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Response of Flight Nurses in a Simulated Helicopter Environment

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A B S T R A C T

Objective: The purpose of this study was to determine if a helicopter flight simulator could provide a useful educational platform by creating experiences similar to those encountered by actual flight nurses.
Methods: Flight nurse (FN) and non-FN participants completed a simulated emergency scenario in a flight simulator. Physiologic and psychological stress during the simulation was measured using heart rate and perceived stress scores. A questionnaire was then administered to assess the realism of the flight simulator.
Results: Subjects reported that the overall experience in the flight simulator was comparable with a real helicopter. Sounds, communications, vibrations, and movements in the simulator most approximated those of a real-life helicopter environment. Perceived stress levels of all participants increased significantly from 27 (on a 0-100 scale) before simulation to 51 at the peak of the simulation and declined thereafter to 28 ($P < .001$). Perceived stress levels of FNs increased significantly from 25 before simulation to 54 at the peak of the simulation and declined thereafter to 30 ($P < .001$). Perceived stress levels of non-FNs increased significantly from 31 before simulation to 49 at the peak of the simulation and declined thereafter to 25 ($P < .001$). There were no significant differences in perceived stress levels between FNs and non-FNs before ($P = .58$), during ($P = .63$), or after ($P = .55$) simulation. FNs' heart rates increased significantly from 77 before simulation to 100 at the peak of the simulation and declined thereafter to 72 ($P < .001$).
Conclusion: The results of this study suggest that simulation of a critical care scenario in a high-fidelity helicopter flight simulator can provide a realistic helicopter transport experience and create physiologic and psychological stress for participants.

Flight nurses (FNs) require extensive and ongoing training to perform their jobs adequately. Current methods to prepare FNs are expensive and time-consuming, partially because of the low flight volume and relatively few critical experiences encountered during FN orientation. The helicopter emergency medical service (HEMS) industry relies heavily on actual patient transports to develop FN competency within the helicopter environment (ie, learning on the job).

The use of simulation has become widespread to train health care professionals in critical and emergency care settings[1] and is increasingly prevalent in the HEMS industry. Although the impact of simulation on patient-oriented outcomes is unknown,[2–4] most participants report increased confidence and feeling better prepared for actual clinical practice after simulation training.[5–8] Winkelmann et al[9] recently showed beneficial effects of simulator-based medical training in experienced emergency air medical staff. Although increasingly used, the degree to which high-fidelity flight simulation can replicate actual FN experiences remains unknown. Therefore, the purpose of this study was to examine whether simulation of a critical care scenario in a high-fidelity helicopter flight simulator could provide a realistic helicopter transport experience and create physiologic and psychological stress for participants.

Methods

Design

A mixed methods exploratory descriptive study was conducted, and internal investigational review board approval was obtained

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(2016-1520). The 2 primary objectives were 1) to identify which components of the high-fidelity flight simulator most replicated that of a real-life helicopter environment and 2) to determine if patient care simulation in this simulated helicopter environment could create a stressful event with measurable changes in heart rate (HR) and perceived stress survey scores.

Setting and Sample

Simulation of an emergency critical care scenario occurred in a patient care high-fidelity helicopter simulator fabricated using a retired Sikorsky S-76 aircraft frame with a medically configured interior. All participants were age 18 years or older, able to read and understand English, and either a current registered nurse working in HEMS or a non-FN. Participants were directed to avoid caffeine before the study, and those taking medications for asthma, heart problems, blood pressure, thyroid, depression, anxiety, and/or a cold were excluded from HR analysis. All participants were later subdivided into 2 groups for analysis: group 1 included all FNs, and group 2 included non-FN participants (ie, paramedics and emergency/critical care nurses).

Study Protocol

Subjects were exposed to a clinical scenario an FN is likely to encounter in practice. Participants were asked to transport a patient having an active inferior wall ST-segment elevation myocardial infarction and were expected to manage the following conditions: hypotension after receiving sublingual nitroglycerin, stable ventricular tachycardia, and ventricular fibrillation (V-fib) cardiac arrest. All participants were exposed to the same simulation lasting 15 minutes and the same preprogrammed patient scenario using the ALSi (iSimulate Pty Ltd, Albany, NY) platform. ALSi runs on 2 iPads (Apple, Cupertino, CA) and uses 1 iPad as a controller (the facilitator) and the second iPad as the student display.[10] Physiologic stress was measured with HR using a Polar RS400 (Polar Electro Oy, Kempele, Finland) monitor, and psychological stress was measured via self-report using a perceived stress sliding bar scale with values ranging from 0 (no stress) to 100 (most stress).

To limit possible confounding of the crew partner effect on stress level, the same research assistant acted as each subject's partner during simulation. Researchers anticipated that the layout of the provided medical equipment (ie, medical bags) would differ from what participants were accustomed to in their normal setting. The inability for participants to find equipment rapidly may have created stress and confounded results. Therefore, for our simulation, researchers informed participants that the research assistant was familiar with the medical equipment and how to operate the monitor. Participants were instructed to direct our research assistant as needed for patient care. Interventions within our scenario were designed and timed so they could be completed by a single individual. Each FN participant was informed that he or she was considered to be the team leader and to assign, as much as possible, specific tasks to the research assistant who would then provide patient intervention.

Once the simulation was finished and stress measurements obtained, subjects completed an online Qualtrics Survey (Qualtrics, Provo, UT) using a computer located next to the flight simulator. Demographic data, work history, and prior simulation experience were reported by all participants. FNs were questioned about which components of the flight simulator were similar to a real-life helicopter environment. The non-FNs (group 2) were not offered this line of questioning. Data indicative of participant performance during the simulation were collected to determine whether or not the patient was managed appropriately. Appropriate patient management was defined as 1) fluid bolus given to correct hypotension after the patient was given nitroglycerin in the setting of an inferior wall ST-segment elevation myocardial infarction, 2) application of defibrillation pads either before or during a 10-second run of ventricular tachycardia, and 3) rapid identification ($0 < 30$ seconds) with subsequent immediate defibrillation of witnessed V-fib arrest. Patient management information was collected for internal assessment of participant performance and to guide the debriefing component of the simulation.

Measurements and Key Outcome Measures

Realism of the simulator was assessed via a survey using a 7-point Likert scale (strongly agree, agree, somewhat agree, neutral, somewhat disagree, disagree, and strongly disagree). We developed the realism survey by incorporating traditional physical senses of sight, hearing, smell, and touch into our assessment. After simulation, participants with experience in HEMS rated the sounds, vibrations, smells, views, movements, and overall experience of the simulator compared with their own real-life experiences.

Evaluation of the stress response was performed using HR and perceived stress with repeated measures analysis of variance (ANOVA) at 3 time points: mean HR before the simulation, peak HR during simulation, and mean HR after the simulation. Polar RS400 HR monitors were applied immediately after written consent was obtained, and HR was recorded in a single continuous measurement at 5-second intervals. The RS400 has proven reliability measuring HR with correlation coefficients ranging from 0.97 to 1.00.[11] HR before simulation was obtained while subjects sat in a chair for 10 minutes. We used the mean HR of the final 2-minute period (minutes 8-10) as our HR time 1 measurement. Participants then proceeded to simulation, and the peak HR during simulation was our time 2 measurement. Once the simulation was completed, subjects returned to the same chair, and the post-simulation HR was collected for an additional 15 minutes. The mean HR recorded during the 2-minute period between 40 and 42 minutes was used as the time 3 measurement. Perceived stress levels were recorded using a 0 (none) to 100 (most) sliding bar scale immediately before simulation (ANOVA time 1). Peak and post-simulation stress levels (ANOVA times 2 and 3) were measured immediately after simulation.

Data Analysis

Survey data were collected directly from participants with the Qualtrics Survey platform via a personal computer and then imported into IBM SPSS Statistics 24.0 (IBM, Armonk, NY) for analysis. HRs were extracted from the Polar RS400 using Polar ProTrainer 5 software and then exported into Excel (Microsoft, Redmond, WA). Mean before, peak during, and mean postsimulation HRs were calculated for each participant in Microsoft Excel and then imported into SPSS Statistics 24.0 for analysis. Descriptive statistics were used to identify outliers, data entry errors, and variable distributions in preparation for analysis. Tabulations were also used to examine participants' perceptions of the simulator compared with a real-life helicopter.

Researchers examined the change in participants' perceived stress levels and HRs for times 1 through 3 using repeated measures ANOVA. Model assumptions, including sphericity and linearity, were verified using the Mauchly test and the Shapiro-Wilk test, respectively. All variables approximated a Gaussian distribution; however, the Greenhouse-Geisser correction for sphericity was used to reduce the likelihood of type I error in the absence of equal variances. Bonferroni post hoc comparisons and linear contrasts were used to determine whether stress responses significantly varied over the 3 time points. Alpha was set a priori at .05.