On the Promise of Economy Denied

NEW STUDIES on circle absorption systems by Eger and Ethans, in this issue, suggest that the economy of anesthetic gases sought by Dennis Jackson in his 1915 experiments with the method [1] often are not achieved in practice. Seemingly insignificant variations in the relationship within the circuit of the fresh gas inflow, reservoir bag, unidirectional and overflow or pop-off valves are shown to have a marked influence on consumption of soda lime and conservation of anesthetic agents.

As halothane has increasingly displaced cyclopropane, the true closed circuit method has been replaced by a semi-closed technique using an inflow of two to four liters of fresh gas and halothane per minute. One assumes that the circuit design ensures that the fresh gases are delivered to the patient and that the gases escaping from the overflow valve consist largely of expired alveolar gas. However, Eger and Ethans' work shows that in many present designs appreciable quantities of fresh anesthetic agents are spilled out of the circuit before reaching the patient. This is particularly so if manually-controlled respiration is used. (When ventilators are used, the overflow valve in the anesthesia circuit is normally closed and the surplus gas escapes via the ventilator, which is less wasteful of fresh gases.)

Anesthesiologists will find it instructive to examine their gas machines to compare the location of the fresh gas inlet, unidirectional valves, reservoir bag and overflow valve with the designs found to provide good economy. That these principles of design may not be widely known is shown by such an examination; only one make of machine was found to be designed for maximum economy. Several others added the fresh gas on the patient's side of the inspiratory valve so that any surplus gas would escape from the overflow valve without reaching the patient. Two other designs had the overflow valve downstream from the absorber so that the surplus gas passed through the absorber before escaping from the overflow valve. This unnecessary exhaustion of the soda lime may not appear a serious additional expense; but the loss of expensive agents like halothane from the circuit without even reaching the patient's lungs, as must occur if the fresh gas inflow is on the patient's side of the inspiratory valve, would suggest that the manufacturer should be urged by his clients to alter his present design and eliminate this waste.

Maximum economy during spontaneous respiration, the authors found, was provided by an overflow valve on the mask adapter. However, during manually-controlled respiration all such designs except one provided zero economy because it was the fresh gases that spilled from the overflow valve at the face mask during inflation, and all the expired gases passed to the absorber. The exception, which gave the most economical results under all circumstances, was the one with unidirectional valves in the mask Y-piece and the overflow valve on the expiratory limb. Unfortunately, anesthesiologists may not be aware of the near-fatal accidents that have occurred when such a valved Y-piece has been connected, in error, to a circuit with an absorber which also has valves. If the valves are not in phase with each other, the anesthesiologist suddenly finds he cannot inflate his patient's lungs; nor can the patient breathe from the circuit. If the patient is not disconnected promptly, serious damage may result. It is for this reason that the anesthesia standards committee Z79, USA Standards Institute has sponsored a "gas flow sequence" of male-female fittings which would prevent such accidents. If Eger and Ethans' excellent work leads to increasing popularity of such Y-pieces with valves, then some such safety system will be more than ever essential.

However, it only requires an astute engineer to take the author's hint and add a Steen-type

overflow valve on the mask Y-piece to make the most widely-used machine also the most economical. As a Madison wag might put it, "now is the time for Wayne to make hay while the eager sun shines." Others whose task will not be so simple, it is hoped, will carefully consider how best they can apply the principles so clearly defined here. However, they are unlikely to do so unless anesthesiologists express a keen interest in obtaining the economy Dennis Jackson sought so diligently.

LESLIE RENDELL-BAKER, M.D.
Chairman
Committee on Equipment and Standardization
Mount Sinai School of Medicine
New York

Reference

1. Jackson, D. E.: New method for production of general analgesia and anesthesia with description of apparatus used, J. Lab. Clin. Med. 1: 1, 1915.

Anesthesia

HYPOTHERMIA A marked decrease in adrenocortical secretions was noted in dogs during extracorporeal circulation and deep hypothermia. After extracorporeal rewarming, the blood levels of these compounds increased toward control levels. The rate of return varied according to the thermal level and the type of steroid. These observations illustrate the selective influence of cold per se on the enzyme systems involved in adrenocortical steroid biogenesis and that the C-21 steroid synthesis is more sensitive than the C-19 steroid synthesis. (*Milcw, S. M., and others: Effect of Extracorporeal Circulation and Deep Hypothermia on Adrenocortical Secretion, J. Endocr. 80: 1174 (June) 1967.*)

MAGNESIUM NARCOSIS Two human subjects were given $MgSO_4$ by intravenous infusion, to cause a tenfold increase in plasma magnesium concentration. This caused profound skeletal muscle relaxation, ECG evidence of slowing of atrioventricular conduction, but no loss of consciousness. The patients remained alert, felt pain, could see and hear normally, and subsequently recalled the experience correctly. Despite a widespread acceptance of the concept of magnesium narcosis, it has never been proven to occur in man. These experiments indicate that general anesthesia cannot be provided by parenteral magnesium. (*Somjen, G., Hilmy, M., and Stephen, C. R.: Failure to Anesthetize Human Subjects by Intravenous Administration of Magnesium Sulfate, J. Pharmacol. Exp. Ther. 154: 652 (Dec.) 1966.*)

FETAL HEART RATE A correlation was established between fetal heart rate and fetal scalp acid-base values during labor. When scalp blood *p*H was greater than 7.20, the infant was likely to be born with a low Apgar score (mean 3.6). Of 23 fetuses with acidosis, two were stillborn and one died neonatally. In the presence of clinical evidence of fetal distress, measurements of fetal blood acid-base status improved prognostic accuracy threefold. The importance of fetal heart-rate changes during contractions was confirmed. Two abnormal heart-rate patterns were distinguished, those being associated with low Apgar score. A correlation was also found between abnormal fetal heart-rate patterns and fetal acidosis. All other heart-rate patterns were associated with high mean Apgar scores. Fetal heart-rate monitoring and fetal blood acid-base measurement are valuable in assessing fetal conditions and are complementary to each other. (*Wood, C., and others: Fetal Heart Rate and Acid-Base Status in the Assessment of Fetal Hypoxia, Amer. J. Obstet. Gynec. 98: 62 (May) 1967.*)