OBSERVATIONS ON THE HEART SOUNDS DURING ANESTHESIA WITH CYCLOPROPAINE OR ETHER

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The heart may be influenced in and by a variety of ways and means. During one of these influences, anesthesia with cyclopropane or ether, the heart sounds change audibly, with respect to each other, in a predictable and reversible pattern. It appears that this sound pattern represents the effect of these two drugs on the heart, and that this pattern is highly correlated with the depth of anesthesia or the dosage of the anesthetic, or both.

Only those heart sounds perceptible to the ear have clinical significance. These include the first sound which is long, soft, and low in pitch; and the second sound which is short, sharp, and high in pitch—the familiar "lub-dup." The first sound is related to the static pressure developed during the isometric phase of ventricular systole, being independent of volume or systolic discharge. The intensity of the second sound, coinciding with the end of the ejection period, varies with the height of systolic blood pressure in the great vessels (1).

In this study, the stethoscope was placed at the apex of the heart for better contrast between the sounds. The Electron-cardioscope was used to demonstrate and record the heart sounds simultaneously with the cathode ray tracing. The sound tape analysis was done by Dr. Earl Schubert with camera and sound spectrograph in the Speech Laboratory at the State University of Iowa.

Observations on 15 patients were made. Anesthesia was administered by various inhalation techniques. In the absence of objective measuring equipment, clinical judgment was used in determining depth of anesthesia and in the management of ventilation. Additional observations in which the electroencephalograph and dynamic carbon dioxide analysis will be used are planned.

Specifically, the heart sounds heard at the apex during anesthesia vary relatively in 3 general ways. (1) While awake and in light anesthesia with cyclopropane or ether, the familiar lub-dup is heard. (2) As the dosage of anesthetic is increased, the second sound becomes predominant, assuming a sharp, slapping, or metallic character. This phase roughly corresponds to second and third planes. (3) As anesthesia further deepens or dosage becomes excessive, the sounds assume an equality of pitch and intensity is reduced to the point of muffling.

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Figure 1 is a representative tracing made by the cathode tube of the Electron-cardioscope. In the illustration, the figure 1 indicates the first sound and the figure 2 the second sound. It can be seen that the first sound is of higher intensity than the second sound but that both have significant levels of intensity. In moderate anesthesia, this relationship is reversed, and, as one listens, the slapping or metallic char-

**CATHODE RAY TRACINGS**

![Tracings](image)

**Fig. 1.**

acter of the second sound is clearly distinguishable. In deep anesthesia, both sounds are of significantly less intensity and there is little difference in the intensity of either sound as compared with the other.

Figure 2 is a representative tracing of the sound spectrograph. The vertical lines represent energy of sound or intensity. The width of the line represents pitch or quality of sound. Time relationships have no significance in these tracings. In light anesthesia or with the patient awake, one can see the same relationships in intensity as in the
tape recording of the Electron-cardioscope. With the patient in moderate anesthesia, the intensities are reversed and the metallic second sound is exemplified by the faint, very high tracing at the second sound. In deep anesthesia, the low energy output is depicted clearly in the minimal elevation of the lines. It can be seen also that both sounds have equal pitch.

Because of the work of Brewster (2), a few patients who had sympathetic blockade by reason of neurological lesions or in whom such blocking was induced by epidural anesthesia were observed. It was interesting that in these patients to whom ether anesthesia was given, the
heart sounds assumed the characteristics of deep anesthesia when, by
clinical judgment, the dose and the depth of anesthesia were at least
moderate if not light. With a reduction in the ether concentration and
lightening of anesthesia, together with administration of a vasopressor
(Methedrine®), the sound pattern was similar to that of the patient in
whom anesthesia had been induced in the absence of sympathetic block-
ade. In other words, the typical reversal of sound pattern was seen as
the anesthesia was decreased. These observations tend to support the
hypothesis that ether has a direct cardiotoxic action.

Observations also were made on children with diffuse third-degree
burns in whom blood volume was low, toxic effects were evident, and
so forth. In these patients, the heart sounds also became muffled and
of equal pitch in light stages of anesthesia or low doses of ether, or both.
With blood volume replacement there was a tendency toward a feeble
increase in the intensity of the second sound in light to moderate an-
esthesia. Extra- and intracardiac pathological conditions such as poor
cardiac reserve, inadequate ventilation, or depressed, sick patients,
modify or obtund the general sound pattern.

CONCLUSION

Listening to the heart sounds during anesthesia with ether or cyclo-
propane, and especially in children, may assist in determination of
depth; the sounds may serve also as a qualitative guide for the dose
or amount of anesthetic to accomplish a desired effect.

The observations made in this preliminary inquiry lead one to feel
that the concentration of anesthetic to which the heart is exposed is
the critical factor in the production of the changes noted. Although
there was a good correlation between dose of drug and depth of anes-
thesia, the changes in heart sounds produced apparently by a certain
dose often preceded the clinical signs of depth of anesthesia. Con-
versely, the reverse changes in heart sounds with decrease in dose often
preceded the signs of decrease in depth. It appears that the heart may
be in difficulty from the anesthetic drug before the crude signs of mod-
erate or deep anesthesia become evident. It is hoped that, with addi-
tional observations using the electroencephalograph, the relationship
of dose to heart sound change and depth of anesthesia may be deline-
ated more accurately.

REFERENCES

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