E-6

areas, resistance measured 1,000 and 2,000 ohms.

Discussion

The palladium, gold and carbon all gave highly satisfactory results; there was no significant fall in amperage secondary to a rise in resistance in the metal electrode. As a result of this work, palladium was chosen for general use in our work in electronarcosis and has proven to be satisfactory. Palladium is a tough, bright metal, easy to silver-solder, is firm in its structure and form, and is easy to work with. It can be cut with a cold chisel and can be hammered flat with a few light blows of a hammer.

The other substances were not selected for the following reasons. Gold is just as effective as an electrode, but it is twice as expensive, and very soft. It is tricky to silver-solder lead-wires to gold since its melting point is quite low. Carbon is satisfactory in performance, but it is, again, difficult to work with. Carbon from dry cell batteries was used, and it was necessary to depend on pressure contacts for the lead wires. Sealing the carbon into plastic holders was unsatisfactory. It was necessary to dissolve Plexiglas in a Plexiglas cement and pour the thickened material around the electrode to seal it. The cement appeared to penetrate the carbon, producing a fragile bond which had to be re-established four times in one day's use. Carbon was used as the other electrode in making the silver chloride electrodes which were tested. The thickly plated silver electrodes were placed in a normal saline solution for four hours. At the end of that time the carbon electrode appeared to be unchanged in any measurable function or dimension. The silver electrodes, of course, were coated with white silver chloride.

Part 2—Electrode Holder

As indicated previously, another omission in Anan'ev's report was the method he employed to hold the electrodes on the dog's head. In earlier reports we described the method wherein the oral electrode was tied into the roof of the mouth, and the vertex electrode was held in position by a nonconductive rubber hood secured at the back by the dog's collar, and at the front by the cords which held the oral electrodes in place.

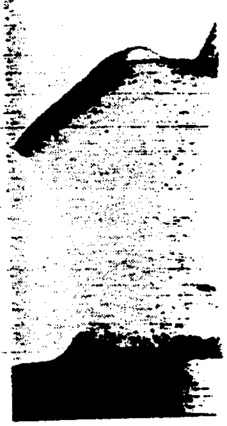
The advantages of this method were few. It was easy to move the lower jaw and tongue and easy to intubate the dog's trachea. If the dog was left stretched out prone, the method was reasonably satisfactory.

The disadvantages were many. The tie about the upper jaw impaired circulation of the area rostral to the tie, and the nose and upper lips were severely swollen within four-six hours. The oral electrode was reasonably stable, but the vertex one was always a source of anxiety. It required a tight collar and a tight tie-down of the dog's head via the collar, and even then the dog could twist his neck in the collar and dislodge the vertex electrode. If the animal was turned to its side or back for the surgical procedure, the turning required a great deal of time and care, and was often unsuccessful. If the dog was tied supine before the electrodes were applied, it was necessary to construct a device so the dog's head could be tied *up* to a platform, to hold the vertex electrode in place.

These problems have been attacked by fixing rigid electrode holders to a rigid bony structure, the upper jaw. A cross member, padded on its under surface, is held tightly to the top of the nose, just anterior to the eyes, by wide hooks clamped onto the heavy back teeth of the upper jaw. The electrode holder is held in position by a bolt welded to this anchored cross-member. The electrode holder is a scissor type structure to facilitate application and equal pressure on both electrodes. A "fulcrum" to prevent pressure on the soft nose, and lateral guides to clamp the head complete the assembly. The holder depicted here is a prototype, and handmade, but has been successful in practical use. One disadvantage has been noted. It is difficult to intubate a dog's trachea with the holder in position. One precaution must be mentioned; the oral electrodes must not touch the metal tooth-clamps, or shortening will result, and electronarcosis cannot be produced.

The dog cannot twist in this holder, and can be placed in any position without losing electrode contact. Nose swelling has been eliminated.

The peculiar shape of the electrode holder is consequent to the shape of the dog's head, and makes the fulcrum depicted necessary to avoid injury to the soft part of the nose.



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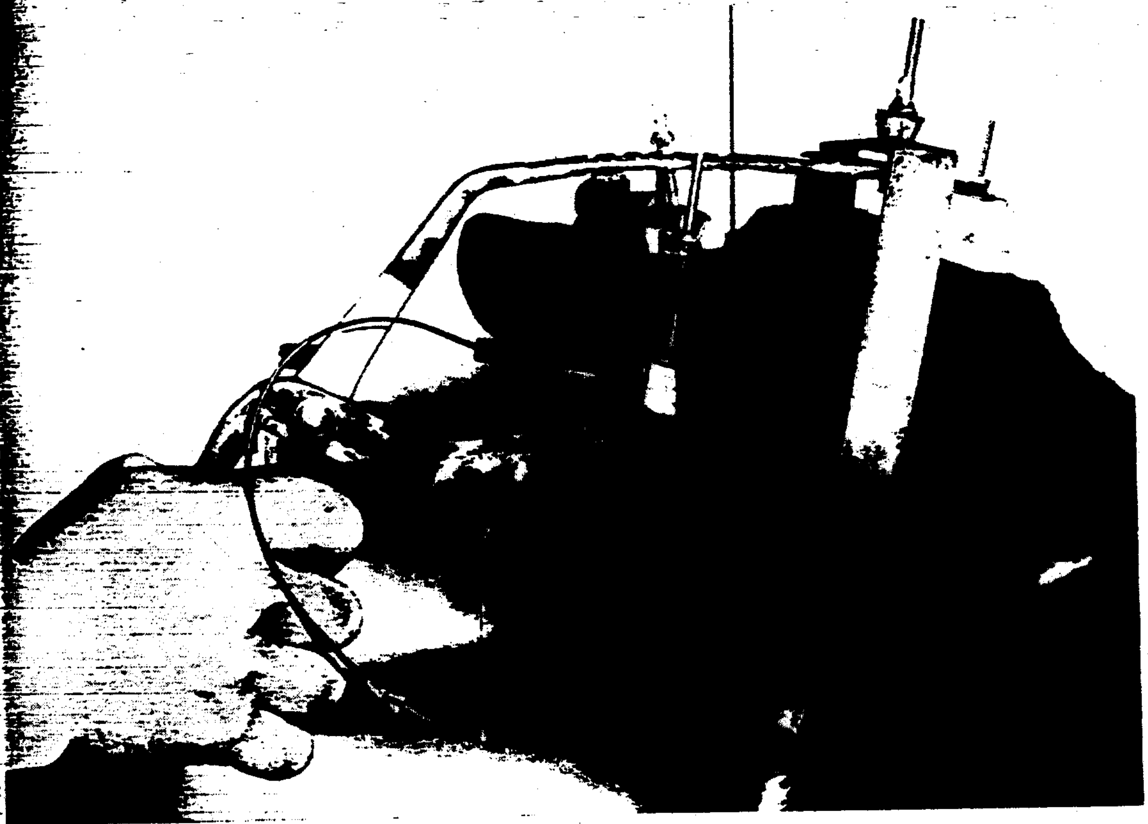

FIG. 1. A view of the electrode-holder in position on a 30-pound dog. The holder is modified from a plier-wrench 11 inches long. The vertex electrode holder measures 4 inches from axle to the angle, and 8 inches from the angle to the end. The oral electrode holder measures 2 inches from axle to the angle, and 5 inches beyond the angle. The lateral guides are 5 inches long, are adjustable, and clamp snugly against the head to avoid the effects of twisting movements. The tooth clamps are of light steel and are ½ inch wide. They are so-built as to catch and hold on the small projections on the back upper teeth. Tightening the wing-nuts holds the cross-member solidly in place. Padding of the ½ × 3 inches cross-member is essential, as is padding of the "fulcrum" which rides the nose rostral to the tooth-clamped cross-member, and prevents bruising of the soft nares. In the photograph, the hand hides the handle-clamp to hold the handles tightly together.

Despite its appearance, this electrode holder is well tolerated by the dogs: it does not produce pain. The pressure of the electrodes is not severe. The pressure on the top of the nose need not be severe; the hooks hold well on the back teeth, and only pressure enough to stabilize the apparatus through induction is required. Awake dogs which have undergone electronarcosis several times will lie quietly for an hour with the electrodes in place and show no distress.

The dog that is a subject for electronarcosis for the first time experiences three new procedures; it is tied down firmly, it has the electrodes fastened in place and it receives electrical current. Each of these is a new and frightening experience. A dog which is tied down and released several times gets over its fear and accepts the situation better with each repetition. The same holds true for the electrode application. Calmer dogs result if the electrodes are applied and removed a few times before electronarcosis is induced. This process of education or training for the dog requires an hour, and it is time well spent. The dog becomes accustomed to the procedure and to the handler's voice and hands. Then, when electronarcosis is begun, the only new factor is the current. The handler's voice and hands control much of the dog's panic during the induction. After the induction, the animal is narcotized and quiet.

The animals are handled as described because no drugs are employed for sedation or tranquilizing. The dog's natural fear and panic must be controlled if one is to avoid wild inductions which result in torn-up equipment and exhausted personnel.

Summary

The tests indicate that electrodes composed of palladium, gold or carbon are superior to those made of silver, in the production and maintenance of electronarcosis in dogs. Palladium has been selected for routine work on electronarcosis. Also described is a rigid electrode holder for use on the dog. Its performance has been satisfactory in routine use.

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Ostwald Solubility Coefficients for Anesthetic Gases in Various Fluids and Tissues

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DURING the course of investigation into the solubility of halothane in blood and body tissues and its role in halothane uptake and distribution,[1] we had frequent occasion to refer to previously determined solubilities of other anesthetic gases. It became apparent, however, that no comprehensive table of solubility coefficients for anesthetic gases in various media at several temperatures existed in the literature.

As a consequence, extensive exploration of the literature on this subject permitted compilation of such a table for a number of anesthetic gases. The table is organized in a manner identical to that used in the *Handbook of Respiration* for oxygen and carbon dioxide.[2] All Bunsen coefficients have been corrected to Ostwald coefficients at the temperature of the experiment in degrees centigrade.[3]

We do not purport that this table contains all solubility coefficients which have been determined for the anesthetic gases listed. Several of the earliest investigators did not appreciate the need for equilibration between liquid and gas phase and hence their results are highly questionable and not perpetuated in this table. References to their work can be found in the International Critical Tables.[4] Solubility values for halothane are not included in this table since these have been tabulated in a previous paper.[1] Reprints of this table are available upon request.

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