

Deriving Information Requirements for a Smart Nursing System for Intensive Care Units

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The workplace environment for nurses is highly stressful, with long working hours (3 or more 12-hour shifts) and a dynamic workload that may induce fatigue. These factors reduce nurses' efficiency and may contribute to medical errors. The Institute of Medicine (IOM) estimates that in the United States (U.S.) 100,000 deaths are caused by preventable medical errors (Kohn et al., 2002). In the U.S. Intensive Care Units (ICU) alone, 1.7 errors per patient per day are reported (Donchin et al., 1995; Wu et al., 2002). Moreover, it is documented in the literature that stress and fatigue are two important factors that contribute to medical errors in nursing (Wu et al., 2002). Factors that affect nurses' stress and fatigue in the workplace are also well documented (e.g., Foxall et al., 1990; Sawatzky, 1996; Erlen & Sereika, 1997; Meltzer & Huckabay, 2004; McHugh et al., 2011). In previous studies, Khamisa et al., (2016) conducted a longitudinal study of 277 nurses from four hospitals in South Africa. Findings revealed health workforce wellbeing is not prioritized and mostly lacking with existing policies failing to address psychosocial stressors among nurses. The authors suggested the need for further studies using biomarker assessments and other cellular variables to investigate the health impact of stress, burnout and job satisfaction. In recent years, the advancement in technology has made wearable tools such as smartwatches easily accessible and widely used (Jovanov, 2015). Despite these advances, there are no validated intervention, continuous monitoring systems or tools to mitigate ill effects of stress and fatigue among nurses in critical care areas such as the ICU (Khanade et al., 2017). It is evident in the literature that accurate detection of stress and fatigue levels remains a research gap; one explanation for such gap would be that such tools could potentially be intrusive and interrupt an already complex task of working in a critical care area. In spite of the challenges, a system that provides continuous monitoring and alerts regarding abnormal physiological reactions might help in increasing nurses' awareness regarding personal responses to their tasks and environment and may contribute to improved patient safety and nurses' well-being. By making this information visible, these systems may also help nurse managers and administrators to improve work environment practices to reduce stressful tasks and reduce effects of fatigue and stress on their nurses. This current study focus is to address the research gap of accurate detection of stress and fatigue levels. A smart wearable system is being designed to help nurses who experience high levels of stress and workload at work. This paper documents the systematic process of deriving information requirements from two focus groups conducted with delivery care nurses and nurse managers working in various Southeastern Texas hospitals. A focus group was conducted to obtain a more in-depth understanding of nurses' expectations of a tool that can help with periods of high-stress and fatigue as well as some of the problems nurses face in their daily work life. The second focus group was conducted to inform the design of an information display for nurse managers to monitor the ICU unit's status in terms of collective stress and fatigue levels. A moderator and two co-moderators led the focus group interviews. Previously formulated questions were presented to the group to guide the discussions. There were 13 questions followed by probing questions to obtain more information or clarification. Questions were organized into four groups to investigate 1) participants' task/roles, 2) situations where high-levels of stress/fatigue are experienced and

their effects on performance, 3) expectation from a tool to help in those instances, and 4) specific expectations from a smart-watch (or supervisory-control) interface. The feedback from participants was documented as FIRs. The FIR method provides a set of design-independent requirements that can be used as objective assessment of needs for displays. Additionally FIRs served to inform the design of a smartwatch-based tool for nurses and supervisory-level interface for nurse managers. While the overall findings from the focus groups are discussed in the paper, the FIRs are out of the scope of this short paper and will be reported elsewhere. The study also sought to determine how the use of technology could assist nurses during the periods of high stress and/or workload.

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