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Efficacy of Medical Device Alarm Integration into a Simulated H-60 Integrated Communication System

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[1]U.S. Army Aeromedical Research Laboratory; [2]Goldbelt Frontier, LLC
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14. ABSTRACT

Objective: The goal was to study the efficacy of incorporating audible medical device alarms into a simulated aircraft Intercommunication Set (ICS). The effect of integrating these alarms on care-provided and time delegation was examined. Subjective data was also collected from the subjects regarding the benefits, drawbacks, and improvements they recognized during participation.

Methods: Subjects performed patient care tasks for two 30-minute scenarios. Each scenario had two priority-level patients, which were preprogrammed to have four decompensation events each. During one configuration the audio alarms were integrated into the subject's ICS, and the other was non-integrated (the current standard). Testing took place in an HH-60 simulator with a Baseline Medical Interior (BMI) litter system. The subjects were given all supplies in the current Medical Equipment Set (MES) and given time to configure the interior of the simulated aircraft as they normally would. The patients were simulated with SimMan3G manikins, which displayed vitals on Zoll Propaq MD patient monitors via a Dynasthetics VitalsBridge 300. Subjects wore a Head Gear Unit Number 56 Personal (HGU-56P) helmet with Communication Ear Plugs (CEPs).

15. SUBJECT TERMS

Integrated Communication Set, ICS, communication ear plugs, CEPs, U.S. Army, helicopter, HH-60, Baseline Medical Interior, BMI, Medical Evacuation, MEDEVAC, patient care, medical device, monitor, vital signs, alarms, proof-of-concept, time delegation, response time, decompensation, questionnaire, Flight Medic, Critical Care Flight Parameic, CCFP, SimMan3G

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14. Abstract (continued)
Medical device alarms were integrated into the subject's CEPs via a custom-built ICS system equivalent, and all audio levels were measured prior to testing.

Inclusion Criteria: Subjects were required to be U.S. Army Active-duty, Reserve, or National Guard Critical Care Flight Paramedics, who were in good health and able to perform their duties, and who possessed normal hearing (which was verified by audiogram).

15. Subject Terms (continued)
Dynasthetics VitalsBridge, Zoll Propaq MD

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Efficacy of Medical Device Alarm Integration into a Simulated H-60 Integrated Communication System

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Acknowledgements

This work was supported by the Fort Rucker DUSTOFF Training Complex, who provided the site for the project walkthrough.

The USAARL Fabrication Shop built a custom HH-60M simulator to support this and other Medical Evacuation Research Team (MERT) projects.

The USAARL Warfighter Performance Group lent MERT their audio expertise to help lay the groundwork for this study.

Several USAARL-affiliated Soldiers assisted in performing data collection.

This research was funded by the Defense Health Program, under proposal number DM167047.

Background

- Medical devices are used in the aeromedical environment, but their alarms cannot be heard due to ambient noise.
- Flight Medics must rely on visual alarms, which may not be visible due to:
  - Lighting conditions
  - Position of the Medic
  - Position of the device
  - Blackout conditions

Objectives

- Examine the efficacy of incorporating medical device audio alarms with aircraft intercommunication set (ICS).
  - Effect on care provided and time delegation
  - Potential benefits, drawbacks, and improvements

Test Configurations

- Subjects performed patient care tasks for two 30-minute scenarios:
  - Scenario 1: Device alarms integrated into simulated aircraft ICS system
  - Scenario 2: Device alarms not integrated (control condition)
- Multiple audio inputs were integrated into the Medic's ICS Communication Ear Plugs (CEPs).
  - Integrated Configuration only - Medical Device alarms (~85 decibels [dB])
  - Medical Validator microphone (~80 dB)
  - Aircraft ambient noise (~75 dB, adjusted)
- Each scenario utilized two simulated patients.
- Each simulated patient was pre-programmed to have four decompensation events to trigger device alarms (eight total per scenario).

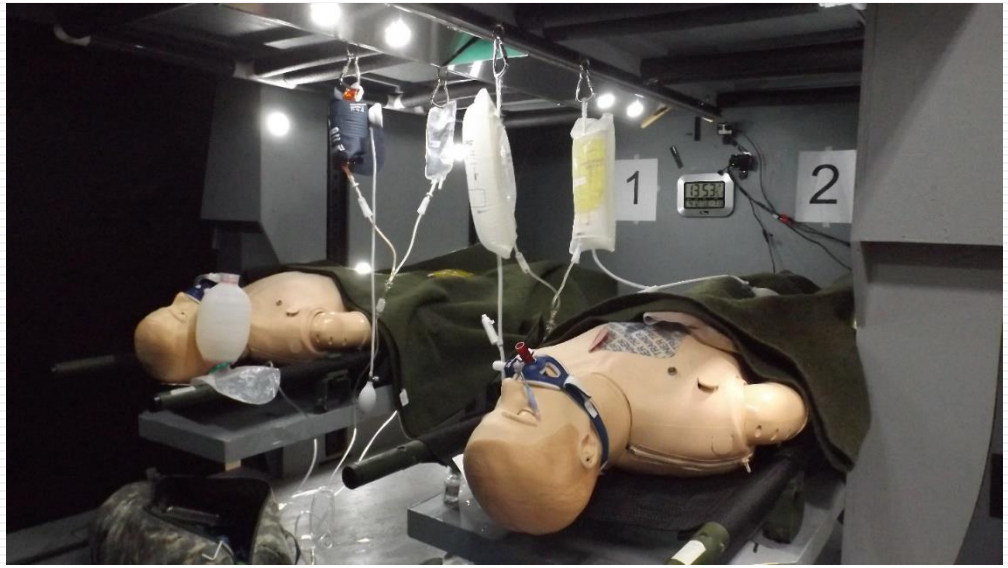
HH-60 Black Hawk Cabin Simulator

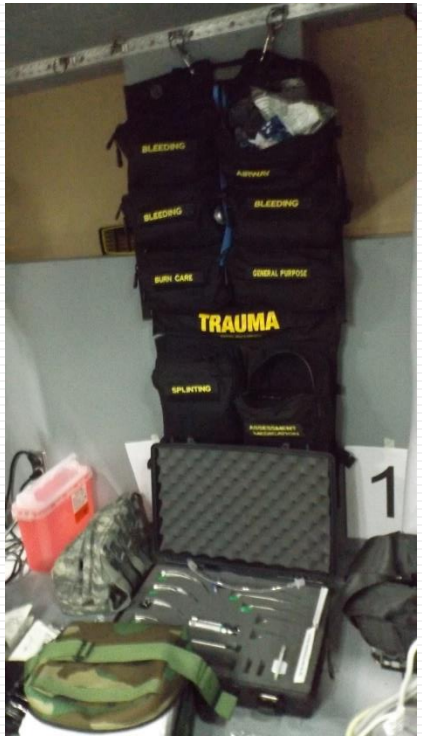
(created by the USAARL Fabrication Shop)

Pictured with configurable interior and exterior panels removed.

Medical Interior Setup

- Two-patient, two-monitor configuration.
- Baseline Medical Interior (BMI) Litter System.
- Provided Medics all medical supplies listed in the current medical equipment set (MES).





Patient Simulators and Monitoring Devices

- Smart manikins produced digital vital signs.
- Interfacing devices bridged the patients and patient monitors.
- Patient monitors were used to display vital signs.
  - Currently used in the MES.

Simulated ICS System

- A custom ICS-equivalent was built to afford the research team easy volume control and amplification for all audio inputs.
- Audio levels within the headset were measured before each run using a test fixture and sound-level meter.

Inclusion Criteria

- Critical Care Flight Paramedic.
- U.S. Army Active-duty, Reserve, or National Guard.
- In good health and able to perform their duties.
- Normal hearing (audiogram).

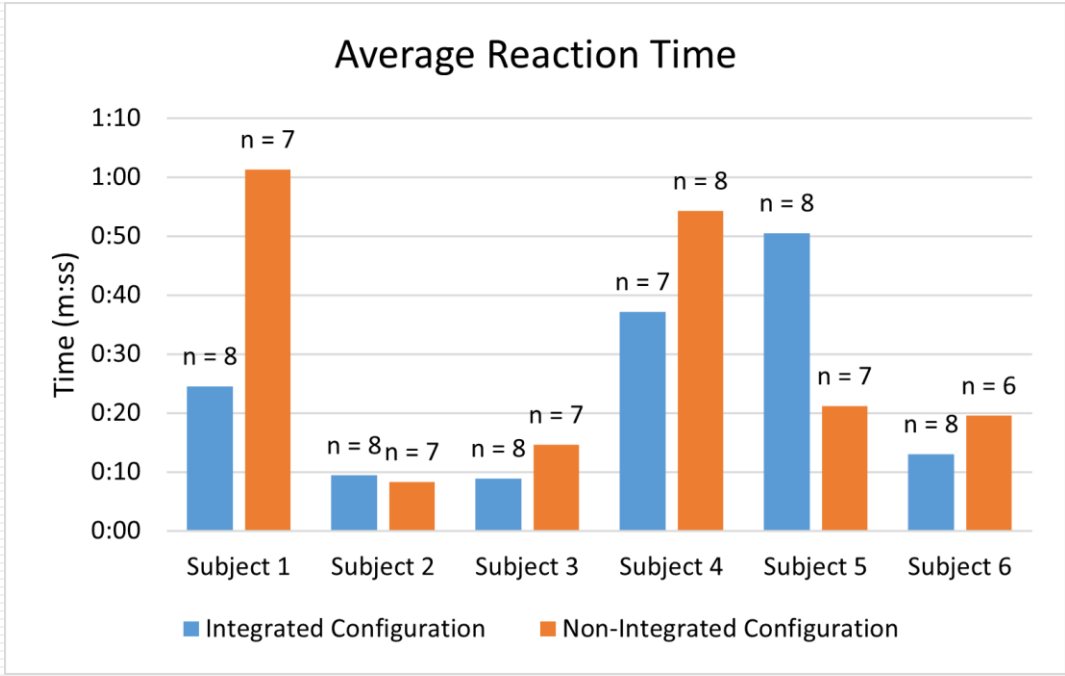
Note: Inclusion criteria did not control for Medic experience level.

Sample Size

Although the initial recruitment goal was at least 15 subjects, only 6 completed data collection due to the effects of the COVID-19 pandemic (travel restrictions, illness, cancellations, etc.).

Results

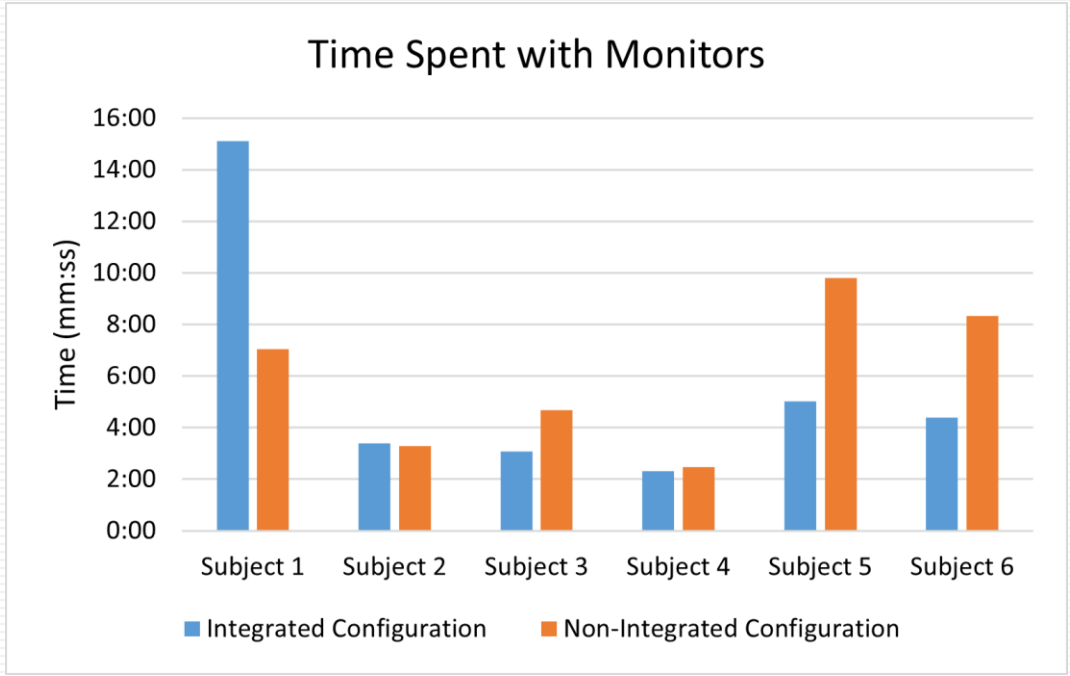
- Reaction Time was measured from when the alarm sounded to when the Medic acknowledged it.
- Determiners of acknowledgement:
  - Verbal
  - Looked at monitor and began treating alarm source
- Integrating alarms decreased Average Reaction Time for 4/6 subjects and increased it for 2/6 subjects.



Note: *n* = # represents the number of alarms that the Medic reacted to during the scenario.

Results

- Time Spent with Monitors definition:
  - Time spent looking at monitor
  - Time spent physically interacting with monitor
- Integrating alarms decreased time spent with the monitors for 3/6 subjects, had no significant effect for 2/6 subjects, and increased it for 1/6 subjects.
- Due to equipment failure, Subject 1 had a different monitor interface than Subjects 2-6.



Statistical Analysis

- There was no statistically significant difference between configurations shown in the time data.
- Study does not have sufficient power for conclusive statistical analysis.
- Subject 1 was excluded from the statistical analysis due to the difference in monitors.

Medic Feedback Summary: Considerations Regarding the Integration of Medical Device Alarms into the ICS

Improvements

Drawbacks

Benefits

Medic Feedback Summary: Benefits Category Highlights

Sub-category	% of Medics that provided response	# times response was given
Improves patient care	100%	25
Would be useful/crucial/essential/ a game changer in real world application	50%	5
Confidence in hearing alarms, notification of patient status change	50%	4

Medic Feedback Summary: Drawbacks Category Highlights

Sub-category	% of Medics that provided response	# times response was given
Alarms were or could be distracting	83.3%	7
Communication	50%	3

Medic Feedback Summary: Improvements Category Highlights

Sub-category	% of Medics that provided response	# times response was given
Different alarms for different devices and vitals	66.7%	5
Capability of remote control/silencing of alarms	50%	4

Time Data

- More subjects would be required to have sufficient power for statistical significance.
- Average reaction time improved in the integrated configuration for 4/6 subjects.
- Time spent with monitors was reduced in the integrated configuration for 3/6 subjects.
- Participants spent most of their time in every scenario performing medical tasks and multi-tasked often.

Questionnaire Responses

- Generally positive response to alarm integration.
  - All Medics indicated that they perceived integration to improve patient care.
  - The most frequently mentioned benefits were Prevention of Inattention to Vital Signs and Quick Notification of Patient Status Changes.

- Significant drawbacks were noted, some of which can be compensated for:
  - Alarms distract and interfere with communication – Remote volume control
  - Would distract pilots/crew – Isolate alarms

Conclusions

- The time data shows indications of alarm integration being a benefit to the Medics, which is supported by strongly favorable subjective questionnaire responses.
- Integrating medical alarms into the ICS seems to have the potential to be helpful to Medics with some improvements.
- The results show that performing follow-on studies which further develop and examine the integrated alarm system are warranted.

Questions?

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