Basic open surgical training course

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ABSTRACT

INTRODUCTION: Fewer open surgical procedures are performed, and thus a need to learn open surgical techniques outside the operating room has emerged. Simulation training offers the possibility to train in a safe environment before operating on patients. The purpose of this study is to evaluate the effect of a simulation-based course in basic open surgical skills and to describe its pedagogical foundation, content and organisation.

METHODS: Surgical trainees at the beginning of their surgical career participated in a basic open surgical skills course and were assessed before the course, after the course and during a one-day course operating on live sedated pigs using the Objective Structures Assessment of Technical Skills (OSATS) instrument.

RESULTS: We found that the course participants matched the target group. The participants' OSATS score increased from 12.1 in the pre-test to 19.9 points ($p < 0.0001$) in the post-test. The completion rate was 99% and the failure rate was 11%. The course met 13 out of 14 requirements for a simulation-based course.

CONCLUSIONS: The basic open surgical skills course teaches trainees the basic skills for open surgery including knot tying, suturing, dissection and surgical assistance. The course significantly increases the participants' surgical abilities and meets requirements for a well-structured simulation course.

FUNDING: Equipment was provided by Copenhagen Academy for Medical Education and Simulation, Capital Region, Copenhagen, Denmark. The authors have no conflicts of interest or financial ties to disclose.

TRIAL REGISTRATION: The study did not require registration as this is a retrospective quality control study using anonymised participant data.

Good surgical results presuppose good technical surgery skills [1, 2], and good technical surgery skills require good education and training, as surgical skills are not innate [3]. So far, surgical departments have been responsible for the training of future surgeons during their employment at the departments. At surgical departments, supervised training takes place during operations according to the apprentice model. However, due to the progress of endoscopic surgery and increasing sub-specialisation, novice surgeons spend less time in the operating theatre. Therefore, their possibility of learning surgical skills has been reduced, and basic open surgical skills such as tying knots, suturing and dissection are implemented sporadically rather than systematically [3].

Training using simulated procedures provides a solution to this problem [3-5]. However, few surgical departments are able to establish a programme for teaching open surgery using simulation as the need for equipment is often extensive. Simulation-based training is therefore often placed at simulation centres and organisations in major cities. As training of surgeons primarily based on simulation is still new to the surgeons, especially in open surgery, there is a need to explore the possibilities offered by simulation training. The literature in this area is sparse and more research is warranted to elucidate the topic [5]. The purpose of this study is to evaluate the open basic surgical skills at Copenhagen Academy for Medical Education and Simulation (CAMES) and to investigate whether course participants matched the target group. We also aimed to determine the effect of the course on trainees' open surgical skills, to explore the failure rate and the completion rate and to determine if the course met requirements for a well-structured simulation-based course [6]. Furthermore, we have described the pedagogical foundation, contents and organisation of the course.

METHODS

The basic open surgical skills course

For the past two years, the CAMES has implemented a course in basic open surgical techniques. The goal of the course is to ensure that young doctors are able to assist during open operations and able to perform common minor surgical procedures and parts of procedures under supervision. The course is aimed at young doctors who are in their first few years after graduation, and participation is voluntary. Prior to the course, the participants receive a course description and dates for the training session and the pig course so that they can organise their working hours accordingly. Currently, the course is a stand-alone course, but we are hoping for a better follow-up on course participants' transfer of surgical skills to the clinical setting in the future.

Structure and content of the course

The course consists of six sessions, each with a duration of 1.5 hours. The sessions are held in the evening on a

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Dan Med J 2018;65(12):A5519

fixed weekday. There are eight participants on each course, and three parallel courses run each week allowing participants to join another group if they are unable to attend their own course day. Before the first session, each participant is given a training kit to allow him or her to train at home. The home training kit includes a knotting board, a skin-pad and a set of surgical instruments; a needle holder, De Bakey forceps, Adson forceps, a scalpel, scissors and a haemostatic clamp. Sutures are supplied during the course. The participants are also given a training log.

The first two lessons focus on the tying of surgical knots, two-handed and one-handed knots. Particular attention is paid to correct movement of the fingers, on combining the movements for laying down the half-knot and pushing it down, as well as on combining the two different types of half-knots. In addition, combining one- and two-handed knots is trained. Daily training of knots during the rest of the course and after the course ends is strongly encouraged. During session three and four, five suturing techniques for skin closure are taught; single suture, running "over and over" suture, single back stich, running back stitch (far-far-near-near) and intracutaneous suture, along with the correct use of forceps and needle holders. Session five includes five additional suturing techniques: single and running subcutaneous sutures, suture of fascia, inverted and everted mattress sutures, and there is a focus on facial suture. In session six, the use of haemostats, scissors and a scalpel is demonstrated and practiced. Participants are instructed about how to act as surgical assistants, including the tasks that assistants typically perform, underlining that they should think ahead of the surgeon and be proactive. Theoretical teaching is provided on the opening and closing of the abdomen using a median laparotomy.

Assessment

Assessments are used throughout the course to objectively monitor the training.

Pre- and post-course assessment

Before and after the course starts, all participants complete a test, where they perform a suture using five different techniques and tie knots on a skin-pad. The tests last twenty-five minutes and is video-recorded. The tests are then assessed by two blinded raters using the Objective Structured Assessment of Technical Skills (OSATS) [7] and give one to five points on five of the seven OSATS domains, yielding in a range from five to 25 points. To support the objectiveness of the assessment [8], a checklist based primarily on yes/no decisions has been prepared, please see **Table 1**. The checklist was developed based on the raters experience from supervising younger surgeons during surgery. The number of points needed to pass the post-course exam is eighteen.

In-course assessment

At the end of session three, a short test measuring speed is used. Participants count the number of two-handed and one-handed knots they can tie in 30 seconds. After session five, participants are tested by counting the number of running back-stitches performed in five minutes. The participants are made aware that they will be tested during the course, but they are not informed of the specific content of the tests prior to testing.

One-day operative course

A full-day operative course, during which participants operate on live sedated pigs, concluded the course. On the morning of the course, participants were informed of how to behave in an operating room and how to demonstrate care and due diligence when using the surgical instruments, and how to treat the staff and the patient with respect. There are two to three trainees at each operating table, and one instructor is responsible for two operating tables.

All participants are asked to open and close the abdomen using a 20 cm median laparotomy incision. All participants place and fixate an abdominal drain. As the course progresses, participants remove the spleen, gallbladder and kidneys. During each procedure, there is special emphasis on the collaboration between surgeon and assistant when placing haemostats, ligatures and cutting of ligatures. Dissection is trained by dissecting the vessels to the spleen, removing of the gallbladder and during the release of the vessels to the kidneys. The importance of safe and correct knot tying is demonstrated through ligation of larger vessels during organ resections. Before finishing, all participants try to suture a liver lesion.

The pedagogical foundations of the course

The course aims to follow the features or best practices of simulated-based medical education [6] and relies on principles of deliberate practice [9]. To give the participants a mental representation of the perfect execution, the course focuses on the conceptualisation of the details and on instruction to make it clear how the techniques are performed correctly. In order to raise awareness of the details and to increase observational learning [10], participants are encouraged to closely observe the surgeons in the departments where they are employed.

At the beginning of each session, participants are taught how instruments are handled, and a demonstration of each technique is given. Subsequently, they try themselves, while the instructor acts as a coach, and fin-

ally they train for the rest of the session with limited supervision. Being able to perform the correct movements from the beginning is given priority over fast execution. At the last session, instructors provide participants with an opportunity for final feedback and correction of techniques before the examination. Between sessions, participants train at home, and they are assessed throughout the course as objective feedback on their present skill level motivates participants to train more [11].

Participants

Medical doctors from hospitals in the Capital Region and the Region of Zealand were expected to participate in the course. We aimed to recruit doctors who were planning to learn to assist before entering a surgical department, or who had been employed in surgical departments previously, but lacked basic surgical skills. Surgical departments included all surgical subspecialties.

Statistical analysis

To investigate whether the participants corresponded to the target group of the course, we described participant characteristics.

To examine whether the participants' surgical skills had improved by attending the course, we compared the participants' OSATS scores on the pre- and post-course test. To ensure normal distribution, the data were graphed using a Q-Q plot and a histogram. The difference was analysed using a paired samples t-test, and $p < 0.05$ was considered statistically significant. To evaluate the course, we calculated the failure rate and the completion rate. To assess the educational content of the course, we explored whether the course met the requirements for a well-functioning course [6].

Trial registration: The study did not require registration as this was a retrospective quality control study using anonymised participant data.

TABLE 1

Assessment checklist.

Domain	Action evaluated (yes/no)	Points added to 5 points given at start
Time and movement	Has no tremor	1
	Punctures the skin with the needle correctly the 1st time	1
	Finishes all tasks within 25 min.	1
	Finishes all tasks within 20 min.	1
Instrument handling	Holds all instruments correctly	1
	Handles needle without using hand, except at the start	1
	Re-directs needle with forceps when pulled from tissue	1
	Re-directs needle with forceps when in needle holder	1
Instrument knowledge	Chooses correct instrument for all 3 instruments	4
	Chooses correct instrument for 2 out of 3 instruments	2
	Chooses correct instrument for < 2 instruments	0
Flow and plan	Always starts at the appropriate end of the wound	1
	Shortens suture before start of intracutaneous technique	1
	Has good control over the suture	1
	Progression is smooth without unnecessary breaks	1
Procedure	Demonstrates all 5 suture techniques	1
	Always uses a correct number of throws	1
	Does 1-handed and instrument knots correctly	1
	Does 2-handed knots correctly	1

TABLE 2

Participants' baseline characteristics.

Participants, n	100
Age, yrs, median (range)	30 (25-42)
Men/women, n	34/66
Experience	
Employed at a surgical department, mo.s, median (range)	8 (0-72)
Procedures performed, n, median (range)	24 (0-300)

RESULTS

Throughout 13 courses, 100 doctors participated, please see **Table 2**. The participants increased their mean OSATS score significantly during the course from 12.1 to 19.9 ($p < 0.0001$), see **Figure 1**. Of 100 participants who attended the post-course test, eleven failed the final exam corresponding to an 11% failure rate. Only one participant dropped out of the course corresponding to a 99% completion rate. The course met 13 of the 14 requirements for a well-functioning course [6], see **Table 3**.

DISCUSSION

In our study, 100 doctors completed a simulation course to learn basic open surgical techniques. The course participants mostly matched the target group of newly qualified doctors. The participants significantly improved their level of basic surgical skills. Of the 100 participants, only one person dropped out of the course. The course met 13 out of 14 requirements for a well-functioning course.

The progression of surgical skills that the course is expected to produce was calculated as the increase of two identical tests assessed with OSATS scores using checklists. We found that the participants' surgical skills had improved significantly following the course. Assessment using OSATS and procedure-specific checklist is valid for measuring training progress [8].

Checklists ensure that raters attest performance but may also result in a loss of information [12]. The checklist can be designed to prioritise general surgical skills or the specific procedures taught during the course. We have chosen the latter, as the exam was regarded a test of the progress made during the course. Previous studies have found checklists to be useful and more objective than a global score on its own [13, 14]. Assessment of skills was done during the course but did not include assessment of participants' skills in the clinical setting. Assessing surgical skills in the clinical setting could have ensured transfer of skills and is an aim for future courses. Participants were older and more experienced than expected (Table 2); thirteen participants had been employed for two or more years in a surgical department. This might be due to the fact that it is a new course, and that there is a group of slightly older surgical trainees who need the basic knowledge and skills that the course provides. In the future, we anticipate that participants will be less experienced and that they will match the target group better. That the course meets a present need is emphasised by the high number of course places that were filled and by the high completion rate. The capacity of the course allows all the future surgeons in the region to learn basic surgical techniques during a period of their training in which they prefer to participate and also benefit the most from the training offered.

Based on literature studies, 14 features or best practices for simulation-based medical education were established [6]. We acknowledge these recommendations and the course follows all recommendations except "finding a successor", see Table 3. Finding a successor is an important part of ensuring the continued delivery of a high-quality simulation-based medical education. Feature 11 describes the transfer of skills into clinical practice. During the course, it has not been possible to assess surgical skills in the clinical setting, which is a limitation to the course. However, the one-day operative course does assess the transfer of surgical skills from the classroom and onto live-tissue surgery. Features and best practice are supported by deliberate practice. One study found that simulation-based education with deliberate practice is more effective than traditional training [11]. The structure of the courses must be supported by the pedagogical foundations. A course with a duration of one or two days only and with whole-day training is counter intuitive.

Strengths and limitations

The course has a strong theoretical basis, fulfilling 13 out of the 14 features of best practices for simulation-based medical education [6]. One of the aims of the course is to improve the participants' ability to act as assistants. It is a limitation that the ability to assist in surgery was not measured directly.

CONCLUSIONS

The simulation-based open surgical skills course at the

FIGURE 1

Objective Structures Assessment of Technical Skills (OSATS) scores. A box plt with mean values and quartiles.

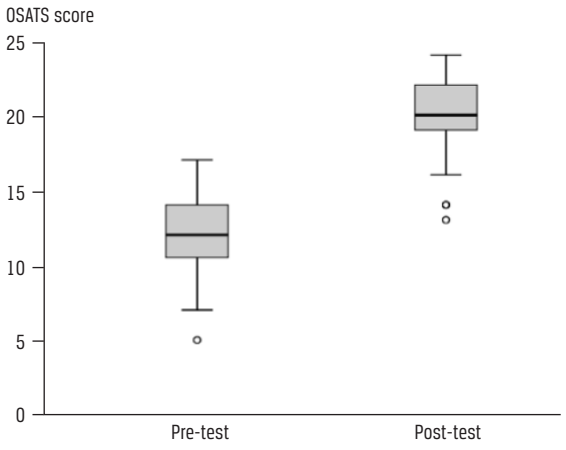

TABLE 3

Features and best practices of simulation-based medical education in the course.

Feature no.	Feature or best practice	Execution
1	Providing feedback	Oral formative feedback during sessions Use of objective interim exams Use of summative final exam
2	Curriculum integration	Available for young doctors in their 1st postgraduate year in surgery
3	Range of task difficulty level	Starting with knots, moving along increasing the complexity of basic techniques and ends with dissection
4	Deliberate practice	Applied during each session
5	Individualised learning	1 on 1 coaching during each session
6	Controlled environment	Training at simulation centre there is no consequence of making mistakes during sessions Exams are assessed by a blinded rater
7	Clearly stated objectives	Objectives are stated orally and in writing
8	Simulation fidelity	The models are made in-house and both physical fidelity and construct alignment with surgical procedures are ensured
9	Skill acquisition	Assessments as well as repeated and distributed training ensures durable skills acquisition
10	Mastery learning	Mastery of a few skills for each session is a cornerstone of the course
11	Transfer to practice	The simulation training is transferred to a live operation during the pig course and on to assisting during a real procedure at clinical departments
12	Team training	Team training is encouraged throughout the course and required during the pig course
13	Professional context	It is emphasised that a professional attitude is used as a tool for further self-development.
14	Instructor training and education	There is only 1 instructor, and no successor identified

Copenhagen Academy for Medical Education and Simulation significantly improves the participants' open surgical skills when assessed in a simulated setting. We have furthermore established that the course reached the desired target group and that it meets most of the requirements for a well-structured simulation-based course.

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ACCEPTED: 3 October 2018

CONFLICTS OF INTEREST: none. Disclosure forms provided by the authors are available with the full text of this article at Ugeskriftet.dk/dmj

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