ABSTRACTS

Editorial Comment: A fixed style of presentation for this department of ANESTHESIOLOGY has purposely not been defined. It is the wish of the Editorial Board to provide our readers with the type of abstract they desire. Correspondence is invited offering suggestions in regard to the length of abstracts, character of them, and source of them. The Board will appreciate the cooperation of the membership of the Society in submitting abstracts of outstanding articles to be considered for publication.

MEEK, WALTER J.: *Cardiac Automaticity and Response to Blood Pressure Raising Agents During Inhalation Anesthesia.* Physiol. Rev. **21**: 324–356 (Apr.) 1941.

"Ever since the discovery of anesthetic agents their action on the circulatory system has been a subject of great medical concern. In this review we shall deal with the inhalation anesthetics, chloroform, ether and cyclopropane, and their actions on the automatic properties of the heart. Particular attention will also be paid to the cardiac effects of the sympathomimetic amines administered during anesthesia."

Of the known inhalation agents chloroform has been the most thoroughly studied and a knowledge of its circulatory effects will also serve as a background for the entire group. For this reason this substance will be considered first.

CHLOROFORM

1. *Effect of chloroform on the heart rate.*—Here a generalization is possible and one can say that the cardiac rate decreases with increasing concentrations of the agent. Bradycardia progresses with increasing depth of narcosis until there is cardiac standstill. The mechanisms responsible for this are two-fold: first, inhibition over vagal pathways, second, direct effect on the myocardium itself.

2. *Cardiac irregularities in chloroform anesthesia.*—From the outset it was observed that chloroform induced cardiac irregularities in addition to the changes in rate mentioned above. The classic work of Levy and Lewis (1911–12) definitely established that this drug may produce a series of irregularities from automatic centers in the ventricles ranging all the way from isolated extrasystoles to ventricular fibrillation.

These irregularities, whether they be studied in the experimental animal or in man, appear to arise more frequently after a bout of deep narcosis. Light anesthesia alone may be endured for an hour or more with no change in rhythm. Most of the arrhythmias are reversible and disappear at once as the anesthesia is lightened and consciousness is regained. A point of the utmost importance, however, is this—with smooth, skillful administration chloroform anesthesia may be carried to respiratory arrest while the heart continues to beat actively. There appears to be some other factor concerned in the onset of the irregularity.

Light anesthesia was soon found to harbor definite hazards. In 1899, for example, of 83 deaths from chloroform reported in England 69 occurred before the operations were even started. It became evident that outside influences, pain, changing depth of narcosis, etc. played an important role in the picture of chloroform irregulari-

ties, most dramatic of which is the fatal ventricular fibrillation formerly known as chloroform syncope.

Here again Levy's work was fundamental. His ideas may be stated as follows: Chloroform first renders the heart irritable; that is, liable to exhibit beats of heterogenic or ectopic origin. These actually occur only when the heart, sensitized by the chloroform, is subjected to some further exciting cause. Such stimulations may be due to reflex increases of accelerator activity, or some change of state in the heart as exemplified by varying the strength of the anesthetic, particularly from deep to light. Cardiac irritability is raised in light anesthesia and lowered in deep. Deep anesthesia, since the heart is depressed and not so irritable, is safer, but even light anesthesia if kept steady, and not preceded by deeper stages, does not readily sensitize the heart.

Another interesting chapter on chloroform anesthesia was written by Beattie, Brow and Long (1930) who demonstrated that chloroform produced cardiac irregularities by virtue of its action on the hypothalamus. A Sherrington decerebration not only abolished any abnormal rhythm existing at the time but extrasystoles could not be produced later on inhalation of optimal amounts of chloroform vapor. Direct stimulation of the hypothalamus produced extrasystoles. The downward pathway appeared to be over the sympathetic chain for the phenomena were absent after removal of the stellate ganglia or their pre-ganglionic fibers. Reflex secretion of adrenalin following hypothalamic stimulation was also a distinct probability.

In view of this work it seems evident that the heart is being sensitized in part by impulses reaching it from the higher mid-brain centers.

Direct action of adrenalin on the automatic ventricular tissue of the heart rendered highly irritable by chloroform must also be considered, and there is a good deal of evidence supporting this possibility. It is axiomatic that adrenalin stimulates cardiac tissue independent of other factors, and its ability to bring on fibrillation during chloroform anesthesia is more than suggestive. Indeed the experimental literature in general would strongly recommend great caution in the use of adrenalin in chloroform anesthesia.

We have, then, an inhalation agent which increases cardiac irritability and predisposes it to irregularities. The precipitating cause may come from the hypothalamus, or from the direct action of adrenalin on ventricular automatic tissue. In the present state of our knowledge it seems impossible to arrive more accurately at any analysis of the chloroform effect on the heart which disposes it towards fibrillation. Alterations in the refractory period of cardiac muscle have been implicated but the evidence is not striking.

ETHER

1. *The effect of ether on the heart rate.*—That inhalation of ether always leads to a fast heart has long been recognized both in the laboratory and the clinic. The probable mechanisms underlying this increase in cardiac rate include (1) paresis of the vagal inhibitory mechanisms; (2) augmentation of cardio-sympathetic impulses; and (3) liberation of certain sympathicomimetic hormones such as adrenalin or sympathin.

2. *Ether anesthesia and cardiac irregularities.*—The early workers were so impressed with the serious cardiac disturbances under chloroform that those observed under ether seemed minor and unimportant. Not until the electrocardiograph came into use were the cardiac irregularities in etherized animals and patients carefully studied.

Blocks and ectopic beats were found to be rare in light ether anesthesia, but as narcosis deepened they began to appear. Striking as they may be, they rapidly disappear on removal of the ether. There is no tachycardia from secondary or tertiary centers. The absence of rapid ventricular rhythms is in sharp contrast to what occurs under chloroform. From both the laboratory and the clinic it may be concluded that ether does somewhat favor certain forms of cardiac arrhythmia. These are mostly delays in A–V conduction, partial blocks, A–V rhythm and premature beats. Ventricular tachycardia and ventricular fibrillation are rarely if ever observed. The irregularities are most apt to occur early in induction or near the level of respiratory arrest, though they are to be observed in all stages. They are evidently not particularly related to operative procedures.

3. *Ether and adrenalin.*—An ether-adrenalin syncope comparable to that of adrenalin and chloroform is not found either in the laboratory or in the clinic. Fibrillation may occur in ether anesthesia from other causes but any relation to the anesthetic has not yet been demonstrated.

From the circulatory standpoint, then, ether resembles chloroform only in a qualitative fashion. Differences in action from a quantitative point of view are extremely great.

CYCLOPROPANE

1. *Effect of cyclopropane on heart rate.*—Some disagreement has existed in the literature regarding this subject. It seems established now, however, that in non-premedicated dogs the heart rate increases. This is attributed by most investigators to a decrease in vagal tone. After premedication with morphine, cyclopropane further decreases an already slow rate. Observations on man have not been reported in detail.

2. *Cardiac irregularities under cyclopropane.*—It is common experience that non-premedicated animals may generally be anesthetized with cyclopropane and carried to the point of intercostal paralysis without signs of cardiac arrhythmia or abnormal changes in the electrocardiogram. Irregularities, of course, do occur under certain conditions. Initial experiences suggested that arrhythmias were most readily produced near respiratory arrest or in association with oxygen want. This was not the whole story as subsequent investigation showed. Cyclopropane does cause alterations in cardiac irritability before these are evident objectively.

It is not enough in judging an anesthetic merely to note that the heart shows no arrhythmia. The normal pacemaker might be approaching a stage of inhibition which could allow escape phenomena, or ectopic centers might be on the point of exhibiting activity, should an additional stimulus appear. This reasoning led Meek, Hathaway and Orth (1937) to test the condition of the automatic tissue of the heart in controlled stages of cyclopropane anesthesia, by a standard injection of adrenalin. While the standard injection of adrenalin in 17 unanesthetized controls produced the usual number of extrasystoles, which were interpreted as escape phenomena, there was only one example of ventricular tachycardia, and ventricular fibrillation never appeared. Under light cyclopropane anesthesia adrenalin produced ventricular tachycardia in 11 of the 17 animals, and one succumbed to fibrillation. Under deep anesthesia 16 of 17 dogs showed ventricular tachycardia and one died of fibrillation. The effect was directly related to the depth of anesthesia.

Similar experiments with many of the same animals under chloroform and ether demonstrated that in dogs cyclopropane had a more marked stimulating or sensitizing effect on the ventricular automatic tissue than either of the other agents.

Although these experiments showed beyond question that adrenalin was contraindicated in cyclopropane anesthesia, they should not be taken to mean that cyclopropane is a particularly dangerous anesthetic. The irregularities with the exception of fibrillation are easily reversible and cyclopropane has the advantage over most anesthetics in that the tissues may be quickly desaturated. Danger may thus usually be quickly averted.

Since adrenalin injected during cyclopropane anesthesia resulted in serious cardiac irregularities, the action of other blood pressure raising amines was investigated. It was found that the following amines acted on the ventricular automatic tissue similarly to adrenalin: arterenol, epinine, kephrine and cobefrine. Ephedrine, propedrine, benzedrine, paredrine, synephrin, and neosynephrin did not exert any such cardiac effects. With the exception of neosynephrin they did, however, markedly accelerate the sino-auricular rate. In the dog under cyclopropane, neosynephrin is the sympathomimetic amine most favorable to the heart.

It has recently been shown that the integrity of some center above the pons is necessary for a cyclopropane-adrenalin response. Cyclopropane sensitization of the heart appears to take place because the anesthetic stimulated a mid-brain center which then sent impulses to the heart by sympathetic pathways. The direct action of adrenalin on the heart thus sensitized produced the ventricular tachycardia. The mechanism of action of cyclopropane has thus been shown to be similar to that described for chloroform.

R. D. D.

MAES, URBAN, AND DAVIS, H. A.: *Fluid Replacement in Surgical States with Particular Reference to Transfusion of Ascitic Fluid: A Clinical and Experimental Study.* Arch. Surg. **42**: 453–479 (March) 1941.

"It is our purpose to present in this paper: (1) a study of the abnormal physiologic picture which results from loss of water, electrolytes and blood; (2) the technic of fluid replacement; (3) a critical evaluation of blood replacement fluids, and (4) the present status of transfusion of ascitic fluid. The indications for fluid replacement fall into four main groups: loss of body water, loss of electrolytes, loss of whole blood [and] loss of plasma. While it is convenient for purposes of discussion to separate each type of depletion state, in actual practice the distinction is not clearcut, and one will find frequently the merging of one state into another. . . . Loss of water from the body in excess of the intake of water results in dehydration. Similarly, desiccation of the blood is known as anhydremia. From the surgical point of view the causes of dehydration may be divided into two groups: (1) exogenous and (2) endogenous. Among the more important exogenous causes are voluntary or enforced deprivation of water, excessive sweating due to sunstroke, heat prostration, traumatic shock and surgical operations. Endogenous causes are prolonged diarrhea due to surgical lesions of the intestinal tract, vomiting due to obstructing lesions of the gastrointestinal tract, and inability to swallow liquids due to obstructing lesions of the esophagus. The physiologic effects of dehydration may be considered at this point. Almost 68 per cent of the total loss of water comes from the muscles, and the major portion of the remainder from the blood and skin. The composition of the blood is altered in the presence of dehydration. . . .