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School of Medicine

UNIVERSITY OF MARYLAND
AT BALTIMORE

ANESTHESIOLOGY RESEARCH LABORATORIES

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SEP 1 5 1992
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MEMORANDUM

TO: Participants and all concerned

FROM: Colin F. Mackenzie, M.D.

DATE: May 14, 1992

Please find attached 4th quarterly Navy Report #N00014-91-J-1540 for your review.

Approved for public release;
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ONR Grant #N00014-91-J-1540

Report Date: May 8, 1992 Quarter #: 4

Report Period: 01/31/92 - 5/01/92

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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

Current staff with percent effort of each on project:

Colin F. Mackenzie	15%
William Bernhard	5%
Kevin Gerold	5%
Brian McAlary	5%
Andy Trohanis	10%
Jim Brown	10%
Bob Moorman	10%
Peter Hu	10%
James Black	50%

Sub-contract Man-Made Systems Corp.

Richard Horst	10%
David Mahaffey	10%
Daniel T. Smith	10%
Karen Webster	10%

Final quarterly report of year one of ONR Grant #N00014-91-J-1540

This quarterly report will concentrate on documentation of the progress made with the recording and analysis of video tapes.

Video Recording and Physiological Data Acquisition

The completed system that is now up and running is shown in Fig. 1 and will be briefly described below. Four locations (2 operating rooms and 2 admitting areas) are cabled with a) camera, b) microphone, c) computer, d) interfaces to physiological monitor and e) network interface. Connections are shown in Figs. 2 and 3.

The system is fully automated. Insertion of a blank video tape into the VCR boots the computer, (via the RS232 board in the VCR), starts the recording of video and sound tracks and video overlay of physiological data. The new tape is initialized with the time and date. Elapsed real time and frame count are then recorded and the tape is assigned an 8 digit code. The eight digit code identifies the location of video acquisition, the time and date of acquisition (Real-Time message log system). All data is batch downloaded through the network to the Anesthesiology Research Laboratory. Acquisition of physiologic data can be reviewed remotely in the Anesthesiology Research Laboratory. The end of the tape (2 hours) is signalled by an ascending crescendo alarm of 5 notes. This alarm reminds the anesthesiologist that the tape has ended and should be replaced with a new one for a case that is continuing beyond 2 hours. If the data acquisition lasts less than 2 hours then the tape is automatically immediately ejected from the VCR when the discontinue or discharge buttons are pressed on the physiological monitoring system (Mennen physiological monitor). Discharge is accompanied by a descending crescendo alarm as a reminder to remove the tape. Each tape is labelled and identified by an anesthesiologist beeper number, date and time of ending.

The anesthesiologist and nurse anesthetist (CRNA) independently complete a post-trauma questionnaire for resuscitation and for anesthesia. An example of a completed questionnaire for the anesthesiologist is attached (Attachment #1). The anesthesiologist and CRNA assess the severity of injury using 4 scales (Attachment #2) AIS = the abbreviated injury scale, GGS = Glasgow coma scale (an assessment of the state of consciousness/head injury). ASA = American Society of Anesthesiologist preoperative assessment. TAG = Trauma Anesthesia Grade, a risk assessment of anesthesia for trauma patients. Portions of this questionnaire relating to team interactions will also be completed by the team-leader and the nurse involved in the patient resuscitation.

Video Data-Analysis

A typical image for video analysis is shown as Fig. 4. Individuals and objects are labelled for clarity of interpretation. Along the top of the image there is a digital display of physiological data which are from top left to right: HR = heart rate/min, SBP = systolic arterial blood pressure, MBP = mean arterial blood pressure, DBP = diastolic arterial blood pressure (this is measured either from an automated blood pressure cuff or from an indwelling arterial catheter) $ETCO_2$ = end tidal CO_2 monitored by a mass spectrometer or Nellcor 1000. SaO_2 = arterial O_2 saturation monitored by Nellcor pulse oximeter, TMP = temperature °C monitored by esophageal probe, CVP = central venous pressure, SPA = systolic pulmonary artery pressure, MPA = mean pulmonary artery pressure, DPA = diastolic pulmonary artery pressure. In the bottom right of the tape is the day, month, date, 24 hour clock time and year. This data appears only briefly to initialize each tape. In the bottom left of the image is elapsed time since the data collection began when the tape was inserted. The elapsed time clock and physiological data collection continues between tapes until the discharge button is pressed on the Mennen Monitor. Discharge stops the clock and ejects the tape. By keeping the elapsed time running between tapes we can determine how much of the video-image is missing because of the tape change. Physiological data can be down-loaded to Paradox and plotted (Fig. 5).

The physiological data collection (every 5 seconds) is simultaneously time stamped with the video image acquisition so that the two can always be related. We can scan the Paradox data base to identify when physiological data is outside normal limits and these time intervals can be exactly related to the video image. We think that acquisition of abnormal physiological data from the patient is more stressful for the anesthesia providers than acquisition of physiological data that is within normal ranges. We have developed algorithms that outline the decision-making, and the mental and physical workload involved in restoring abnormal vital signs (physiological data that is above or below the normal range) to normality (see Quarterly Report #1 for these algorithms). Part of the videoanalysis will involve identifying whether these algorithms reflect what happens in the real-life stressful environment. In the example image shown in Fig. 4 the physiological data recorded was heart rate and blood pressure. At the time of acquisition the pulse oximeter was not connected to the Mennen monitor, but from the sound track we can hear the monitor and one of the anesthesia personnel comments that 'Sat is 100%.' This patient died about 10 min later. Attachment #1 is the post resuscitation/anesthesia questionnaire completed for this patient. The lack of stress reported by the anesthesia care providers may have been due to their good teamwork, access to additional help (see Fig. 4) or the fact that the patient's chances of survival were minimal as he had sustained a fatal injury. The severity of injury scales and other assessments of risk were predictive of death.

Sources for Independent and Dependent Variables

The following listing documents the sources of information about the various independent and dependent variables anticipated to be of interest in this study. During data analysis, we will determine appropriate groupings of the values in each variable, use Paradox to selectively sort the corresponding dependent variables according to these groupings using a relational data-base structure (see below) and calculate summary derived measures for the dependent variables based on this selectively accessed data.

Independent Variables:

Stressors:

- Anesthesiologist Workload -- from the appropriate items on the Post-Trauma Questionnaire (case difficulty; patient severity), from the data analyst's ratings in the OCS Tools raw data files (time stress, cognitive difficulty), and from the physiological data (times during which patient was unstable or presenting critically abnormal values).

- Information Uncertainty -- from the appropriate items on the Post-Trauma Questionnaire (uncertainty of diagnosis) and from the data analyst's ratings in the OCS Tools raw data files (information uncertainty).

- Fatigue -- from the appropriate items on the Post-Trauma Questionnaire and from the items on the Fatigue Assessment Questionnaire.

- Team compatibility -- from the appropriate items on the Post-Trauma Questionnaire and from the data analyst's ratings in the OCS Tools raw data files (team effectiveness).

Individual Differences:

- Experience -- from the appropriate items on the Demographic Questionnaire and from the appropriate items on the Post-Trauma Questionnaire (experience similar cases).

- Personality -- from the six derived scales of the Neo-Personality Inventory.

Dependent Variables:

- Frequencies and durations of behaviors coded into OCS Tools raw data files during data analysis. These will typically be summarized separately for different periods of time during the patient treatment scenarios, depending on the groupings of independent variables (e.g., when data analyst ratings suggested different levels of time stress, cognitive workload, or team effectiveness; when physiological data suggest that the patient's vital signs were unstable).

- Response times derived from Paradox analyses of OCS Tools raw data files (particular mitigating behaviors by the anesthesiologist related to events that occurred) or anesthesiologist behaviors related to patient physiological data (when vital signs reached critical values).

- SYNWORK performance scores.

SYNWORK Fatigue Assessment

The SYNWORK test battery produces an ASCII output file that is named with subject number and session information. Subject and session numbers, as well as date and time, are also coded internally in the file. Participants will enter their beeper numbers as the subject number. The data file for each session will be stripped of labelling information with a C or PAL program, imported into Paradox, and saved as an additional record in a single Paradox data file. Separate data files will be maintained for training sessions and for post-trauma treatment sessions of SYNWORK.

The data from the hard-copy questionnaire that the participant fills out before each administration of the SYNWORK test will be entered manually into Paradox. Each questionnaire's worth of data will comprise one record in this file. There will be fields for participant's beeper number and for the date, start-time, and location of the case just completed. Separate files will be maintained for training sessions and for post-trauma sessions of SYNWORK.

Neo-Personality Inventory/Demographic Questionnaire

The NPI produces a binary output file that is named (externally and internally) with the subject number. This binary file will be processed with a program supplied by PAR, Inc. to produce an ASCII output file. This output file will be stripped of labeling information as needed with a C or PAL program, imported into Paradox, and saved as a separate record in a single Paradox data file.

The data from the hard-copy Demographic Questionnaire will be manually entered into Paradox with each anesthesiologist participant's data comprising a record in this file. There will be a data field for the participant's beeper number.

MicroSAINT Model(s) Predictions

It may be useful to port the quantitative performance data that is produced when executing a MicroSAINT model into Paradox or the statistical package being used, in order to facilitate comparisons between these predictions and the empirical data derived from the Video Analysis. MicroSAINT data can be exported as an ASCII file. This file will then be imported into Paradox. The data file that results from a given set of MicroSAINT model executions (i.e., with a given set of model parameters in effect) will be imported and saved as a separate record in a Paradox file. The different records in this file will therefore be the performance data predictions from executions of the model with various parameters in effect (i.e., from varying the independent variables in the present study).

Cross Referencing of Different Types of Data

Paradox's relational data-base capabilities will be utilized to selectively access data. The following list indicates the typical means of cross-referencing (i.e., "pointing" from one file to another) for each of the data files described above:

- Patient physiological data (one file per patient) -- by file name (date, start-time, location of the case)
- Post-trauma treatment questionnaire data file -- by participant anesthesiologist, case information (date, start-time, location) or range of values or particular variables (i.e., fields)
- OCS Tools raw data file (one file per patient) -- by file name (as above)
- OCS Tools summary data file -- by participant anesthesiologist, case information (as above) or range of values on particular variables (i.e., fields)
- SYNWORK data file -- ibid
- Fatigue Assessment questionnaire data file -- ibid
- Neo-Personality Questionnaire data file -- by participant anesthesiologist
- Demographic Questionnaire data file -- by participant anesthesiologist

OCS Tools Output Files

The data files derived from the Video Analysis will be of two types -- raw data files and summary data files. The raw data files will contain event-by-event listings of the elapsed time and type of event that was coded along with an optional comment field. The analyst's periodic ratings of case difficulty will also be included. The summary data files will contain frequency counts of each type of event being coded and summary statistics (mean, standard deviation, etc.) of the event durations. Both files are in ASCII format.

The raw data files will be stripped of labeling and comment information (i.e., converted to flat ASCII) with a C program (or Paradox PAL program), imported into Paradox, and saved as separate Paradox files. They will be named according to the date, start-time, and location of the case in a manner which corresponds with the physiological data file from that case. During data analysis these Video Analysis output files will be assessed by file name.

The summary data files will likewise be stripped with a C or PAL program, imported into Paradox, and saved as separate records in a single Paradox file. This file will contain fields for participants' beeper numbers, and case date, start-time, and location.

Coding With OCS Tools:

(Abstracted from Documentation Notebook for project. See Attachment #3)

The main menu is called OCSMENU. The path off this menu for coding, editing etc. takes you to a submenu called OCS. When you see these menus referred to below, remember that they are two different menus. Also, any choice off of the main menu brings up a screen that is essentially an advertisement. Press any key to proceed.

From the main OCSMENU choose DATA/OCS. You will now see the OCS menu. From the OCS menu choose CODE/CODE/VCR. Next you are prompted to choose a data file. You can either choose an existing file to append or overwrite, or create a new data file. The existing files are shown on the left side of the screen. To create a new file, type in the new file name. You are now ready to begin coding.

To begin coding, start the VCR and press "enter" on the keyboard. The coding block and menu will now appear on the computer monitor. The coding block will appear in the upper right of the screen. The coding block contains the character code, timecode associated with the character code, code number and the timecode (continuously updated) which is read from the video tape. The coding menu will appear at the bottom of the screen. The coding menu choices are punctuation marks (semicolon, period, apostrophe and tab) rather than numbers or letters.

Semicolon - (;dat)	Provides a full screen edit of all coded entries.
Period - (.end)	Allows the user to end a coding session. Be sure to save the file
Apostrophe- ('txt)	Allows the user to edit or input the description text for the current code.
Tab - (<->edit)	Allows the user to edit the coding block.

Using the VCR Controller:

The keyboard command to activate the VCR controller menu is "alt/left shift." This will start/stop etc. the VCR. To remove the VCR controller menu, press "escape." The VCR controller menu must be removed in order to use the OCS Tools menus.

Coding Procedures:

There are two logical types of events to be coded. First, events which have observable start and stop points, where the duration of the events are of interest. These events may overlap in time. For example, monitoring vital signs, monitoring equipment, conversing with a team member, preparing medication. Second, events where frequency is of interest, i.e. the start time, but not the duration. For example, how often communications occur, or the occurrence of an alarm. An alarm may remain active for some time after the team responds to the triggering event. So the duration of the alarm is not as meaningful as its occurrence.

In addition to coding the events mentioned below, the data analyst will make periodic assessments of the following:

- anesthesiology-related time stress

- o anesthesiology-related cognitive workload
- o non-anesthesiology-related time stress
- o non-anesthesiology-related cognitive workload
- o apparent certainty/uncertainty of diagnosis

These assessments will be made approximately every five minutes. As the tape is rolling, the analyst will jot down these ratings and later edit them into the OCS Tools data file.

Event Codes (Grouped according to function)

INF -- general information; miscellaneous

Three character codes ending in B (begin) or E (end):

ABC's/Patient

AB -- Inspect patient airway/breathing
VS -- Inspect vital signs
PC -- Patient coded (cardiac arrest)

Monitoring/Inspection

ME -- Monitor equipment
MP -- Monitor patient

Beeper/Alarms

BPR -- Beeper Alarm sounds (individual or system)
COH -- Communication overhead (i.e., loud speaker, new admission)
SYS -- SYSCOM phone/beeper sounds

Verbal Communications

CA -- Communicate with other anesth. personnel
CC -- Communicate command or directive
CP -- Communication with patient
CT -- Communicates with team/member
OC -- Other communication
PC -- Patient communication
TC -- Team or team member communication

Anesthesiologist Walk Out

WO -- Anesth. walks out of the room, Patient present
WNP -- Anesth. walks out, No patient
NO -- Anesth. no activity

Interventions and Manipulations

DI -- Drug injection/intervention
IV -- IV line installation
O2 -- Oxygen given
TI -- Intubation
VE -- Ventilator manipulation

Miscellaneous Codes

NC -- new

Tape Logging Procedures

We are using two black folders as tape logs. The first, logs tapes as they come in (from shock trauma) with names, dates etc. The second, logs the coding and other analytic steps that occur as the data are processed.

Publications

Attached is an abstract submitted for possible presentation at the 2nd American Physiology Assoc./National Institute for the Occupational Safety and Health Conference, November 20-22nd, 1992 in Washington DC. (Attachment #4).

The abstract titled "Video Data Acquisition and Analysis Systems for Anesthesiology" was accepted for presentation at the 5th Int. Trauma Anesthesia and Critical Care Society Meeting in Amsterdam, June 12th 1992.

Attachment #1

ANESTHESIOLOGIST
POST TRAUMA RESUSCITATION/POST ANESTHESIA QUESTIONNAIRE

1. Your Beeper # 1266 MIEMSS Patient # 9C713

2. How many similar cases have you anesthetized (to the one just completed and videotaped) in your career. Number = unknown multiple too many Location of Video [✓ O.R.] [✓ A.A.] (Circle as appropriate) both

3. How long ago was the similar case anesthetized? 1 yr or more ago [✓ 6 mos - 1 yr] 3-6 mos 0-3 m
(Circle as appropriate)

4. Please score this videotaped patient by: a) AIS 6 b) GCS 8 c) ASA VE
(See VCR for abbreviated score systems) (o = no injury) (15 = norm) (I-V)

d) Trauma Anesthesia Grade (TAG) IV
(I-IV)

5. How many hours sleep did you have the night before your present duty? 4.5 Hours

6. How long was your present on call. 12 Hours. Today's Date 92.05.02-03

7. What hours (between 1st and 12th) of your present on call did the videotape include?

7 8
0230 to 0330 approximate.

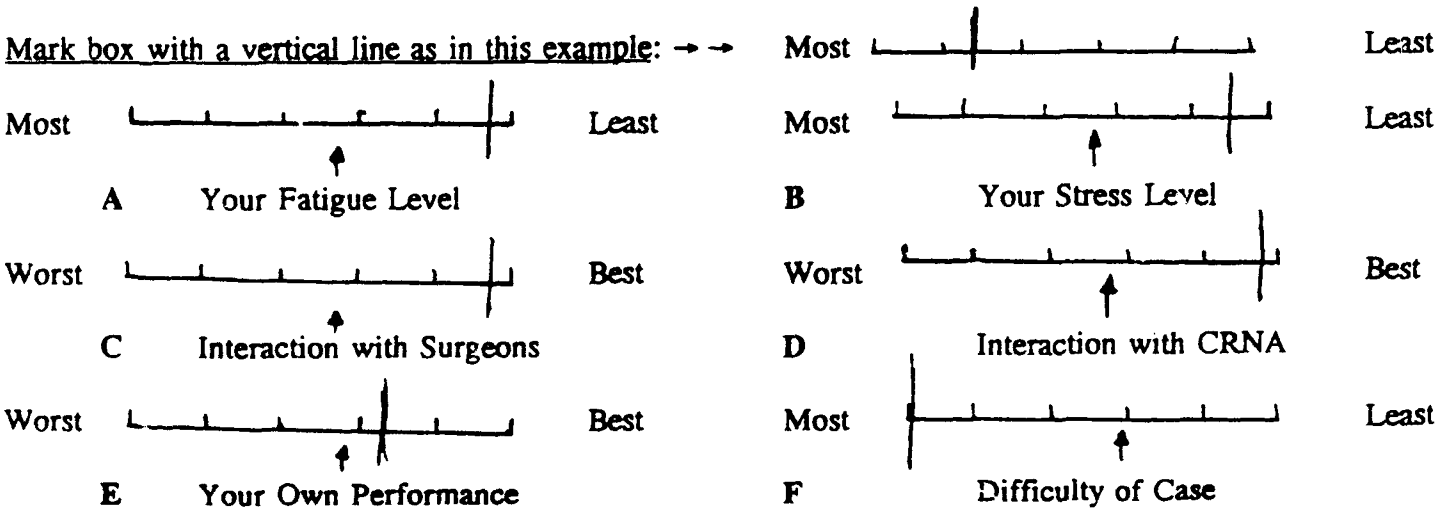
8. When were you last on call? Date 92.05.01

9. How many hours of the last on call period were you actively involved in patient care?

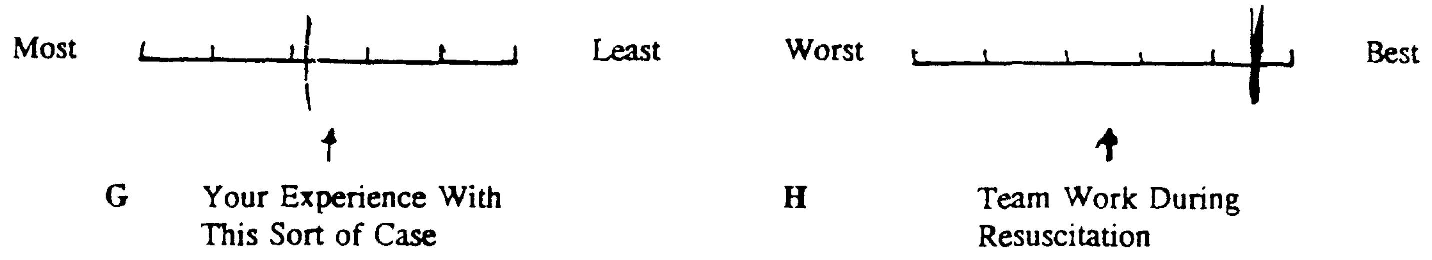
12 Hours

10. Please complete the analog scales of your perception of the resuscitation and anesthesia.

Mark box with a vertical line as in this example: → →



PLEASE COMPLETE FOR VIDEO TAPES IN A.A. AND O.R.
ONE FORM FOR THE PATIENT IN A.A.
ONE FORM FOR THE PATIENT IN O.R.



Comments on Analog Scale Responses. (Circle letters to identify comments)

A. B. C. D. E. F. G. H. → went well

F. → moribund youth

E. → my performance OK - but not principal anesthesia care provider

D. → Good teamwork among anesthesia care providers

C. → minimal really.

A. B. → I did not feel tired nor stressed in the least

11. Did you make any errors in management? Y/[✓ N]
If yes identify

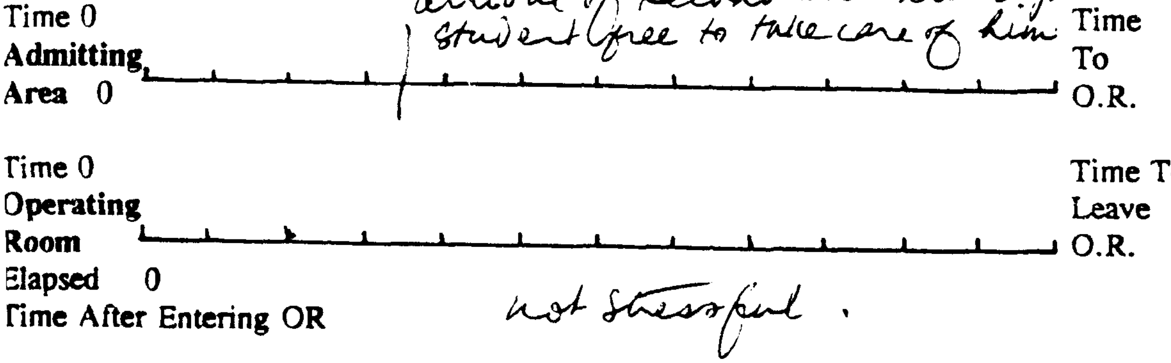
12. Did you make any misjudgements in management? Y/[✓ N]
If yes identify

13. If you had the identical patient again would you manage the same way? Y/N
If no please identify what would you do differently.
Did. Simultaneously with this one

14. Of the video taken of resuscitation and anesthesia describe on the analog scales below which parts were most stressful.*

*PLEASE COMPLETE AN ELAPSED TIME SCALE (IDENTIFY UNITS PLEASE) ON THE BOTTOM OF THE ANALOG BOXES - THIS WILL GREATLY SIMPLIFY VIDEO-ANALYSIS AND SAVE MANY HOURS OF INVESTIGATOR TIME.

arrival of second moribund patient with only a student free to take care of him



AA time only about 10 mins total.

not stressful.

navygran.tl
Revised 5/1/92

ABBREVIATED SCORING SYSTEMS TO BE USED WITH VIDEO DATA ACQUISITION

AIS

Injury

0 = None
1 = Minimum
2 = Moderate
3 = Severe (non-life threat)
4 = Severe (life threat)
5 = Critical (low survival)
6 = Max (untreatable)

GCS

Best Verbal	
None	1
Incomprehensible	2
Inappropriate words	3
Confused	4
Oriented	5
Eyes Open	
None	1
To pain	2
To speech	3
Spontaneously	4
Best Motor	
None	1
Abnormal Extensor	2
Abnormal Flexion	3
Withdraws	4
Localizes	5
Obeys	6
Total GCS Score	

ASA

Class I Healthy.
Class II Mild to Moderate Disease.
Class III Severe Systemic disturb or disease.
Class IV life-threatening severe systemic disorders.
Class V Moribund and profound shock. Little anesthesia required.

TAG

I Minor Trauma
II Major Trauma (Non-life threat)
III Major Trauma (Life Threat)
IV Not Expected to survive

Attachment #3

DOCUMENTATION NOTEBOOK
TABLE OF CONTENTS

(Last changed 5/07/92)

Submitted to 2nd Annual
APA-NIOSH Conference

Attachment #4

MODELING THE EFFECTS OF STRESS ON ANESTHESIOLOGIST PERFORMANCE DURING TRAUMA TREATMENT[4]

Richard L. Horst, Ph.D.[1], Colin F. Mackenzie, M.D.[2], David L. Mahaffey[1], James Black[2], and the LOTAS Group[3]
[1]Man-Made Systems Corporation, Ellicott City, MD; [2]Anesthesiology Research Laboratories, University of Maryland School of Medicine, Baltimore, MD; [3]Maryland Institute for Emergency Medical Services System, Baltimore, MD.

Basic questions remain unanswered in the study of the effects of stress on human performance and decision-making. To what extent do different stressors, alone and in combination, affect time-critical performance? What cognitive skills are needed for successful decision-making under stressful conditions? How do individual differences interact with task requirements in determining outcomes? What training strategies are most effective in preparing decision-makers for the moment of crisis?

It is difficult to adequately study human performance and decision-making under stress in contrived laboratory settings, because it is difficult to emulate the sense of urgency and emotional involvement that may modulate cognitive processing in a true crisis situation. The overall goal of the present project is to systematically study the task variables and cognitive processes that influence successful skilled performance and cognitive decision-making in a real-life setting in which life and death decisions are being made. The management of patients with acute massive trauma is such a real-life 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 in trauma victims during resuscitation and surgery.

Our interest is in studying the effects of a number of stressors in the trauma treatment setting that are also characteristic of other high stress jobs — time pressure, information uncertainty, fatigue, and team compatibility. Our approach 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 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. This process is being facilitated by the Observational Coding System (OCS) Tools[6] software package. The present paper will focus on the task analysis and modeling process, which is ongoing. We will present the initial modeling

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[4] 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.
[5] Micro Analysis and Design Corporation, Boulder, CO.
[6] Triangle Research Collaborative, Inc., Triangle Research Park, NC

effort and preliminary validation results from our analyses of empirical data.

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 for trauma patients depends heavily on restoration of abnormal physiological parameters to normal ranges, these decision trees were organized around the following physiological abnormalities — Tachycardia, Bradycardia, Hypotension, Hypertension, Hypoxemia, Hypothermia, Hyperthermia, Increased End Tidal CO_2, Decreased End Tidal CO_2, Difficult Airway. Originally developed as training tools, these decision trees provide flow charts of decision choice points and information requirements. Of course, a given patient may exhibit symptoms that would require the anesthesiologist to mentally access more than one of these decision trees simultaneously and make judgments as to which conditions are most critical and which interventions should be given highest priority.

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 hypotensive", "Patient 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). This task analytical information is being maintained in key-word retrievable MS-Excel spreadsheets.

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 time, frequency of alternative choices) about performance based on presumed manipulations of the task environment. In our case the manipulations (independent variables) that drive the 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 will then be brought to bear in enhancing and refining these models, with new quantitative predictions then being validated against subsequently collected empirical data. Particularly challenging will be the need to coordinate the use and predictions of various models, in order to capture the quite realistic scenarios in which a patient presents more than one set of physiological abnormalities to be dealt with concurrently.

Fig. 1

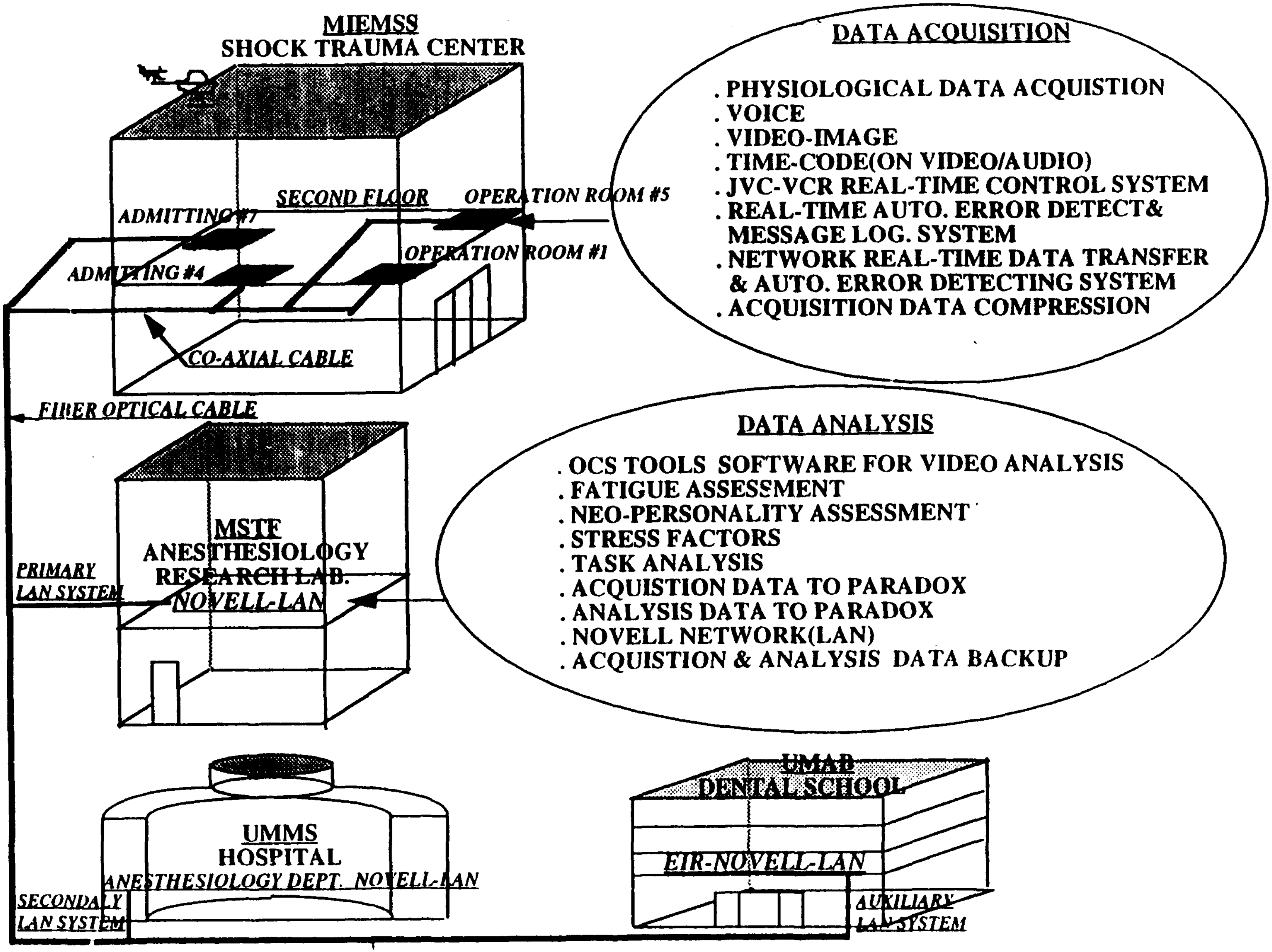
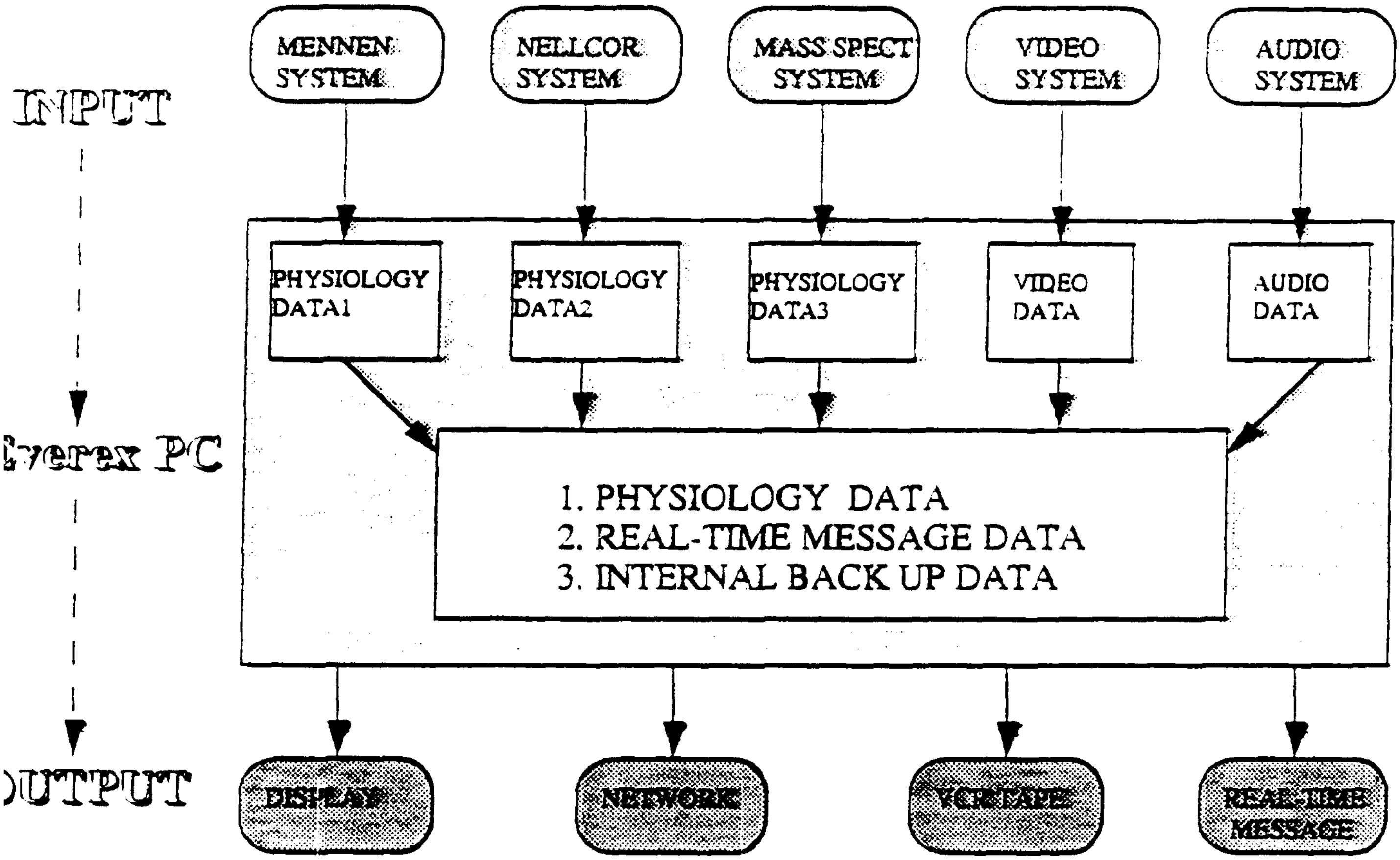

MIEMSS
SHOCK TRAUMA CENTER
SECOND FLOOR
OPERATION ROOM #5
ADMITTING #7
ADMITTING #4
OPERATION ROOM #1
CO-AXIAL CABLE
FIBER OPTICAL CABLE
DATA ACQUISITION
. PHYSIOLOGICAL DATA ACQUISTION
. VOICE
. VIDEO-IMAGE
. TIME-CODE(ON VIDEO/AUDIO)
. JVC-VCR REAL-TIME CONTROL SYSTEM
. REAL-TIME AUTO. ERROR DETECT& MESSAGE LOG. SYSTEM
. NETWORK REAL-TIME DATA TRANSFER & AUTO. ERROR DETECTING SYSTEM
. ACQUISITION DATA COMPRESSION
MSTF
ANESTHESIOLOGY
RESEARCH LAB.
NOVELL-LAN
PRIMARY LAN SYSTEM
DATA ANALYSIS
. OCS TOOLS SOFTWARE FOR VIDEO ANALYSIS
. FATIGUE ASSESSMENT
. NEO-PERSONALITY ASSESSMENT
. STRESS FACTORS
. TASK ANALYSIS
. ACQUISTION DATA TO PARADOX
. ANALYSIS DATA TO PARADOX
. NOVELL NETWORK(LAN)
. ACQUISTION & ANALYSIS DATA BACKUP
UMMS
HOSPITAL
ANESTHESIOLOGY DEPT. NOVELL-LAN
SECONDALY LAN SYSTEM
UMAB
DENTAL SCHOOL
EIR-NOVELL-LAN
AUXILIARY LAN SYSTEM

Fig. 2



NAVY DATA ACQUISITION SYSTEM

Fig. 3

NAVY DATA AQUISITION SIDE(OR'S&AA'S) HARDWARE CONNECTION

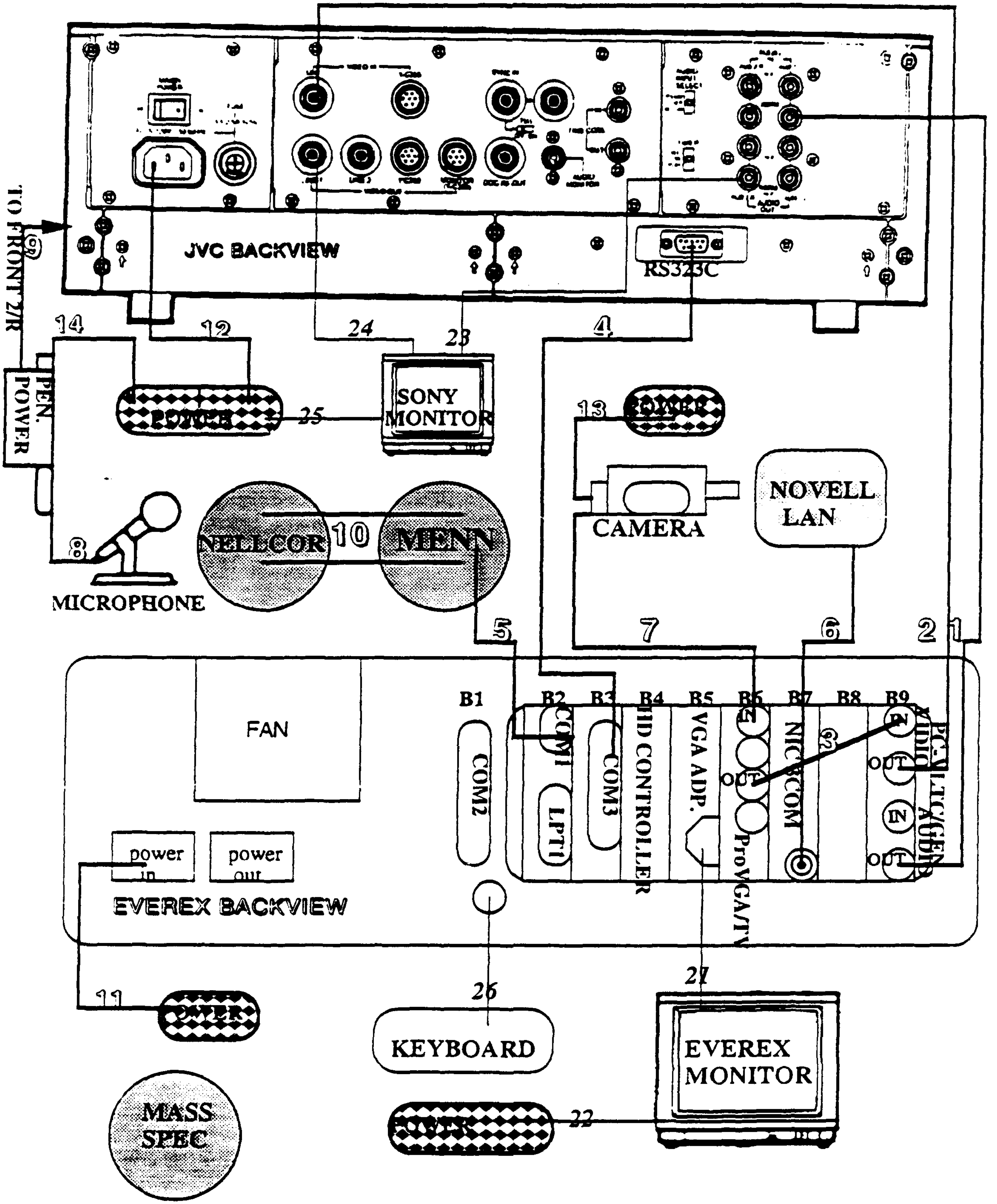


Fig. 4

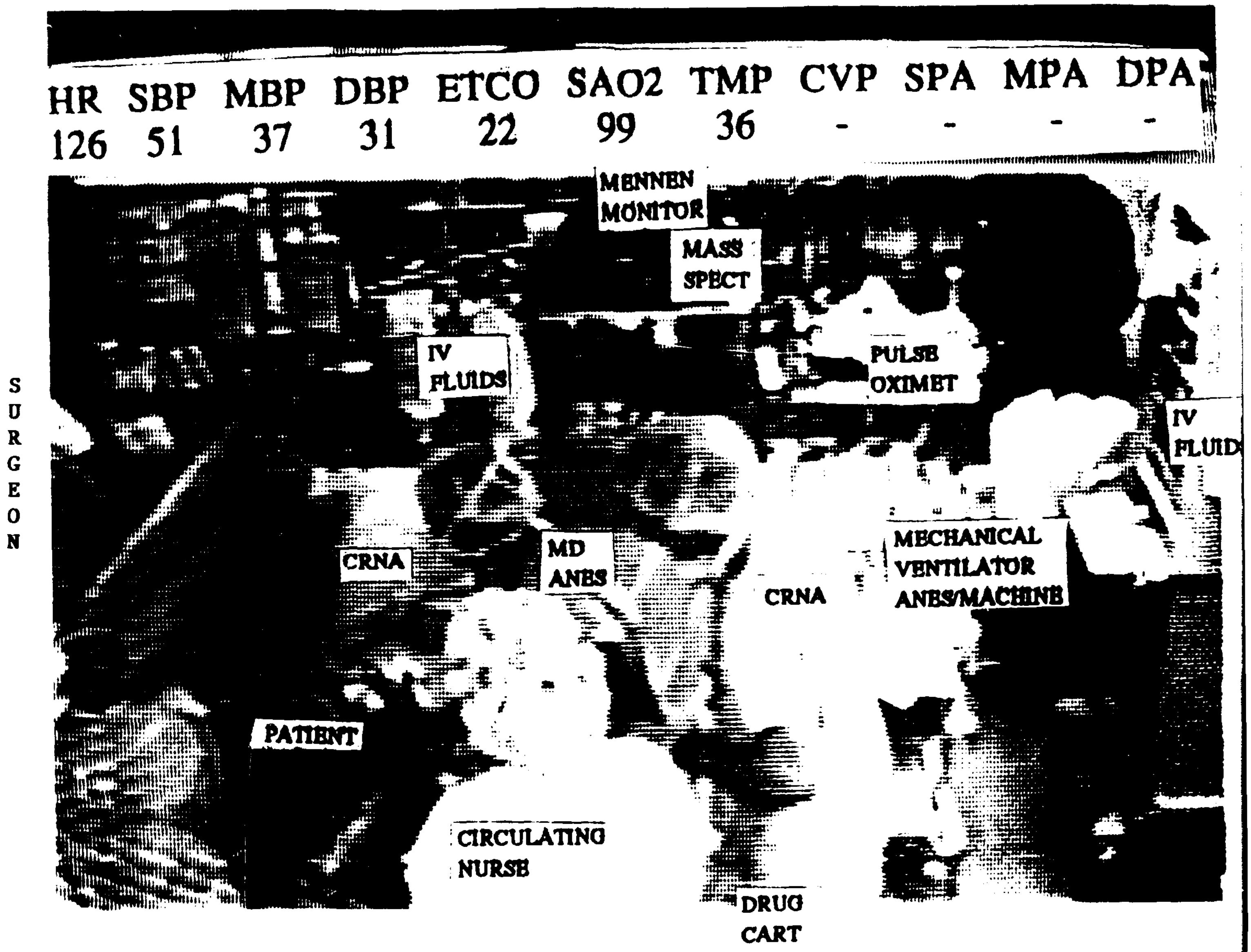

HR SBP MBP DBP ETCO SAO2 TMP CVP SPA MPA DPA
126 51 37 31 22 99 36 - - - -
MENNEN MONITOR
MASS SPECT
IV FLUIDS
PULSE OXIMET
IV FLUID
SURGEON
CRNA
MD ANES
CRNA
MECHANICAL VENTILATOR ANES/MACHINE
PATIENT
CIRCULATING NURSE
DRUG CART

Figure #5

Heart Rate, Mean, Diastolic, and Systolic Blood Pressures as a function of time in patient shown in figure #4.