Editorial

Developing competency in video-assisted thoracic surgery (VATS) lobectomy

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The first thoracoscopy was performed by Jacobeus in 1910 (1) and today the technique has evolved to a point where the majority of thoracic procedures can be performed using a minimally invasive technique. At our institution at Rigshospitalet in Copenhagen, Denmark, all minor procedures (i.e., wedge resections, pleural biopsies, or operations for pneumothorax) and 86% of major pulmonary resections were performed by video assisted thoracoscopic surgery (VATS) in 2016 (2). However, traditional thoracotomy is still the preferred method for major pulmonary resections in many centers and countries even though the minimally invasive approach has proven beneficial for patients in randomized trials and meta-analysis of large retrospective series (3,4). This clearly shows that the development of superior surgical techniques is not enough to ensure that patients get superior treatment—surgeons and teams need to learn the new techniques and these have to be implemented in the organizations.

A recent review by Divisi *et al.* acknowledges the importance of education in VATS and continues to discuss the importance of simulation (5). We totally agree that simulation-based training could ensure that future patients will not bear the burden of the steep part of novice VATS surgeons' learning curves and thereby improve patient safety. However, the shift from the classical apprenticeship model in surgical training to mandatory simulation-based training requires significant dedication and resources from the thoracic surgical community and support from the institutions and authorities. Hence, it is essential that this fundamental change is based on solid evidence (6). Randomized controlled trials in areas as diverse as ultrasound and cataract surgery have shown that training on a simulator prepares trainees for clinical training and results in better performance on patients (7-9). So far, these important studies are missing regarding VATS surgery and VATS education for future residents in thoracoscopic surgery should be developed based on general principles from best evidence medical education. First of all, it is important to acknowledge that simulation equipment, in itself, will never be able to ensure competent surgeons—training has to be embedded in a structured curriculum.

At the Simulation Centre at Rigshospitalet we have used a "four-step approach" to medical simulation training programs (10). Initially, we acknowledge that sufficient theoretical knowledge (e.g., knowledge regarding the anatomy and the surgical equipment) is essential for acquiring sufficient technical skills. Hence, we require that our trainees have studied (i.e., read books, articles, or engaged in e-learning) and passed a validated theoretical VATS exam (step 1) before starting their simulation-based training (11). Hands-on training starts with an introduction by an experienced VATS surgeon (step 2) to ensure that future trainees know the right surgical technique before commencing dedicated training themselves (12). VATS lobectomy is a complicated and challenging procedure that is impossible to master after a single educational intervention, e.g., a 1- or 2-day course. Therefore, the training program allows ample time and opportunities for directed, self-regulated learning (13) where the trainees conduct several, short and focused training sessions whenever their clinical duties allow (step 3). This approach aligns with scientific evidence showing that 'distributed learning' is superior to 'massed practice' when acquiring new skills, i.e., full day courses will cause fatigue in trainees and the resulting cognitive overload will reduce the efficacy of the training (14). The flexible approach to hands-on training where every trainee is responsible for his/her own training offers several advantages but also introduces the risk that certain trainees will abandon or neglect training and thereby put their future patients at risk. Trainees learn at different paces and demanding a certain number of training sessions, training hours, or performed procedures will not make everybody proficient. The only way to ensure basic competency before allowing the individual trainee to proceed into supervised clinical training is to test their skills using specific assessment tools with solid evidence of validity (15). This mastery learning concept acknowledges that all trainees must reach a pre-defined level of proficiency and demonstrate this in a final test (step 4).

Demanding that every trainee pass final tests before moving to the next level can only be done if the tests are fair and measure what they are supposed to measure, i.e., that they have solid evidence of validity. Otherwise, future VATS surgeons' careers can be delayed or jeopardized if we fail competent trainees (false negatives) and patients are put at risk if we allow non-competent trainees to pass (false positives). Assessment of surgical skills is a rapidly evolving field over the past few years with hundreds of assessment tools being developed to test competence in different surgical procedures. Unfortunately, the vast majority of these lacks validity evidence based on a contemporary framework and has no established pass/fail standards ('when is the trainee good enough?') which makes them unfit for mastery learning training programs (16). For VATS lobectomy in particular, recent studies have shown promising results regarding valid assessment of technical skills in both a simulated and in a clinical environment (17,18). We believe that these newly developed assessment tools can aid in ensuring efficacy of future VATS training programs and the safety of future VATS patients.

An important question acknowledged by Divisi *et al.* (5) relates to which simulation modality to use. Very few randomized controlled trials have compared the efficacy of different training programs. Jensen *et al.* compared black-box training with virtual-reality training and their results favored the first (19). However, the study was performed before any software had been developed for VATS lobectomy forcing the virtual-reality group to practice on a module designed for trainees in urology. The module included nephrectomy and requires division of a three-vessel structure similar to VATS lobectomy. However, practicing nephrectomy on a virtual-reality simulator before being tested on a physical VATS lobectomy model had obvious limitations regarding transfer of skills. The first virtual reality simulator for training VATS lobectomy (LapSim™, Surgical Science, Gothenburg, Sweden) has shown promising results regarding realism and ability to discriminate between surgeons with different experience (17,20) but the transfer of skills from virtual-reality training into clinical practice has not yet been explored. At our simulation center, we have used and studied several different training methods and found that pros and cons exist for all of them and it is not possible to decide on one gold standard. Simple task trainers (e.g., peg transfer or cutting tasks) are cheap and allow novice trainees to practice hand/eye coordination and basic movements (21). However, they lack specificity for VATS lobectomy and do not supply anatomical knowledge. Wet-lab training using porcine heart/lung blocks as developed by D'Amico's group in North Carolina simulates a left upper lobectomy and looks and feels quite realistic (22). The simulated operation follows the steps of the real procedure and real operating instruments are used which is an obvious advantage but also poses a challenge regarding costs, especially for the single-use tissue staplers. Other downsides are that the specimens must be specially prepared before each training session and that the porcine anatomy makes it difficult to practice removing other lobes, e.g., the right upper lobe bronchus branches off directly from the pig's trachea. Using live animals also have practical and ethical challenges, but we believe that the superior feel and realism makes this approach warranted for higher-level trainees that already possess the basic surgical technique. Virtual reality simulators on the other hand have been developed that allow trainees to practice the same procedure over and over while receiving feedback regarding their progression (17,20). Unfortunately, these are still expensive to acquire and more software modules need to be developed to practice the removal of all five lobes, bi-lobectomies, and even segmentectomies in the future. Future studies should explore the efficacy and cost/benefit of the different models, but the overall advantages of simulation-based training are sufficiently clear that implementation in VATS training should not await these. Every institution must choose the method(s) that are practically and economically feasible in their own context and optimally combine these with the opportunities provided by our medical societies and the industry. Such training opportunities require that the trainees travel and spend more time away from their home institution, but this is often justified by the complexity and costs involved in setting up and running high-quality training programs. Especially, regarding a highly specialized procedure as VATS lobectomy that only relatively few surgeons in each institution need to master—even though the number is rising as VATS lobectomy becomes standard of practice for lung cancer resection. Only the most extensive and advanced procedures will require a thoracotomy in the future. VATS will be the "bread and butter" of future thoracic surgeons and studies have shown that it is both safe and feasible for an inexperienced young surgeon to be taught the technique using simulation and close supervision during clinical training (23). However, just as in general surgery, trainees are now trained directly in the endoscopic procedures without the extensive experience with open surgery that we were used to previously. That will be the challenge in the future, in particular in case of complications. Simulation allows trainees to make mistakes in a safe environment and try to handle complications themselves while learning during the process (24). However, managing major complications that need open surgery is not possible to train on simulators. To that end, training on animal models and cadaver models will probably have a new importance.

In conclusion, we recommend that all thoracic interns undergo mandatory VATS training including simulation-based training that must be embedded in their overall training curriculum. Training at each level should proceed until competency has been established and demonstrated using valid assessment methods. Finally, it must be acknowledged that even the best surgeons are dependent on their operating team (25). Team-training including non-technical skills should not be neglected and the importance of a highly competent VATS team with a shared mental model of the operation cannot be underestimated. Future training programs should aim at creating competent surgeons and teams and thereby allow the safe and complete implementation of the VATS lobectomy procedure worldwide.

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Footnote

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