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Title: Development and Enhancement of a Model of Performance and Decision Making Under Stress in a Real Life Setting

Institution: University of Maryland at Baltimore and Maryland Institute for Emergency Medical Systems

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Colin F. Mackenzie 22% Peter Hu 5%
William Bernhard 5% Paul Delaney 5%
Cliff Boehm 5% Denise Ovelgone 50%
Yan Xiao 30% Robert Durocher 50%
John Wesolowski 5% Ben Harper 50%
Sandy Hunter 5% Sub-contract Man-Made Systems Corp.
Andy Trohanis 5% Richard Horst 20%
Jim Brown 5% David Mahaffey 33%

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Annual Report Summary for ONR Grant # N00018-91-J-1540

1. Brief Overview
We have concentrated our analysis on 50 of over 100 videotapes acquired of trauma patient resuscitation and anesthesia. The management of the airway (tracheal intubation) in these 50 videotapes was classified into three types of situations: emergency (<10 min after patient admission), semi-emergency (<30 min after patient admission) and elective. Such a classification allowed us to contrast the impact of stress on performance and team activity. The following data were collected and analyzed under this classification: (1) Subjective ratings of stress made every minute for 10 min before (when available) during and for 10 min after tracheal intubation. (2) Transcription and coding of communications occurring during same time period. (3) Plotting of patient vital signs and identification of points where previously constructed decision-trees are activated. (4) Acquisition of anesthesia care providers’ heart rate and rhythm electrocardiograms and ambulatory blood pressure monitoring of anesthesia care providers during provision of elective and emergency airway management and non-anesthesia activities. (5) Task analysis of tracheal intubation and identification of task omission, task shedding, relationship with subjective ratings of stress and performance of tracheal intubation. (6) Inter-rater reliability analysis of subjective ratings of stress and neural network prediction of perceived stress from weighted combination of subjective ratings of stress. (7) Comparison of errors identified by videotaping and self-reports including the anesthesia record, anesthesia quality assurance reports and the questionnaire completed immediately after videotaping. (8) Examining Task Complexity and its implication for team coordination using data from the post-trauma questionnaire we analyzed task conditions in emergency and non-emergency circumstances. (9) Extracting patterns of team coordination and identifying major decision points through activity analysis.

As a result of these analyses, we have illustrated several factors that may have contributed to untoward incidents[^1,^3], identified the impact of task complexity on team coordination patterns[^8], and investigated the linkage between task performance and communication failures[^2]. We found that compared to other means of incident reporting (e.g. post-trauma questionnaire and quality assurance report), video analysis has the advantage of identifying the root causes of errors[^5,^9]. Through artificial neural network simulation and inter-rater reliability analysis, three subjective ratings were found to be reliable indicators of stress: time pressure, workload and uncertainty. Currently, we are primarily focusing on activity analysis to test several models of team coordination and decision-making, and on the analyses of differences between expert and novice performance and examination of recovery from errors.
2. **High-lights of accomplishments**

(1) **Physiological responses to stress in real environment.**

Anesthesia care providers were asked to wear Holter (ambulatory electrocardiographs) and blood pressure monitors during trauma patient resuscitation. We have observed dramatic differences in both heart rate and blood pressure between cases where patient conditions were life-threatening and those cases where conditions were not so (Fig. 1). Currently more physiological data of the anesthesia care providers are being collected and analyzed. Ambulatory monitoring of physiological data of practitioners in real life situations is difficult, but it provides critical information about the impact of stress and the base for evaluating subjective assessment of stress. The data we have collected reflect the response of anesthesia care providers to stress caused by real-life experience, and are thus particularly valuable.

![HR 63/min BP 122/75 ELECTIVE NON-EMERGENCY AIRWAY MANAGEMENT](image1)

![HR 156/min BP 156/106 EMERGENCY AIRWAY MANAGEMENT](image2)

**HOLTER MONITOR + AMBULATORY BP**

**MONITORING OF ATTENDING ANESTHESIOLOGIST**

Fig. 1. Ambulatory electrocardiogram monitoring of an anesthesiologist during elective tracheal intubation (top panel) showing normal blood pressure and heart rate. The same anesthesiologist two hours later dealing with an emergency intubation has over twice the heart rate (lower panel) and clinically significant diastolic hypertension.
Video analysis as an effective tool for diagnosing root causes of human errors. Human errors have been blamed as the cause of many accidents, but eliminating human error and alleviating the impact of errors is a challenge. One approach is to diagnose the root cause of these errors, be they ergonomic, social, training-related, or organizational.

We compared the results of video analysis with three types of records that can be used for incident investigations: post-trauma questionnaire (filled by anesthesia care providers immediately after each case), anesthesia record (on-line logs of anesthesia care), and anesthesia quality assurance reports, and evaluated the values of each as a means to diagnose the root causes of errors. Fig. 2 is the summary of the comparison.

The results of the comparison show that video analysis can be used to identify some of the root causes (which we termed "system failures") of human errors, whereas self-reports, on-line logs, and quality assurance reports provide little information on potential problems in areas such as training, equipment, and social factors (e.g. production pressures).

Given the advances in video recording technology, this finding provides us with adequate justification for using video analysis as a means to diagnose causes of human errors and to make systems more reliable and more efficient.

Meeting series on Team Performance Analyzing Techniques (TPAT).
We held a series of 4 meetings in the Anesthesiology Research Laboratories at the University of Maryland to which we invited researchers working in the area of team performance in stressful environments. The participants included (alphabetical order) Richard Botney, Micheline Chi, Susan Chipman, David Gaba, Joan Hall, Richard Horst, Susan Kirschbaum, Colin Mackenzie, Judith Orasanu, Daniel Serfaty, Gray Wanye, and Yan Xiao. The themes of each TPAT meeting were different and related to video analysis techniques, inter-rater reliability assessment, communication analysis and decision modelling. We prepared a white paper summarizing each meeting. As a result of these meetings two successful collaborations occurred. The first was with Judith Orasanu of NASA and the second with Daniel Serfaty of AlphaTech. Pre-proposals have been submitted to NASA and ONR for possible funding of these collaborations.
Publications during reporting period


Under Review - Submitted


INVITED PRESENTATIONS


CONTRIBUTED PRESENTATIONS


ONR ANNUAL PRODUCTIVITY REPORT, 01 OCT 1993 TO 30 SEPT 1994

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Project Title: Development and Enhancement of a Model of Performance and Decision-Making Under Stress in a Real-Life Setting

Number of ONR supported:
- Papers published in refereed journals: 3
- Papers accepted for publication in refereed journals: ___
- Papers or reports in non-refereed journals: 2
- Books or book chapters published: ___
- Books or book chapters in press: ___
- Papers Submitted in refereed journals: 4

** Attach list of papers and other publications with full citation.**

Number of ONR supported patents/inventions filed 0 or granted 0, with patent numbers:

** Attach title and brief description of patents/inventions, if any.**

Number of Presentations:

Invited: 6
Contribution: 3

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