Training on a new, portable, simple simulator transfers to performance of complex bronchoscopy procedures

Charlotte Loumann Krogh, Lars Konge, Johanna Bjurström and Charlotte Ringsted

Centre for Clinical Education, University of Copenhagen and Capital Region of Denmark, Copenhagen, Denmark

Abstract

Introduction: Virtual-reality (VR) simulation provides a safe and effective learning environment prior to practicing on patients. However, existing bronchoscopy simulators are expensive and not easily portable.

Objectives: The aim of this study was to assess the effect of self-directed training on a new, portable, simple simulator measured by transfer of skills to performance of more complex bronchoscopy procedures on an advanced VR simulator.

Methods: Twenty medical students participated in the study. After a general introduction to bronchoscopy, they were randomised into two groups, receiving either self-directed bronchoscopy training using a portable, simple simulator or no manual training. Subsequently, all participants were tested on complex scenarios in an advanced VR simulator using a validated bronchoscopy quality test. Bronchoscopy quality scores were compared using independent samples *t*-test and correlated with a previously established pass-fail standard.

Results: The intervention group spent an average of 71-min training on the new simulator. The intervention group performed significantly better than the control group, mean bronchoscopy quality score 0.55 [standard deviation (SD) 0.16] vs 0.36 (SD 0.10), $P = 0.005$, effect size = 1.47. Eight out of 10 participants in the intervention group passed the test compared with only 1 out of 10 in the control group.

Conclusion: The effect of a brief, self-directed training session using a portable, simple simulator was substantial and transferred to performance of more complex skills.

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Key words:
bronchoscopy – education – simulation – transfer of learning – virtual reality

Correspondence
Lars Konge, MD, PhD, Kongestien 72,
2830 Virum Denmark
Tel: +45 35 45 54 28
Fax: +45 35 45 44 37
email: lkonge@yahoo.dk

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Authorship and contributorship
Charlotte Loumann Krogh contributed to the design of the study, acquisition of data, and analysis and interpretation of data, and drafted the article. Lars Konge contributed to the design of the study, and analysis and interpretation of data, and critically revised the article. Johanna Bjurström contributed to acquisition of data and critically revised the article. Charlotte Ringsted contributed to the design of the study and critically revised the article. All authors have finally approved of the manuscript.

Ethics
The study protocol was submitted to the local research ethics committee, which waived the need for full ethical approval (protocol-no.: H-1–2010-125). All participants were informed about the purpose of the study and gave written informed consent.

Conflicts of interest
The authors have stated explicitly that there are no conflicts of interest in connection with this article.

Introduction

Bronchoscopy remains one of the cornerstones for diagnosing diseases in the airways and lungs. For decades, development of bronchoscopy skills has been based on training on real patients, compromising patient safety and comfort (1). Furthermore, the traditional apprenticeship model requiring supervision by experienced clinicians is problematic, as the clinical environment is pressurised by shorter work weeks and demands for greater operating room efficiency (2).

Simple inanimate models allow basic bronchoscopy training but carry a risk of costly damage to the flexible bronchoscopes and require trained personnel for guidance and feedback. Trainees can practice unsupervised and apply self-directed learning strategies on virtual-reality (VR) simulators that provide consistent feedback, objective measurements of acquired skills and the opportunity of unlimited repetition of procedural manoeuvres in a changing and safe environment (1, 3, 4). Recent studies have demonstrated that guided self-directed learning may be advantageous over instructor-led training (5), although evaluation of learning outcome by a clinical educator is required (2, 5). In research of motor skill learning, learning is defined as a relatively permanent change in capability to perform a task (6). To demonstrate sustainable skills, it is recommended to test learning outcome after a pause in training (retention of learning) and/or to test performance of similar tasks in another context (transfer of learning). The advantage of a transfer test is that it requires newly achieved skills and reflects how the trained skills are internalised in a test setting (7).

The existing VR bronchoscopy simulators are heavy and not easily portable, which limits the usability across medical institutions. Furthermore, prices of approximately 100 000 Euros make the simulators unaffordable for many educational programmes. A smaller simulator has been developed, and a price of approximately 15 000 Euros makes it more accessible. However, it is also less realistic, and it is unknown whether skills learned on this simple simulator would transfer to more complex bronchoscopy tasks. Studies comparing high-fidelity simulators and simple bench models suggest that less realistic skill training is more cost-effective for novices (8, 9), and less sophisticated and mobile simulators may be feasible for lower level trainees achieving competencies in basic motor skills (8, 10, 11).

Hence, the aim of this study was to investigate the effect of a brief, self-directed training session using a new, portable, simple simulator on performance of more complex tasks on an advanced VR simulator.

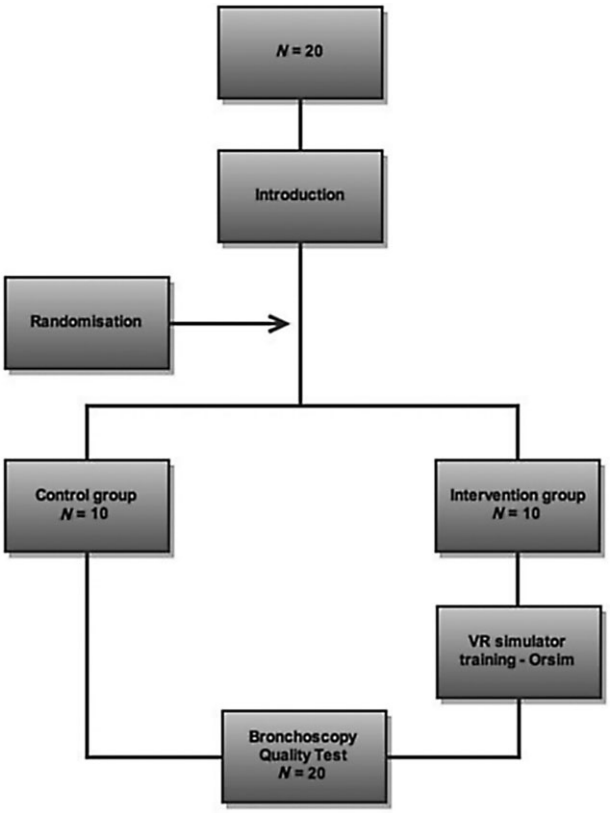

Figure 1. Flow chart showing the study design. Twenty novices were introduced to bronchoscopy before randomisation to a control group and an intervention group. The intervention group trained on a new portable simulator (Orsim™) before performing a bronchoscopy quality test. VR, virtual reality.

Materials and methods

Design

This was a randomised, controlled, blinded, experimental study. The participants were randomised into two groups. The intervention group received VR simulation training using a portable simulator, whereas the control group received no manual training. Primary outcome measure was performance in an advanced VR simulator using a previously validated bronchoscopy quality test (12). The study design is illustrated in Fig 1.

Sampling

The study group consisted of 20 medical students. The students were in their third to sixth year of medical school, thereby having knowledge of the anatomy of the lungs. Exclusion criteria included prior experience in either real-life or bronchoscopy simulation. Participants were recruited by an electronic invitation to

members of Society of Danish Medical students with interest of anaesthesiology and intensive care medicine, University of Copenhagen, Denmark. We chose members of this interest organisation as these students in general are highly motivated to practice invasive procedures. No fees were paid.

Day 1: introduction and randomisation

The participants came to the Centre for Clinical Education pairwise on two consecutive days. First, they watched an instructional video of bronchoscopy technique by E. James Britt, MD, followed by a 15-min 'warm-up' session on a VR simulator in order to get familiar with the bronchoscopy procedure. The simulator used in this session was the Accutouch™ endoscopy simulator (CAE, Ontario, Canada) (1, 3, 4, 13). The 'warm-up' session was administrated by CLK who guided the students through the simulation. Subsequently, the students were randomised into either the intervention group or control group. The randomisation was administrated by LK using the students' date of birth and a list of random numbers (created using http://www.random.org). After the randomisation, both groups were given traditional study material consisting of a poster of the anatomy of the lungs and 20-page written material about bronchoscopy. Both groups were allowed unlimited time for studying the material at home. Participants randomised to the control group did not receive any further hands-on training, while the participants randomised to the intervention group started self-directed training on a portable, simple simulator.

Description of the simulator

The portable Orsim™ bronchoscopy simulator (Airway Simulation Limited, Auckland, New Zealand) consists of a flexible bronchoscope, a small interface device for the flexible tube and simulation software modules (Fig 2). The interface device is connected to a standard laptop working as a monitor. The flexible bronchoscope is modelled after a conventional bronchoscope, however, without a working channel to simulate complex procedures such as forceps or needle biopsies. The three-dimensional (3D) graphics for the model of the bronchial tree is designed from pictures and video footage of real bronchoscopies. Entry point to the airway includes both nasal and oral access. As the flexible bronchoscope is inserted through the interface device, a 3D image of the airway is displayed. The motions of the bronchoscope are continuously tracked by the simulation software, which changes the image corresponding to the location of bronchoscope. Movement of the scope is not accompanied with tactile sensation or force feedback. The simulation software records all actions of the user providing instant feedback in terms of procedure time and number of bronchial segments visualised.

Figure 2. The Orsim™ bronchoscopy simulator consists of a small, portable interface device connected to a standard laptop and a proxy flexible bronchoscope.

Training of the intervention group

Participants in the intervention group were trained using the Orsim bronchoscopy simulator. The training was self-directed and unsupervised. The training program consisted of a number of simulated bronchoscopies in three different scenarios with increasing difficulty. All three scenarios simulated a patient with normal airways.

In the first scenario, the entrance to each bronchial segment was marked by the number of the segment and a 'goal sphere' that disappeared, as the segment was entered. Continuously written instructions on the monitor about the next step in the procedure were provided. The second scenario noted the visited and the missing segments, while the third scenario offered no help. All bronchoscopies had a time limit of 10 min. After each bronchoscopy, the number of segments visualised and the amount of time spent were noted, and these data were plotted graphically to estimate a performance curve.

Day 2: outcome measure

On the second day, the individual performance of each participant was tested on an advanced VR simulator using a validated bronchoscopy quality test (12) (Appendix A). The test was administered on the Accutouch endoscopy simulator by CLK or JB. The test included performance of six procedures: two diagnostic bronchoscopies, two bronchioalveolar lavages (BALs) and two procedures using biopsy tools. During

the test, no feedback or help was provided. CLK/JB were blinded regarding the participants' study group. All bronchoscopies were recorded and LK, who was blinded as well, assessed the performance using a checklist containing 28 items, the maximum possible score being 28 points (12). An *aggregate score*, the bronchoscopy quality score, defined as the checklist score divided by the amount of time taken to perform the procedures were calculated. A pass/fail standard of 0.42 points per minute had been established previously by using the contrasting groups methods and data from 28 participants (14).

Statistical analyses

The performance was compared using independent samples *t*-test. A *P* value of less than 0.05 was considered significant. To estimate the magnitude of the difference between the intervention and the control group, we used Cohen's d effect size (ES). According to Cohen, ES of 0.2–0.5 is considered small, ES of 0.5–1.0 is considered moderate, and ES > 1.0 is considered substantial (15). The PASW statistical software package version 18.0 (SPSS inc., Chicago, Illinois, USA) was used for all calculations.

Results

All 20 participants completed the study. The distribution of males vs females was identical in both the intervention and the control group (seven males and three females in each group). The mean ages were similar, intervention group = 25.9 years and control group = 27.7 years, $P = 0.28$. The participants of the intervention group performed 12 bronchoscopies each on average (range 7–19) during training on the Orsim simulator. Practice time was on average 71 min (range 46–99 min). Figure 3 shows the performance curve of the intervention group during training and demonstrates a continuous learning by consecutive trials without reaching a plateau.

The control group spent significantly more time studying the written material than the intervention group before the test, mean 49 [standard deviation (SD) 24] vs 23 (SD 17) min, $P = 0.011$.

Performance on the bronchoscopy quality test is shown in Table 1. The intervention group obtained a significantly higher bronchoscopy quality score than the control group, mean 0.55 (SD 0.16) vs 0.36 (SD 0.10), $P = 0.005$, ES = 1.47. This difference was mainly due to faster performance by the intervention group, ES 1.87, whereas the difference between checklist scores was moderate, ES 0.76. Eight out of 10 participants in the intervention group obtained a passing level score (0.42 point per minute) as opposed to 1 out of 10 in the control group, Fig 4.

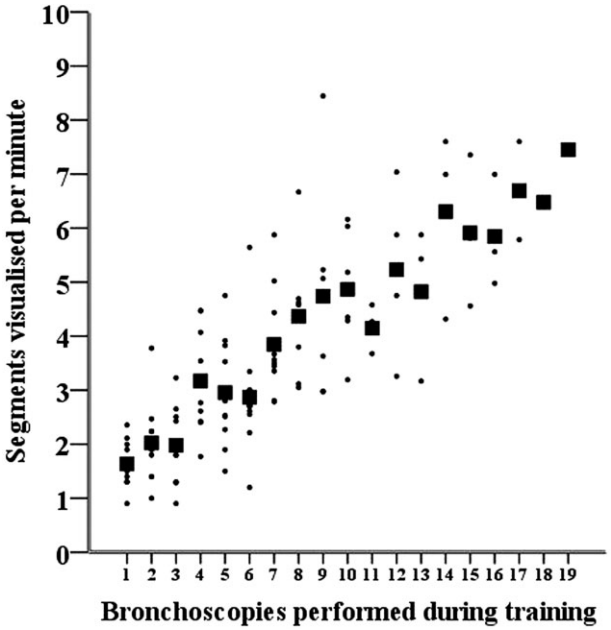

Figure 3. Performance curve of the intervention group during training on the Orsim™ simulator. Dots = individual scores; squares = mean score.

Discussion

This study demonstrated that training novices in a brief, self-directed training session using the new, portable, simple Orsim simulator lead to a steep learning curve and significant learning outcome, i.e. the intervention group obtained significantly higher bronchoscopy quality scores compared with the control group. Eight out of 10 in the intervention group obtained a passing level on the bronchoscopy quality test as opposed to only 1 out of 10 in the control group.

The intervention group performed significantly faster than the control group because of a significant motor skills learning from training on the Orsim simulator. Although rapid procedural time is part of superior clinical performance, it is not an indication of bronchoscopy quality by itself. Features of expert performance are recognised by both rapid completion of the task and the quality of the procedure (1, 16).

The control group obtained surprisingly high checklist scores, only moderately lower than the intervention group. The checklist score reflected knowledge of the anatomy and the ability to perform complex

Table 1. Performance of the intervention group after training on the Orsim simulator compared with performance of the control group measured in a bronchoscopy quality test

Outcome measures	Intervention group	Control group	*P* value	Effect size
Bronchoscopy quality score (score per minute)	Mean 0.55 (SD 0.16)	Mean 0.36 (SD 0.10)	0.005	1.47
Time (minutes)	Mean 42.8 (SD 8.74)	Mean 58.5 (SD 8.02)	0.001	1.87
Checklist-score (points)	Mean 22.7 (SD 2.95)	Mean 20.5 (SD 2.84)	0.106	0.76

SD, standard deviation.

procedures. The control group spent more than twice the time preparing for the test compared with the intervention group, which may explain why they did well regarding anatomy.

Being aware of the possible advantage of the intervention, group may have influenced the behaviour of the control group in terms of studying before the test (17). To avoid this bias, we could have tested the control group immediately after the randomisation. However, we deliberately chose to give both the intervention and the control group the opportunity to study in a traditional manner, as test of complete novices does not reflect a clinical setting. Allowing the control group to prepare in the traditional way is helpful for investigation of learning outside the intervention (18).

The Orsim simulator did not have a working channel, which made it impossible for the participants in the intervention group to practice complex procedures before the test. This could also explain why the difference in checklist score was only moderate. Whether the lack of sophisticated features such as working channel and tactile feedback on the Orsim simulator impeded the ability of the intervention group to perform quality procedures on the Accutouch simulator is unknown. However, studies regarding laparoscopic simulation found limited benefit of simulated tactile sensation and force feedback in terms of efficiency (19, 20), and a recent review found minimal relationship between simulation fidelity and transfer of learning (21).

A growing body of evidence suggests that clinical skills acquired in medical simulation may be transferred to improved patient care and outcomes (16, 22). Several studies have demonstrated improved operating room performance in residents who had received VR simulator training, indicating that simulators may be able to provide basic skills training for clinical procedures (23, 24). These findings emphasise the clinical relevance of simulation in training of clinical skills in the future endoscopy training program (25–29). A recent review analysed the effect of technology-enhanced simulation in training of health professionals and found that in comparison with no interventions, simulation-based medical education was associated with improved outcomes of knowledge, skills and behaviour (18). A meta-analysis suggested that simulation-based medical education with deliberate practice was better than traditional clinical medical education when training specific clinical skills (22).

The learning curve of the intervention group demonstrated that they had not reached the performance plateau. This observation suggests that the training time should be extended beyond 71 min. Previous studies have demonstrated that longer training time could be associated with improvement in terms of speed and percentage of segments visualised (1, 4, 30, 31). Future studies are needed to estimate the training time necessary to reach the plateau phase.

A limitation to this study was the small sample size ($n = 20$). However, the number of participants in simulation studies is generally small – in randomised studies concerning bronchoscopy simulation around

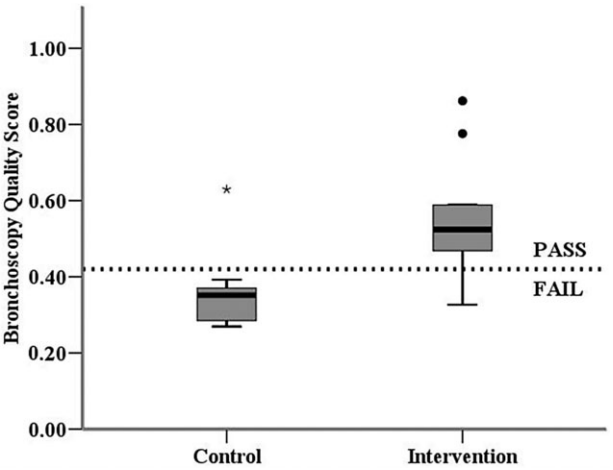

Figure 4. The bronchoscopy quality score of the control group and the intervention group. Boxplot showing outliers, minimum, first quartile, median, third quartile and maximum. The dotted line marks the previously established pass-fail standard.

6–10 participants (1, 24). The study population consisted of medical students, and this group may not be representative of the target group in a clinical setting, i.e. residents in pulmonary medicine. However, all the students had attained knowledge of the anatomy and physiology of the lungs. Moreover, the bronchoscopy quality test used in this study did not require knowledge of the pathogenesis or treatment of specific pulmonary diseases. The test only measured the participant's ability to navigate the scope in the airways and lungs using hand-eye coordination and management of tools for invasive procedures. Hence, training on the Orsim simulator may improve the participant's confidence in terms of handling the bronchoscope and serve as preparation prior to patient examination. However, the quality of performance of complex procedures must be obtained by repetitive practice in a real-life clinical setting.

Another limitation is that the control group only received traditional study material as preparation. However, this design is comparable with reality, where residents in general do not have simulation experience prior to procedures performed in a clinical setting.

Finally, the performance of the participants where tested using another VR simulator and not patients. This solution was chosen due to ethically concerns of allowing medical students to perform bronchoscopies on real patients for study purposes. As an alternative, we used a high-fidelity VR simulator allowing to test performance of both diagnostic bronchoscopy and more complex skills, i.e. BAL and taking biopsies. By modulating the context and nature of the motor skills, we were able to investigate the adaptive aspects related to the obtained skills.

However, testing performance of skills obtained via simulation on another simulator will always favour trainees who are familiar with simulation, reflecting a great amount of transfer because simulator training is very similar to a simulation test. Also, we must acknowledge that the bronchoscopy quality test used in this study is validated for 'VR simulator novices', i.e. trainees who have never performed bronchoscopies on a simulator before. This may have influenced the large amount of participants in the intervention group who reached the passing level.

A brief, self-directed training session using a new, portable bronchoscopy simulator enabled a group of novices to demonstrate a steep learning curve and perform bronchoscopy manoeuvres faster. Further studies are required to investigate if the motor skills achieved using the simulator are transferable to real-life bronchoscopies in order to determine the future potential in the bronchoscopy curriculum.

References

1. Ost D, DeRosiers A, Britt EJ, Fein AM, Lesser ML, Mehta AC. Assessment of a bronchoscopy simulator. Am J Respir Crit Care Med. 2001;164(12): 2248–55.
2. Reznick RK, MacRae H. Teaching surgical skills – changes in the wind. N Engl J Med. 2006;355(25): 2664–9.
3. Colt HG, Crawford SW, Galbraith O III. Virtual reality bronchoscopy simulation: a revolution in procedural training. Chest. 2001;120(4): 1333–9.
4. Rowe R, Cohen RA. An evaluation of a virtual reality airway simulator. Anesth Analg. 2002;95(1): 62–6. table.
5. Brydges R, Dubrowski A, Regehr G. A new concept of unsupervised learning: directed self-guided learning in the health professions. Acad Med. 2010;85(10 Suppl): S49–S55.
6. Wulf G, Shea C, Lewthwaite R. Motor skill learning and performance: a review of influential factors. Med Educ. 2010;44(1): 75–84.
7. Magill RA. *Defining and Assessing Learning. Motor Learning and Control*, 8th edn. New York, McGraw-Hill, 2007: 246–62.
8. Matsumoto ED, Hamstra SJ, Radomski SB, Cusimano MD. The effect of bench model fidelity on endourological skills: a randomized controlled study. J Urol. 2002;167(3): 1243–7.
9. Davoudi M, Wahidi MM, Zamanian RN, Colt HG. Comparative effectiveness of low- and high-fidelity bronchoscopy simulation for training in conventional transbronchial needle aspiration and user preferences. Respiration. 2010;80(4): 327–34.
10. Anastakis DJ, Regehr G, Reznick RK, Cusimano M, Murnaghan J, Brown M, Hutchison C. Assessment of technical skills transfer from the bench training model to the human model. Am J Surg. 1999;177(2): 167–70.
11. Grober ED, Hamstra SJ, Wanzel KR, Reznick RK, Matsumoto ED, Sidhu RS, Jarvi KA. The educational impact of bench model fidelity on the acquisition of technical skill: the use of clinically relevant outcome measures. Ann Surg. 2004;240(2): 374–81.
12. Konge L, Arendrup H, von Buchwald C, Ringsted C. Using performance in multiple simulated scenarios to assess bronchoscopy skills. Respiration. 2011;81(6): 483–90.
13. Crawford SW, Colt HG. Virtual reality and written assessments are of potential value to determine knowledge and skill in flexible bronchoscopy. Respiration. 2004;71(3): 269–75.
14. Konge L, Clementsen P, Larsen KR, Arendrup H, Buchwald C, Ringsted C. Establishing pass/fail criteria for bronchoscopy performance. Respiration. 2012;83(2): 140–6.
15. Zakzanis KK. Statistics to tell the truth, the whole truth, and nothing but the truth: formulae, illustrative numerical examples, and heuristic interpretation of effect size analyses for neuropsychological researchers. Arch Clin Neuropsychol. 2001;16(7): 653–67.
16. Sturm LP, Windsor JA, Cosman PH, Cregan P, Hewett PJ, Maddern GJ. A systematic review of skills transfer after

surgical simulation training. Ann Surg. 2008;248(2): 166–79.
17. Ericsson KA. The influence of experience and deliberate practice on the development of superior expert performance. In: Ericsson KA, Charness N, Feltovich PJ, Hoffman RR, editors. *The Cambridge Handbook of Expertise and Expert Performance*, 1st edn. New York, Cambridge University Press, 2006: 683–704.
18. Cook DA, Hatala R, Brydges R, Zendejas B, Szostek JH, Wang AT, Erwin PJ, Hamstra SJ. Technology-enhanced simulation for health professions education: a systematic review and meta-analysis. JAMA. 2011;306(9): 978–88.
19. Thompson JR, Leonard AC, Doarn CR, Roesch MJ, Broderick TJ. Limited value of haptics in virtual reality laparoscopic cholecystectomy training. Surg Endosc. 2011;25(4): 1107–14.
20. Salkini MW, Doarn CR, Kiehl N, Broderick TJ, Donovan JF, Gaitonde K. The role of haptic feedback in laparoscopic training using the LapMentor II. J Endourol. 2010;24(1): 99–102.
21. Norman G, Dore K, Grierson L. The minimal relationship between simulation fidelity and transfer of learning. Med Educ. 2012;46(7): 636–47.
22. McGaghie WC, Issenberg SB, Cohen ER, Barsuk JH, Wayne DB. Does simulation-based medical education with deliberate practice yield better results than traditional clinical education? A meta-analytic comparative review of the evidence. Acad Med. 2011;86(6): 706–11.
23. Seymour NE, Gallagher AG, Roman SA, O'Brien MK, Bansal VK, Andersen DK, Satava RM. Virtual reality training improves operating room performance: results of a randomized, double-blinded study. Ann Surg. 2002;236(4): 458–63.
24. Blum MG, Powers TW, Sundaresan S. Bronchoscopy simulator effectively prepares junior residents to competently perform basic clinical bronchoscopy. Ann Thorac Surg. 2004;78(1): 287–91.
25. Hueppchen N, Dalrymple JL, Hammoud MM, *et al*. To the point: medical education reviews – ongoing call for faculty development. Am J Obstet Gynecol. 2011;205(3): 171–6.
26. Issenberg SB, Pringle S, Harden RM, Khogali S, Gordon MS. Adoption and integration of simulation-based learning technologies into the curriculum of a UK undergraduate education programme. Med Educ. 2003;37(Suppl 1): 42–9.
27. Issenberg SB, Scalese RJ. Simulation in health care education. Perspect Biol Med. 2008;51(1): 31–46.
28. Marco J, Holmes DR Jr. Simulation: present and future roles. JACC Cardiovasc Interv. 2008;1(5): 590–2.
29. Murphy JG, Cremonini F, Kane GC, Dunn W. Is simulation based medicine training the future of clinical medicine? Eur Rev Med Pharmacol Sci. 2007;11(1): 1–8.
30. Wahidi MM, Silvestri GA, Coakley RD, *et al*. A prospective multicenter study of competency metrics and educational interventions in the learning of bronchoscopy among new pulmonary fellows. Chest. 2010;137(5): 1040–9.
31. Moorthy K, Smith S, Brown T, Bann S, Darzi A. Evaluation of virtual reality bronchoscopy as a learning and assessment tool. Respiration. 2003;70(2): 195–9.

Appendix A: The assessment tool

				SCORE	TIME
General varm-up: Module 1 Case Three (Max. 15 minutes)					
Module 1 Case One Max. 15 minutes	Tumor 1	Tumor Photographed?			
		Correct Localization?	Right – Middle lobe bronchus		
			Right – Bronchus to segment 4		
			Right – Bronchus to lateral part of middle lobe		
	Tumor 2	Tumor Photographed?			
		Correct Localization?	Left – Bronchus to Lingua (Upper lobe bronchus accepted)		
			Left – Bronchus to segment 4 and 5		
	Tumor 3	Tumor Photographed?			
		Correct Localization?	Left – Bronchus to apical part of lower lobe		
			Left – Bronchus to segment 6		
	TIME →				
Module 1 Case Two Max. 15 minutes	Tumor 1	Tumor Photographed?			
		Correct Localization?	Right – Bronchus to basal part of lower lobe		
			Right – Lower lobe bronchus below segment 6		
			Right – Bronchus to segment 8,9 and 10		
	Tumor 2	Tumor Photographed?			
		Correct Localization?	Left – Bronchus to apical / posterior part of upper lobe		
			Left – Bronchus to segment 1/2		
	TIME →				
Module 2 Case One Max. 10 minutes	At least one lavage performed in the middle lobe?				
	Exactly three lavages performed in either lateral OR medial part of middle lobe?				
	Correct amount of suction?		Between 30 and 45 seconds (both numbers included)		
	TIME →				
Module 2 Case Two Max. 10 minutes	At least one lavage performed in the middle lobe?				
	Exactly three lavages performed in either lateral OR medial part of middle lobe?				
	Correct amount of suction?		Between 30 and 45 seconds (both numbers included)		
	TIME →				
Biopsi tools varm-up: Module 3 Case One (Max. 15 minutes)					
Module 3 Case Three Max. 20 minutes	Tumor Photographed?				
	Correct Localization?		Left – Bronchus to anterior segment of upper lobe		
			Left – Bronchus to segment 3		
	Correct Lavage performed?				
	Correct Needle Biopsy performed?				
	Correct Brush Biopsy performed?				
	Exactly four Forceps Biopsies performed?				
	TIME →				
Module 3 Case Four Max. 20 minutes	Tumor Photographed?				
	Correct Localization?		Left – Bronchus to apical segment of lower lobe		
			Left – Bronchus to segment 6		
	Correct Lavage performed?				
	Correct Needle Biopsy performed?				
	Correct Brush Biopsy performed?				
	Exactly four Forceps Biopsies performed?				
	TIME →				
	TOTAL SCORE (max 28)				
	TOTAL TIME →				
	SCORE PR. MINUTE				

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