Reports of Scientific Meetings

Nicholas M. Greene, M.D., Editor

Monitoring the Anesthetized Patient

The techniques, merits and importance of monitoring the anesthetized patient were the subjects of a symposium held in Los Angeles in August, 1969. The meeting was sponsored by the UCLA School of Medicine and the Division of Continuing Education in Medicine and Health Sciences of the University Extension. Organized by Course Chairman, John B. Dillon, the guest faculty included: John Adriani (New Orleans), Douglas W. Eastwood (Charlottesville), James E. Eckenhoff (Chicago), Edwin S. Munson (Davis), C. R. Stephen (Dallas), and Verne L. Brechner and Leonard F. Walts (Los Angeles).

Anesthesiology has seen rapid advances in the area of patient monitoring in recent years. These have resulted primarily from increased knowledge of respiratory and circulatory physiology, spill-over from research in the basic sciences, and rapid technological advances in the electronics industry. The potential hazards of the use of electronic equipment in the operating room, namely, thermal burns and explosions, have not changed over the years. Apprehension about the use of flammable anesthetic agents in such environments has prompted some to advocate the abolition of all flammable anesthetic agents (J. B. D.).

Circulation

Present methods of measuring circulatory efficiency remain quite primitive (J. E. E.). The adequacy of the circulation is usually judged by the force with which the blood is pumped (blood pressure).

The presently used Riva-Rocci method characteristically is inadequate at low pressures, since it requires the production of turbulence beneath the stethoscope head. The width of the blood pressure cuff is also critical for accurate measurement. In some areas the use of the Riva-Rocci sphygmomanometer in the care of the anesthetized patient has been abandoned (J. E. E.). A more reliable apparatus is the von Recklinghausen oscillometer. This instrument is not dependent on turbulence and is particularly useful during deliberate hypotension because it is extremely reliable at low pressure. The use of the oscillometric method precludes the need to determine diastolic blood pressure.

John Snow is credited with the description of the first clinical monitor, "the finger on the pulse." This method has seen some modifications in recent years, in the form of a photoelectric sphygmometer (Anesthesiology 20: 704, 1959) (D. W. E.). This monitor indicates the pulse rate and propagation time, as well as the presence of significant arrhythmias. The apparatus can also be used to estimate blood pressure, and is particularly useful in treating the newborn infant and the shock patient. The photoelectric sphygmometer combined with a digital nerve block permits adequate visualization on the pulse wave during hypothermia. With the use of an ordinary blood pressure cuff an estimate of systolic pressure can be made.

The ultimate method of circulatory monitoring is that of intra-arterial (IA) pressure recording (J. E. E.). However, due to the fear of IA needles, these measurements are usually reversed for seriously-ill patients. Radial or brachial artery techniques are most commonly used and also afford easy withdrawal of samples for blood gas and *p*H determinations. Central venous pressure monitoring is also useful but is not routinely indicated.

The electrocardiograph (ECG) was one of the first electronic monitors used in the operating room. Although continuous monitoring of the ECG does not guarantee good patient care, it is often useful in recognizing impending circulatory disorders. However, it is imperative that changes be correlated with clinical information (J. A.). Electrical activity of the heart only indicates the status of the conductive mechanism and does not reveal any information of a functional nature such as cardiac output or pulse volume. Routine ECG monitoring during anesthesia is of questionable value because of the possible introduction of iatrogenic problems (J. E. E.). Too

much attention is often paid to the monitor and not enough attention given to the patient.

Ventilation

The clinical assessment of ventilation is frequently inadequate (E. S. M.). Anesthesia has profound effects on ventilation both at the level of the exchange organs and at the regulating centers. Most anesthetic drugs produce depression of ventilatory exchange, resulting in respiratory acidosis. Hypoventilation is further aggravated by the increase in wasted ventilation, which results from the development of inequalities in ventilation and perfusion. This condition apparently is not agent-specific. Measurement of the partial pressures of oxygen (P_{O_2}) and carbon dioxide (P_{CO_2}) in arterial blood are the only reliable criteria for the determination of ventilatory adequacy. Sampling of central venous blood is a reliable, practical substitute for arterial sampling in assessing metabolic abnormalities in the acid–base status. It is only a rough screening procedure in the evaluation of respiratory acid–base disturbances (Ann. Intern. Med. 70: 745, 1969).

Estimation of arterial P_{CO_2} can be accomplished by infrared analysis of end-tidal gases. However, difficulties encountered with calibration as well as cross-over and pressure-broadening effects from other gases (Anesthesiology 22: 429, 1961) make the routine use of this monitor unrewarding. Future developments in ventilatory monitoring should be directed toward tissue and blood P_{CO_2} and P_{O_2} electrodes. These data can then serve as part of a servo-mechanism to adjust inspiratory gas composition and exchange to insure adequate ventilatory function.

Central Nervous System

The level of anesthesia is one of the least precise parameters measured during the course of clinical anesthesia (E. S. M.). The response of various organ systems to anesthetics have served as guideposts for clinicians for many years. These responses represent undesirable side-effects, the magnitudes of which are usually proportional to the level of anesthesia. Precise evaluation of the depth of anesthesia can be made by the measurement of the effective alveolar (end-tidal) concentration (tension) of anesthetic (Anesthesiology 28: 994, 1967).

The electroencephalogram (EEG) is not useful in the precise quantitation of anesthetic depth (V. L. B.). The EEG may be valuable in the recognition of changes in the cerebral circulation, particularly during surgical operations on the neck, where alterations may be mechanical in nature. EEG signs of hypoxia appear relatively late, long after the cerebral insult occurs. Since cerebral perfusion is preserved at the expense of other organs, the lack of EEG abnormalities does not necessarily indicate that blood flow to other systems is adequate.

Muscular Relaxation

By means of videotape presentation, the presence of muscle fade following single-twitch stimulation and facilitation following tetanic stimulation during curarization was illustrated (L. F. W.). Although peripheral-nerve stimulation is valuable in the assessment of competitive muscle relaxant effect (Anesthesiology 29: 1054, 1968), it has little value after the single injection of succinylcholine (except when recovery is prolonged). In order to avoid development of dual block during succinylcholine infusion, administration of the drug should be limited to 75 minutes. Inspiratory forceometer measurements are also useful in detecting residual muscle-relaxant effect (Anesthesiology 23: 315, 1962).

Temperature

One of the most predictable methods for inducing hypothermia is anesthesia (C. R. S.). The lack of shivering, presence of marked vasodilation, and reduction in heat production (metabolic rate) are all conducive to heat loss in the anesthetized patient. Additional insult may result from the administration of cold blood. Since hypothermia may reduce the requirements for depressant drugs (Anesthesiology 28: 689, 1967) relative overdoses in the depth of anesthesia easily may occur. Reduction in metabolic rate may also affect the actions of intravenously administered drugs by altering the rates of metabolic degradation. Residual hypothermia in the postoperative period delays recovery

and produces sluggish reflexes. Patients are more likely to aspirate gastric contents into the lungs if regurgitation occurs. Therefore, it is essential that body temperature be monitored and warming instituted immediately should hypothermia occur.

In contrast to hypothermia, a syndrome of fulminant hyperthermia (greater than 108 F) is now being seen in relatively young patients. In the last three years more than 200 cases have been reported. This syndrome characteristically lacks prodromal signs and is associated with a fatality rate of 90 per cent. Although no specific agent has been indicated, the condition is associated with the administration of succinylcholine. It is possible that a genetically linked enzymic abnormality may be involved. To date there are no reports of the occurrence of this syndrome during local (conduction) anesthesia. Treatment of this disorder is immediate immersion in ice. Prevention of the syndrome demands careful monitoring of body temperature. This may be accomplished by using the esophageal probe (core temperature) or the more recently developed tympanic membrane technique.

Recommendations

Every major surgical and anesthetic event, together with its treatment and result, should be monitored and recorded on the anesthetic record (D. W. E.). Monitors serve as sentinels which warn of impending danger to the patient. However, with the use of increasing numbers of monitors, care must be taken that multiple input of data does not distract and inhibit the clinician from providing proper care to the anesthetized patient. The ability to utilize and interpret information from various monitors differs among clinicians. Selection of appropriate monitors depends to some degree on prevailing local customs. Monitoring equipment cannot substitute for adequate monitoring and care of the anesthetized patient.

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Surgery

AWARENESS UNDER ANESTHESIA Factual recall of events was found in 2 per cent of 150 obstetric patients, the majority of whom underwent caesarean section under thiopental, nitrous oxide, and succinylcholine anesthesia. There was, however, a 17 per cent incidence of unpleasant recall, which in ten cases (6 per cent) included recall of pain. There was a negative correlation between the giving of a narcotic within six hours of the operation and the occurrence of unpleasant recall. Several other etiologic factors—age, parity, preoperative emotional tension, ventilation, nitrous oxide washout with oxygen, and nitrous oxide concentration—were investigated; no relations between them and unpleasant recall were found. Premedication still has an important function in light anesthesia to prevent any form of unpleasant operative awareness. (*Wilson, J., and others: Awareness during Caesarean Section under General Anaesthesia, Brit. Med. J. 1: 280 (Feb.) 1969.*)

BUNDLE-BRANCH BLOCK Risk of anesthesia and surgery was studied in 194 patients with complete bundle-branch block who underwent 221 surgical operations. Circulation during and after operation, as well as the incidences of thrombosis, pulmonary embolism, pneumonia and heart failure, were examined, and the results compared with those obtained from a similar group of patients without bundle-branch block. A bundle-branch block alone had no direct effect on anesthesia or surgery. Age and cardiac decompensation were far more important factors. Without clinical signs of heart disease, anesthesia and surgery offered no increased risk for patients with bundle-branch block. (*Vinz, H., and Jahn, H.: Bundle Branch Block ECG and Operative Risk, Der Anaesthesist 17: 377 (Dec.) 1968.*)