A NOTE ON NITROUS OXIDE AS AN ANESTHETIC IN ANIMAL EXPERIMENTATION.*

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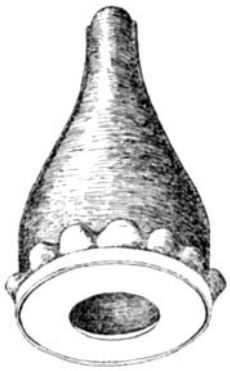
As far as the writer can discover from the literature and from personal inquiries, nitrous oxide, now commonly used in surgery, has not been applied as a routine in animal experimentation.

Its use in this laboratory has been limited to the dog, though there is no reason why it can not be extended to other animals. The writer was led to investigate its possibilities in the hope that it would be useful in simple and short operations, such as intravenous administration of drugs for later results, dressings which demand an anesthetic, etc. A test quickly showed that above all it possesses an inimitable value as a preliminary anesthetic, a value



TEXT-FIG. 1. Head mask for administration of gas to animals.

so great that it is worth the initial expense for that alone. For an ether anesthesia, a preliminary dose of morphin is apparently inferior to nitrous oxide as regards the ease of handling the animal.

The Gatch nitrous-oxide-ether-oxygen apparatus has been used

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for administration.[1] It was necessary to devise a suitable head mask, which is represented in the accompanying text-figure. It consists of a cone ten inches in length and five inches in inside diameter at its base, made of fairly thick harness leather. The seams are paraffined inside and out to make it air-tight. The smaller orifice of the cone fits over the orifice of the tube conveying the gases from the apparatus, and the connection again is made air-tight by rubber bushing glued around the inside of the cone's orifice. The tube slips in and out with ease, yet the compressible rubber holds it firmly. The larger orifice is kept distended and circular by a ringlet of brass riveted just inside the opening. A cuff of rubber sheeting is fitted over the larger orifice and has a circular opening for the dog's nose. The cuff is held in place by an outside ring of brass, which slips on tightly. The cuff can therefore be removed from the cone at will, and several with different sizes of opening may be provided to fit the individual case. Cast off automobile inner tubing has been found to combine sufficient strength with the needed elasticity. This contrivance, devised to try out the apparatus, at least offers a tested suggestion for one of better construction and possibly of metal. The important feature is the cuff of rubber, which, with proper size of opening, has been found to fit over a dog's head practically in an air-tight way.

The convenience and ease of handling which the Gatch apparatus promotes may be briefly indicated by a summary of the records on twenty-one dogs. When the cone is applied and the gas turned on, it is slightly more usual for the animal to hold its breath. The average time required from the moment of admitting the gas until the animal becomes perfectly limp was one minute and eight seconds. The maximum time was two minutes and ten seconds, during which the animal held its breath for one minute and ten seconds. The average time of actual inhalation, from the first breath to complete anesthesia, was forty-nine seconds. The maximum duration was one minute and thirty seconds, and the minimum thirty seconds. In only the one instance just mentioned as the maximum has it been over sixty seconds. The time record, however, gives only a partial idea. Without the local irritation of ether and its physiolog-

[1] Gatch, W. D., *Jour. Am. Med. Assn.*, 1910, liv, 775; 1911, lvii, 1593.

ically excitant effect, struggling is reduced to a minimum. In fact many animals do not struggle at all, but, possibly after holding the breath for a few moments, pass quietly to deep inhalations. All the objectionable features of primary ether anesthesia are eliminated. The record embraces dogs of all types, ages, and sizes, including five large animals weighing over twenty kilograms. By this method the largest animal has been handled like the smallest one, and readily by two men.

In this apparatus the factor of rebreathing is involved. This question as well as the possibilities of administration are fully discussed in papers by Gatch.[2] It is sufficient to say that with proper management no deleterious effects have been noted from rebreathing. To have three possibilities of instantaneous shift of administration combined within one apparatus, namely, nitrous oxide, ether, and oxygen, is not infrequently advantageous. It seems of value to mention only a few details of application to the dog, as these are for the most part obviously apparent. It has become our practice to turn on the ether as soon as the animal breathes the nitrous oxide deeply. As the animal relaxes the valve box is quickly shifted to in and out breathing of the gas to empty the bag, and is then changed to to and fro rebreathing of ether and oxygen or of ether and air. Air and ether are mentioned because it has been found possible to get essentially the same results as circumstance requires by inflating the bag with air in the place of oxygen by a connection with a foot pump, which is a considerable economy. In either case the shift requires careful management to hold the anesthesia, as the animals come out quickly. Occasionally more nitrous oxide is necessary. Usually the initial bagful of nitrous oxide suffices. If the animal be subjected too long to nitrous oxide alone, fresh air, by disconnecting the tube, and perhaps a compression or two of the chest are sufficient to restore respiration. Our only fatality from this cause was the first experiment. If any objection is raised in regard to an admittedly forced administration of both nitrous oxide and ether at the beginning, it is not a practical one, and at the worst the anoxyemia and overconcentration of ether vapor can be no greater than they are by the usual cone method.

[2] Gatch, W. D., *loc. cit.*

The usefulness is not limited to preliminary anesthesia. If desired, as in experiments for recovery, a perfectly even anesthesia with ether may be maintained through the mask, as is proved by records of blood pressure and respiration; or the apparatus may be used only for the preliminary preparation for other ways of administration. It has also been shown to be feasible to maintain anesthesia with nitrous oxide and oxygen. Moreover, the student becomes familiar with the use of an apparatus which is a close imitation of current surgical procedure. Finally, after the initial cost, it is economical. The animal inhales all the ether given, the oxygen can be reserved for an emergency, and, as stated, one bagful of nitrous oxide has been the average per dog.

SUMMARY.

Nitrous oxide, administered by means of the Gatch[3] apparatus, as a preliminary anesthetic to ether has been found to be superior for the dog in rapidity of action, in promotion of ease of handling, and in absence of disorder; the anesthesia may be maintained solely by nitrous oxide in combination with oxygen; it is economical; and its use is instructive to students from closer imitation of current surgical methods.

[3] The Gatch apparatus is at present manufactured by the Charles Willms Surgical Instrument Company, Baltimore.