

Editorial Views

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New Directions:

The Anesthesia Machine and the Practice of Anesthesia

MODERN inhalational anesthesia would not be possible without precise control of its administration. For example, it is difficult to imagine acceptance of halothane as a safe anesthetic agent if used in early ether vaporizers, since a change in delivered concentration of a few per cent could change patient state from responsiveness to lethal cardiovascular depression. Yet, vaporizer improvements have not been completely satisfactory. There has been a consistent trend away from the kettle system because many feel that it requires the user to remember too many factors in order to calculate the delivered concentration. However, percentage-calibrated vaporizers are demonstrably more complex and prone to failure. Failure can be subtle, and regular calibration checks are necessary in the absence of any indication of failure.

The rest of the anesthesia machine embodies similar trends. Additional devices appear each year: to prevent backflow into a vaporizer, to prevent anesthetic flow with failure of oxygen pressure, to control vaporizer temperature, and so on. In many applications the anesthesia machine has become the physical support for records, drugs and other monitoring equipment, but functional integration has proved more difficult. The incentive to include information from the machine in monitoring records grows stronger—but the present design makes an electronic signal expensive and unreliable.

In view of these trends, it is fascinating that the basic design of the anesthesia machine has not changed significantly since the first closed-circuit system was built in 1914.¹ Design stability has not been a passive result. It has proven remarkably difficult to improve on the simplicity and reliability of the classic approach.² These observations suggest that the present anesthesia

machine is a mature design. That is, little further improvement in performance using present technology can be obtained without noticeable changes in cost, complexity and reliability. Yet the trends just cited have contributed to increasing dissatisfaction by proponents of both simplicity and improved performance.*

For these reasons, the report by Cooper *et al.*³ is of unusual interest. They began by re-examining professional needs, then built a prototype using modern technology. The result is a startling departure from present practice. However, the most significant aspect is not the use of sonic nozzles, fuel injectors, micro-processors, or modern electronic displays. It is the opportunity to rethink our needs, with altered technical constraints. Space permits suggesting only a few of the most exciting and disturbing possibilities:

Man-Machine Interactions

A computer permits automated error checking, and more sophisticated alarms. Displays can be in front of the anesthetist, decreasing visual angle, and reducing response time. Displays can be altered or calculations performed to increase the relevance of acquired information. The computer can be used to perform checks, or to prompt the anesthetist, decreasing the risk of distraction. Information can be summarized, displayed and even printed in efficient cost-effective ways.

* Rendell-Baker L: Left-handed anesthesia machine for a right-handed anesthesiologist. Presented at the meeting of the Association for the Advancement of Medical Instrumentation, March 1978, Washington, D. C.

Education

The system permits an automated record, for retrospective analysis. More detailed alarms could be incorporated in training. The instructor could "lock out" certain anesthetic combinations until proficiency or adequate supervision is assured. And, this equipment increases the probability of constructing a "trainer," where anesthetic events are simulated and responses evaluated in a realistic clinical environment.

New Techniques

Closed-system anesthesia has been widely discussed, but apparently not commonly practiced. It appears that this approach would be less demanding with the new system. Combining information about anesthetic gas mixtures and vital signs with known trends in uptake and distribution could substantially enhance the safety of the technique. Integration of monitoring and gas-delivery devices should decrease complexity and increase reliability.

Regulation

Although the FDA has legal authority to regulate medical devices, it is by no means clear how best to do so. For example, the FDA has determined that computer programs may be considered medical devices. In this machine the computer program influences ma-

chine performance as much as the tangible components. How does the user satisfy himself that it is safe? It has been suggested that the user should be able to alter programs for individual applications, but is this appropriate? And, who will decide?

As our monitoring and management skills have grown, so also have the opportunities to apply them. It seems clear that better clinical instruments are needed to utilize present knowledge fully. The article by Cooper *et al.* in this issue suggests a way to address this need.

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Halothane—A Behavioral Teratogen?

THE CONSEQUENCES of abnormal prenatal development are usually observed through occurrences of "birth defects," physical abnormalities detectable at or shortly following birth. It has become increasingly apparent, however, that not all the ramifications of injury *in utero* are represented by physical malformations. The effects of some prenatal injuries may become known only through observation of the course of postnatal functional development. For example, striking departures from normal developmental patterns have recently been found in children exposed prenatally to alcohol¹ and anticonvulsant medications.² There is no secure system for detecting hazards of pregnancy that result in diminished functional ability. Were it not that each of these agents produces some dysmorphogenesis, the postnatal growth deficiencies, mental impairments and other developmental disabilities that are the most frequent and disabling symptoms

of exposure *in utero* would probably not have been discovered. These studies of alcohol and anticonvulsants have provided valuable new information about the ultimate consequences of the consumption of drugs and chemicals during pregnancy, but it would be tragic if observations of handicaps in human infants remained the sole method of detecting such effects. The report of Smith, Bowman and Katz in this issue³ represents an experimental approach to the examination of such potential hazards. In this article, the adequacy of postnatal functioning following prenatal exposure to halothane is assessed through testing the behavioral capacities of the offspring.

Such a study of "behavioral teratology" is most properly viewed as a complement to the techniques used to appraise teratogenic potential, and instructions for investigations of this sort are now included in the British and Japanese guidelines for reproductive