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Simulation training for pleural procedures: a review

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Abstract

There is an increasing burden of pleural disease in the UK, and investigation and management require invasive procedures including medical thoracoscopy, intercostal drainage and thoracic ultrasound. Simulation based medical education is now increasingly used to teach these technical skills, however there are multiple methods that can be used and there is no clear consensus on the most effective training models. In this paper we have conducted literature reviews for thoracoscopy, intercostal drainage and thoracic ultrasound simulation training with the aim of identifying the most effective training methods.

Introduction

Simulation based medical education is now increasingly used to teach technical and non-technical skills. A simulation teaching model for invasive procedures has many benefits over that of the traditional 'see one, do one, teach one' model(1). The use of part task trainers allows repeated deliberate practice with educational supervision leading to skill improvement(2). Simulation in practical procedures also improves patient safety by ensuring that a level of competency is achieved before trainees perform the procedure on a patient. Additionally, trainees may be assessed in a controlled and predictable environment without impacting on patient care(3).

It is widely recommended that simulation or skills lab training is used as a first step in obtaining these skills and thus there is a need for simulation courses to support national training. Simulation based training is expensive to run, is faculty dependent, and centres may need to invest in new equipment before instigating courses. A robust evidence base for the efficacy and use of the best practice best model for simulation training can support development of courses at a local level and justify initial financial outlay. In increasingly time pressured training programmes, trainees and educational supervisors can also be reassured that the training time investment is worthwhile.

There is an increasing burden of pleural disease in the UK(4), and investigation and management require invasive procedures including medical thoracoscopy, intercostal drainage and thoracic ultrasound. The need for safe patient care requires provision of good quality and accessible training in pleural procedures. In this review, we examine the evidence for simulation based training for thoracoscopy, chest drain insertion and thoracic ultrasound. We aim to assess the most effective means of providing

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simulation based training to support the ongoing creation and provision of courses.

Thoracoscopy

Medical thoracoscopy, also known as local anaesthetic thoracoscopy or pleuroscopy, is an important diagnostic and therapeutic tool in the management of pleural disease. The procedure, usually done by respiratory physicians, is performed in the endoscopy suite under local anaesthesia and with intravenous conscious sedation. The operator is required to have the requisite skills to perform the procedure and excellent knowledge of pleural anatomy and the associated landmarks. Therefore, training in thoracoscopy should be considered equally important for respiratory physicians as that in other respiratory procedures such as bronchoscopy.

The British Thoracic society pleural disease guideline 2010 describes three levels of competence of medical thoracoscopy practice seen in Europe that are anticipated to be reflected in UK practice as use of this procedure becomes more common(4).

However, specific information regarding training to obtain competence at each level is not mentioned. The Thoracic Society of Australia and New Zealand advocates a minimum of 20 supervised procedures to attain competence (5). The American College of Chest Physicians (ACCP) guidelines recommend a similar number (6). The optimum start for gaining such a procedural competency would be to attend a simulation based course. However, there are few courses nationally for respiratory trainees.

The use of simulation based training for thoracoscopy has been studied by cardiothoracic surgeons previously. Bjurstrom et al showed that 3 hours of intensive simulator training with a dedicated educator enables novices to perform an acceptable wedge resection in a simple, simulated Model (7). They used a low fidelity and video trainer simulator. Colt et al described a thoracoscopy course aimed at pulmonary and critical care physicians, which combines didactic lectures and hands-on simulation based training (8). The course involves use of Laerdal SimMan, discarded animal parts, silicone-suturing pads and Storz video laparoscopy-thoracoscopy simulation box. Competency based metrics were used to demonstrate the effectiveness of the course and they were able to show an improvement in both the mean cognitive knowledge score as well as the technical skill score. Chowdhury et al describe a simulation course for Medical thoracoscopy (MT) and indwelling pleural catheter (IPC), aimed at Respiratory medicine trainees in the Yorkshire region (9). Confidence levels were assessed using pre and post course Likert scale questionnaires. They were able to demonstrate statistically significant improvements in confidence levels, particularly in technical ability to perform procedure.

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Intercostal drain placement

Intercostal drain insertion is a common procedure performed by both speciality and non-speciality physicians. The procedure is known to cause potentially life threatening complications including intra and extra thoracic visceral injuries. Although the Seldinger technique is perceived as safer than the traditional Argyl drains, complications are still common and can involve multiple organ injuries including insertion into left ventricle of heart [10]. Due to the high rate of serious complications, a national patient safety rapid response report was released. Its key recommendation was that intercostal chest drains should only be inserted by trained staff who have received appropriate training. Most training centres in the UK use simulation based training for intercostal drain placement as part of a structured training programme for specialist and non-specialist physicians which typically include didactic lecture and video demonstration, followed by a practical workshop using a simulate. Most often a commercially available mannequin is used, however a need for a more realistic model has been perceived by some trainees and hence various animal models have been used to create an ideal intercostal drain training model which could minimise the gap between simulation and clinical practice.

Hutton et al [11] have shown that as little as a 2 hour simulation based training session is effective in improving confidence and skill in intercostal drain insertion. Trainees were filmed while performing intercostal drainage both before and after the simulation training on a mannequin. The videos were scored by 2 independent assessors using an 18 point scoring system. West Midlands deanery introduced a novel porcine rib simulation model [12] and validated for chest drain insertion training and described this model as practical and affordable in all clinical labs using porcine ribs mounted on a resin cast of human thorax [13]. Van Doormal et al [14] has shown the validity of porcine model as a cost effective teaching tool for chest drain insertion by demonstrating through a cross over design of using both a pork rib model and commercially available simulation task trainer (Trauma Man) by recruiting 38 residents and practising physicians. Participants in this study perceived the porcine model to be a more realistic experience and did not express any ethical concerns regarding its use. Nazerali-Maitland et al[15] described lamb thoraces as superb model and reiterated the benefits of animal model training in chest drain insertion due to its anatomical and tactile realism.

Irrespective of the simulation model used in training, the trainees need to be mentored further by direct supervision in bedside until full competency in chest drain insertion is achieved. Naicker T.R. at al claims at least five to seven further supervised insertions on patients are required to achieve full competency in chest drain insertion[16].

Thoracic ultrasound

Thoracic ultrasound provides a means for rapid diagnosis for acute conditions such as

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pneumothorax[17], more chronic conditions such as pleural effusion[18] and is also now recognised as an essential technique to ensure safe thoracocentesis following a national patient safety report in 2008[19]. The BTS guidelines strongly recommend the use of ultrasound guided procedures, and that all doctors should be trained with didactic lectures, simulation and supervised practice[20]. Despite this, a respiratory trainee survey found that structured training is limited and only a small proportion of trainees are attaining the required competency[21].

Adhikari et al presented evidence that lightly embalmed cadavers could be used as a training model for the diagnosis of pneumothorax by ultrasound with high sensitivity and specificity. They list the benefits of cadavers as offering a wider range of anatomical variation and closer model of scanning in real patients when compared to high fidelity simulators or porcine models[22]. Keddis et al used cadavers to train interns in a number of ultrasound assessment skills including identification of pleural effusion and insertion of a Seldinger drain. An increase in confidence was identified however there was no assessment of technical skill[23]. Lyon et al demonstrated that pre-hospital critical care providers were able to identify the sliding lung sign to indicate pneumothorax on intubated cadavers, and were able to show retention of this skill at 9 months with 100% accuracy[24]. Euthanised and ventilated porcine carcass with induced pneumothoraces have a similar distribution of intra-thoracic air to human patients despite anatomical differences[25]. Bloch et al concluded that porcine model can be used for the training of detection of pneumothoraces with detection rates rising from 66% to 100% over a 2 day training course. The study acknowledges that training is limited due to the anatomical difference between porcine and human thorax[26]. A similar study by Oveland et al using porcine models with induced pneumothoraces demonstrated increased proficiency and speed diagnosis and retention of skill at 6 months in medical students. The course also utilised healthy human models as a training aid[27]. A preliminary study by Monti concluded that a porcine model with minimal focused training for a wide variety of ultrasound naive non-physician candidates could successfully be used to teach the detection of pneumothorax with high sensitivity and specificity[28].

A 1 day training course for thoracic ultrasound was developed by the BTS pleural diseases group using a combination of real patients and low cost homemade phantom models. There was a statistically significant increased performance on video and image test from 53.8% to 84.6%, with evidence of retention at 3 months. This was the first description and evaluation of a thoracic ultrasound training course and the authors concluded that thoracic ultrasound training courses of this type can support physician

training and allows candidates to develop skills in a zero risk environment[29].

Cuca et al investigated if virtual learning is a useful tool in teaching thoracic ultrasound. Candidates undertaking eLearning modules almost equalled scores of candidates who had didactic and practical training when testing on theoretical knowledge and image recognition. This did not assess if the candidates undergoing practical training had additional benefit from acquisition of psychomotor skills[30]. Krishnan et al used only a 5 minute online tutorial on identifying pneumothorax before assessing candidates' ability to identify this on 20 ultrasound videos. Candidates were found to be able to rule out pneumothorax with 86% sensitivity and 85% specificity and demonstrated retention of this skill over 6 months[31]. Sekiguchi et al used a more in-depth and blended approach to teaching ultrasound skills. The use of 2 hours of online lectures covering vascular and thoracic imaging including identification of lung anatomy and pleural effusion was supported by sessions in a simulation lab with standardised patients and phantom models and improved candidates knowledge and skill. The authors did, however, conclude that web based teaching may not be adequate to teach image acquisition as the scores between the online tutorials and the simulation exercises were lower than expected[32].

Conclusion

Of the three procedures we examined, medical thoracoscopy is the most invasive and is the highest risk procedure, and is only performed in selected centres, and therefore is ideally suited to simulation based training. Despite this, only 3 papers were identified although they all demonstrated favourable outcomes. We conclude that further research in this area would support the development of future courses thus increasing the access to thoracoscopy training and the skills base for this increasingly important procedure.

Intercostal drainage is a commonly performed procedure, and competency is required for many training programs. Larger studies are required to define the ideal simulation model based on realism and cost effectiveness, to identify the factors which enhance the acquisition of skills, the need for the level and duration of mentorship, the level of supervision required for procedures post simulation training and the average period of retention of skills.

All papers identified for simulation based thoracic ultrasound training demonstrated an improvement technical skills or self-reported confidence levels despite the large variety of simulation methods used. There was no attempt to examine transfer into clinical practice. It is widely accepted that all trainees preforming invasive thoracic procedures should be ultrasound trained, which necessitates training courses for a large number of trainees over multiple specialities. Considering the availability and reusability of simulation models versus cadaveric and porcine models for training, there is a persuasive argument for their use,

along with virtual learning if they can also be proven effective.

There is also evidence that some self-directed learning can be effective, although not as effective as faculty led training, which could lead to the introduction of a self-directed approach to increase access and flexibility to thoracic ultrasound training. This could be used in a blended approach to support training, and to allow trainees to revisit their learning and maintain skills over a longer period of time. Research needs to be conducted to prove transfer into clinical practice.

Simulation based training for pleural procedures is already widespread, and the review supports their use. There is still a paucity of evidence available, and the outcomes of the studies available do not examine transfer of skills into clinical practice and studies often rely on confidence intervals. With increasing faculty and funding invested into simulation training, we argue that an increase in the evidence base could provide national recommendations for constructing courses to ensure the best possible clinical outcomes and value for money, and justify further expansion into simulation training for pleural procedures.

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