Modeling Junctional Tourniquet Skills from Empirical Data

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Taylor Curley
Georgia Institute of Technology

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Bauchwitz, B.[1], Kwan, C.[2], Curley, T.[3] Niehaus, J.[1], Pugh, C.[2], and Weyhrauch, P.[1]

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Background

The control of junctional hemorrhage, a serious life-threatening issue facing combat personnel, has benefited from recent technological advances such as the development of the SAM® Junctional Tourniquet (SJT) and Abdominal Aortic Junctional Tourniquet (AAJT™). Applying these devices correctly is challenging, and existing training processes are highly subjective, leading military medical providers to lack confidence in their ability to use these devices. Military medical training systems that instruct on the use of these tourniquets would benefit from an empirical model of the required skills, enabling targeted instructional design and objective assessment. The Methodology for Annotated Skill Trees (MAST), which has been previously described (Perez et al. 2013), enables hierarchical decomposition of tasks with annotations such as skill descriptions, metrics, and information requirements. Here we describe the use of MAST to create a model of the skills needed to control inguinal bleeding using the SJT. The SJT skill model was developed based on video evidence from a data collection with 46 EMS professionals, interviews with military medical instructors, and instructional material produced by SAM Medical, the manufacturers of the SJT.

Methods

To construct a MAST skill model for applying the SJT, we created a hierarchical skeleton of the steps needed to stop inguinal bleeding with the SJT using instructional material produced by SAM Medical. Using these and other instructional materials, we annotated each step in the hierarchy with knowledge required to perform that step (such as landmarks to identify the iliac artery) and decision-making rules (such as when to stop inflating the hand pump). We then held discussions with experts from SAM Medical and the University of Wisconsin School of Medicine to identify the critical skills at each step. Finally, we conducted a data collection in which we filmed EMS professionals as they attempted to apply the SJT during manikin simulations. During data analysis, participants were categorized as experts or non-experts according to their professional experience and familiarity with junctional tourniquets. Videos were reviewed in detail to determine the types of errors made by the participants, and were then scored on a variety of metrics, including the number and types of errors made as well as time to complete the simulation. Based on the analysis of these videos, we further annotated each step in the skill model by identifying common errors, techniques, learning curves, and metrics for assessing skill mastery, and associating these with different levels of expertise.

Results

The result of this process was a hierarchical MAST skill model describing the tasks for applying the SJT to stop inguinal hemorrhage. This model was annotated with references to instructional material for training each task, decision-making rules for selecting tasks, required knowledge and critical skills for completing each task, learning curves for the critical skills, and metrics for assessing them.

Conclusions

We were able to model the skills for using the SJT to manage inguinal hemorrhage based on empirical data. This skill model includes objective assessment measures to correlate performance with expertise, enabling its use as a training tool.

[1] Charles River Analytics
[2] University of Wisconsin-Madison
[3] Georgia Institute of Technology