INTERFACE
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The "Depth of Anesthesia Monitor"
An Impossible Dream?

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How much anesthetic is enough? Using anesthetic drugs is more complex now than when we used a single agent: many specific agents produce different parts of the anesthetized state, and we vary their proportions throughout the case as an organist plays a fugue. Clinicians have asked industry to develop monitors for depth of anesthesia to help us use our drugs wisely. Why have they failed to meet the challenge? I propose that it is because of conceptual barriers to developing such monitors.

Can We Define "Depth of Anesthesia?"

What does "depth of anesthesia" mean? I have asked hundreds of resident and attending anesthesiologists this question and, despite a great deal of head scratching, the concept eludes definition and containment. How can we develop a monitor for a parameter we can't define?

To develop an anesthetic depth monitor we must first determine what it is we are trying to produce during an anesthetic? Here is the earliest recorded account of a sufficiently deep anesthetic: "The Lord God caused the man to fall into a deep sleep; and while he was sleeping, he took one of the man's ribs and closed up the place with flesh."(1) This account records neither recall nor patient movement, and the experience apparently was satisfactory to patient and surgeon. During the last 150 years, we have seen many accounts of unsatisfactory patient response during surgery: awareness and recall, suffering, movement, and harmful cardiovascular responses. Unfortunately, we cannot always recognize when an anesthetic is deficient until after the fact. *["To sleep: perchance to dream: ay, there's the rub;"—Hamlet: Act III: Scene I]*

We can consider that anesthesia is intended to relieve suffering with life support provided as an adjunct. Some clinicians assert, "If there is no recall of unpleasant events, the goal has been met." But many adjuvant drugs, such as muscle relaxants, or cardiovascular agonists and antagonists, mask or mimic classical signs of response to surgery and anesthetic agents. Would you want to suffer terribly during your surgery and to have no memory of the experience later? The growing literature testifies to repression of unpleasant perioperative memories with resultant emotional upsets.

continued on page 44

Efforts to Computerize the Medical Record Getting Organized

For many years, the vision of a computerized medical record has been discussed in the medical literature. Despite tremendous advances in information management technology in many industries, medicine has lagged behind. Aspects of the medical record, such as laboratory data and basic financial information, are routinely computerized, but a unifying approach to patient information has yet to evolve from the paper format. The anesthesia community has been amongst the most active of the medical specialties in, if not adopting the computer-based record warmly, witnessing the development of the technology and discussing it actively. Recent activities at the national level are likely to hasten the appearance of the computer-based patient record of which, the automated anesthesia record will undoubtedly be a part.

Institute Formed

The Computer-Based Patient Record Institute (CPRI) was incorporated early in 1992 following a two year study by the Institute of Medicine which concluded that the computer-based patient record should be adopted as the standard for all medical records [1] (See Inset on page 40). CPRI is actually an organi-

continued on page 40

INSIDE THIS ISSUE:

- Mini-Theme: CNS Monitoring
- Computer-Based Patient Records Coming
- European Meetings
- STA Bylaws Changing— see pg. 48
- *JCM* Abstracts on CompuServe

Transcranial Doppler Sonography

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While the first applications of the Doppler principle for measuring blood flow velocity took place in 1960, and the first intraoperative Doppler study of the major intracranial arteries was noted in 1979 (Nornes, et al., *J. Neurosurg* 50:570-577), it was not until 1982 that Transcranial Doppler (TCD) sonography was introduced by Aaslid and coworkers (*J. Neurosurg* 57:796-774,1982).

The Doppler shift involves a change in the frequency of a wave resulting from the relative motion between an observer and a source of (ultra)sound. The magnitude of the shift is related directly to the velocity of the moving object (red blood cells), and the cosine of the angle between the direction of blood flow and the beam of the ultrasound. In the pulsed ultrasound Doppler, transmitting and receiving wave energy utilizes the same transducer. In the TCD sonographic technique, a cranial "window" is localized so that beam passage can occur without excessive damping. Insonation techniques for the different access routes to the different intracranial arteries, as well as their normal values for TCD velocity, have been described by Aaslid (*Transcranial Doppler Sonography*, Springer-Verlag, Vienna, 1986, pp 177).

It is important to recognize that while the TCD findings are expressed in velocity of flow units, these velocity measurements may also reflect changes in volume flow. Volume flow (cm^3/sec) is the product of velocity (cm/sec) and cross-sectional area (cm^2). The relatively "stiff" walls of the large basal arteries appear to minimize changes in the cross sectional area of these vessels, even in the face of significant fluctuations in cerebral perfusion pressures. Knowing the velocity of blood flow thus allows for estimation of volume flow (Aaslid, *Transcranial Doppler Sonography*, Springer-Verlag, Vienna, 1986, pp 177; Lundes, et al, *Ann Thorac Surg* 40:144-148, 1985.) Halsey and co-workers, have however (*Stroke* 20: 1-3, 1989), expressed reservations concerning the validity of expressing volume flow as a function of TCD velocity measurements.

There is no question as to the versatility and increased clinical application of this non-invasive monitor. It has been used:

1. To estimate the hemodynamic response resulting from carotid stenosis as indicated by a decrease in CO reactivity (Zanette et al., *Stroke* 23:680-685, 1991).

2. To indicate the need for shunt placement during carotid endarterectomy. Halsey and colleagues (Newsletter, Soc Neurosurg Anes Crit Care, Fall 1989) feel a shunt is not indicated when the MCA velocity after carotid clamping is greater than 20 cm/sec and the EEG shows no changes.

3. To determine brain death. In these patients, a characteristic picture indicated a net flow velocity of less than 10 cm/sec as well as a reversed diastolic flow and/or small early systolic spikes (Lewis, et al *J R Soc Med* 76:308-310, 1983; Ropper et al., *Neurology* 37:1733-1735, 1987; Powers et al., *Neurosurgery* 24: 884-889, 1989).

4. To diagnose and predict cerebral vasospasm after subarachnoid hemorrhage, usually characterized by an increase in TCD velocities (Acylate, et al, *J Neurosurg* 60:37-41, 1984). SPECT studies carried out after onset of delayed neurological dysfunction indicated abnormal perfusion patterns and correlated with TCD velocities (Grosset et al., *Stroke* 23:674-679, 1992).

5. As an addition to CT scanning and angiography for diagnosis of an arteriovenous malformation (AVM) and for the delineation of defective autoregulation in vascular structures adjacent to an AVM (Lindegaard et al. In: *Transcranial Doppler Sonography* 86-105, 1986.) Flow velocities considerably higher than normal are noted in the intracranial arteries feeding large or medium sized AVMs.

6. As a means of monitoring an intracranial pressure (ICP) profile by demonstrating an initial increase in flow velocity followed by an increasing pulsatile high resistance flow profile (Reingelstein, *Transcranial Doppler Sonography* 147-163, 1986.)

7. To detect right-to-left cardiac or pulmonary shunt following intravenous injections of contrast dye by imaging microemboli of air in the right middle cerebral artery (Chimowitz et al., *Neurology* 41:1902-04, 1991).

8. To study cerebral perfusion and autoregulation during cardiopulmonary bypass (Lundar et al., *Am Thorac Surg* 40:144, 150, 1985).

continued on page 43

INTERFACE is the official newsletter of the Society for Technology in Anesthesia. The newsletter is published quarterly and mailed directly to the membership of the society. The editors invite suggestions, contributions and commentary about published items. Please send all correspondence to:

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PERSPECTIVES ON TECHNOLOGY
TOPIC: Evoked Potential Monitoring

■ ***"Interestingly, the challenges do not relate to technological obstacles, but to a small market size, problems identifying the user and a lack of monitoring standards."***

The Industrial Perspective

Dick Moberg, MSE
President
Moberg Medical, Inc.
Ambler, PA

Compared to other areas of medical instrumentation, there have been surprisingly few advances in commercial evoked potential (EP) monitors in over a decade. Few, If any, EP instruments would satisfy the requirements of a well-designed operating room monitor (small size, reliable, easy-to-use, trending displays, alarms, etc.). Manufacturers of this equipment face many challenges to enhancing current EP monitors. Interestingly, the challenges do not relate to technological obstacles, but to a small market size, problems identifying the user and a lack of monitoring standards.

Market Size

In the past, the relatively small market size for intraoperative EP equipment did not justify the R&D necessary to develop an advanced OR monitor. Consequently, complicated diagnostic machines were brought to the OR from the EEG lab. As a result, only those institutions with the resources to purchase and operate the device could perform EP monitoring. Smaller, easier-to-use units do exist, but with limited capabilities.

The literature suggests there are many applications for EP monitoring both in the OR and in critical care, however, few are considered a standard of care. Thus, the manufacturer's dilemma. Do we develop an easy-to-use advanced EP monitor in hopes that more users will see its utility and it will become a standard of care and widely used? Or do we wait for the field to mature? Until now, industry has chosen to wait.

Today, however, the increasing user demand, the emphasis on body systems measurements and the recent national focus on the brain has caused some important changes. Whereas EP monitoring has traditionally been separate from the typical equipment used by the anesthesiologist, most of the larger monitor and anesthesia machine manufacturers now consider neurophysiologic function a monitored parameter. At this point, the race is on.

Who is the user?

In order to build effective neurophysiologic monitors, we must know who the user will be. Is it a neurologist, an EEG technician, a monitoring technologist or the anesthesiologist? Also, is the user necessarily the customer? All have different requirements for equipment.

continued on page 46

■ ***"EP equipment is now being developed that is actually designed as an intraoperative monitor."***

The Clinical Perspective

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Central nervous system (CNS) injury can occur during any operation but is most likely when actual CNS structures or their blood supply can be compromised during the operation. Evoked potentials are responses produced in the peripheral or central nervous system to specific applied stimuli such as electrical shocks (somatosensory), loud clicks (auditory) or light flashes (visual). The initial application of evoked (EP) monitoring in the operating room utilized somatosensory EPs to detect spinal cord injury occurring during and after distraction of the spinal column during posterior spinal fusions for scoliosis. Success in that application led to a rapid increase in utilization of EPs until today, EPs are used during multiple procedures (Table) in an attempt to detect CNS injury before it becomes irreversible and allow therapeutic intervention to correct the problem. Multiple types of EP monitoring are now in use and include somatosensory, auditory, visual, and recently motor (transcranial or spinal magnetic or electrical stimulation).

Is Evoked Potential Monitoring Useful?

The only way to answer this question would be to perform an outcome study. Such a study at this point in time would be virtually impossible to perform for several reasons. First, many surgeons are so convinced that EP monitoring is useful, they would not permit a study where EPs were monitored but the results not made available to the operative team., Second, any outcome study would have to involve multiple institutions in order to have a large enough patient population to detect a small difference in outcome. Furthermore, there is little standardization of EP monitoring methods from institution to institution at this time.

Are these outcome studies really necessary? The insurance companies are demanding such studies in order to justify reimbursement. Many intraoperative monitors have become part of the standard of care without any outcome studies to support their utility. When pulse oximetry was tested to determine its impact upon outcome, no difference in outcome could be identified whether the pulse oximetry data was available to the clinicians or not! EP monitoring provides information about the functioning of certain parts of the CNS during surgery that would not otherwise be available. How

continued on page 46

Medical Record

continued from the cover

zation of organizations "committed to initiating and coordinating urgently needed activities to facilitate and promote the routine use of computer-based patient records." There are currently 22 member organizations which include representatives from the healthcare industry, public sector and organized medicine. Each organization has one designee with voting privileges who is also eligible to be nominated for the governing board. Individuals, such as physicians, engineers, and health care managers, are also involved with CPRI through subscriptions to the newsletter and participation in the working groups.

CPRI Goals

CPRI has a number of goals designed to support the ultimate development and acceptance of the computer-based patient record. For some of the goals, specific working groups have been established. The goals and working groups are:

✔ To promote the development and use of standards for computer-based patient record messages, communications, codes and identifiers.
Working group: Codes and Structures

✔ To demonstrate how computer-based patient record systems can lead to improvements in effective and efficient patient care.
Working group: CPR Justification

"Recent activities at the national level are likely to hasten the appearance of the computer-based patient record."

✔ To encourage creation of policies and mechanisms to protect patient and provider confidentiality and ensure data security.
Working group: Confidentiality/Privacy/Legislation

✔ To educate health professionals and the public about computer-based patient records.
Working group: Professional/Public Education

✔ To coordinate the building of technical and legal infrastructures that enable the use of computer-based patient records.

✔ To promote computer-based patient record research activities.

A fifth working group, Financing CPRI, is tasked with membership recruitment and identification of funding sources.

The first meeting of the working groups took place on July 14th 1992. This meeting resulted in annual plans for all of the work groups that have been published in the CPRI newsletter. One important project, scheduled for completion by November, entails developing a compendium of existing literature on the computer-based patient record. The literature database will be updated continuously, and may ultimately be available for distribution in electronic form. The next meeting of the working groups is scheduled for November 12. Details about the site and times are available from CPRI.

How to Become Involved

For more information about the computer-based patient record, the Institute of Medicine report has been published and is available in hard-cover from the National Academy Press, PO Box 285, Washington, DC. 20055, (800-624-6242) for $24.95 US. Individuals can subscribe to the CPRI newsletter and participate in the working groups. The newsletter annual subscription fee is $100 US. The address for information is: CPRI, Inc., c/o American Health Information Management Association, 919 N. Michigan Ave., Suite 1400, Chicago, IL 60611, 1-800-621-6828 or (312) 787-2672.

— J. Feldman

Based upon an interview with Margaret Amatayakul, CPRI Interim Executive Director. ◆

Summary of the Recommendations of the Institute of Medicine Committee on Improving the Patient Record

1. Health care professionals and organizations should adopt the computer-based patient record (CPR) as the standard for medical and all other records related to patient care.

2. To accomplish Recommendation No. 1, the public and private sectors should join in establishing a Computer-based Patient Record Institute (CPRI) to promote and facilitate development, implementation, and dissemination of CPR.

3. Both the public and private sectors should expand support for the CPR and CPR system implementation through research, development, and demonstration projects. Specifically, the committee recommends that Congress authorize and appropriate funds to implement the research and development agenda outlined herein. The committee further recommends that private foundations and vendors fund programs that support and facilitate this research and development agenda.

4. The CPRI should promulgate uniform national standards for data and security to facilitate implementation of the CPR and its secondary databases.

5. The CPRI should review federal and state laws and regulations for the purpose of proposing and promulgating model legislation and regulations to facilitate the implementation and dissemination of the CPR and its secondary databases and to streamline the CPR and CPR systems.

6. The costs of CPR systems should be shared by those who benefit from the value of the CPR. Specifically, the full costs of implementing and operating CPR's and CPR systems should be factored into reimbursement levels or payment schedules of both public and private sector third-party payers. In addition, users of secondary databases should support the costs of creating such databases.

7. Health care professional schools and organizations should enhance educational programs for students and practitioners in the use of computers, CPR's and CPR systems for patient care, education, and research.

Reference: Dick RS, Steen EB (eds). The Computer-Based Patient Record: An Essential Technology for Health Care. National Academy Press. Washington DC. 1991. ◆

Symposium on Anaesthesia Record Systems

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The Netherlands

On June 20th, 1992, a symposium dedicated to anaesthesia record systems was held in The Hague, The Netherlands, just after the 10th World Congress of Anaesthesiologists Meeting The symposium was organized by ESCTAIC (European Society for Computing and Technology in Anaesthesia and Intensive Care) as host to the American and Japanese Societies for Technology in Anaesthesia (STA and JSTA). Since these societies are relatively new, and closely aligned, time was provided at the start of the symposium for each society's president to present the goals and achievements of their society. The international audience heard lectures on ergonomics, the necessity of quality control of monitor signals, the expectations from Anaesthesia Record Systems, the format of archives and on the utility of a database. After each session a lively discussion ensued, stimulated by the twelve invited speakers.

continued on page 42

MEDINFO 92—A Glimpse into the Future of Medical Informatics

The 7th World Congress on Medical Informatics MEDINFO 92 was held in Switzerland, 6-10 September 1992. About 1400 computer scientists, physicians, nurses and health care administrators convened at Palexpo Hall in Geneva. The Congress was presented by the International Medical Informatics Association (IMIA). More than 450 scientific papers were presented during 160 (!), mostly parallel, sessions. This heavy, State-Of-The-Art program was published in two, hard-bound, brick-sized volumes of Proceedings. These proved valuable since an active participation in more than 15% of the sessions was virtually impossible. On the other hand the organizers, by allowing for only 2-4 papers per session, provided ample time for both presentations and discussions. The speakers discussed the present state of research in medical informatics, which sometimes reminded me of a science fiction movie. R. Penrose in his keynote address underlined however, that the computers have obvious limitations and it must never be forgotten that their ability to perform computations can not replace the human ability to understand.

The issues directly related to Anaesthesia and Intensive Care, such as real time data acquisition and display, anaesthesia workstation, closed loop drug delivery systems or intelligent alarms were only sparsely addressed. The topics, which could be considered indirectly relevant were software and systems integration, presentation of large data sets, standardization and decision support. T. Timmers (Erasmus University, Rotterdam, The Netherlands) presented an interesting concept of integrating heterogeneous clinical databases in a medical workstation using knowledge-based modeling (HERMES). This very promising idea lessened my fears about future utilization of "old-fashioned" clinical databases, the ones we are building now. The totally integrated newly-built hospital information system in Osaka, presented by H. Takeda was impressive, but for the majority of us the "intelligent" usage of "old" databases will probably be the future.

continued on page 42

UPCOMING EVENTS

ASA 92

To be held October 17– 21 in New Orleans, Louisiana. Contact: American Society of Anesthesiologists, 515 Busse Highway, Park Ridge, IL 60068-3189, (708) 825-5586.

STA Sponsored Events

Sunday, October 18, 1992

- ✎ ***Journal of Clinical Monitoring*** **Editorial Board Breakfast/Meeting**
  Sheraton New Orleans Hotel
  7:00 am
- ✎ **National Anesthesiology Database Committee Meeting**
  Sheraton New Orleans Hotel
  1:00 pm – 2:30 pm
- ✎ **STA Education Committee Meeting**
  Sheraton New Orleans Hotel
  2:30 pm – 4:00 pm
- ✎ **STA Board of Directors Meeting**
  Sheraton New Orleans Hotel
  4:00 pm – 6:30 pm
- ✎ **STA Annual Dinner**
  (by ticket only, $40/person)
  Sheraton New Orleans Hotel
  6:30 pm – 7:15 pm *Reception*
  7:15 pm–9:30 pm *Dinner and Speaker*
  John K. Lauber, PhD
  National Transportation Safety Board
  "Human Error and Accident Prevention"

For information on any of the above STA sponsored events, contact the National Office at (804) 378-4959.

Wednesday, October 21, 1992

- ✎ **Breakfast Panel**
  New Orleans Hilton, Grand Salon C-D
  7:30 am
  "Anesthesia in Remote Locations"

Computers in Anesthesia XIII

To be held October 21–24 at the Bourbon Orleans Hotel, New Orleans, LA. Contact:Ann Y. Loffi, T-4126 MCN, Vanderbilt Univ. Medical Center, Nashville, TN 37232-2125.

1993 STA - ISCAIC Annual Meeting

See meeting brochure accompanying this issue of the newsletter for details. ◆

Symposium on Anaesthesia

continued from page 41

Active Discussion

In the session on ergonomics for instance, experience with the instrumentation panel of the Fokker 100 airplane was presented. In designing that aircraft, the development engineers learned that nuisance alarms must be prevented, that the user acceptance of computers should be high, and, finally, that a checklist should be designed with feedback input. In the session on quality control of physiologic data it was noted that, although industry is planning to market anaesthesia management systems, we as a profession prefer that efforts be directed towards validation of monitor signals and warning systems. Dr. K. Suwa (Japan), in the session on the utility of databases, pointed out the difficulties in using Western computers without facilities for use of Japanese characters. In the same session Dr. B. Hallen (Sweden) was skeptical about the use of routinely collected perioperative data for scientific purposes. In order for substantive scientific questions to be addressed, prospective decisions must be made regarding the data to be stored. This question was further explored in the closing lecture by Dr. A. Lack (U.K.) concerning the contribution of an anaesthesia record system towards improving the quality of anesthetic care. The anaesthesia record system should support auditing, critical incident recording and training reports to name a few applications.

The companies involved in anaesthesia recordkeeping and information management are to be thanked for supporting the symposium and exhibiting their recordkeeping technology. Almost all the devices on the market were available for inspection. ◆

MEDINFO 92

continued from page 41

Requirements for Innovation

S.H.F. Guist in the paper "The Rise and Fall of the Innovator", based upon the experience with British National Health Service Information projects, depicted what many of us already have experienced: the difficulties in gaining acceptance for the new systems. He underlined the fact that all innovation requires an "initiator" who sees opportunities and creates the environment for change, but he has to be superseded by a "leader", who follows through on the original idea and facilitates the solution. Thus, future, modern utilization of contemporary systems, as described by T. Timmers, can be used by the leader as the motivating factor for users.

Large amounts of data presented in digital form are unintelligible to the majority of users. The group from Munich presented two interesting papers, referring to the knowledge-based system for interpretation of renal function in the ICU-environment (NIMON). The first, presented by J. Schwaiger, addressed the successful implementation of uncertainty-handling methodology in the knowledge-based system, the second, presented by U. Wenkebach, described the graphical presentation of the results. The authors chose to display three-dimensional data sets in the form of hemispherical shapes generated on the screen. This allowed the users for rapid interpretation of voluminous and complex data.

ESCTAIC Working Group

The standardization and coding of medical data was the issue of a substantial number of papers. Different approaches were presented, but, so far, no general standard seem to emerge. The ESCTAIC Working Group on Standardization in Anaesthesia (A. Tecklenburg and B. Schwilk) organized a workshop on Minimal Data Set in Anaesthesia. The aim is to establish a European data standard that would facilitate comparison of anaesthesia departments in terms of education, "production" and quality of care. An interesting discussion developed, where Dr. Bob Webb from Australia substantiated the idea of recording Critical Incidents (potentially deleterious, although not necessarily leading to a complication) as a tool of quality assessment. The decision support was almost invariably associated by the speakers with the rule-based expert systems. Such systems, however, are still relatively slow and can cover only limited areas of expertise. With the exception of NIMON no such system for emergency or intensive care medicine was presented.

A step towards a development of an integrated patient record and decision support system (MEDAS) was presented by F. Naeymi-Rad, Illinois, USA. The patient data recording in a hypertext-type forms allows for acquisition of uniform information, which should interface readily with knowledge data bases available within the Hospital Information System. Moreover, the process of data acquisition is structured so that the user perceives it as a series of personal successes. This should enhance the user acceptance of the system.

During the Congress a number of Technical Excursions and Meet-the-Expert sessions were organized. The Industrial Exhibition was dominated by the large stands of Digital Equipment Corporation and Hewlett-Packard. The latter presented a video "Imagine" presenting a future "paperless" hospital with workstations integrating real-time video communication and image transfer, voice recognition, PDMS, HIS and who-knows-what. Although none of the techniques employed was science-fiction today, the combination gave a preview of the 21st century.

The organization of the Congress allowed me to participate in only a fraction of what was shown and said during MEDINFO 92. To get a more complete idea of it I will have to rely on the Proceedings. This, however, will take time, considering the impressive size of these two volumes. The Congress gave me the impression that system integration, including wide-area communication, object-oriented programming, knowledge engineering and graphical user interfaces are the keywords of today and tomorrow. ◆

—Andre Dellermalm

Transcranial Doppler

continued from page 38

9. To detect, differentiate and quantitate microemboli of air and particulate matter during cardiopulmonary bypass and neurovascular procedures (Albin, et al J. *Neurosurg Anesthesiology* 1:134-135, 1989; Spencer, et al, *Stroke* 21: 415-423, 1990; Vander Linden, *Ann Thorac Surg* 51: 237-241, 1991).

This has been a capsular presentation of a monitoring technique that is non-invasive with beat to beat, real time availability, whose potentially exciting applications have yet to be totally developed.

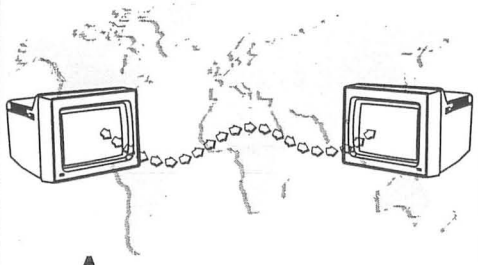
[Ed. Note: There's a big jump between correlating monitored data with clinical events and basing clinical decisions on data from a monitor. Intuitively, it seems that knowing regional cerebral blood flow should be useful in decision-making in anesthesia. TCD can provide information about the velocity of flow from which actual flow information may be inferred. Are we still a long way from routine clinical application? The anesthesiologist already must monitor many different parameters. Perhaps continuous monitoring will be delegated to a technician in the way that evoked potential monitoring is typically performed at present. Cost and documentation of the impact upon outcome will also be key factors determining acceptance. —R.S.] ◆

Clinical Temperature Measurement Survey

There is still time to respond to the survey on clinical temperature measurement. The results will be used to guide an international standard currently being completed. See *Interface* Volume 3, Number 3 or download the library file THERM.ASC from the STA CompuServe forum.

SIGnatures

Notes from the STA Special Interest Group



After several months, we have succeeded in placing abstracts for the *Journal of Clinical Monitoring* on-line on CompuServe in advance of their publication. In addition to providing advance notice of upcoming *JCM* articles, authors will have visibility as early as possible after acceptance of their manuscript. Since this is the first time this is being done, we are interested in feedback regarding the concept and format. Anyone interested can participate in the beta-testing of this process by downloading the abstracts, reviewing them and sending commentary to Dr. Frank Block (70147,440). Commentary has already started in the STA forum about what to include in the abstract citation, and how to organize the files to indicate new abstracts and those that have already been published.

To download the abstracts, you must first sign on to CompuServe and access the STA forum area by typing GO MEDSIG<cr>. Follow the prompts to access Library 6 and download the file entitled JCM921.ASC. The filename indicates the *Journal of Clinical Monitoring* (*JCM*), first set for 1992 (921) and ascii format (ASC).

The most confusing aspect of downloading usually occurs when CompuServe asks what protocol you want to use. The choices are:

1 XMODEM
2 CompuServe B+ and original B
3 DC2/DC4 (Capture)
4 YMODEM
5 CompuServe QB (B w/send ahead)
6 Kermit

The secret here is that YOUR terminal software must also support one of these six downloading protocols. Use CompuServe B+ and original B, or CompuServe QB, if available, they will usually be faster. After selecting a protocol on the CompuServe menu, CompuServe will instruct you to start the downloading process. What you must then do is have your specific modem control software begin capturing using the selected protocol. Since each software package is different, you must consult your manual for the exact commands. An easier approach is to use CompuServe Information Manager, a program available from CompuServe that automates all of the interactions with CompuServe.

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The file is in ASCII format. Once you have the file, you can view it on the screen, print it, or edit it with a word processor. ◆

—F. Block

LOOK IN THE LIBRARY

FILENAME (type/size)	Description
JCM921.ASC (ascii/10K)	Abstracts of *Journal of Clinical Monitoring* abstracts accepted but not yet published
THERM.ASC (ascii/12K)	Questionnaire on clinical requirements for temperature measurement

SUMMARY OF SIGN-ON INSTRUCTIONS:

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4. At the "!" prompt type "GO MEDSIG" to access the medical forum.
5. STA uses the Subspecialty forum which is entered from the MEDSIG menus.
6. If it is not clear how to best use the forum, type "GO PRACTICE" at the "!" prompt to get the practice forum which can be used without charge.

For CompuServe Customer Service, call 800-848-8990.
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Depth of Anesthesia

continued from the cover

> ***We need a real-time, continuous indicator of the balance between surgical stimulation and anesthetic effect on the central nervous system.***

We all want to be unaware of unpleasant events *during* surgery, not just afterward. Can your anesthesiologist know whether you are suffering?

Stanski defines anesthesia as "the lack of response and recall to noxious stimuli." This definition depends upon external effects we can observe. He defines adequate depth of anesthesia differently: "a collage of effects sufficient for the comfort of the patient and the conduct of surgery." We can't currently define depth of anesthesia in measurable terms, yet we try to measure it anyway. Investigators enthusiastically measure movement, cardiovascular changes, autonomic responses, EEG, EMG, or whatever external state is handy. Unfortunately, these substitutes for knowing the patient's mental state are inadequate indicators of depth of anesthesia because the variables influencing these responses are so complex. Pre-existing disease, other medications and side effects of the anesthetic drugs themselves may cause effects independent of "anesthetic depth."

The Basis for Monitoring "Depth of Anesthesia"

Monitoring depth of anesthesia is torn between two approaches: statistical and reactive. Statistical methods such as MAC and Minimal Infusion Rate (MIR) predict the quantity of anesthetic in the patient that will prevent suffering. But statistics are imperfectly predictive, so if that's our only guideline, we excessively anesthetize 95% of the population to take care of the other five per cent. Since modern anesthetics dissipate rapidly, does it matter? We want (and can get) most of our patients awake and analgesic immediately after surgery to prevent complications from oversedation.

Do the statistical approaches deal with the real problem? Most of the statistical approaches are based on all-or-nothing patient response following a noxious stimulus, during a period of equilibration with the brain during which there is no stimulus. That method may help predict whether the patient reacts to skin incision. What about the rest of the operation, which comprises most of the patient's surgical experience? Stimulus strength varies throughout the surgery and so does secretion of endorphins and other analgesic substances.

Reactive approaches to monitoring depth of anesthesia, such as EMG, EEG, patient movement, cardiovascular and autonomic changes, and esophageal contractility (no longer available in the U.S.) tell us how the patient is reacting right now. Yet they all share two major defects: (1) we don't know how closely they relate to pain and suffering and (2) they don't tell us what to do next. While reactive indices of depth may be indirect indicators of patient suffering, they don't tell us whether the anesthetic state is adequate to prevent suffering in the next moment, and they certainly cannot predict the changing intensity of the surgical stimulus.

We need a real-time, continuous indicator of the balance between surgical stimulation and anesthetic effect on the central nervous system. A continuum of response to stimulation lets us deepen the anesthetic as the stimulus grows more intense. Extensive clinical experience with esophageal contractility monitoring at our institution suggests that such an indirect indicator can be a useful adjunct to clinical observation and judgment.

New Approach Necessary

Previous attempts at defining depth of anesthesia have been limited to variables we can measure now. I believe that approach was short-sighted and inhibited investigation of new monitoring methods. To liberate our search for effective depth of anesthesia monitoring, I propose the following definition:

Depth of anesthesia is the effect on suffering of the balance between stimulation and anesthetic action.

This definition allows for both predictive and reactive approaches to monitoring depth of anesthesia. It adapts to multiple receptor sites and mechanisms of anesthetic action. It acknowledges our purpose in giving anesthesia. And it leaves treatment of physiological responses a separate issue from the task of preventing suffering. Research and development need to focus on definition, detection and measurement of suffering (or,preferably, its prodromal states).

We can deliver anesthetic agents to their receptor sites more rapidly and specifically than ever before. We will only be able to improve monitoring of anesthetic depth when we learn to detect and measure suffering and the effect of different drugs in preventing it. Success will require intense investigation into the nature of suffering in the perioperative period. Although success may not be guaranteed, at least we will be going in the right direction.

REFERENCES:

1. Genesis 2:21. The Holy Bible, New International Version. Zondervan Bible Publishers, Grand Rapids, Michigan. 1978.

2. Stanski DR. Monitoring Depth of Anesthesia. pp. 1001-1029. In Miller RD (Ed.), Anesthesia (3rd Ed.). New York, Churchill Livingstone. 1990. ◆

STA Membership Update

STA membership currently stands at 361. The membership committee is working on a new membership brochure. In addition, a STA logo sticker is enclosed with this newsletter for you to place on your name badge at ASA in New Orleans. This is all part of an effort to make STA more visible.

If you know someone who is interested in joining, have them contact the National Office at (804) 378-4959 to request membership information or pass on the membership application that is included with this issue of the newsletter.

Vol. 3 No. 4 STA *INTERFACE* OCTOBER 1992

The Devil's Advocate

This column is intended to provide a springboard for lively discussion on issues and controversies relating to the application of technology to the practice of medicine. Opinions expressed by contributors to this column should not be construed as reflecting the views of the column editor, the STA Board of Directors, nor of the organization's membership. On the contrary, the opinions expressed are intended to be challenging and provocative, and should stimulate vigorous, reasoned correspondence. To preserve the uninhibited character of the column, the editor reserves the right to maintain the anonymity of contributors if requested. Correspondence and manuscript contributions should be directed to the Editor, ***The Devil's Advocate****, The Society for Technology in Anesthesia, 11512 Allecingie Parkway, Richmond, VA 23235.*

The Depth of Anesthesia Monitor: Whom Would It Serve?

Jeffrey M. Feldman, MD

The decision to purchase a new monitoring modality is based in part upon the assumption, proven or not, that the monitor will be beneficial for patients. If the "perfect" anesthetic depth monitor became available tomorrow, would it merit purchasing on the basis of patient benefit? I think not.

Controversies over how to define adequate depth of anesthesia notwithstanding, the anesthetic depth monitor would presumably help the clinician provide just enough anesthesia to insure physiologic and psychologic wellness during surgery, and postoperative analgesia, without the need to administer excessive amounts of medication. I submit that for most patients, this goal is readily obtainable without the need to monitor depth. For the average, relatively healthy patient, one can administer a combination of potent, short-acting narcotic (eg. fentanyl) and a potent amnestic (midazolam or low-dose inhalation agent) and maintain perfectly adequate anesthesia along with homeostasis. If postoperative analgesia is required, the short-acting narcotic can be replaced with a long-acting narcotic and/or intraspinal agents. Aggressive pain management in the PACU can readily accomodate for inadequate intraoperative analgesic dosages.

The times when we might need an anesthetic depth monitor are more likely when we cannot provide the usual, comfortable doses of anesthetic medications without sacrificing physiologic stability. The very elderly patient, the trauma patient, or the patient who becomes unstable from surgical hemorrhage all may receive minimal, if any, anesthetic in an attempt to maintain homeostasis. The clinican wonders in that scenario, Is this minimal amount of anesthesia enough? Efforts are usually taken to provide amnesia in this setting, but one cannot be comfortable that the patient is not suffering. How will a depth of anesthsia monitor help?

Consider the following scenario. The hospital administration, with uncharacteristic foresight, has bought for you the perfect anesthetic depth monitor. You are also now faced with one of the difficult patients outlined above. You quickly fasten the monior's elegant sensor to the patient and, voila, you are monitoring "anesthetic depth." You look at the bright colorful dispay and the monitor informs you - "The Patient is Deep Enough." You then congratulate yourself on the quality of anesthetic care and continue with the anesthetic, ever vigilant of that reassuring adequate depth indication. This information has had no impact upon anesthetic management, but perhaps a feeling of personal comfort is worth something!

Consider the alternative situation. The monitor says, "The Patient is not Deep Enough." Now you have a problem. You have already attempted to provide additional "anesthesia" without success due to physiologic instability and your worst fears have been confirmed. What to do now? In some rare instances, you might be persuaded to add some hemodynamic support in order to provide more anesthesia, but clinical judgement has already told you this may be necessary.

I submit that the problem with anesthetic depth is not monitoring it, but having better drugs to provide selective analgesic and amnestic properties without concomitant respiratory depression, sedation and hemodynamic instability. If such drugs were available a depth of anesthesia monitor would be immaterial. Given the difficulty of solving the problem of monitoring depth, and the increasing scarcity of research funds, perhaps resources would be better spent in pharmacologic research. ◆

STA National Office Goes Online

In an effort to provide greater service to the membership, the STA National Office recently became a member of CompuServe. The user ID number is **76620,1456**.

The Clinical Perspective

continued from page 39

the information is used is likely the most important factor which will determine outcome with this as well as most other monitors.

Evoked potential monitoring has not been routinely applied in the above listed operations. Many of these operations are conducted at hospitals where the hospital cannot afford to support full-time EP technologists or neurophysiologists to perform the monitoring which would be needed only occasionally. Evoked potential monitoring remains technically very complex both at the equipment level and at the intraoperative application level. EP monitoring, therefore, requires skilled personnel to perform properly. Medical interpretation is also often difficult and requires experience and training. This interpretation may be done by neurophsiologists or by physicians with training in neurophysiologic monitoring. These factors have limited most use of EP monitoring to teaching hospitals and larger medical centers where cases needing EP monitoring are common. The American Society for Neurologic Monitoring has been recently formed to develop standards for intraoperative monitoring of EPs and for training of personnel responsible for performing and interpreting EP monitoring. Hopefully this society will be able to provide the education and training necessary to increase the availability of this important monitoring modality

New applications of EP monitoring are occurring all the time but are particularly exciting in the area of motor evoked potentials. Some centers are experimenting with transcranial electrical or magnetic stimulation of the motor pathways (MEPs) to help detect CNS injury involving the motor pathways. While conceptually very attractive, MEPs have presented severe problems to the anesthesiologist. These potentials are exquisitely sensitive to most commonly used anesthetic agents, and cannot be recorded with most commonly used anesthetic techniques. MEP monitoring may be successful with several anesthetic techniques that are not commonly used (etomidate and narcotic infusions, ketamine, or nitrous/narcotic/relaxant technique without any inhalation agent or amnestic agent supplementation). Much more work needs to be done before this type of monitoring will be as extensively applied as somatosensory or auditory EP monitoring.

EP equipment is now being developed that is actually designed as an intraoperative monitor. Most EP equipment used in the OR today was designed to be used in the diagnostic laboratory. Thus, data presentation and management is not ideal for the intraoperative situation where EP changes can occur in a short period of time. Technologic advances that will allow more rapid acquisition of data (the average EP tracing takes at least a minute to obtain under ideal conditions and may take much longer when environmental noise is a problem) and will display the data in such a fashion that trending over time may be readily performed will greatly enhance intraoperative EP monitoring. ◆

Table:
Some Operations Where Evoked Potential Monitoring Is Felt to Be Useful

Vascular Surgery
- carotid endarterectomy
- thoracoabdominal aneurysm repair
- coarctation of aorta repair

Orthopedic Surgery
- posterior spinal fusion
- (re-do) total hip replacement

Neurologic Surgery
- spinal stabilizations
- vertebrectomies
- discectomies
- intracranial aneurysm clippings
- resection intracranial or spinal cord tumor
- selective dorsal rhizotomy
- microvascular decompression of

The Industrial Perspective

continued from page 39

Anesthesiologists must have monitors which are "plug 'n play". You turn it on, plug in the electrodes and its up and running. EEG Technologists are used to more complex and flexible instruments whereas neurologists only want to see the data to make their interpretation. This dichotomy of users becomes a problem for the salesforce when the hospital has the EEG lab evaluate the neurophysiologic monitor even though it will be used by the anesthesiologists in the OR. In this case the customer whom you want to please (the EEG lab) may not be the user.

Three potential groups of users for this equipment exist; anesthesiologists, monitoring technologists and Ph.Ds. Anesthesiologists do most of the monitoring in the OR at present and the ideal should be to incorporate the nervous system into their bag of tricks. This puts the burden on the manufacturers to develop a fool-proof system. With today's equipment, I have to acknowledge that EP monitoring is best performed by a technologist or neurophysiologist. EEG monitoring, however, is quickly getting to the point where it is simple enough for the anesthesiologist to handle it along with his other duties. Will EP monitoring follow? This is the manufacturer's challenge.

Technology

I am convinced that new technology for evoked potential monitoring is the least of the problems facing manufacturers. One only has to read the existing literature to find new techniques for noise reduction, faster averaging methods, pattern recognition techniques, and statistical analysis tools. More exciting is the wealth of engineers, formerly funded by defense projects, who are now available for work on new projects such as medical monitoring. As soon as we get out of the "chicken-and-egg" loop between market size and R&D dollars, then advanced technology will undoubtedly be incorporated into clinical monitoring tools.

continued on next page

Call for Papers

The deadline for receipt of abstracts for the 1993 STA - ISCAIC Annual Meeting is **December 1, 1992**. Abstracts kits were mailed to all STA members in July. If you are not a member of the Society, but would like to submit an abstract, please contact the National Office to request an abstract kit.

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The Industrial Perspective

continued from previous page

What needs to be done?

The first step is to come up with guidelines (and eventually standards) for intraoperative and critical care monitoring. Lets collectively decide which cases must be monitored, by whom and what are the technical requirements. Unfortunately, there are at least three different societies developing these guidelines, hopefully, their arrows are all aimed at the same target rather than at each other.

The words "monitor" and "OR" must be foremost in the minds of the equipment designers throughout the specification stage. We don't need another piece of diagnostic equipment wheeled from the EEG lab. Rather we need a monitor which acts like other monitors and is easily integrated into the OR environment.

Anesthesiologists monitor a large number of systems during the course of an anesthetic. The patient's cardiovascular system, pulmonary and renal function, response to drugs as well as the anesthesia equipment are all major concerns. Despite the importance of the nervous system, little time is spent monitoring neurological function. Technological advances are important, but until there is an increased emphasis on neurophysiologic monitoring during training, it is unlikely this field will mature as quickly as it could. ◆

National Anesthesiology Database Committee Meeting

To Be Held At ASA

In October 1991, the STA formed a committee of members interested in developing standards/guidelines for a national anesthesiology database. In order to enable members of the committee to communicate, an electronic bulletin board was setup with an 800 number. This communication method, however, has not proven effective. An alternative suggestion, to utilize CompuServe, was not preferred by most members, but may eventually prove to be useful.

A meeting of any individuals interested in this committee is being held on Sunday, October 18th, at the Sheraton New Orleans Hotel from 1:00 pm - 2:30 pm. The goal of the meeting is to decide upon more effective means of communication and, to outline a strategy for the committee. Please check at the Hotel registration desk for the room location.

The committee's agenda is totally open for any issues that could be involved with developing a national database. Examples would be:

✔ The purpose of a national anesthesiology database

✔ Should it be designed for research

✔ Should it provide quality assurance benchmarks, such as: Average vomiting rates for spinal, general, endotracheal, anesthetics, etc.; Frequency of intubations, swan ganz, arterial lines; Induction times, emergence times, etc.

✔ Should the database be reserved only for those departments that have electronic anesthesia databases

✔ Should the database be run by a governmental organization, a nonprofit organization, or commercial organization

✔ What concerns should be addressed for patient, institution, or anesthetist confidentiality

✔ What might be the best mechanism for standardizing definitions, such as: Anesthesia start and surgery start; Incision; Aspiration; MI; Hypotension, etc.

There are now over forty hospitals with electronic anesthesia databases in the country so the possibility of having a merged database with 100,000–200,000 cases per year is very real. Given adequate safeguards and consistency of data the potential benefits of such a database are tremendous.

If you are interested in participating in this committee but cannot attend the meeting, or have any questions or concerns, please contact:

David Edsall, MD
Wachusett Anesthesiology Associates
33 Electric Avenue
Suite 205-A
Fitchburg, MA 01420
(508) 343-5492

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STA Bylaws Revised

Thanks to Allen Ream, the STA Bylaws have been thoroughly reviewed and revised. The proposed revisions were presented to the membership for discussion at STA '92 in San Diego. Enclosed with this issue of the newsletter is a complete copy of the revised bylaws. Ratification by a vote of the membership is necessary for these changes to be accepted.

Summary of Revisions

✎ **Terms of Office**: The new bylaws reflect the decision to make the present three year term for the President and Vice President into one year each. Three offices are created: President Elect, President, and Immediate Past President. Under normal circumstances, a President Elect would be elected each year; the other two offices would be filled by succession.

✎ **Board of Directors**: Considerable discussion led to the following compromise between the need to keep the board small enough to function efficiently (groups beyond a certain size can become unwieldy) and economically (since we try to reimburse voting members of the board for attendance at meetings), and the need to accept input from all members, and develop a broad base of leaders.

The members of the board will include the officers: President, President Elect, Secretary, Treasurer, Immediate Past President, and three elected members of the board. The Immediate Past President shall have no vote except in case of a tie (seven voting members of the board, unless someone is absent, or Secretary and Treasurer are the same person...allowed by the bylaws, but expected to be very unusual). In addition, the committee chairmen are ex officio members of the board, encouraged to attend, and strongly encouraged to participate in discussion, but without vote. Current practice is expected to continue; Board of Directors' meetings are held at the annual meeting, and at ASA...and otherwise as necessary to conduct the business of the Society.

✎ **Voting**: The sections dealing with voting have been collected and made consistent. Upon instruction from the board, and after approval from the membership attending the annual meeting, quorum requirements for voting at the annual meeting have not been imposed, except that if less than 50 members or 10% of the membership are present, any member may require a mail ballot.

Mail ballots carry if a majority of those responding vote in favor.

✎ In addition to these specific items, substantial effort was devoted to make the bylaws more compact and accessible. Revisions included:

- Like material was collected under one heading.
- Duplications were eliminated where noted.
- Requirements, where duplicated, were made consistent.
- A Table of Contents was added.
- Topical headings were introduced where absent, and made consistent.
- Spelling errors were corrected. ◆

The Neuro Science Monitor

For anyone interested in neuroscience issues, the Neuro Science Monitor, published by Dick Moberg, is a valuable source of information. This quarterly publication is available free of charge and is intended to be a source of information exchange for the neuroscience community. Typical contents include a calendar of courses and conferences, reviews of recent publications and articles by individuals on specific topics. There are also want ads for advertising and locating used equipment. No commercial interests are served by this publication.

To subscribe to the Neuro Science Monitor, send a note with your address to:

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