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 machine 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.

ALLEN K. REAM, M.D.
Assistant Professor
Department of Anesthesia
Director, Institute of Engineering Design in Medicine
Stanford University School of Medicine
Stanford, California 94305

References

1. Jackson DE: Anesthesia equipment from 1914 to 1954 and experiments leading to its development. ANESTHESIOLOGY 16:953–969, 1955
2. Thomas KB: The Development of Anaesthetic Apparatus: A History Based on the Charles King Collection of the Association of Anaesthetists of Great Britain and Ireland. Oxford, Blackwell Scientific Publications, 1975
3. Cooper JB, Newbower RS, Moore JW, et al: A new anesthesia delivery system. ANESTHESIOLOGY 49:310–318, 1978

Anesthesiology
49:308–309, 1978

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 alcohol[1] 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 issue[3] 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

0003-3022/78/1100/0308 $00.60 © The American Society of Anesthesiologists, Inc.

Downloaded from http://asa2.silverchair.com/anesthesiology/article-pdf/49/5/308/299776/0000542-197811000-00002.pdf by guest on 20 May 2022

studies of new drugs. In the basic reproductive studies, observations of fertility, embryolethality, and malformations of the fetuses would be made. Smith and associates offer here a different set of standards by which hazard during pregnancy may be judged. They attempt to determine whether exposure to halothane *in utero* alters the functional capacity of the CNS, as such alterations are manifest in the postnatal behavioral performance of the offspring. Their results suggest that such an effect does occur: following exposure to the anesthetic on day 3 or day 10 of gestation, the offspring showed diminished learning capacity and lower shock thresholds. These abnormalities were observed when the subjects were young adults and hence can be regarded as representing an enduring change in their behavioral pattern.

Although this area of investigation is in its infancy, there is an experimental background against which the results of this study can be judged. It is a basic principle of teratology that a system is vulnerable during a period of differentiation, and it is well known that the nervous system is unique in the prolonged course of its development. It would be expected, therefore, that the CNS could be damaged over an extended period and, indeed, behavioral deficits have been found to result from exposure to test agents administered over a wide range of gestational ages. Behavioral effects also result from exposure at doses below those that produce dysmorphology of the CNS. Both the long term of vulnerability and the smaller doses that produce CNS dysfunction act to enlarge exposure within a population. General principles that might serve as a guide in determining which agents will produce behavioral deficits are, unfortunately, no more secure for behavioral teratology than for the study of morphologic abnormalities, but agents inducing teratology of the CNS almost always produce abnormalities in behavioral performance. It would also appear that many psychoactive compounds may be regarded as behavioral teratogens, but the nature and magnitude of the effects produced are far from uniform. The results of the study of Smith *et al.* are consistent with the generalizations drawn from previous experimentation: the behavioral effects result from subteratogenic exposures; they are produced during the first two thirds of gestation; and they are induced by a substance that has marked activity within the CNS.

Although the results of this study fit exceptionally well into the pattern of previous findings, the determinants of behavior are complex, and all the variables involved are rarely explored in a single set of experiments. For example, the extent to which the effects observed could have resulted from altered caretaking of the offspring by halothane-intoxicated dams remains to be explored. Are behavioral abnormalities seen when the tests use something other than electrical shock to motivate the subjects? The difficulties involved in further examination of the status of halothane as a behavioral teratogen would seem more than justified by its status as a potent CNS depressant to which pregnant women and their unborn children are exposed when undergoing surgical procedures or when present as workers in the operating room.

We should welcome and encourage experimental studies in this area and foster additional inquiry into the developmental status of children from mothers exposed to halothane during pregnancy. If confirmed by these investigations, the suggestion of Smith *et al.* that acute halothane administration has detrimental effects on the developing nervous system will have been an invaluable warning signal.

RICHARD E. BUTCHER, PH.D.
Associate Professor, Research Pediatrics
Institute for Developmental Research of the
Children's Hospital Research Foundation
Cincinnati, Ohio 45229

References

1. Streissguth AP, Herman CS, Smith DW: Intelligence, behavior and dysmorphogenesis in the fetal alcohol syndrome; A report on 20 patients. J Pediatr 92:363–367, 1978
2. Smith DW: Teratogenicity of anticonvulsive medications. Am J Dis Child 131:1337–1339, 1977
3. Smith RF, Bowman RE, Katz J: Behavioral effects of exposure to halothane during early development in the rat: Sensitive period during pregnancy. ANESTHESIOLOGY 49:319–323, 1978

Downloaded from http://asa2.silverchair.com/anesthesiology/article-pdf/49/5/308/299776/0000542-197811000-00002.pdf by guest on 20 May 2022