An Action-based Task Analysis for Error Prediction in Medical Devices

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Background

Human Error in Medicine

Since the release of the Institute of Medicine medical error report in 1999, human errors in medicine have become of great interest and concern in the medical field. Like other landmark events in the history of human factors, events like this have increased overall awareness of human factors within this domain. Of particular concern are device level incidents stemming from poorly designed interfaces. For some time, literature has suggested that the number of injuries resulting from these types of problems far exceeds that of injuries due to device failures (e.g., Cooper, Newbower, Long, & McPeek, 1978).

Volumetric Infusion Pumps

One pervasive device in medicine that has led to numerous medical error incidents is the innocuous volumetric infusion pump. From the standpoint of pure research, the volumetric infusion pump provides a benchmark medical device on which the development of human-device error evaluation and intervention techniques may be developed and tested.

Methodology

Extended Hierarchical Task Analysis

Six popular volumetric infusion pump models were studied along the dimensions of overall usability and propensity for generating human error. Using hierarchical task analysis (Kirwan & Ainsworth, 1992) as our framework, the devices were analyzed on a variety of common tasks using Norman's (1986) Action theory and Reason's (1997) idea of error "affordances". The introduced method of evaluation divides the problem space between the external world of the device interface and the user's internal cognitive world (Zhang & Norman, 1994), allowing for descriptive and explanatory predictions of error at the human-device level.

Conclusion

Early evaluation of predictions against error reports from the FDA Manufacturer and User Facility Device Experience Database (MAUDE) shows promising results. Nevertheless, further validation of the methodology with data from controlled experiments and computational modeling will be necessary and is currently underway.

The prospect of developing a bulletproof method for predicting human error given an interface and task still seems distant. Nevertheless, the current state of theory and research in human-device error and interaction (e.g., Reason, 1997; Zhang & Norman, 1994) seems sufficient to generate much needed improvement over current techniques. This work represents one such effort.

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