# Managing Nurse Cognitive Load in Emergency Patient Care Situations with Decision-Making Aids

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*Abstract*— In an emergency setting, patient status can change in seconds, and failure to react in a timely manner can pose significant risks to patient outcomes. Nurses are responsible for processing large volumes of complex information in a limited time, which can result in high cognitive load (CL). With the advent of new technology, tools such as augmented reality (AR) can be utilized as an aid to nurses in decision making (DM). Previous interviews indicated experienced nurses thought AR could be beneficial in nursing education. Based on this feedback, the team constructed a virtual checklist to leverage clinical judgment for novice nurses. This pilot study aims to determine whether using the Microsoft HoloLens, an AR device, to display a virtual checklist will reduce CL in novice nurses.

***Keywords— Augmented Reality, Novice Nurses, Decision Making, Cognitive Load***

## I. Introduction

### A. Challenges in Nursing

When nurses care for a patient, they have to quickly make decisions such as when to escalate care and determine what information is salient to the patient's status. Managing all these tasks can impede cognitive performance. CL is the level of demand imposed on working memory as an individual processes information. The psychological impacts of stress, which acts as a CL, can cause significant detriment to cognition. As we try to balance the demands of an environment and a task, divided attention occurs; this and competition for mental resources results in extensive stress [1]. Under CL combined with time-sensitive situations, automatic processing will be activated, and DM is impacted [2]. Data on HRV can help understand the CL novice nurses experience, and improve performance.

Decision making for novice nurses is particularly challenging. They lack the exposure and confidence of experienced nurses. Novel situations, which impose high load on working memory, are often encountered [3]. This can lengthen time to diagnosis and impede DM. High stress situations impose a significant CL. Experience facilitates the use of unconscious DM [4]. This exposure permits the clinician to access more short-term memory [5]. AR could bridge the gap in ability between novice and experienced nurses, improve patient outcomes, and reduce CL.

## II. Methods

### A. Study Design and Data Analysis

Following Purdue University Institutional Review Board approval, participants were recruited. Participants were all final year students in the Purdue Nursing School. Following their informed consent, nurses completed a demographic questionnaire detailing their experience. During this time, we collected three minutes of baseline heart rate data. Nurses were equipped with the Microsoft HoloLens. A member of the study team gave an SBAR handoff. Once the participants entered the room the scenario began. The team recorded HR data to measure CL throughout the scenario. The HoloLens displays the virtual checklist, throughout simulation, of items experienced nurses attended to in an identical situation. The scenario was comprised of two phases; the initial phase where a general patient assessment was performed and the change in status phase. In the first phase, the patient was responsive and vital signs are unremarkable. The change in status phase was marked by the rapid onset of stroke symptoms. Upon contacting the rapid response team, the scenario ended. After the scenario, participants completed the NASA-TLX survey, to gauge subjective CL. The root mean square of successive differences (RMSSD), low frequency high frequency Fourier transform (LF/HF FFT), low frequency high frequency ratio autoregressive (LF/HF AR) and mean relative risk (MeanRR) data serve as an objective measure of CL since it is difficult to control physiologic responses, when compared to surveys.

To determine normality we performed the Shapiro-Wilk. The data failed the test for RMSSD, LF/HF FFT, LF/HF AR, and MeanRR, so we performed a Mann-Whitney U test to determine differences between groups.

## III. Results

Twenty-nine novice nurses completed the study. Of the twelve individuals in the control group, one hundred percent were female. The experimental condition, with 17 individuals, was almost 90 percent female with two male participants.The Mann-Whitney U test showed no significant differences in relative values between control and experimental groups. The p values for RMSSD, LF/HF FFT, LF/HF AR, and MeanRR were 0.711, 0.711, 0.227, and 0.152. Effect sizes for the RMSSD, LF/HF FFT, LF/HF AR, and MeanRR are 0.041, 0.152, 0.596, and 0.685 respectfully. Average values for the four metrics previously listed are displayed in the Figure below.

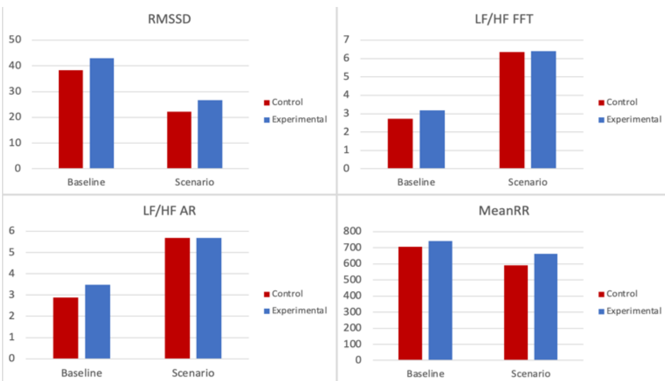


Figure 1: Mean values across conditions for AOIs

## IV. Discussion

The research team sought to understand the potential for applying AR in a clinical setting for novice nurses. Error rates for novice nurses are between 49% and 53%. One of most common sources of error is delay in care and failure to intervene. For novice nurses, it as high as 37% [6]. Critical attributes that can impede nurse DM are time management, critical thinking, and confidence. Around 80% of patient care errors were attributed to perceived time pressure [7]. Under time pressure, quality of behavioral choices worsens. HRV will decrease when CL is high. Unlike seasoned nurses, novice nurses are less comprehensive in their patient assessment. Novice nurses struggle with situational awareness, an understanding of a situation and its causes, which helps anticipate outcomes and inform the DM process. For both groups, RMSSD was lower and LF/HF was higher for the experiment than baseline values. This indicates the scenario is eliciting stress for the participants.

### A. *Limitations and Future Work*

The small sample size of the study serves as a limitation. Due to the limited sample size we also assessed the independent sample effect size. Effect sizes are small for the RMSSD and LF/HF FFT. However, LF/HF AR and MeanRR have large effect sizes. Since there was not a statistically significant difference in these variables, we may have experienced a Type II error, which indicates we falsely accepted the null hypothesis. Further data collection is warranted. Also, the subjects are all from one school. Also, during the scenarios another student was present, which may have impacted the CL data. Using the HoloLens could be overwhelming. If participants were habituated to using the technology, it could be helpful, but we did not control for this which could have impacted findings.

The HoloLens has the potential to be utilized as a training tool to perform realistic simulations without the pressure or risk. It could be more useful in a clinical setting, where actual patients are involved. There, stress levels are reflective of what a nurse would typically experience. The team could provide dynamic feedback, based on physiologic data, directed to a specific point in the scenario rather than an invariable list. Alternatively, the team could adapt the checklist based on feedback from students. In nursing education, students could engage in the technology in a low risk setting that can allow them to establish confidence and familiarity with situations and reduce their CL.

## V. Conclusion

Our team's goal was to test the efficacy of our AR checklist in reducing CL for novice nurses. We found that the virtual checklist did not affect significant change in CL based on the HRV analysis in initial test. However further tests focused on effect size indicate a difference between conditions in two of the HRV metrics suggesting the HoloLens contributed to appreciably lower stress than controls. Students indicated the checklist served as a valuable starting point, but perhaps more comprehensive or individualized items are needed.

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