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Rescuing the obese or burned airway: are conventional training manikins adequate? A simulation study

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Editor's key points

- Obesity and airway burns are risk factors for failed tracheal intubation.
- Percutaneous tracheal access is required in ~40% of airway emergencies, but failure rates are high.
- The authors modified standard airway manikins to simulate the airways of obese and burned patients.
- In airway emergency simulations modified manikins better simulated reality than standard manikins.

Background. Percutaneous tracheal access is required in more than 40% of major airway emergencies, and rates of failure are high among anaesthetists. Supraglottic airway management is more likely to fail in patients with obesity or neck pathology. Commercially available manikins may aid training. In this study, we modified a standard 'front of neck' manikin and evaluated anaesthetists' performance of percutaneous tracheal access.

Methods. Two cricothyroidotomy training manikins were modified using sections of belly pork to simulate a morbidly obese patient and an obese patient with neck burns. An unmodified manikin was used to simulate a slim patient. Twenty consultant anaesthetists were asked to manage a 'can't intubate, can't ventilate' scenario involving each of the three manikins. Outcome measures were success using their chosen technique and time to first effective breath.

Results. Success rates using first-choice equipment were: 'slim' manikin 100%, 'morbidly obese' manikin 60%, and 'burned obese' manikin 77%. All attempts on the 'slim' manikin succeeded within 240 s, the majority within 120 s. In attempts on the 'morbidly obese' manikin, 60% succeeded within 240 s and 20% required more than 720 s. All attempts on the 'burned obese' manikin succeeded within 180 s.

Conclusions. Significantly greater technical difficulty was experienced with our 'morbidly obese' manikin compared with the unmodified manikin. Failure rates and times to completion were considerably more consistent with real-life reports. Modifying a standard manikin to simulate an obese patient is likely to better prepare anaesthetists for this challenging situation. Development of a commercial manikin with such properties would be of value.

Keywords: airway management; obesity; tracheostomy; training

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Airway management is more likely to fail or prove difficult in patients with obesity or pathology of the head or neck, for example, burns.[1] Difficulties encountered may be supraglottic (difficult ventilation via facemask or supraglottic airway, or difficult laryngoscopy and intubation) and, in such cases, there may be a need for infraglottic approaches such as cannula or surgical cricothyroidotomy. In the Fourth National Audit Project of the Royal College of Anaesthetists and Difficult Airway Society (NAP4), emergency percutaneous tracheal access was required in 43% of airway emergencies.[2] Patients reported to NAP4 were twice as likely to be obese (45%) and four times as likely to be morbidly obese (8%) than the general population (24% and 2%), and rescue techniques failed in obese patients in NAP4 more often than in non-obese patients.[3] Given the likelihood of difficulties with supraglottic airway management in patients with head and neck burns, this group is also at increased risk of requiring emergency percutaneous tracheal access.[4]

There has been resurgent interest in techniques of percutaneous tracheal access since NAP4 showed high failure rates when performed by anaesthetists.[2] Techniques include needle- or cannula-based approaches and open surgical techniques. Clinical opportunities to rehearse such skills are relatively infrequent, and, as a result, training is usually undertaken using part-task manikins, with human or animal cadavers or live anaesthetized animals being used less commonly. Commercially available manikins are usually based on the anatomy of slim adults without pathology. Previous studies reporting training using human cadavers have described exclusion of specimens which were obese or had neck pathology.[5 6] As such, the use of conventional training resources may not prepare clinicians for more challenging situations, particularly performing emergency percutaneous tracheal access in the obese or morbidly obese, or in patients with significant head and neck pathology.

In this study, we have used standard and modified airway manikins to compare their utility in simulating emergency percutaneous tracheal access in obese or burned patients.

Methods

This was a prospective, observational study to evaluate the utility of novel manikins in simulating airway management. Approval for the project was granted by the Trust's research and development department. Ethical approval was not requested.

Subjects and simulation

All 20 consultant anaesthetists in our department, not otherwise involved in the study, were enrolled in the study. The investigators provided written information regarding the study purpose and process, and each subject gave written consent before participating. Subjects completed a short questionnaire designed to determine their prior experience in percutaneous tracheal access in elective and emergency situations, and also how recently they had received training in these techniques.

Each subject was then presented with a clinical scenario for the simulation exercise, constituting a 'can't intubate, can't ventilate' (CICV) situation which required emergency percutaneous tracheal access. The key elements of the scenario are presented in Table 1. They were then asked to volunteer what equipment they would call for in this situation, when managing each of three different hypothetical patients: (i) a slim patient (BMI 25 kg m^{-2}) with no head or neck burns; (ii) a morbidly obese patient (BMI 50 kg m^{-2}) with no head or neck burns; and (iii) an obese patient (BMI 30 kg m^{-2}) with deep full-thickness burns and eschar on the anterior aspect of the neck. If the subject felt unable to volunteer equipment choices, they were offered the equipment available in our hospital for three different techniques: a 13 G Ravussin cannula and Manujet (VBM GmbH, Sulz, Germany) for tracheal cannulation and high-pressure source ventilation; a 5.0 mm cuffed Melker emergency cricothyroidotomy catheter set (Cook Medical, Bloomington, IN, USA); and equipment for a 'surgical' airway comprising a handle-mounted size 20 scalpel blade, a gum-elastic bougie, tracheal spreaders, a tracheal hook, and a size 6.0 mm cuffed tracheal tube. A self-inflating bag was provided for ventilation where the Melker and surgical techniques were chosen.

Table 1 Key elements of the simulation scenario used

You are called to the emergency department to intubate a patient after a house fire
You have given propofol and rocuronium (1 mg kg^{-1})
After multiple attempts, you have been unable to intubate the trachea
Attempts at ventilation using facemask and laryngeal masks have failed
The patient is cyanosed and oxygen saturation is unrecordable
Sugammadex is not available
You are in a 'can't intubate, can't ventilate' situation

Each candidate was then asked to perform emergency percutaneous tracheal access within the simulation scenario, on each of the three hypothetical patients, using their chosen equipment. Each manikin was concealed until the moment the simulation began, at which point a timer was started. Candidates were allowed to change to either of the other two equipment choices at any point, and were told when 3 min had elapsed. The timer was stopped at the first delivery of an effective breath, giving an overall time for success. In addition, split times were recorded when a candidate made a change to their equipment, enabling measurement of time taken for each technique and choice.

The three manikins were presented in a randomized order to minimize the chance of rehearsal bias. Randomization was performed by the investigators using a web-based random number generator (https://www.random.org): each manikin was assigned a 'magnitude' (lowest number='slim' neck; middle number='morbidly obese' neck; highest number='burned obese' neck) then three random numbers were generated in sequence. The order of the sequence determined the order in which the manikins were presented. Randomization was concealed from participants. Each subject was supplied with standard personal protective equipment.

Materials

Three cricothyroidotomy training manikins were used in this study:

(i) 'Slim neck manikin': The unmodified manikin, manufactured by Pharmabotics Ltd (Hampshire, UK), is shown in Figure 1. Key components are a plastic head, neck, and upper torso, housing a soft plastic trachea encased in harder plastic rings (simulating cartilage), with soft synthetic skin and subcutaneous tissue overlying. Thickness of this latter tissue is ≈3 mm and landmarks (thyroid cartilage, cricothyroid membrane) are readily palpable. The manikin was used in its unmodified form to simulate the slim patient.

Fig 1 Unmodified 'slim neck' cricothyroidotomy manikin (Pharmabotics, Hampshire, UK).