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Simulation and education

Emergency skill training—A randomized controlled study on the effectiveness of the 4-stage approach compared to traditional clinical teaching☆

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ABSTRACT

Introduction: The "4-stage approach" has been widely accepted for practical skill training replacing the traditional 2 stages ("see one, do one"). However, the superior effectiveness of the 4-stage approach was never proved.
Objectives: To evaluate whether skill training with the 4-stage approach results in shorter performance time needed for a successful percutaneous needle-puncture cricothyroidotomy, and consequently in a reduced number of attempts needed to perform the skill in <60 s compared to traditional teaching.
Trial design: Randomized controlled single-blinded parallel group study at the University Hospital Bern.
Methods: With IRB approval and informed consent 128 undergraduate medical students were randomized in four groups: traditional teaching, no stage 2, no stage 3, and 4-stage approach for the training of cricothyroidotomy. Everyone watched a video of the cricothyroidotomy as stage 1 followed by skill training in the respective teaching group. Participants had to perform the cricothyroidotomy 10 times on skin-covered pig larynxes. Performance time was measured from skin palpation to trachea ventilation. Study participants filled out a self-rating on competency during the training.
Results: Performance time for each attempt was comparable in all groups and improved similarly to reach a performance time of <60 s. Self-rating revealed that all groups felt equally competent throughout.
Conclusions: Even if the 4-stage approach is widely accepted and used as a didactic method for skill teaching we could not find evidence that its use or omitting stage 2 or 3 results in superior learning of an emergency skill compared to traditional teaching.

1. Introduction

Teaching practical skills are essential in the training of medical personnel. Traditionally, medical teachers explain theory and demonstrate procedure. Then trainees practice on manikins or patients ("see one, do one"). This traditional "2-stage approach" was standard for decades but has been criticised due to inadequate skills acquisition and retention.[1] Furthermore, traditional teaching was challenged by society's reaction to medical errors,[2,3] changes in the medical educational paradigm focusing on student centred teaching,[4] the increasing number of medical students,[5] and the legislative reduction in training time during specialization.[6–9] Under these circumstances a new model for teaching clinical skills was introduced by R. Peyton (Royal College of Surgeons) in the late 1990s, the so-called 4-stage approach.[10,11]

Briefly, teachers first show the skill at its original speed but without any commentary (demonstration phase). Students get a picture of the skill. Trainees move away from an unconscious incompetent level of knowledge.[12]

Stage 2: Teachers repeat the skill, describing and explaining all the necessary theory behind facts and details (deconstruction phase). Trainees observe and ask questions. This brings the student to a conscious incompetent level of knowledge, now knowing the skill but unable to perform it.[12]

Stage 3: Students should know what to do and should be able to explain how to perform the skill properly. The student guides the teacher through the skill while the teacher performs the student's instructions (comprehension phase). The student is thinking and talking through the procedure without the challenge of performing the skill at the same time. Teachers assess student learning and can show and explain what was missed or show them what they do not

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know. Students move from a conscious incompetent to a conscious competent level, knowing what to do while still thinking about the procedures during the skill performance.[12]

The final 4th stage: Students demonstrate and comment the skill procedure (performance phase) combining conscious thoughts about what to do, cognitive skills with sensory motor skills. The teacher provides enough repetition to reinforce learning by correcting mistakes or false concepts.

The educational logic behind the "4-stage approach" seems to be so convincing that it was widely accepted and integrated into teaching programs at various educational institutions (e.g. General Medical Council London,[2] University of Western Australia,[12] American Heart Association,[13] European Resuscitation Council[14]). But besides this widely accepted use, no study has been published showing that the 4-stage approach is superior to traditional teaching methods.

The primary objective of our study was to compare the time needed to successfully perform a percutaneous needle-puncture cricothyroidotomy. Furthermore we compared the number of attempts needed to perform the skill in <60 s, if omitting one of the stages influences the learning outcome, and if there was a correlation between objective skill performance and subjective participant self-evaluation.

2. Methods

2.1. Trial design

This randomized, controlled, single-blinded 4-parallel group trial (balanced allocation ratio of 1:1:1:1) was conducted at the Department of Anaesthesiology and Pain Therapy, University Hospital Bern, Switzerland in 2007/8 (Fig. 1).

2.2. Participants

We asked undergraduate medical students during their obligatory advanced life support course to participate in the study. They were informed about the study, the chance to learn cricothyroidotomy by performing the skill 10 times, that performance time will assess the learning curves and that this time is crucial in re-establishing an obstructed airway. The only inclusion criteria were assigned informed consent and no previous experience in cricothyroidotomy. One hundred and twenty-eight students and the teachers signed informed consent. The cantonal ethics committee of Bern approved the study.

The teachers were anaesthesiologists focused on airway management and emergency medicine. All were ERC, AHA, and ATLS instructors with previous experience in teaching skills following the 4-stage approach. To maintain their cricothyroidotomy skill level these teachers participated in the annual departmental airway management course.

2.3. Interventions

The four teaching methods were:

Traditional teaching (Group 1): Immediately after watching the video participants performed the skill 10 times.
Stage 2 omitted (Group 2): After watching the video (stage 1) participants explained the steps of the skill to the teacher and the teacher performed the skill (stage 3). Then the study participants performed the skill 10 times (stage 4).
Stage 3 omitted (Group 3): After students watched the video (stage 1) the teacher performed the skill again slowly and explained each procedural part with the necessary background (stage 2). Finally students performed the whole skill on their own with teacher supervision (stage 4).
4-Stage approach (Group 4): After watching the video (stage 1) the teacher performed the skill again slowly and explained each procedural part with the necessary background (stage 2). At stage 3 the student told the teacher what to do and the teacher performed the skill. Finally in stage 4 the student performed the whole skill on his own with teacher supervision.

During the study, all students watched a 2-min video of the cricothyroidotomy on prepared skin-covered pig larynxes produced by the TV-Studio of the University Hospital. The emergency procedure and the handling of the puncture set were shown in real time without comment. After that they practiced the cricothyroidotomy according to the assigned teaching method (groups 1–4) 10 times on prepared skin-covered pig larynxes to assure a correct and timely procedure as reported earlier.[15–19] Teachers gave corrective feedback after each attempt if necessary to assure correct performance and no false learning outcomes. Successful cricothyroidotomy was defined as ventilation of the trachea with a standard self-inflating bag connected to the tracheostomy tube.

In short, cricothyroidotomy was performed as follows: The puncture site was located by palpating the soft spot between the cricoid cartilage and the thyroid cartilage of the trachea. The skin was punctured midline at an angle in the caudal direction with an 18-gauge thin-wall needle attached to a syringe filled with 3 mL of water. The trachea was located when air was aspirated into the syringe. The syringe was removed and a 0.035-in guide-wire from the pre-assembled cricothyroidotomy kit (Melker Emergency Cricothyroidotomy Catheter Set C-TCCS-400, Cook Critical Care Inc., Bjaeverskov, DK) was inserted via the needle into the trachea. The needle was removed over the wire leaving the wire in place and the puncture site was enlarged with a scalpel blade no. 15 with about a 4 mm vertical incision. A precurved uncuffed 4 mm tracheostomy tube over a 12-French dilator was inserted into the trachea over the guide wire. The dilator and the wire were removed from the tube leaving the tracheostomy tube in place and the trachea was ventilated with a self-inflating ventilating bag.

To resemble real life as much as possible we used freshly prepared pig larynxes with an intact trachea, skin and subcutaneous tissue around it from the slaughterhouse. Pig skin was fixed over the larynx and trachea as described before.[20] Like in humans, skin and subcutaneous tissue was mobile and tissue resistance to perforation was comparable as well.

2.4. Outcomes

The primary outcome concerning efficacy of teaching was the time needed to successfully perform a percutaneous needle-puncture cricothyroidotomy. The 0-hypothesis was that the 4-stage approach and traditional teaching have equal performance time on cricothyroidotomy in a two-sided test.

Secondary outcomes were: (a) number of attempts to perform the skill in <60 s; (b) number of attempts to reach a cricothyroidotomy time plateau; (c) the influence of omitting stage 2 or stage 3 on performance time and the number of attempts to perform the skill in <60 s; (d) the correlation of objective skill performance (time) and subjective participant self-evaluation.

In manikins Wong[15] arbitrarily defined 40 s using the same puncture kit as we did. Vadodaria[21] confirmed these times on manikins with 38 s. On human cadavers cricothyroidotomy time ranged from about 100 s[17,18] to 109 ± 60 s.[22] Fikkers[20] reported with the same wire-guided puncture technique 129 ± 36 s on prepared pig larynxes. After literature review we defined 60 s arbitrarily as a target time to reach for this life saving skill.