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FACULTEIT GENEESKUNDE EN GEZONDHEIDSWETENSCHAPPEN

Development of a stepwise competency-based training program for chest tube insertion

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FACULTEIT GENEESKUNDE EN GEZONDHEIDSWETENSCHAPPEN

Chest tube insertion (CTI) is an invasive procedure, frequently performed in trauma care and following thoracic surgery. Although potentially life-saving, the procedure is associated with a high rate of complications, ranging from malfunction or malposition of the tube to disability and death.
The efficiency of daily practice, restrictions in resident working hours, and patient safety concerns limit the clinical training of junior residents. As a result, modern medical education is increasingly using simulation based mastery-learning (SBML) programs, in which residents train skills and procedures in simulated settings away from the patient until a predetermined mastery standard is achieved.
The aim of this thesis was to develop a SBML curriculum for CTI, in which residents acquire skill on several simulators prior to patient contact.

Any test or assessment requires validity evidence, demonstrating its objectivity and reliability. **Chapter 3** explores the validity evidence for a test included in the free mobile application Touch Surgery®, which provides residents with a learning and testing phase for several procedures.
This study provided a robust validity argument: the test was able to differentiate between medical students and surgical residents, and between medical students and experienced surgeons. However, its internal structure was not explored. All participants found the application useful and realistic.

An assessment tool with sufficient validity evidence is also needed to assess the technical skills of residents in training sessions and in real life. **Chapter 4** describes a Delphi study in which a panel of 29 European experts was asked to participate in the development of a new assessment tool. The result of this process was the Assessment for Competence in Chest Tube InsertION (ACTION) tool, consisting of a 17-item rating scale, and a 16-item error checklist.
Additional validity evidence for the ACTION tool was collected on a porcine rib model and on Thiel bodies in **Chapters 5 and 6**, respectively. Novice and experienced participants were asked to perform two separate CTIs on each simulator, while being observed and recorded. These recordings were anonymized, and scored post-hoc by three and two blinded raters, respectively.

For the porcine rib model, both the rating scale and the error checklist showed moderate to high reliability. While the rating scale was able to discriminate between novices and experienced participants on the first performance, the error checklist did not observe any difference. A pass/fail score of 44/68 points was calculated for the rating scale, and all participants reported high motivation during the test.
Similar results were found for the Thiel bodies: the rating scale could be used reliably, in contrast to the error checklist. Additionally, experienced participants significantly outperformed the novice group. Again, the error checklist showed no difference between the groups. The calculated pass/fail score for the rating scale was 47/68.

Having confirmed that the rating scale in the ACTION tool could differentiate between different skill levels, a program was proposed in which residents would first train on the porcine rib model, progress to a summative test on Thiel embalmed bodies, and finally graduate to supervised clinical training and practice. **Chapter 7** describes a Randomized Controlled Trial (RCT) to compare the effect of the proposed ACTION curriculum to the traditional residency program. Junior residents were recruited and underwent a baseline test, which evaluated their theoretical knowledge and technical skills on a Thiel body. They were then either enrolled in a dedicated training program where they could train CTI on the porcine rib model until the pass/fail score was reached (intervention) or they participated in their traditional residency program (control). All participants were summatively tested on Thiel bodies at the end of the study.

In this RCT, both the control and intervention group significantly improved their performances between the baseline and summative test. The intervention group outperformed the control group on the summative assessment, highlighting the benefit of the ACTION curriculum. Based on subjective surveys reflecting motivation, both groups showed a comparable decrease in 'perceived pressure' and increase in 'perceived competence'. It should be noted that the intervention group achieved these results over a much shorter period of time than the control group.

In conclusion, the proposed ACTION curriculum has established its efficiency as a training program for CTI, supported by a defensible assessment strategy. Residents who participated in this training program significantly increased their theoretical knowledge, and outperformed their peers who did not receive this training.
This thesis can guide educational stakeholders to consider SBML as an alternative to traditional clinical training, thereby simultaneously improving patient safety and resident education. Future research should focus on implementing this program in residency training, exploring the downstream effects of SBML curricula on patient safety, and the development of SBML programs for several other invasive procedures.