Auditorium of the future: e learning platform

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Abstract: Principles of surgical training have not changed, but methods of training are evolving very fast. Online tools are being adopted in both knowledge and skills training for surgical residents. As a result, to evaluate the outcome of these tools, online assessment is also developing. Knowledge resources are very diverse ranging from lectures, webinars, surgical videos to three-dimensional planning and printing. Skills resources include virtual reality simulators, remote skills training and interdisciplinary teamwork. Assessment of E-learning tools can be performed using online questions, task-based simulations, branching scenarios and online interviews/discussions. In thoracic surgery, video assisted thoracic surgery (VATS) lobectomy simulator has been developed and it appears to be an important tool for minimally invasive thoracic surgery education. Training programs incorporate e-Learning in their curriculum and online training and assessment will become an important part of thoracic surgical training as well.

Keywords: E-learning; surgical education; simulation; assessment

Principles of surgical education are more than a century old and have not changed since. But methods for surgical teaching have evolved with time, especially with the advent of the World Wide Web. There are two main novel technologic tools that can be integrated into surgical training:

- ❖ Online knowledge sources, such as lectures, webinars, journal clubs, surgical videos, three dimensional planning/printing and anatomic models. These technologies are available everywhere on computers, tablets, cell phones, and allow global access to anyone in the medical field.
- ❖ Second important tool is remote skills education. This has been available for a while in laparoscopic surgery. Other than local proctors, remote proctors are also involved and can evaluate or contribute to the training of a surgical colleague from a distant location.

Those new tools are defined as E-learning or online education. Their ultimate goal is to assess the trainees who are using them. Indeed, no educational tool would be validated or widely used without measuring its efficacy and contribution to behavioral change in clinical practice. Thoracic surgery is no stranger to those latest breakthroughs in medical education. In this article, we will review these e-learning tools and analyze their introduction in Thoracic Surgery education.

Online knowledge sources

William Halsted's legacy in surgery has been marked by his tenets regarding tissue handling, but also three principles in surgical training (1):

- ❖ The resident must have intense and repetitive opportunities to take care of surgical patients under the supervision of a skilled surgical teacher;

❖ The resident must acquire an understanding of the scientific basis of the surgical disease.
❖ The resident must acquire skills in patient management and technical operations of increasing complexity with graded enhanced responsibility and independence.

Can these principles be supported by online resources?

One of the first studies on this topic was a multicenter study, published by Gold and colleagues in 2004. The Thoracic Surgery Directors Association Prerequisite Curriculum allowed residents to acquire basic important knowledge before they began their thoracic surgery residency. The content would also serve them as a permanent educational support during and after the completion of formal thoracic surgery residency. The material was presented in the form of a CD-ROM with Internet access; this educational product had relevant media, including videos, photographs, CT-scans, images, multiple-choice/true-false, self-assessment examination and other materials. A randomized study with two groups (one receiving the CD-ROM and the other one an outline of the content of the curriculum, appropriate references, but no educational content) included 69 residents in each group. Among all the residents, regarding self-assessment survey parameters, there was a significant difference favoring the residents who received the CD-ROM both in knowledge, teaching and application of knowledge and in all of the comfort/satisfaction parameters (2). The software had real-time tracking features, allowing instructors to monitor student engagement and success.

In another multicenter study, Antonoff and colleagues chose a topic in which the American Board of Thoracic Surgery applicants performed poorly: tracheal surgery (3). They used Moodle (modular object-oriented dynamic learning environment) software (Moodlerooms, Inc., Baltimore, MD, USA), an open source course management system, also known as a Learning Management System or a Virtual Learning Environment. The software allows quizzes, feedback pages, discussion forums, group projects, and wiki pages, as well as real-time tracking features, allowing instructors to monitor student engagement and success. Four courses were set up:

❖ Pulmonary physiology and assessment;
❖ Radiographic and surgical anatomy of the trachea;
❖ Disorders of the trachea and the bronchus;
❖ Tracheal and bronchial surgery.

The study group was composed of 19 residents. An average of 1.35 (0.18–3.5) hours were spent for each course and 6.4 (2.75–9.5) hours for the four courses. Residents passed each quiz after a mean of 2.86 [1–7] attempts. Overall courses were found to be easy to navigate; courses, multimedia content and quizzes were beneficial in learning content (3).

Webinars and online lectures are another source of knowledge. As of 2018, European Society of Thoracic Surgeons organized monthly webinars covering a wide variety of topics, from sublobar resections in lung cancer, simulation in thoracic surgery to esophageal resections. An average of 194 [114–274] surgeons from around the world registered, 90 [55–142] attended the webinars. Replays of the webinars were available and were watched at an average of 70 [53–98] times. An average of 26 [9–53] questions were asked during the webinars and polls were encouraged during the webinars to get feedback from the audience. There's a real interest for online learning resources throughout the world.

Surgical videos are now available everywhere and the standards of such videos are questionable. An international survey on 388 participants in the field of gynecology showed that an ideal surgical teaching video should be 10 to 15 minutes long, provide information on the surgical setup, have clearly defined steps in divided subheadings and with access to the entire non-modified video for reviewers (4). Thoracic surgery is no stranger to this practice: Dr. Robert Cerfolio regularly uploads videos on his YouTube channel, giving tips and tricks to fellow surgeons doing robotic-assisted thoracoscopic surgery for lung cancer.

Three-dimensional planning and printing are also becoming tools for pre-operative planning and anatomical understanding. There are several reports of using these technologies in apical tumors, tumors with vertebral invasion, chest wall invasion and tracheobronchial reconstruction (5-8). In a very recent study that involved 16 patients who underwent video-assisted thoracoscopic surgery (VATS) lobectomy, preoperative 3D printing of pulmonary hilum was found to be the most accurate to show the variations of hilar vessels (5). Another case report was on a very difficult patient with right main bronchus carcinoid tumor that required resection and reconstruction of carina and right main bronchus. 3D CT scan reconstruction allowed accurate recognition of extra-bronchial extent of the tumor and there was a correlation between preoperative and intra-operative findings (6). In another study on chest wall resection and reconstruction, 3D planning and printing technology was applied for primary chest wall tumors and lung cancers with chest wall involvement (7).

3D reconstruction allowed accurate preoperative planning of the possible defect and titanium plates were 3D printed based on this planning. The authors showed less bleeding and pain in 3D planned and reconstructed group (7,8).

In a study carried out among congenital cardiac surgeons, 3D printed models had more impact on the understanding of complex anatomy among residents such as in Tetralogy of Fallot (9). 3D stereoscopic images and digital virtual simulation are now used in the teaching of gross anatomy for medical students and integration of these tools to classical education such as specimen dissection caused a significant increase in the understanding of gross anatomy and outcomes in examinations (10).

Online skills training: simulation and multimedia

Simulation is becoming an important training tool in surgical fields. Simulation leads to acquisition of surgical skills before advancing to practice on patients and thus affects clinical practice and patient safety (11). A virtual reality VATS lobectomy simulator was developed in 2014 and was used with 100 thoracic surgeons/residents (12). It was found to be realistic with good content. It was initially developed only for right upper lobectomy and now it is available for all lobes. However, it requires physical use of the simulator by the surgeon.

In the current era, tele-simulation is a novel concept that uses the internet to link simulators between an instructor and a trainee in different locations. It was extensively used to teach laparoscopic skills. It was tested in underserved remote places (13). A study involving 16 surgeons in Botswana was carried out. Eight surgeons had simulator practice and watched DVDs on the fundamentals of laparoscopic surgery (FLS). A second group of 8 surgeons had one remote training session per week with an FLS proctor at the University of Toronto who provided feedback and demonstrated proper technique in addition to simulator practice. Tele-simulation group achieved 100% pass rate, whereas it was only 38% in the self-trained group (13).

Another study was performed in Chile (14). The participating institutions were 250–750 km apart from each other. The aim was to test a web-based mobile iOS and Android application (Lapp) which enables a remote student-teacher interaction. Instructors used Lapp to assess video-recorded training sessions of students at distant locations and guide them through the laparoscopic skill course with specific and personalized feedback. Thirty trainees were trained using Lapp and compared with 25 locally taught.

Performance in the Lapp group improved significantly after the course and was found to be as effective as in-person instruction in teaching advanced laparoscopic surgical skills (14).

Even Google Glass (GG) (Mountain View, California) was compared with Skype™ for its feasibility in scoring the technical skills component of the fundamentals of laparoscopic surgery examination (15). Twenty-eight participants were asked to complete the peg transfer and intracorporeal knot tasks of FLS using both GG and Skype™ setups. Google Glass (Mountain View, California) was found to be equivalent with Skype™ and feasible in remote assessment of FLS skills with strong interrater reliability.

A randomized control study from Germany compared multimedia based with practical training, and combination training using either multimedia-based + practical training or no training (control group) (16). Eligible participants were 70 medical doctors (MDs) participating in surgical fellowships. Participants were evaluated by blinded raters using a modified objective structured assessment of technical skills. Multimedia-based training improved surgical performance significantly and was recommended to be included in surgical curriculum.

Last but not least, simulation in e-learning is a great way to promote interdisciplinary teamwork. It is important in thoracic surgery where management of non-small cell lung cancer involves various specialists (pathologist, radiologist, oncologist, pulmonologist and other related specialties) (17). It's in that perspective that engaging an interdisciplinary team for NSCLC (GAIN 3.0) was designed to enhance interdisciplinary collaboration for effective diagnosis, assessment, and treatment. This program consists of a first phase with each participant completing online assessments before attending live programs simulating cancer tumor board. Amongst 416 attendees, there was an overall knowledge increase of 13% from pre-test to post-test (17).

Online assessment of classical surgical training and E-learning

As the adage emphasizes, "It is not how much you know but how well you know". Evaluation of any educational initiative is critical to conclude that the new method benefits the trainer and the students and/or residents. However, assessment in the field of surgical science is particularly complex, because E-learning can only validate a theoretical

part of knowledge. The practical aspect of surgical training remains based on hands-on sessions or on experience acquired in the operating room. Rather than assessing the surface of E-learning course, understanding assessment allows the trainer to gauge the depth of an online learner's comprehension and ability to solve surgical scenario. Basically, there are several ways to track online residents' progress:

(I) Multiple-choice questions or open-ended questions: this is the simplest qualitative online assessment method for learners, allowing the most creative freedom. The only caution is that open-ended questions are difficult to grade and multiple-choice questions can be too restrictive if they are not well written.

(II) Task-based simulations: learners have to use all of their resources and skills to achieve the task. The simulation has to be closer to reality as possible to achieve accurate results. The virtual environment can be enhanced by immersive sounds, videos or images. Trainer can assess the performance of the specific task in specific conditions (such as simulation of major bleeding, surgery under pressure).

(III) Branching scenarios: learners are facing several situations involving multiple decision points. The trainer can assess the different choices highlighting the negative or positive repercussions of their actions.

(IV) Online interviews and online discussion: if direct face-to-face interviews are not possible, online learners can interact with their peers and discuss the topic. Moreover, forums give online learners the possibility to communicate ideas, discuss specific topics, and interact with instructors.

Kirkpatrick's four levels of evaluation are also valid for e-learning (18):

❖ Level one is related with student/resident reaction and level of satisfaction with the educational activity by the learner;

❖ Level two relates to learning and the evaluation of knowledge;

❖ Level three expands on this and considers whether the education has influenced behavior.

❖ Level four evaluates the impact on outcomes such as improvement in quality of care and best practice application.

Almost all the research in surgical fields is related with level one and two. One of the recent researches leads to development of VATS lobectomy assessment tool (19). Using Delphi method, eight steps were determined for evaluation of competency in VATS lobectomy with over 90% consensus rate. The follow-up study involved rating 53 participants who performed 106 VATS lobectomies on a virtual reality simulator (20). Rating was performed by 3 raters. The participants' VATS lobectomy experience correlated significantly with their score and a pass/fail score was found. It is obvious that remote certification and competence assessment will become important in minimally invasive thoracic surgery as well.

In order to improve results during the surgical teaching process, trainers also need to implement reliable assessment instruments during theoretical learning. Based on teaching of cardiothoracic surgeons, the Zwisch model has been developed (21). Based on a 4-stage process, the model provides a conceptual framework to help interactions between trainers and trainees in the operating room. The model includes 4 stages:

❖ Show and tell;

❖ Smart help;

❖ Dumb help;

❖ And no help.

The method consists of dividing a procedure into several components followed by immediate real-time feedback allowing the degree of autonomy of the residents. This method allows to gauge the level of skills acquisition. Application of this model in the online assessment of e-learning seems possible and may open some perspectives on assessment tools. Using a model of orchidopexy, 11 trainees were coached with a dedicated e-learning with the main goal to "how to" assess trainee surgical skills objectively based on classical Zwisch scale (22). The e-learning included 3 modules: (I) core concepts, where assessment tool methods were learnt; (II) learn to assess, where learners watched video clips, explained the assessment method; (III) test phase where leaners rated surgical and global skills as viewed in the video clips. A total of 89 surgical skill ratings were performed. There was a strong and significant difference before and after e-learning process in interclass correlation coefficient and inter-rater reliability consensus between attending. It appears that Zwisch scale would be efficient providing standardized approach for assessment surgical performance even if comprehension has been transmitted by e-learning.

Conclusions

E-learning sources are becoming important in thoracic surgical training. Online knowledge resources such as lectures, webinars and VATS lobectomy simulators are already available. These tools and many other novel methods will become an essential part of the curriculum as well.

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Footnote

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