(2)

ONR Grant #N00014-91-J-1540

Report Date: August 20, 1992 Quarter #: 5

Report Period: 05/01/92 - 08/01/92

P.I.: Colin F. Mackenzie, M.D.

Tel: (410) 328-3418
E-MAIL LUNGCD@UMAB.UMD.EDU
FAX: (410) 328-2550

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

Current staff with percent effort of each on project:

Colin F. Mackenzie	22%
William Bernhard	5%
Kevin Gerold	5%
Brian McAlary	5%
Kenneth Dauphinee	5%
Michael Parr	5%
Andy Trohanis	5%
Jim Brown	5%
Peter Hu	5%
Paul Delaney	5%
James Black	50%
GRA - TBA	50%

Sub-contract Man-Made Systems Corp.

Richard Horst	15%
David Mahaffey	20%

As summarized below, a number of patient treatment scenarios have been video-taped and are undergoing video analysis. In addition, demographic and personality test data are being collected from staff anesthesiologists, and a number of participants are undergoing baseline training (i.e., being trained to asymptote) on the SYNWORK performance assessment test in anticipation of self-administering this computerized test after selected trauma treatment sessions as an objective measure of fatigue. As also summarized below, an extensive data-base environment (using Borland's Paradox Data-Base Management Software) has been implemented for importing or entering, maintaining, and relating the various types of data being collected.

This quarterly report will concentrate on our approach to video analysis. Based on information gathered at the ONR contractors meeting and on our own early experience in video analysis, we have revised our video analysis protocol. This revised scheme is still to be considered as a working version and will be further modified as we gain additional experience in video coding and as new research questions arise.

VIDEO ANALYSIS APPROACH

The video analysis protocol is organized by treatment sessions (i.e., cases). A treatment session, of course, pertains to a particular patient, but there may be more than one session analysed for a given patient, for example, when separate recordings are made in the Admitting Area and in the Operating Room for a given patient. For each session, the overall strategy is to extract information from the following sources:

- video tape(s) from the treatment session with that patient.
- physiological data that was logged from that patient during the treatment session.
- the hard-copy anesthesia record or admitting area consultation form that was completed by the anesthesiologist for that session.
- the post-session questionnaires that were completed by the anesthesiologist and/or CRNA for that session.
- an anesthesiologist subject-matter expert, preferably one of those who participated in the video taping, who will view the tape(s) along with the data analyst.
- surgical summary of procedures carried out, obtained through Shock Trauma Computer Network.

Case Summary

The video analysis process starts with a review of the Admitting Area or Operating Room Anesthesia Records and the completed Post-trauma Treatment Questionnaire. The Anesthesia Records document events as they occur and are the legal record of these events. The Post-Treatment Questionnaire, which we designed for this project, is completed by the anesthesiologist and nurse anesthetist (if involved) after the treatment session is complete. In addition, the Surgical Summary of the admitting area and operating room events is accessed via the Shock Trauma Computer Network from our video analysis workstation in the Anesthesiology Research Laboratories. These Surgical Summaries identify briefly the extent and site of injury and provide an overview of the type of trauma and the physiological state that the patient was in on admission. For surgery they identify the reason for surgery, the operative findings, the surgical procedure carried out and any complications that occurred. An abstract (up to 500-character summary) of each case is derived from these sources and entered into a Paradox database file (CASESUM).

Video Coding

Video tapes are analyzed in three passes using OCS Tools software. Separate data files are created from each pass and they are then merged into a single master data file for the video taped session.

1. Event Coding. The first pass provides an overview of the session by coding general comments about the patient's condition at various times, significant events that occurred, and subjective ratings of anesthesiologist workload. This pass is completed by a video analyst with support from one or more anesthesiologist subject matter experts (SMEs), if possible including one of the SME involved in the case (i.e., one of the anesthesiologists on the tape). The intent is to get into the data file a skeleton account of what transpired during the session along with retrospective subjective ratings of the degree of stress present. In so doing, we solicit information and clarification from the SME that can be used by the data analyst in subsequent coding passes.

While the eventual interest is in characterizing anesthesiology-related activities, the focus of this first pass is more on the major events that occurred in the patient's treatment as a whole, rather than behaviors on the part of the treatment team. The events might include changes in the patient's condition (e.g., cardiac arrest, physiological variables passing into normal or abnormal ranges), milestones in the course of the treatment (e.g., successful intubation), major interventions (e.g., administration of drugs, cricothyroidotomy), and other major occurrences that are readily apparent (e.g., equipment alarms, equipment failures). As indicated in the attached list of OCS Tools Codes (Appendix A), alarms, physiological abnormalities, and certain treatment interventions are coded with specific OCS codes. General comments and miscellaneous events are coded with generic "miscellaneous" codes in order to time stamp the entry, with a brief note being entered in the OCS Comments field.

While viewing the tape, the SME "talks through" the case, identifying events and behaviors of interest and speculating about the participants "thought processes" as appropriate, while the video analyst codes as much of the event information as possible in real-time. The SME's comments are recorded on a dictaphone, so that they can be referenced in subsequent coding passes. The video tape can be stopped, rewound, or advanced in non-real-time as needed. In order to relate the audio dictation to the video tape, the video analyst intermittently verbalizes the time code that is being displayed on the video tape.

Subjective Ratings. At approximately 5-minute intervals (of video tape time), the data analyst pauses the tape and enters subjective ratings, in consultation with the SME, as to the stressfulness of the anesthesiology-related tasks that took place over that last 5-minute period. Ratings are solicited for each of the following dimensions of potential stress (detailed descriptions of these stressors, in the form of instructions for conducting the ratings, are presented in Appendix B; a reference sheet for use by the SME in providing the ratings is presented in Appendix C):

Noise
Team Interactions By or Among Non-anesthesia Personnel
Team Interactions By or Among Anesthesia Personnel
Time Constraints
Task Workload
Diagnostic Uncertainty

Each of the above dimensions of potential stress are rated according to the following scale:

1 = a lot less (stress) than usual
2 = a little less than usual
3 = a typical or usual amount (for trauma anesthesiology)
4 = a little more than usual
5 = a lot more than usual

These ratings are to reflect the highest degree of stress experienced in the last five minutes (of taped time) along each of these dimensions, not just the degree of stress in effect at the particular point in the scenario where we pause to do a set of ratings. The ratings are done with respect to anesthesiology related tasks not surgery related per se. Moreover, the ratings reflect how stressful the tasks are that need to be done regardless of how many team members are available to share these tasks.

2. Behavior Coding. In the second pass, a more detailed coding of the video tape is accomplished for all performance-related behaviors and activities except communications (i.e., verbalizations). This analysis is completed by the video analyst. The video analyst plays back the SME audiotape to help resolve issues of interpretation. If there are still difficulties of interpretation, occasional support may be needed from an SME to resolve questions or uncertainties in the analyst's observations. The focus of this pass is on coding the anesthesiology related behaviors and activities; however, activities performed by surgical or nursing staff are also included if they pertain to anesthesiology-related aspects of patient care. The coding scheme in use (see Appendix A) includes both codes for the action and for the agent (i.e., actor). Verbal communications that are intelligible on the tape are used to infer and understand the observed actions being coded, however no attempt is made in this pass to categorize verbalizations per se.

3. Communications Coding. The third pass is devoted to a detailed coding of verbal communications. Team performance is of interest here, so all recognizable verbalizations are coded. In addition, the presence of background chatter (unintelligible verbalizations) and periods of silence) are coded. Again, the coding scheme (see Appendix A) includes both codes for the action (i.e., type of communication) and for the agent (i.e., who spoke the communication).

IMPLEMENTATION OF DATA-BASE MANAGEMENT FILE STRUCTURES AND DATA ENTRY PROCEDURES

In order to facilitate exploratory data analysis, the various types of data being collected are ported into a common relational data-base management system environment. Paradox (Borland International) is the software package of choice. Data file structures (Paradox tables) and data importation procedures (using Paradox scripts and data entry protocols) have been implemented for each of the following sources of data:

Demographic questionnaire (anesthesiologists)	DEMOG-A
Demographic questionnaire (CRNAs)	DEMOG-C
Neo-personality Inventory	NEO
Case summary abstract	CASESUM
Post-trauma questionnaire (main items)	PTQ
Post-trauma questionnaire (comment items)	PTQCMTS
SYNWORK performance test of fatigue	SYNWK
Fatigue questionnaire accompanying SYNWORK	FQ
Patient physiological data	(not yet finalized)
OCS Tools summary output data	(not yet finalized)

SYNWORK Fatigue Assessment

Eleven anesthesiologists who are involved in this ONR project and work at MIEMSS have participated in training using SYNWORK. Dr. Ellsmore at OMPAT who designed the software proposes that 8 training sessions in the use of SYNWORK are necessary before the user reaches asymptotic performance. The data in Fig. 1 (attached) identifies the scores obtained in daily tests taken by 11 anesthesiologists. Several anesthesiologists took the SYNWORK tests repeatedly on a single day (Fig. 2 left-hand graph) and 3 anesthesiologists took the test repeatedly on a second occasion after a 9,20 or 4 day gap (Fig. 2 right hand graph). It appears that a) some anesthesiologists reached asymptotic performance before 8 training sessions were completed (subjects h and g), b) large variations were present in some anesthesiologists performance (subjects e and f), c) other subjects appear to follow the trend of improvement for the first 8 training sessions (subjects j,d,i and c). The data in Fig. 2 suggests that a) repeated practicing within a short interval improves performance (subjects j,i,a and b), b) despite a 4-20 day gap performance on the lst of a series of SYNWORK measures starts where the previous best performance ended, c) a second series of multiple practices within a short interval appeared to again improve performance. The inability to improve performance on repeated attempts within a short interval may therefore be another means of identifying asymptotic performance.

DATA COLLECTION AND ANALYSIS

Thirty-four videotapes have been collected. Twenty-four taped in the Admitting Area, 10 taped in the Operating Room 12 SME have been involved in video taping, seven tapes are in various stages of analysis.

ADMINISTRATION

A budget modification for Year 2 was sent to ONR for consideration.

PUBLICATIONS/PRESENTATIONS

1. <u>May 14-15, 1992</u>
   Coordination Meeting for the ONR University Research Initiative: "Decision Making in Hierarchical Teams." Orlando FL Dr. Horst presented material from ONR Grant N00014-91-J-1540.

2. <u>June 11th 1992</u>
   5th Annual International Trauma Anesthesia and Critical Care Symposium. Amsterdam The Netherlands. LOTAS - "Video Analysis systems for trauma anesthesia." Dr. Mackenzie Chaired the session and presented material.

3. <u>June 12th 1992</u>
   5th Annual International Trauma Anesthesia and Critical Care Symposium. Dr. Grande presented abstract "Video Data Acquisition and Analysis System for Anesthesiology."

4. <u>June 12th 1992</u>
   13th International Symposium in Computers in Clinical Medicine and Anesthesiology. Erasmus University, Rotterdam The Netherlands. Dr. Mackenzie presented: "Video Data Acquisition and Analysis."

5. <u>June 30th 1992</u>
   Abstract accepted for presentations at American Physiological Association/NIOSH Meeting. Horst RL, Mackenzie CF, Mahaffey DL, Black JF and the LOTAS Group. "Modeling the effects of stress on anesthesiologists performance during trauma treatment." Abstract attached as Appendix D.

APPENDIX A

OCS TOOLS CODES FOR DECISION-MAKING UNDER STRESS PROJECT

- o As described elsewhere, various subsets of codes are utilized in separate passes through the video tapes of interest.

- o In all passes, the liberal use of the OCS Comments field is encouraged.

- o All coding is implemented in the OCS START/STOP mode, i.e., with B ("begin") or ("end") appended to the code used otherwise.

- o In the case of the "behavioral" codes (i.e., Observation, Intervention, Activities, and Communication Behaviors) the agent of the behavior (i.e. the initiator) is coded with a two-character code prepended to the code used otherwise. Staff members are categorized as anesthesiologists, surgeons, other physicians, CRNAs, other nursing staff, and other technical staff (e.g., X-ray technicians). Staff members within each of these categories are numbered, e.g.:

  A1 -- attending anesthesiologist
  A2 -- assisting anesthesiologist or anesthesiology fellow
  ...
  S1 -- attending surgeon
  ...
  P1 -- other physician
  ...
  C1 -- first CRNA to appear
  ...
  N1 -- first nurse to appear
  ...
  T1 -- first technician to appear
  ...

  The numbering scheme applies to individuals throughout the case, and does not change as participants come and go during the treatment session. The intent is not to identify individuals per se, but to ascribe various behaviors and communications to the above categories of caregivers.

- o In all instances where there is some uncertainty about which code to use (or which distinguishing character in a code), an "X" is used in place of the uncertain character(s).

<u>Miscellaneous codes</u>

MC Miscellaneous *comment*; useful information or an opinion offered by the data analyst or by a subject matter expert (put content in OCS Comments field)

ME Miscellaneous *event* worth noting but not otherwise captured by event codes (put content in OCS Comments field)

MB Miscellaneous *behavior* of participants worth noting but not otherwise captured behavior/performance codes (put content in OCS Comments field)

Physiological Events (these codes are entered with reference to the patient physiological data that is displayed on the video tape or with reference to the patient physiological data file that is logged on-site; normal and abnormal ranges are as defined in the LOTAS decision trees and task analyses)

PH Heart rate abnormality
PB Blood pressure abnormality
PO Oxygen saturation abnormality
PC End tidal CO_2 or other respiratory abnormality
PT Body temperature abnormality
PV Venous pressure abnormality

Alarms Events

AA Alarm, airway-related (i.e., ventilator, mass spec -- end tidal CO_2 pulse oximeter O_2 saturation)
AC Alarm, circulatory-related (i.e., Mennen -- blood pressure, heart rate)
AO Alarm, other equipment (e.g., IV infusion devices, etc)
AE Alarm, external (e.g., intercom, pager, beeper, phone)

Observation Behaviors (these activities are often done in conjunction with interventions/ manipulations; for coding purposes, intervention/manipulation codes should take precedence over observation codes; use observation codes only when an observation is apparent in the absence of a related manipulation/intervention)

OP Observe, monitor, or check patient *directly* without reference to instrumentation or equipment

OE Observe, monitor, or check the functioning of instrumentation or equipment *for other than the purpose of taking a reading* (e.g., observe integrity of oximetry sensor, blood pressure cuff, etc.)

OR Observe, monitor, or check instrumentation or equipment *for the purpose of taking a reading* (e.g., take reading from Mennen)

Intervention/Manipulation Behaviors

II Initial instrumentation of the patient; adding something new (e.g., attaching sensors, intubation, installation of arterial line, venous pressure sensor, or IV access)

IS Manipulate sensors or other equipment already attached to the patient (i.e., after initial installation of that equipment) (e.g., take a blood pressure manually)

ID Manipulate drugs or other anesthetic agents being given to the patient (by whatever route)
IF Manipulate fluids being given to patient (other than blood) (this includes suctioning the patient)
IB Manipulate blood being given to or taken from the patient (e.g., blood infusion to the patient, draw blood)
IV Manipulate ventilator or other oxygen supply to the patient
IH Other hands-on manipulation of the patient
IE Manipulate equipment at other than the interface with the patient (e.g., set dials, calibration, silence or reset alarms)

Activity Behaviors (i.e., activities of the anesthesiology team)

PA Preparatory activity (e.g., workstation set-up; mixing drugs)
TA Treatment activity (direct, hands-on intervention with the patient)
SA Supervisory activity (not hands-on intervention; directing the activity of teammates)
RA Recording information activity (i.e., writing)
NA Not actively involved but present in the environment (not necessarily in the cameras field of view)
ZA Absent (after having been present previously)

Communication Behaviors

CP Communicate with patient (meaningful communication between staff member and patient)
CO Communicate with oneself (utterances that are seemingly "absent-minded"; i.e., not directed at teammates)
CQ Ask a task-relevant question or ask for assistance
CA Provide an answer or other direct response to an inquiry or request for assistance
CI Provide task-relevant information unsolicited
CS Communicate a strategy, plan or schema
CD Communicate a directive, give instructions, or delegate tasks, but not in a strategic sense
CR Other task-relevant communication
CN Non-task relevant communication (but directed at a teammate or at the patient)
CU Unintelligible verbalization
CZ Silence (i.e., no verbalizations)

APPENDIX B

INSTRUCTIONS FOR SUBJECTIVE RATINGS OF STRESS FOR DECISION-MAKING UNDER STRESS PROJECT

-- Ratings are given for each of the following dimensions as described below:

Noise
Team Interactions By or Among Non-anesthesia Personnel
Team Interactions By or Among Anesthesiology Personnel
Time Constraints
Task Workload
Diagnostic Uncertainty

The ratings should reflect the *highest degree of stress* experienced in the last five minutes along each of these dimensions, not just the degree of stress in effect at the particular point in the scenario where we pause to do a set of ratings.

-- Each of the above dimensions of stress (i.e., stressors) are rated according to the following scale:

1 - "a lot less (stress) than usual"
2 - "a little less than usual"
3 - "a typical or usual amount (i.e., for trauma anesthesiology)"
4 - "a little more than usual"
5 - "a lot more than usual"

-- The degree of stress should be judged with respect to *all trauma cases that involve anesthesia*, not just those taped and not all Shocktrauma cases (since many of these don't involve anesthesia).

-- These ratings are done with respect to *anesthesiology-related tasks*, not surgery-related tasks or the patient's injury severity per se.

-- The ratings of stressfulness should pertain to the *anesthesiology team as a whole*, not to just the attending anesthesiologist nor to specific team members who are particularly busy or not busy; i.e., the ratings should reflect how stressful are the *tasks* that need to be done, *regardless of how many team members are available to share these tasks*.

-- to the extent possible, the ratings should be done from the *standpoint of the participants* in the case, inferring the degree of stress on them and the possible influence that this had on their thought processes, rather than reflecting the rater's particular experience, what he/she would have done if involved in the case, or what we in retrospect know about the outcome of the case.

The data analyst and SME should be thoroughly briefed on the following descriptions of and distinctions among the various stressors of interest. A reference sheet that can be used to prompt SME's for the desired ratings is attached (Appendix C).

-- Stress due to **NOISE** -- the emphasis here is on auditory noise that is not critical to effective treatment of the patient, including *extraneous verbalizations, nuisance alarms, equipment noise, radios*, etc. Some sounds are, of course, necessary in the trauma treatment environment (e.g., questions/ answers, discussion about the case, alarms, intercom announcements). While these necessary sounds may also be stressful by their sheer magnitude, we are interested here in characterizing the noise that is not critical to effective treatment. Granted, some of this extraneous noise (non-task relevant chatter, radios) might be stress inducing to some and calming to others. The intent here is to rate the degree of extraneous noise in the environment regardless of whether the raters themselves would have experienced it as stress inducing or not. High ratings reflect a lot of noise; low ratings reflect less than a typical amount of noise.

-- Stress due to **TEAM INTERACTION BY OR AMONG NON-ANESTHESIA PERSONNEL** -- the emphasis here is on the team interactions initiated by (or taking place among) the non-anesthesia personnel on the trauma team. Surgical personnel do not usually work in the field of view of the camera, the effectiveness of their interactions typically is best inferred from verbal communications. The interest is in characterizing *team compatibility* and *team spirit*. A lack of compatibility might be reflected either in overt arguments/confrontational communications or in silence/lack of typical communications. While the focus remains on the effects of stress on anesthesiology decision making, this item attempts to capture any tension caused by *ineffective* or *inappropriate interactions* initiated by non-anesthesia personnel, the idea being that such tension would have been apparent to, and might potentially have affected the performance of, everyone in the environment. High ratings reflect a lack of team compatibility or effectiveness, i.e., higher stress due to poor interactions; low ratings reflect unusually good team spirit and compatibility.

-- Stress due to **TEAM INTERACTION BY OR AMONG ANESTHESIA PERSONNEL** -- the emphasis here is on the team interactions initiated by (or taking place among) anesthesiology team personnel. The intent is similar to the previous item, and will probably also derive largely from verbal communications, although in evaluating the anesthesia team interactions we may be able to make additional judgments about the *effectiveness and efficiency* of anesthesiology team functioning. Factors to be considered in regard to this latter aspect of team interactions include the effectiveness of team management, the division of labor, and the efficiency and timeliness with which tasks are getting done. The focus here is specifically on anesthesiology-related tasks. High

-- Stress due to **Time Constraints** -- the emphasis here is on the *urgency* with which anesthesiology-related tasks need to be done in order to ensure patient safety. This urgency determination is made *without regard to the number of people among whom the tasks are shared*. High ratings reflect high urgency or lack of time; low ratings reflect an unusually leisurely pace.

-- Stress due to **Task Workload** -- the emphasis here is on the *complexity, difficulty, or multiplicity* of anesthesiology tasks that are to be done. This rating is intended to reflect how demanding the anesthesiology-related activities are, *without regard to time stress per se*. Factors considered in making this judgment might include the number of tasks that have to be attended simultaneously (or in rapid succession), the degree of problem solving required, or the degree of mental concentration required. Again the judgment should be made *without regard to the number of people among whom the tasks are shared*. High ratings reflect higher than normal workload; low ratings reflect lower than normal workload.

-- Stress due to **Diagnostic Uncertainty** -- this rating is intended to reflect any stress due to a *need for diagnostic information that is not readily available* (and thus the need to make decisions based on some degree of uncertainty). At issue is whether there is anything that the anesthesiology team would like to know that they don't presently know at particular times during the case. Needed information might include the nature of the injury (site, extent of injury), lab values or investigations (e.g., X-rays, blood gases), patient monitoring information (e.g., vital signs), or patient history -- i.e., any information that might influence the certainty of diagnosis and consequent decisions about patient care. High ratings reflect a lack of needed information; low ratings reflect a high degree of diagnostic certainty, i.e., that all needed information is known.

These ratings are each coded in OCS Tools by entering a five character code where:

1st character =	"S" to designate a subjective rating.
2nd character =	"P" if the rater is one of the participants in the case (i.e., one of the people on the tape), "A" if the rater is a non-participant anesthesiologist, or "N" if the rater is a non-anesthesiologist.
3rd character =	A sequential number that is assigned to individual raters of each of the above types for this case (e.g., "P1" in the 2nd and 3rd characters would designate the first participant to offer ratings for this case; "A2" would designate the second non-participant anesthesiologist to rate the case, even if one or more participants had already done so, etc.). In instances where an SME is working with a data analyst in doing the ratings, this character should reflect the status of the SME. We should keep notes elsewhere as to who, specifically, rated each case.

4th character = A letter designating the dimension being rated, "N" = Noise; "O" = Other Team Member (i.e., non-Anesthesia) Interactions, "A" = Anesthesia Team Interactions "T" = Time, "W" = Workload, "I" = Information.

5th character = A number designating the degree of stress on the following five-point scale:

1 - "a lot less (stress) than usual"
2 - "a little less than usual"
3 - "a typical or usual amount (i.e., for trauma anesthesiology)"
4 - "a little more than usual"
5 - "a lot more than usual"

When approximately five minutes of taped time have elapsed since the last set of ratings, the data analyst should pause the VCR and enter six codes into OCS Tools using this scheme, one for each of the six dimensions of stress. An example set of coded ratings is as follows:

SP2N2
SP2O1
SP2A3
SP2T2
SP2W4
SP2I

REFERENCE SHEET FOR SUBJECTIVE RATINGS OF STRESS

STRESS DUE TO:

1) **NOISE** = Extraneous (clinically unimportant) Chatter
= Equipment Noise/Radio Noise
= Uninformative or Nuisance Alarms

2) **TEAM INTERACTIONS BY OR AMONG NON-ANESTHESIA PERSONNEL**

e.g. = effectiveness of communication among or by non-anesthesia trauma team
= team compatibility or efficiency of teamwork
= communication with other members of trauma team in critical event

3) **TEAM INTERACTIONS BY OR AMONG ANESTHESIA PERSONNEL**

e.g = effectiveness of communication among or by entire anesthesia team
= team compatibility or efficiency of teamwork
= communication with other members of team in critical event

4) **TIME CONSTRAINTS** = CRITICAL FOR PATIENT THAT INTERVENTION CARRIED OUT QUICKLY BY ANESTHESIA TEAM

5) **TASK WORKLOAD** = NUMBER AND COMPLEXITY OF TASKS BEING CARRIED OUT BY ENTIRE ANESTHESIA TEAM

6) **DIAGNOSTIC UNCERTAINTY**

e.g. = Lacking lab values or examination (e.g. physical or x-ray)
= Lacking monitoring
= Lacking knowledge of site of injury
= Lacking knowledge of extent of injury
= Lacking knowledge of cause of critical event

SUMMARY/DEBRIEFING

- OVERALL PERFORMANCE - WAS RESUSCITATION ADEQUATE - WAS ANESTHESIA SKILLED
- DID THE ANESTHESIA TEAM FOLLOW THE DECISION TREES FOR MANAGEMENT OF ABNORMAL PHYSIOLOGICAL VARIABLES? (SEE BELOW)
- REVIEW POST TRAUMA QUESTIONNAIRE COMPLETED BY ANESTHESIA PERSONNEL

LIMITS DEFINING ABNORMAL PHYSIOLOGICAL DATA SCORING OF STRESSORS

(Relate to all patients that require anesthesia involvement)

	Low	High	
Heart Rate (/min)	<60	>100	1 = a lot less(stress) than usual
Blood pressure (mm Hg)	SBP<90	DBP>100	2 = a little less than usual
SaO_2(%)	$<90\%$($PaO_2<60$)	-	3 = typical or usual amount (for trauma anesthesia)
$ETCO_2$ (mm Hg)	<20	>40	
TEMP(°C)	<35	>39	
Mean PA Pressure (mm Hg)	<8	>30	4 = a little more than usual
PCWP or PA diastolic (mm Hg)	<5	>24	5 = a lot more than usual

MODELING THE EFFECTS OF STRESS ON ANESTHESIOLOGIST PERFORMANCE DURING TRAUMA TREATMENT[1]

Richard L. Horst, Ph.D.[2], Colin F. Mackenzie, M.D.[3], David L. Mahaffey[2], James F. Black, Jr.[3], and the LOTAS Group[4]

[2]Man-Made Systems Corporation, Ellicott City, MD; [3]Anesthesiology Research Laboratories, University of Maryland School of Medicine, Baltimore, MD; [4]Maryland Institute for Emergency Medical Services System, Baltimore, MD.

It is difficult to adequately study human performance and decision-making under stress in contrived laboratory settings, because it is hard to emulate the sense of urgency and emotional involvement that can modulate cognitive processing in a true crisis situation. The goal of the present project is to systematically study the stressors and coping strategies that influence skilled performance and cognitive decision-making in a job setting in which meaningful decisions are made under time pressure. The resuscitation and treatment of patients with acute massive trauma is such a setting. The trauma team functions daily with considerable stress, making life sustaining decisions under severe time pressure and often with incomplete information about the extent of the patient's injuries. The present study focuses on the trauma anesthesiologist, the team member responsible for maintaining the airway, providing adequate ventilation, and optimizing cardiorespiratory function

[1]This research project is funded by the Office of Naval Research under Grant #N00014-91-J-1540 to the University of Maryland School of Medicine. Man-Made Systems Corporation is a subcontractor on this project.

in trauma victims during resuscitation and surgery. The intent is to develop process models of the decision-making performance of the trauma anesthesiologist, to generate both quantitative and qualitative predictions from these models of the effects of various stressors on performance, and then to iteratively attempt to validate and improve upon these models based on empirical observations during actual trauma treatment cases.

The stressors of interest include time pressure, severity of the patient's injuries, lack of adequate information about these injuries, fatigue, and team incompatibility. The models are being developed initially from expert judgments, using decision trees, task analysis techniques, and the MicroSAINT[5] modeling and simulation software package. Empirical data are being derived from detailed analyses of video tapes recorded during actual trauma patient resuscitation and surgery. The present paper will focus on the task analysis and modeling process, which is ongoing. The results of the initial modeling effort and preliminary validation results from analyses of empirical data will be presented.

The starting point for the modeling process is a set of decision trees that have been developed by the Level One Trauma Anesthesia Simulation (LOTAS) group at the University of Maryland. Because the efficacy of resuscitation and anesthesia

---

[5]Micro Analysis and Design Corporation, Boulder, CO

for trauma patients depends heavily on restoration and maintenance of abnormal physiological parameters to normal ranges, these decision trees are based on various physiological abnormalities -- Tachycardia, Bradycardia, Hypotension, Hypertension, Hypoxemia, Hypothermia, Hyperthermia, Increased End Tidal CO_2, Decreased End Tidal CO_2, and a "Difficult" Airway. Originally developed as training tools, these decision trees provide flow charts of decision choice points, alternative strategies, and information requirements.

Based on these decision trees, a more detailed task analysis is being conducted by human factors and experimental psychology specialists working in conjunction with LOTAS subject matter experts. For each physiological abnormality the decision process is being delineated in terms of functions, tasks, and subtasks. Functions are higher level, goal-oriented activities (e.g., "treat cause"). Tasks are the lower level, more action-oriented activities by which functions are accomplished (e.g. "treat with fluids at 20 cc/kg"). Tasks may themselves consist of subtasks (e.g., "inject fluids," "monitor blood pressure"). The contingencies in the present decision trees (e.g., "Patient is or is not hypotensive") are characterized as "entry conditions" for a given task or subtask. Also detailed for each task and subtask are observable actions (i.e., overt actions or utterances by which an observer can infer that a particular task is being performed) and criteria for task completion (typically in terms of patient vital signs or displays providing feedback that a desired condition has been achieved or that equipment is functioning as expected).

The decision trees and task analytic information are then translated into process models using the MicroSAINT software package. MicroSAINT provides an environment for building task networks, associating performance variables and values with each task, establishing probabilistic contingencies that control the branching of the modeled process, and making quantitative predictions (response times, frequencies of alternative choices) about performance based on presumed manipulations of the task environment. The manipulations (independent variables) that drive the present models are predictions about the effects of the aforementioned stressors on performance. Initial quantitative estimates of these effects are, like the decision trees themselves, being derived from expert judgments. However, empirical data are then brought to bear in enhancing and refining these models, with new quantitative predictions then being validated against subsequently collected empirical data. This poster presentation will detail the analytical process summarized here and will present illustrative results from each phase of the analysis.

Fig. 1 SYNWORK Test Score on Y Axis
Test number on X Axis
Subjects identified by letter

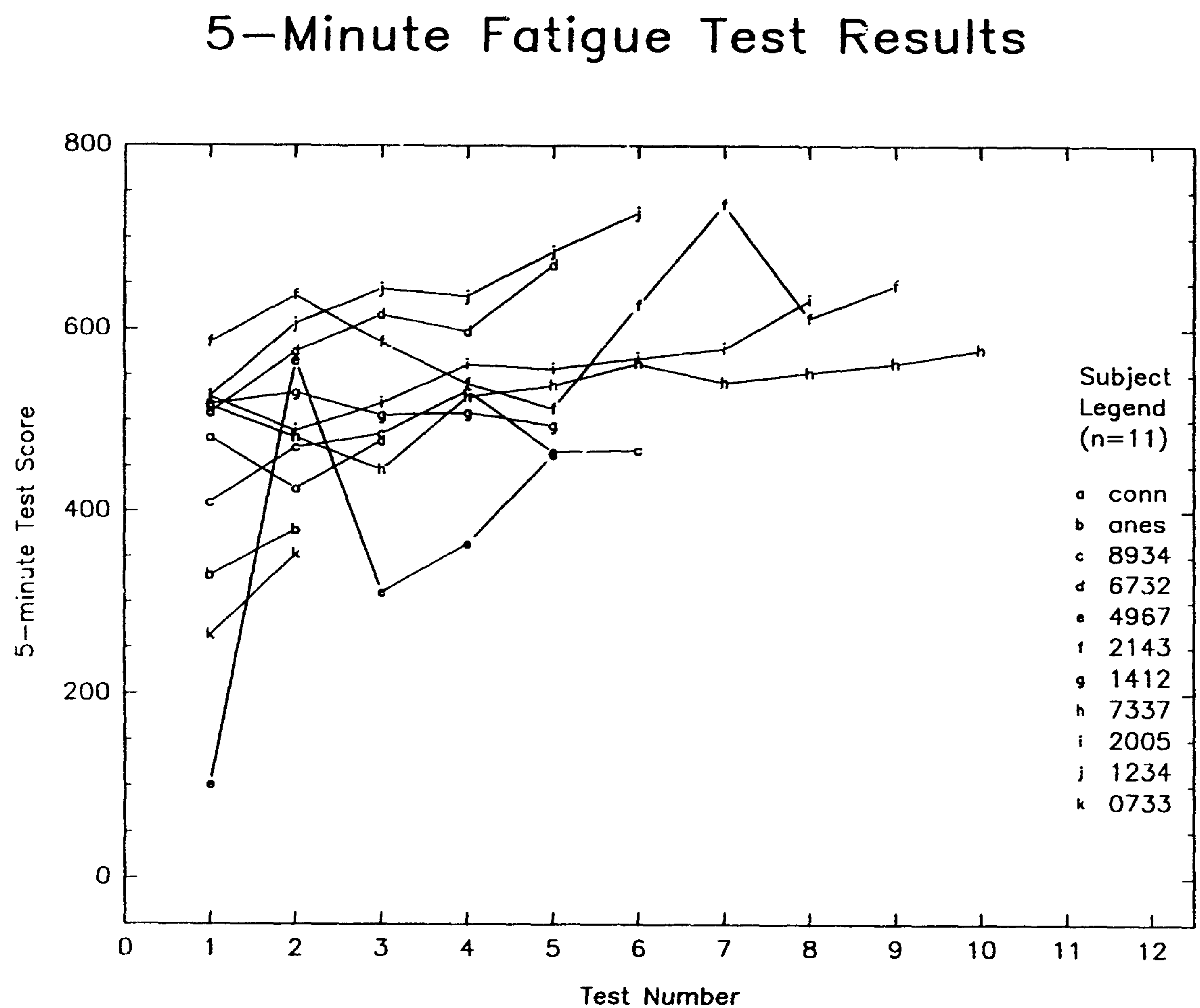

Fig. 2 SYNWORK Test Score after up to 6 sequential attempts within 1 day in 5 subjects (left panel). Three of the subjects repeated a further sequence of attempts after a 4-20 day gap (right panel).