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# Simulation Based Training in Basic Surgical Skills: Experiences from a Repeat Cross-Sectional Study in Saudi Arabia

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## ABSTRACT

*Introduction: The conventional surgical apprenticeship has been challenged by patient safety concerns, cost of lengthy operation, and surgical complications. Simulation-based training (SBT) has emerged as a realistic option for surgical skills acquisition outside the operating room (OR). The study aimed to document our experience in implementing SBT to acquire basic surgical skills, offered as an educational course, known as the Basic Surgery Skill Course (BSSC).*

*Methods: This was a repeated cross-sectional study conducted between January 2017 and December 2019 at King Abdulaziz University Hospital (KAUH) in Saudi Arabia, including all participants who participated during BSSCs. A pretested questionnaire was used to collect data on age, sex, training level, institution, overall experience, course overload, course duration, best feature of the course, and whether participants would recommend the course to their colleagues. Whenever possible, self-reported data were compared with registration records, and any conflict was resolved by discussion.*

*Results: BSSC was found in a total of 489 participants. More than 58% of the participants were men. Majority of students came from out of KAUH (61%) and were medical interns (63%). Overall experience of the course was very beneficial (57%). The course workload and duration were rated as about right by 82% and 75% of participants, respectively. Majority of participants found the "hands-on practice" as the best segment of the course (76%).*

*Conclusion: The study showed a positive perception of this surgical education modality among participants. This study will help guide the future research on advanced simulation-based surgical training in the region.*

**Key words:** Medical education, Surgical training, Basic surgery skills, Surgery

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## INTRODUCTION

In the last decade, a paradigm shift was observed in the surgical education away from the traditional surgical apprenticeship. In this training model, the opportunity for deliberate practice is rare and sometime not possible [1-5]. Recently, this conventional model has been challenged by patient safety, cost of lengthy operation, and surgical complications [6-8].

The advanced technology makes the training out of the operation room (OR) possible in a friendly and forgiving environment [1,3,9]. Fitts and Posner's theory is a well-accepted principle in motor skill science. Hence, practicing the basic skills should be the rule until automaticity was achieved outside the OR [5].

Since 2007, the American College of Surgeons (ACS) and the Association of Program Directors in Surgery (APDS) have established a national skill curriculum to integrate the simulation into surgical training [10,11]. However, the implementation of this curriculum in the surgical training program is very low due to a wide range of challenges. These challenges notably include lack of motivated faculty and protected time for surgical trainees [10].

Locally in Saudi Arabia and since 2015, there has been a movement toward incorporating simulation in the health training [12]. In a meta-analysis Saudi study, incorporating simulation in teaching laparoscopy skills at a junior level has been shown to improve cognitive and psychomotor skills. However, the integration of simulation into surgical training programs is still in its initial steps and face different challenges that include surgeon's acceptance of SBT, cost, and lack of qualified manpower [13].

In collaboration between different sectors in KAUH including Clinical Skill and Simulation Center (CSSC) and Center of Excellence in Trauma and Accidents (CETA),

multiple courses have been developed and implemented to cover a wide range of basic and advanced surgical skills. Therefore, this study aimed to document our experience in implementing SBT to acquire the basic surgical skills offered as an educational course, namely, the Basic Surgery Skill Course (BSSC), and to assess student's perception and their overall experience.

## METHODS

### Setting

The study was conducted at a tertiary center, KAUH, Jeddah, between January 2017 and December 2019. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines of reporting our study methods and results were followed. The Unit of Biomedical Ethics of King Abdulaziz University and the Academic Affairs at KAUH approved the study protocol. An initial invitation and explanation were conducted during the BSSC, and an evaluation form was distributed to participants after the explanation. Informed written consent was obtained from all participants prior to the participation.

### Design

This was a repeated cross-sectional study that aimed to evaluate the overall experience during BSSCs among participants from different medical schools and institutions in Saudi Arabia.

### Study participants

All medical students and practitioners who participated in BSSC at KAUH were included between January 2017 and December 2019.

### Description of BSSC

BSSC was developed in KAUH as collaboration between multiple sectors in the university, including CSSC and CETA. It was introduced as an initiative for safe surgical practice and for the improvement of basic surgical skills acquisition. The initiative is not limited to KAUH students and is offered to all medical trainees across Saudi Arabia. BSSC was conducted at CSSC in KAUH using different types of simulators (Table 1). BSSC aims to impart essential basic surgical skills and techniques within a controlled environment. Curriculum was developed to teach basic surgical skills along with adequate hands-on training. The curriculum was planned after reviewing several similar courses [11,14]. The scientific committee at CETA reviewed and approved BSSC. Moreover, several surgical skills appropriate for the undergraduate level were included to broadly cover senior medical students and junior residents' surgical needs. Bedside Ultrasound is regularly used by surgeons to assess a variety of surgical diseases, however, no formal undergraduate ultrasound training. A British objective assessment study has reported that ultrasound is an achievable educational goal at the undergraduate level [15]. Hence, the scientific committee found it important to be an integral part of BSSC's curriculum. The covered surgical skills included 1) Knot tying and suturing; 2) Asepsis and instrument identification; 3) Gowning, Gloving, and scrubbing; 4) Nasogastric insertion and urethral catheterization (surgical tube); 5) chest tube insertion; 6) Abscess drainage; 7) Local anesthesia infiltration; 8) Wound debridement and dressing; and 9) FAST +/- EFAST (trauma ultrasound).

**Table 1: Equipment and simulators used in Basic Surgery Skills Course (BSSC).**

| Stations | Equipment |
|---|---|
| Gowning, gloving, and scrubbing | Scrub brushes, surgical gowns, surgical gloves, masks, theater hats, and shoe covers. |
| Knot tying and suturing | Skin simulator pads, surgical sutures, needle holder, Adson's forceps, suture scissors, sharps bin, knotting boards. |
| Wound care | I&D simulated cyst/abscess tissue pad, scalpel handle size 3, 11 blade and 15 blade, non-sterile gloves, swabs, forceps, packing mesh, dressing tray, measurement taps. |
| Surgical tube | Male and female catheterization simulators, nasogastric tube simulators, different sizes of Foley catheters, different sizes of nasogastric tube, trauma man, different sizes of chest tubes. |
| Surgical instruments | Different surgical instruments. |
| FAST/EFAST | Ultrasound simulator, laptops. |

The course employed an instructor–student ratio of 1:4 for a better training opportunity, with a target audience of junior surgical trainees. However, it was made open for other healthcare providers. The course duration was 8 h, and the course was offered many times during the year consisting of 16 students per course. The participation in BSSC is not compulsory. Moreover, to cover the cost and assure accessibility of outside participation, CETA studied multiple examples of successful international surgical courses. A charge fee was required to enroll in BSSC. This helped to attract motivated applicants and to avoid no show [16].

### Data sources and measurement

A standardized and pretested questionnaire was used to obtain data from a pre-existing mandatory evaluation record. Using a consecutive sample of the first 30 evaluations, the validity of the questionnaire was determined based on three questions according to age,

gender, and educational level. Responses from the questionnaire were compared to the evaluation form records. The overall agreement rate was 80%. To reduce the interrater variability, three jointly trained medical secretaries conducted data extraction, following predefined standardized procedures. Any concerns or questions during the data collection were resolved through discussion.

### Study variables

Data on age, sex, training level, institution, overall experience, course overload, course duration, best feature of the course, and whether the participant would recommend the course to others were collected. All questions had one answer, except on questions regarding the best feature/s of the course where participants were allowed to select multiple answers.

### Statistical methods

A descriptive analysis of study findings was performed, and variables are presented as counts and percentages. Statistical analysis was conducted using the SPSS (IBM, Armonk, NY) and Excel (Microsoft, Redmond, WA).

### Risk of bias

To reduce the selection bias, all participants enrolled in BSSCs at CSSC in KAUH were included. The questionnaire and cross-validated its findings with the registration and evaluation records were pretested to minimize the measurement bias.

## RESULTS

### Demographics

The BSSC program included a total of 489 participants between 2017 and 2019. Men accounted for >58% of participants. Most of participants came from outside KAUH (62%). Majority of participants were within the 20 – 29-year (92%) group and were predominantly medical interns (63%) (Table 2).

**Table 2: Demographic of participants in Basic Surgery skills course (BSSC).**

| Variables | 2017 | 2018 | 2019 | Total | Percentage |
|---|---|---|---|---|---|
| Gender | | | | | |
| Male | 151 | 111 | 22 | 284 | 58.08 |
| Female | 112 | 53 | 40 | 205 | 41.92 |
| Total | 263 | 164 | 62 | 489 | 100.00 |
| Institution | | | | | |
| KAUH (King Abdulaziz university Hospital ) | 106 | 54 | 26 | 186 | 38.04 |
| NON KAUH | 157 | 110 | 36 | 303 | 61.96 |
| Total | 263 | 164 | 62 | 489 | 100 |
| Age | | | | | |
| 20-29 | 243 | 152 | 53 | 448 | 91.62 |
| 30-39 | 6 | 3 | 7 | 16 | 3.27 |
| 40-49 | 1 | 0 | 1 | 2 | 0.41 |
| Unspecified | 13 | 9 | 1 | 23 | 4.7 |
| Total | 263 | 164 | 62 | 489 | |
| Training | | | | | |
| Medical Student | 69 | 31 | 3 | 103 | 21.06 |
| Medical Intern | 156 | 106 | 47 | 309 | 63.19 |
| Resident/Registrar: 0-2 years for formal surgical training | 22 | 18 | 11 | 51 | 10.43 |
| Resident / Registrar: 3-4 years for formal surgical training | 2 | 0 | 0 | 2 | 0.41 |
| Unspecified | 14 | 9 | 1 | 24 | 4.91 |
| Total | 263 | 164 | 62 | 489 | 100 |

### Questionnaire findings

The overall experience of the course was rated as “very beneficial” by a majority of students (57%). The course workload and duration were rated as “about right” by 82% and 75% of participants, respectively. Majority of participants indicated that the practical teaching was the best segment of the course (62%) and 81% reported that

they would recommend this course to their colleagues (Table 3).

**Table 3: The perception of participants on the Basic Surgery skills course (BSSC).**

| Variable | 2017 | 2018 | 2019 | Total | Percentage (%) |
|---|---|---|---|---|---|
| Overall Experience of The Course | | | | | |
| No benefit | 1 | 0 | 0 | 1 | 0.2 |
| Some benefit | 17 | 8 | 4 | 29 | 5.93 |
| Quite helpful | 71 | 33 | 20 | 124 | 25.36 |
| Very beneficial | 137 | 107 | 35 | 279 | 57.06 |
| Indispensable | 22 | 6 | 3 | 31 | 6.34 |
| No answer | 15 | 10 | 0 | 25 | 5.11 |
| Total | 263 | 164 | 62 | 489 | 100 |
| Course Workload | | | | | |
| Inappropriately low | 3 | 4 | 3 | 10 | 2.04 |
| About right | 215 | 131 | 56 | 402 | 82.21 |
| Inappropriately high | 29 | 18 | 3 | 50 | 10.22 |
| No answer | 16 | 11 | 0 | 27 | 5.25 |
| Total | 263 | 164 | 62 | 489 | 100 |
| Course Duration | | | | | |
| Too short | 17 | 7 | 5 | 29 | 5.93 |
| About right | 191 | 130 | 47 | 368 | 75.26 |
| Too long | 38 | 14 | 8 | 60 | 12.27 |
| No answer | 0 | 1 | 0 | 1 | 0.2 |
| The Best Features of The Course | | | | | |
| Case discussions/interactive presentation | 29 | 21 | 19 | 69 | 11.46 |
| Practical hand-on segment | 208 | 119 | 45 | 372 | 61.79 |
| Experienced instructors | 88 | 48 | 18 | 154 | 25.58 |
| Others, specify | 5 | 2 | 0 | 7 | 1.61 |
| Total | 330 | 190 | 82 | 602 | 100 |
| Would You Recommend This Course to Others? | | | | | |
| Yes | 218 | 121 | 56 | 395 | 80.78 |
| No | 10 | 12 | 5 | 27 | 5.52 |
| No answer | 35 | 31 | 1 | 67 | 13.7 |
| Total | 263 | 164 | 62 | 489 | 100 |

## Trends

The participation in BSSC program markedly declined between 2018 and 2019 (from 164 to 62 participants), with the 2019 attendance comprising only approximately 13% of 489 participants. However, female participants comprised almost two-thirds of the attendance in 2019, increasing from 43% and 32% in the last two years.

## DISCUSSION

This study showed the ability of our institution to introduce the transition toward SBT in surgical education. BSSC had attracted many interested participants from inside and outside of the institution since its implementation in 2017. Majority of participants realized the importance of SBT in acquiring surgical skills because their overall experience with the program was helpful and very beneficial to their surgical endeavor. This occurs because SBT provides a controlled and forgiving environment that allows trainees to focus and learn psychomotor skills in a much more comfortable way [9,17].

However, some challenges were still found in the SBT implementation in our country. The number of participants remarkably declined in 2019, which is in stark contrast to the reality that majority of participants will recommend this program to their colleagues and found their overall experience helpful and beneficial. However, this decline can be explained by some factors. Changes in the SCFHS admission criteria in the surgical residency programs across the country in October 2018 were the most common factor that may have influenced this decline [18]. Since then, the SCFHS does not consider preadmission surgical skill courses and focuses only on theoretical grades of the applicants. These selection criteria changes are in contrast to the overwhelming evidence that support SBT in surgical training [9,19-21]. However, the reasons and impact of this decision are outside the scope of this study. Subsequently and to compensate for the low number of applicants, the price of BSSC was increased. Undoubtedly, this increased price is another logical reason that limits the number of applicants since October 2018. In addition, the study consistently showed a low participation from the surgical residency programs. Grabski et al. also showed a very low implementation of the ACS/APDS curriculum due to low motivation of faculties in surgical programs and lack of protected time for residents in their survey study [10,11].

The number of male participants was found to be higher than that of female participants who are attracted to BSSC. This could be due to the gender tendency toward surgical specialty [22,23]. Hui-Ling Kerr et al. have shown in their survey study that life–work balance is still a real barrier toward the surgical career for most women [23]. However, our study showed a trend of a significant increase in female participation in 2019 as compared to male.

Intern students were the most attracted groups that joined BSSC. Medical interns, who are fresh graduates from medical schools and not enrolled in any surgical residency programs, were the more eager group to be part of these educational activities. This has also been noted in previous studies and can be explained by a possible deficit in undergraduate surgical skills education and/or to challenges they face in complex clinical settings during their clinical rotations [24-26].

Majority of participants featured the “hands-on practice” segment of this program. This goes with the overwhelming evidence that SBT is very effective and more powerful toward skill acquisition as compared to the traditional medical learning method [20,27]. In 2019, a study showed a small increase in the percentage trend of the “interactive discussion” segment of the program. This could be explained by the quality of the participation in 2019. Since changes in the admission criteria by SCFHS, participants, who enrolled in the BSSC program, were more self-driven, and conscious about their surgical training needs. This added more to the quality of “interactive discussion” of the program.

The study presents some strength points. It is one of the early studies that promote SBT in the region with a relatively large number of samples. Moreover, the sample represented a wide range of medical schools with different academic years and clinical levels.

The present study shares limitations of the questionnaire study regarding the quality of obtained answers and data collected. Some participants left questions unanswered. However, their percentage was very minimal and had no significant effect on the main points of the study. Again, this is an observational study, and confounding selection bias is impossible. However, to mitigate this risk, all participants during the study period were included.

## CONCLUSION

The simulation-based surgical education is a valid option for advanced surgical training in the region. The study showed the positive perception of this surgical education modality among participants. However, several challenges were still observed to maintain this type of training. Therefore, this study will help guide future researches on advanced simulation-based surgical education in the region.

## DECLARATIONS

Ethics approval and consent to participate: The Unit of Biomedical Ethics of King Abdulaziz University and the Academic Affairs at KAUH approved the study protocol. Informed written consent was obtained from all participants prior to the participation.

## CONSENT FOR PUBLICATION

Not applicable.

## AVAILABILITY OF DATA AND MATERIALS

The data sets used and/or analysed during the current study are available from the corresponding author upon request.

## COMPETING INTERESTS

The authors declare that they have no competing interests.

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## AUTHOR CONTRIBUTIONS

Yahya Almarhabi–Data collection, data analysis, editing of manuscript, drafting of manuscript, and literature review.

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