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SIMULATION CENTRES

Developing and running a surgical simulation centre: experiences from Copenhagen, Denmark

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Abstract

The Simulation Centre at Rigshospitalet in Copenhagen, Denmark, focuses on providing simulation-based skills training to young doctors in surgical procedures such as laparoscopy, bronchoscopy, gastroscopy, colonoscopy, cystoscopy, hip fracture surgery, and ultrasonography. It is the leading training centre in Denmark, with its vision to have all doctors train on technically advanced clinical procedures in a simulation-based environment before performing procedures on patients. Our training curricula follow the FACER strategy: flexible, accessible, certification, evidence based and research generating. Along with these criteria, we follow a four-step approach in all courses: theoretical preparation, introduction by a clinical specialist, directed self-regulated training sessions, and certification assessed by a specialist. Our commitment to simulation-based training continues and we aim to fulfil our vision by establishing more simulation-based training programmes, covering more than 50 clinical procedures by 2020.

Keywords: *surgical simulation; technical simulation; minimally invasive surgery; simulation training; virtual reality simulation*

Introduction and history

The Simulation Centre at Rigshospitalet has a simple, yet crucial vision: "All doctors should practice before performing procedures on patients". The strong focus on technical (mainly surgical) skills distinguishes the centre from most simulation centres where anaesthesiology and team-based training traditionally play a major role. The Simulation Centre is part of the Centre for Clinical Education (CEKU), which has provided courses for the approximately 4000 medical students at the University of Copenhagen for many years. CEKU also has a long history of communication training for young doctors and in 2011, it decided to expand its activities to postgraduate skills training. A certified surgeon was employed to establish the centre and simulation equipment for endoscopic procedures and minimally invasive surgery was purchased. Two years later, the centre was officially inaugurated and is continuing to grow. The aim is to fulfil the vision by focusing on providing surgical trainees with simulation-based education that is flexible and available when the trainees need it, and ending with certification. We strive to provide evidence-based education that also generates new research. Our strategies are summed up in the acronym FACER: flexibility, availability, certification, evidence based, and research generating (Table 1).

Facilities and equipment

All the equipment at the Simulation Centre is organised in dedicated rooms according to procedures. This provides the flexibility to continually introduce new trainees to procedures without spending time on setting up and organising simulators. Furthermore, the equipment is always available and the permanent line-up has made it possible to focus on ergonomics e.g. by using height-adjustable tables, soundproofed partition walls, and noise-cancelling headphones. The rooms in the simulation centre are equipped with a mix of virtual reality simulators and phantoms, and are arranged according to procedure (Table 2).[1,2]

Courses

The Simulation Centre offers surgical trainees training in the procedures listed in Table 3.

Table 1 The FACER criteria

	Reasons for the criterion	Solutions that help meet the criterion
Flexibility	Physicians should practice before they perform a procedure on patients Simulation-based education must be offered when needed to fit the curriculum of each individual doctor	Video-based introduction to simple procedures (e.g. lumbar punctures and cricothyroidotomy) One-on-one introduction by a specialist to more advanced procedures (e.g. bronchoscopy, colonoscopy) National or multi-specialty introductory courses for every advanced procedure (e.g. laparoscopy and endovascular stenting)
Availability	Simulation-based self-directed learning should be available to fit the busy schedules of trainees Training tasks should be prepared and training on advanced equipment should be supervised	A two-way internet-based booking system shows available training slots and allows trainees to make individual requests Specially trained medical students assist with training outside normal working hours Portable simulation equipment with well-described and prepared tasks allow home-training
Certification	Training to a criterion ensures basic competency on simulators before advancing to supervised practice on patients Testing motivates learning and improves retention	Virtual simulator metrics with credible pass/fail standards Direct observation by supervisors using assessment tools with established pass/fail standards Video-recordings allowing assessment by specialists not present during testing
Evidence based	Simulation equipment is expensive and the time of both faculty and trainees is limited → training must be as efficient as possible	Self-directed learning Distributed learning Multi-modalities available (e.g. physical phantoms and virtual reality simulators) Individual or dyad training ensures maximum hands-on time Feedback available
Research generating	Research drives the evolution of new training programmes Research creates attention and adds credibility to the simulation centre Research helps attract funding	Qualitative studies exploring the needs and attitudes towards new areas Psychometric studies gathering validity evidence including standard setting for simulation-based tests Randomized controlled trials comparing the efficiency of different training regimens

Table 2 Equipment for the different procedures offered at the Simulation Centre

Rooms	Equipment	Procedures
Laparoscopy room (Figure 1)	4 LapSim virtual reality simulators (Surgical Science, Sweden) 4 Box trainers with high definition cameras 4 iPad Tablet trainers for training and assessment of basic laparoscopic technique (TABLT)[1]	Laparoscopic surgery
Surgical endoscopy room (Figure 2)	1 AccuTouch Endoscopy and 1 EndoVR simulator (CAE Healthcare, Canada) 1 GI-BRONCH Mentor (Simbionix, 3D Systems, USA) 1 URO Mentor (Simbionix, 3D Systems, USA) 3 Olympus Exera II video scope towers (Olympus, Japan), equipped with bronchoscopes, gastroscopes, colonoscopes and cystoscopes used in the performance of procedures on phantoms	Bronchoscopy; colonoscopy; gastroscopy; cystoscopy
Orthopaedics room (Figure 3)	TraumaVision orthopaedic virtual reality simulator (Swemac, Sweden) ARTHRO Mentor virtual reality arthroscopy simulator (Simbionix, 3D Systems, USA) Olympus Exera II video scope tower with a 30 degree arthroscope and knee and shoulder phantoms	Hip fracture surgery; arthroscopy
Vascular surgery and eye surgery room	2 VIST-Lab virtual reality endovascular simulators (Mentice, Sweden) Eyesi surgical virtual reality simulator (VR Magic, Germany)	Endovascular procedures; cataract and vitreoretinal surgery
Ultrasonography room (Figure 3)	4 Ultrasonography machines (GE Medical, USA) 2 Virtual reality ultrasonography simulators (Schallware, Germany) ScanTrainer virtual reality simulator for vaginal ultrasonography (Medaphor, UK)	Point of care ultrasonography; abdominal ultrasonography; vaginal ultrasonography
Simulation room	AirSim Advance (TruCorp, Ireland) Chest Drain and Needle Decompression Model (Limbs and Things, UK)	Emergency cricothyroidotomy; chest tube insertion

The simulation-based training consists of four steps:

(1) Theoretical preparation: through e-learning, watching instructional videos, and reading book chapters, articles and practical procedure handbooks specially prepared by the instructors at the centre.

Table 3 List of simulation procedures offered to trainees

Speciality	Training courses
Gastrointestinal	Laparoscopy, gastroscopy and colonoscopy
Thoracic	Thoracoscopy and bronchoscopy
Orthopaedic	Hip fracture surgery and arthroscopy
Vascular	Endovascular aortic repair and percutaneous transluminal angioplasty
Ophthalmology	Cataract surgery and vitreoretinal surgery
Gynaecology	Laparoscopy, vaginal ultrasonography
Urology	Laparoscopy, cystoscopy
Emergency	Cricothyroidotomy and chest tube insertion
Radiology	Point of care ultrasonography and vaginal ultrasonography

(2) Introduction to the procedure: clinical specialists are responsible for introducing the procedures to either an individual trainee or to small groups of 2–12 trainees.

(3) Self-training: practicing in the simulators, with the help of simulation training assistants (i.e. directed, self-regulated learning).[3]

(4) Final practical examination (simulation-based certification): the practical examination is assessed by a clinical specialist. All examinations have evidence of validity and established pass–fail standards based on either virtual reality metrics or expert assessments.[4–9]

The four-step approach is fundamentally different from traditional courses. The 'flipped classroom' model where theory is pre-learned allows efficient and effective use of time, technology, and instructors in the simulation centre.[10] Individual or small group learning makes it possible to offer education whenever there is a need (flexibility instead of a fixed number of courses every year) and individual self-regulated learning allows trainees to space out their training sessions over several days (distributed learning), which is superior to full-day courses (massed practice).[11] Finally, the end-of-course tests ensure basic competence, motivate learning, and increase retention.[12]

Instructors and support staff

A professor of surgery has the overall responsibility for the Simulation Centre at Rigshospitalet, and an associate professor of surgery is the daily manager. The surgical

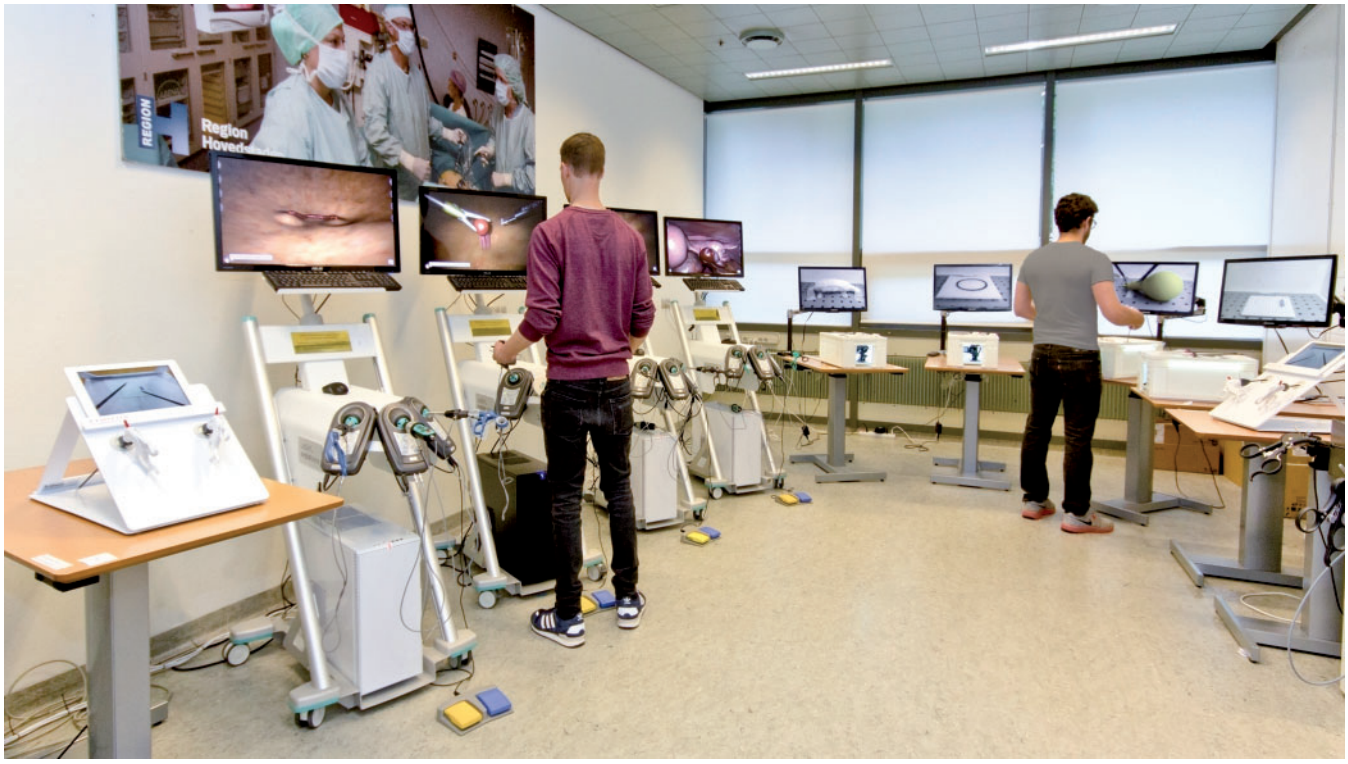

Figure 1 The laparoscopy room.

Figure 2 The endoscopy room.

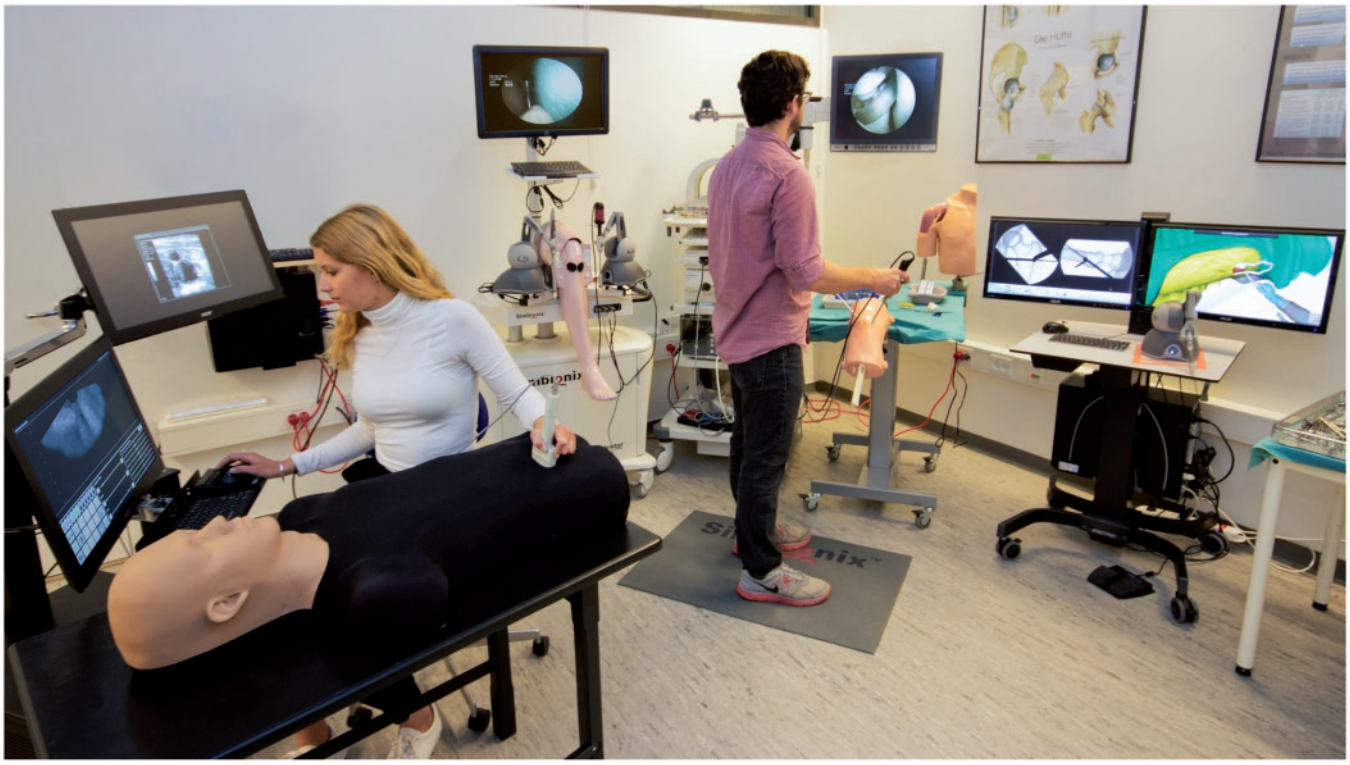

Figure 3 The orthopaedics and ultrasonography room.

background of the leaders has undoubtedly played an important role in the strong surgical focus of the centre. A specialist is appointed to be responsible for each procedure and he or she has hired one or more colleagues as instructors to teach and certify trainees at the centre. Self-regulated training sessions are assisted and directed by a registered nurse and her team of 16 medical students with intimate knowledge of the simulation equipment and the training programme. They ensure that the equipment is ready before the trainees arrive, help them during training, and clean up after each session. A secretary handles the e-mails and phone calls from the trainees and maintains a specially developed web-based booking system that accommodates the several thousand bookings every year and where the trainees can book training times themselves.

Trainees and research students

All doctors from the 18 hospitals in the eastern part of Denmark can attend courses at the Simulation Centre at Rigshospitalet free of charge. The consultants responsible for education at the local departments of each hospital act as gate keepers to ensure that the simulation-based education fits into the individual curriculum of each trainee; simulation-based training should be scheduled immediately before performing procedures on patients. Trainees from most surgical specialities (general surgery, urology, gynaecology, thoracic surgery, vascular surgery, ophthalmology, orthopaedic surgery and ear-nose-throat surgery) have been attending our simulation-based training programmes in 2015, and more than 1000 simulation-based certificates of competence will be awarded.

Currently, 13 PhD students are conducting studies in the Simulation Centre. The ongoing research projects include virtual reality and box trainer laparoscopy simulation, technical and non-technical skills in minimally invasive lung surgery, virtual reality training in eye surgery, temporal bone drilling, endovascular aortic repair simulation, colonoscopy simulation, abdominal ultrasonography, and emergency cricothyroidotomy training.

Research and publications

Research is an integral part of the daily life at the Simulation Centre. We strive to offer simulation-based education according to best evidence and we have set the goal that the majority of our educational activities should generate new research (see Table 1). The introduction of new training initiatives should be done according to a protocol similar to the way new treatment options for patients are explored. For all the procedures mentioned above, we have formed a research group consisting of a junior researcher, a researcher with experience in medical education research, and at least one experienced clinician acting as content expert for the procedure. The aims of the research groups vary from publishing a single article (e.g. chest tube insertion) to conducting several PhD studies (e.g. thoracoscopy). Our research strategy has resulted in a rapid increase in the number of publications in peer-reviewed journals, with 39 publications in 2014[13] and more than 50 in 2015.

The future

In February 2015, the politicians in the Capital Region of Denmark decided to make simulation-based training mandatory for every procedure, allowing us to establish more training programmes and strengthen the commitment to simulation-based training in the future. The increased budgets will allow the Simulation Centre at Rigshospitalet to develop 5–6 new courses per year, with the plan to cover and offer more than 50 clinical procedures by 2020. This expansion will make it necessary to acquire more rooms and hire more hourly paid instructors and medical students. We also plan to affiliate with experienced clinicians and researchers in part time positions, where they can maintain their strong clinical focus while working 1–2 days a week at the Simulation Centre, helping with the development of new courses and doing research in medical education. We will continue to focus on the criteria mentioned in Table 1 (flexibility, availability, certification, evidence based, research generating) and we recommend considering these FACER criteria when developing simulation-based training opportunities for new procedures.

Supplemental material

For more information, please use the following links: Simulation Centre video presentation, https://youtu.be/e48ms-ZcI6o or http://vimeo.com/109224706; Simulation Centre brochure: http://www.sebrochure.dk/Simulation_Centre_Rigshospitalet/WebView/

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Conflict of interest

The authors have no conflicts of interest.

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