

## Assessment of the use of webcam based workflow detection for providing real-time feedback in central venous catheterization training

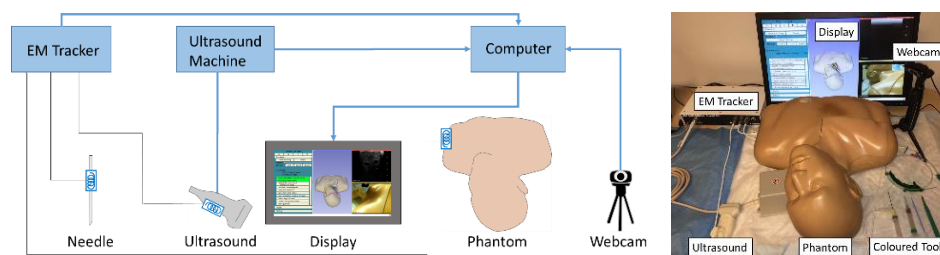
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**Introduction:** Central venous catheterization is an important skill used in several different medical disciplines. The procedure is complex, and requires many steps and multiple different tools. Research has shown that novice residents have complication rates as high as 35% for this procedure [1]. This complication rate can be reduced through the use of simulators. It has been shown that students who first train on simulators show superior performance when compared to those trained using traditional methods [2]. Central Line Tutor creates a realistic training environment that provides residents with real-time instruction and feedback in order to gain competency without risking patient safety. In this work we evaluate the effectiveness of the workflow detection method used.

**Methods:** Central Line Tutor (Fig.1) provides real-time instruction and feedback by assessing which task is being completed at a given time. Tasks that require precise positional information, such as those involved in locating and inserting the needle into the vessel, use electromagnetic (EM) tracking. EM sensors are placed on the phantom, needle and the ultrasound probe. The remaining tasks are detected through the live webcam video using coloured object recognition. The EM tracker, ultrasound machine along with the webcam are connected to a computer which shows the user the ultrasound and webcam videos as well as a 3D model of the setup. While performing the procedure, Central Line Tutor records the positional information from the EM tracker, the ultrasound and webcam videos as well as the timestamps of when key transition points occur. For this study, five trials of the procedure were recorded using Central Line Tutor. Using these recordings five reviewers were asked to identify the same transition points as Central Line Tutor. The times identified by the reviewers were then compared to those identified by Central Line Tutor and were used to calculate the average transitional delay. A negative transitional delay indicates that Central Line Tutor identified the transition point earlier than the reviewers.



**Figure 1:** Central Line Tutor setup

**Results:** The Central Line tutor correctly identified 100% of all 19 transition points in the procedure. The average transitional delay between Central Line Tutor and the reviewers was  $1.5 \pm 0.8$ s. The average transitional delay of tasks detected using the webcam video and those using EM tracking were  $2.5 \pm 3.6$ s and  $0.3 \pm 2.5$ s respectively.

**Conclusions:** Central Line Tutor was able to identify all transition points in the procedure with minimal delay. This shows that Central Line Tutor is able to detect all tasks in the procedure's workflow. The low values of average transitional delay indicate that Central Line Tutor may be used to provide residents with real-time instruction and feedback.

- [1] Kumar A, Chuan A. Ultrasound guided vascular access: efficacy and safety. *Best Pract Res Clin Anaesthesiol.* 2009 Sep;23(3):299-311.
- [2] 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 Jun;86(6):706-11.