a lesion on a real patient (Pugh and Salud, 2007). Interestingly, in our study, this anxiety was similarly the only cause of unease that was actually relieved by the introduction of hybrid simulation as a teaching tool. The poor communication skills noticed in the hybrid group could be attributed to one or both of the following potential biases. Despite standardization, the subjectivity of Standardized Patients as graders might have skewed the results of grading. Also, inter-rater variability of SP’s in filling out the grading rubric was not tested prior to the actual OSCE. In addition, the fact that students from the hybrid simulation group were previously exposed to the teaching model and OSCE-like setting, along with their higher perceived comfort during the evaluation, potentially contributed to an over-confidence leading to less than optimal communication with the SP in this group.

In line with our findings, it had been previously shown that the use of simulators in teaching CBE, in addition to lectures, improved satisfaction among teachers and students (Pissen et al, 2014). Students who learned CBE in the hybrid simulation setting recommended that this teaching tool become adopted in the medical school curriculum. This finding reflects higher appreciation of the value of the practical teaching session of CBE for students who learned using the hybrid simulation model as opposed to those who learned on a table-top model.

Limitations

We do not believe that practicing on the breast jacket could have given the medical student an advantage in lesion identification over the control group, as previous studies in simulation have shown (Pissen et al, 2014).

The sample size might have not been sufficient to detect effects at the level of certain variables that were not specified as primary outcomes of interest for this study. Accordingly, the small number of study subjects might explain the failure to find statistically significant differences in some of measures, despite an inclination to effects in the same direction in parallel measurements such as comfort and unease. This warrants the need for further investigations that are adequately powered to target these variables and explore other factors that affect didactic efficacy of simulation tools. Although females and males students were equally distributed in both groups, another limitation could have been the medical student gender and the possible fact that female students are more at ease conducting a CBE on another woman.

The cultural background of the students was also not assessed. Although the cultural background of the SP’s was addressed through training, that of the medical students could not be controlled except with randomization.

Further studies ought to be designed to specifically test for the secondary outcome of the potentially distracting effect of cultural background i.e. whether religiousness or liberalism of the patient interferes with the ability of the medical student to detect the same lesion in different patients. Our study represents the first step in this direction. We recommend the implementation of such hybrid simulation in the curriculum of the third-year medical students at the American University of Beirut (Lebanon). We also recommend the use of hybrid simulation in other settings where more a realistic simulation needs to be integrated, and in settings where confidence of medical students needs to be encouraged.
Conclusion

Hybrid simulation is a new method that employs the use of standardized patients and breast model jackets to teach CBE. The findings of this study were congruent with previous studies in CBE simulation but added the following: hybrid simulation leads to an important improvement in the capacity of medical students to correctly identify a lesion and provide an accurate description of its location and malignant potential. The hypothesized role of hybrid simulation in improving the communication skills and cultural sensitivity of medical students during breast examination was not confirmed possibly due to the small sample size. Although hybrid simulation might not provide an advantage over the traditional method in terms of CBE completeness, it may increase CBE sensitivity (the whole goal of a screening examination) without affecting its specificity.

Take Home Messages

1. The hypothesized role of hybrid simulation in improving communication skills and cultural sensitivity of medical students proved inconclusive likely due to the small sample size.
2. Hybrid simulation has an advantage on traditional teaching methods in terms of CBE completeness and improved capacity of students to correctly identify lesions and provide an accurate description of its location and potential malignancy.
3. Hybrid simulation may increase the sensitivity of CBE without affecting its specificity.
4. The study showed that working with SPs requires rigorous training and audits prior to and during the intervention.
5. This study shows that there is a gap in the literature for similar studies, and an opportunity for further research.

Notes On Contributors

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### Tables:

#### Table 1: Performance scores for CBE completeness

|                      | Hybrid Simulation (N=56) | Control (N=26) | p-value * |
|----------------------|--------------------------|----------------|-----------|
| CBE completeness score| 16.58 (7.33;19.00) [41.25] | 16.83 (9.33;19.67) [42.04] | 0.889     |
| Visual inspection score | 5.00 (0.33;6.00) [41.49]  | 4.83 (2.33;6.00) [41.52]  | 0.996     |
| Palpation score      | 11.50 (6.00;13.33) [41.24] | 11.67 (6.67;13.67) [42.06] | 0.885     |

* The scores are reported as median (range) and [Mean Rank]. Whenever the distributions are significantly different in the Mann-Whitney test, the Mean Rank values would indicate the direction of the effect. Level of significance is 0.05

#### Table 2: Lesion identification grade and its six constituents

|                      | Hybrid Simulation (N=56) | Control (N=26) | p-value * |
|----------------------|--------------------------|----------------|-----------|
| Lesion identification grade | 3.00 (0.00;5.33) [51.35] | 1.00 (-1.00;3.33) [20.29] | <0.001   |
| Reporting a lesion   | 1.00 (0.00;1.00) [49.19]  | 0.50 (0.00;1.00) [24.94]  | <0.001   |
| Malignant features of the lesion | 0.67 (0.00;2.00) [49.20]  | 0.00 (0.00;1.00) [24.92]  | <0.001   |
| Accurate location of the lesion | 1.33 (0.00;2.00) [52.45]  | 0.33 (0.00;1.00) [17.92]  | <0.001   |
| Falsely reporting a lesion | 0.00 (-0.67;0.00) [43.25]  | 0.00 (-1.00;0.00) [37.73]  | 0.250    |
| Detecting lymph nodes | 1.00 (0.00;2.00) [42.21]  | 1.00 (0.00;2.00) [39.96]  | 0.651    |
| Falsely reporting lymph nodes | 0.00 (-0.67;0.00) [40.27]  | 0.00 (-0.67;0.00) [44.15]  | 0.306    |

* The scores are reported as median (range) and [Mean Rank]. Whenever the distributions are significantly different
in the Mann-Whitney test, the Mean Rank values would indicate the direction of the effect. Level of significance is 0.05

Table 3: Performance scores for communication competence

|                           | Hybrid Simulation (N=56)         | Control (N=26)          | p-value * |
|---------------------------|---------------------------------|-------------------------|-----------|
| Communication competence  | 8.33 (4.00;9.00) [35.21]        | 8.67 (8.00;9.00) [55.06]| <0.001    |
| Communication skills      | 3.67 (2.00;4.00) [37.95]        | 4.00 (3.33;4.00) [49.15]| 0.033     |
| Cultural sensitivity      | 4.67 (1.67;5.00) [36.36]        | 4.67 (4.00;5.00) [52.58]| 0.002     |

* The scores are reported as median (range) and [Mean Rank]. Whenever the distributions are significantly different in the Mann-Whitney test, the Mean Rank values would indicate the direction of the effect. Level of significance is 0.05.

Table 4: Participating students' self-reported performance and attitude during CBE OSCE activity

|                              | Hybrid Simulation (N=56)         | Control (N=26)          | p-value ** |
|------------------------------|---------------------------------|-------------------------|------------|
| **Self-reported communication** | 3 (0;8) [43.16]                  | 2 (0;8) [37.92]         | 0.346      |
| Effective communication      | 32.14% (18)                     | 34.62% (9)              | 1.000      |
| Understanding patient's disclosure | 50.00% (28)                  | 34.62% (9)              | 0.237      |
| Understanding patient's behavior | 51.79% (29)                   | 38.46% (10)             | 0.343      |
| Awareness of cultural differences | 50.00% (28)                  | 42.31% (11)             | 0.636      |
| Control over attitude        | 51.79% (29)                     | 42.31% (11)             | 0.482      |
| Examination without prejudice | 35.71% (20)                    | 38.46% (10)             | 0.811      |
| Attitude without prejudice   | 39.29% (22)                     | 42.31% (11)             | 0.813      |
| Adjustment of behavior       | 35.71% (20)                     | 30.77% (8)              | 0.804      |
| Comfort during OSCE          | 1 (0;5) [43.77]                 | 0 (0;5) [36.62]         | 0.172      |
| Overall CBE                  | 39.29% (22)                     | 23.08% (6)              | 0.212      |
| During visual inspection     | 37.50% (21)                     | 34.62% (9)              | 1.000      |
| During eliciting nipple discharge | 37.50% (21)                   | 23.08% (6)              | 0.219      |
| During detecting abnormalities| 32.14% (18)                     | 15.38% (4)              | 0.180      |
With level of knowledge and experience & 26.79% (15) & 15.38% (4) & 0.399  \\
Unease during CBE † & 2 (0;6) [39.46] & 2 (0;8) [45.88] & 0.249  \\
Fear of missing a lesion & 23.21% (13) & 46.15% (12) & 0.043  \\
Intimate nature of CBE & 42.86% (24) & 53.85% (14) & 0.476  \\
Fear of causing harm or pain & 23.21% (13) & 19.23% (5) & 0.780  \\
Due to nipple and areola palpation & 30.36% (17) & 19.23% (5) & 0.423  \\
Trying to communicate effectively & 41.07% (23) & 61.54% (16) & 1.000  \\
General performance anxiety & 41.07% (23) & 53.85% (14) & 0.343  \\
Cultural dissimilarity & 7.14% (4) & 11.54% (3) & 0.673  \\
Other sources of fear & 5.36% (3) & 3.85% (1) & 1.000  \\
No anxieties during CBE & 7.14% (4) & 7.69% (2) & 1.000  \\

* These items summarize the student's answers on self-reported surveys from all three stations.  
** Fisher's exact test was used to compare the frequencies for the individual items, and the Mann-Whitney test for the distributions of the composite scores. Level of significance is 0.05  
† Composite scores are calculated from the sum of the set of individual items beneath, and are reported as median (range) and [Mean Rank]. Whenever the distributions are significantly different in the Mann-Whitney test, the Mean Rank values would indicate the direction of the effect.

**Table 5: Participating students’ satisfaction with the teaching activity**

| Item                                                                 | Hybrid Simulation (N=56) | Control (N=26) | p-value * |
|----------------------------------------------------------------------|--------------------------|----------------|-----------|
| Satisﬁcation with teaching activity **                              | 3 (0;9) [47.67]          | 2 (0;8) [29.58] | 0.002     |
| was a worthwhile use of my time                                      | 20.37% (11)              | 19.23% (5)     | 1.000     |
| had no added value to the learning experience (inverted)            | 89.29% (50)              | 84.62% (22)    | 0.718     |
| did not help me develop conﬁdence in clinic (inverted)              | 87.50% (49)              | 61.54% (16)    | 0.017     |
| constituted a valuable learning experience                            | 16.67% (9)               | 3.85% (1)      | 0.154     |
| provided a chance to learn in a safe environment                    | 31.48% (17)              | 15.38% (4)     | 0.177     |
| was realistic                                                        | 18.52% (10)              | 11.54% (3)     | 0.531     |
| was effective in helping me integrate theory and practice           | 24.07% (13)              | 3.85% (1)      | 0.029     |
| should become a regular part of the curriculum                      | 57.41% (31)              | 23.08% (6)     | 0.004     |
| I feel more prepared for my upcoming CBE                           | 11.11% (6)               | 3.85% (1)      | 0.418     |
* Fisher's exact test was used to compare the frequencies for the individual items, and the Mann-Whitney test for the distributions of the composite score. Level of significance is 0.05

** The composite score is calculated from the sum of the set of individual binary items beneath, and is reported as median (range) and [Mean Rank]. The distributions are significantly different in the Mann-Whitney test, and the Mean Rank values indicate the direction of the effect.

**Supplemental Material** for Hybrid Simulation in Teaching Clinical Breast Examination

The list of learning objectives (a) also served as a basis for the scoring checklist (b) used by the Standardized Patients at each encounter.

Table 1-S (a) Learning objectives

| Learning Objectives |
|---------------------|
| **1. Visual Inspection** |
| Inform patient (to minimize potential misunderstandings) and explain (what is being assessed during this part of the examination) |
| Three positions (arms over head, against waist, leaning forward) |
| Skin changes (erythema, edema, retraction, dimpling) |
| Size and symmetry |
| Characteristics of the nipple (position, changes) |
| **2. Palpation** |
| Inform patient (to minimize potential misunderstandings) and explain (what is being assessed during this part of the examination) |
| Examine both sides in supine position |
| Ipsilateral hand overhead (full palpation area of flattened breast tissue: visible to examiner) |
| Cover opposite side (drape) |
| Examine all 4 quadrants |
| Examine axillary tail |
| Finger pads of three middle fingers |
| Examine consistency and check for tenderness |
| Examine Lymph nodes (Neck, supraclavicular, infra-clavicular and axillary nodes) |
| Mobility of lumps (if applicable) |
| Palpation of nipple and checking for discharge |
| **3. Communication** |
| Introduce self |
| Maintain eye contact |
Avoid medical jargon
Maintain professionalism

4. Cultural competency

Elicit information and encourage disclosure
Accept patient's views and accommodate their health beliefs
Explore understanding of cultural impact, empathize and support
If needed, use a culturally sensitive argument or justification (based on the patient's beliefs)

Table 1-S (b) CBE performance scores and the corresponding individual scoring checklist items

| Graded item                          | Score points |
|--------------------------------------|--------------|
| **CBE completeness score**           | 20           |
| **Visual Inspection score**         | 6            |
| Informing the patient and explaining| 1            |
| Visual inspection in 3 positions     | 2            |
| Inspection for changes in the skin  | 1            |
| Inspection for size and symmetry     | 1            |
| Inspection for changes in the nipples| 1            |
| **Palpation score**                 | 14           |
| Informing the patient and explaining| 1            |
| Bilateral examination in supine position| 2        |
| Ipsilateral hand overhead           | 2            |
| Draping of opposite side            | 1            |
| Four quadrants of the breast        | 1            |
| Axillary tail                       | 1            |
| Finger pads of 3 middle fingers     | 1            |
| Tissue consistency and tenderness   | 1            |
| Lymph nodes in 3 locations          | 2            |
| Mobility of lump (if applicable)    | 1            |
| Palpation of nipple and checking for discharge | 1 |
| **Communication competence score**  | 9            |
| **Communication skills score**      | 4            |
Introducing self | 1
Maintaining eye contact | 1
Avoid medical jargon | 1
Maintain professionalism | 1

**Cultural sensitivity score** | 5
Eliciting information and encouraging disclosure | 1
Accepting patient's views and accommodating her health beliefs | 2
Exploring for cultural impact, empathizing and support | 1
Using a culturally sensitive argument or justification | 1

| Self-reported item | Score Points |
|--------------------|--------------|
| **Self-reported communication efficacy** | 8 |
| Own communication with the patient was effective | 1 |
| Understanding patient's disclosure in view of her cultural background | 1 |
| Understanding patient's behavior in view of her cultural background | 1 |
| Awareness of cultural differences between self and patient | 1 |
| Ability to control own attitude towards patient's cultural behavior | 1 |
| Capability of performing the examination without prejudice | 1 |
| Retention of own attitude without prejudice | 1 |
| Adjustment of behavior according to patient's culture | 1 |
| **Comfort during OSCE** | 5 |
| Overall comfort | 1 |
| Comfort during visual inspection of the breast | 1 |
| Comfort during eliciting nipple discharge | 1 |
| Comfort during detecting abnormalities | 1 |
| Comfort regarding current level of knowledge and experience in CBE | 1 |
| **Causes of unease during CBE** | 8 |
| Possibility of missing a lesion | 1 |

Table 2-S
Students' self-reported performance and attitude scores and the corresponding individual survey items
| Intimate/personal nature of the examination | 1 |
| Causing harm or pain to the patient | 1 |
| Nipple and areola palpation | 1 |
| Communicating effectively with the patient | 1 |
| General performance anxiety | 1 |
| Cultural dissimilarity between you and the patient | 1 |
| Other sources of fear | 1 |
| **Absence of anxieties during CBE** | |
| No causes of unease in practicing CBE during OSCE | 1 |

**Declarations**

*The author has declared that there are no conflicts of interest.*

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