many and varied pediatric operations and have been enthused with the easy maintenance and control of anesthesia even in most difficult cases. As an example, a hydrocephalic baby was managed from the foot of the table while a neurosurgeon inserted plastic tubing through a burr hole into the lateral ventricle, and a urologist simultaneously performed a nephrectomy and inserted the other end of the tubing into the severed ureter. Two surgeons, each with an assistant and a surgical nurse, were allowed to work freely on a 3 months old infant without interference from the anesthesiologist. Numerous other cases of head, neck, thoracic, and even abdominal surgery have been handled with equal satisfaction (figs. 4, 5).

SUMMARY

A valve based on the Ayres T-tube principle is presented for use in pediatric anesthesia. It combines the features of durability and flexibility, and can be closed directly or remotely when controlled respirations are desirable.

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PEDIATRIC ANESTHESIA EQUIPMENT

The development of special equipment for the administration of anesthesia to children has been a progressive aid in the technique of anesthesia for this age group.

The anesthesia technique chosen for children must fulfill the following requirements: (1) small resistance, (2) minimal dead space and (3) high oxygen tension.

We found that the ordinary equipment for children does not meet the second requirement satisfactorily. This is especially true for children under one year of age. In addition, we wish to emphasize a fourth point: *The equipment must be as light as possible.* Heavy masks, valves, connections and pieces for catheters will often cause complications during the anesthesia.

The equipment described here has been designed to meet the four requirements as nearly as possible. It has been necessary to introduce a catheter piece of a *new diameter* and the attached connecting pieces. Although we think that only one standard size of fitting should ordinarily be used in anesthesia equipment, the advantages obtained in this instance are so great that this should not be a major objection. In this way the different pieces are lighter and the dead space is reduced to a minimum. Furthermore, the connections have been made *solid* whenever possible, in order to reduce the dead space further. To do this without increasing the weight materially, the solid parts have been made of aluminum. Before aluminum was used, various plastic materials were tested; however, all proved to have a greater expansion coefficient than those parts made of brass. Thus, with the heating from the absorber the pieces became adherent. In addition, it is difficult to combine metal and the plastic materials so that they will hold firmly.

The construction of the equipment is shown in figure 1. By means of the parts shown here it is possible to construct the systems best adapted for anesthesia for children (1).

A more exact description of the individual parts of the equipment is given below.

The absorber (fig. 1) is made of chromium-plated brass which also is used for the rest of the equipment except for the solid pieces. The materials are as thin as possible to obtain a minimal weight; they are of two sizes, 200 and 280 ml. In order to obtain the greatest possible absorption and the least possible dead space, the construction of the absorber was altered somewhat from the usual models of the Water's absorber. In the bottom of the fitting to which the middle part is connected is found a perforated plate; thus the soda lime is situated just behind this plate. The resistance in the absorption system is approximately 1.0 mm. of water pressure.

In this way the absorption of the carbon dioxide will start as soon as the expired air reaches the absorber. Built into this absorber is a cone which distributes the air in all directions, thus making the best use of the soda lime.

In figure 1 the direction of the air is shown by 2 arrows and the built-in cone is marked as a wedge. The other end of the absorber to which the rubber bag is connected is of the usual construction, with a metal plate in the middle of the metal mesh. This end connects the bag by means of a metal piece (D). The fitting at this end is not of the same diameter as the one at the opposite end. This prevents the absorber from being turned. If it should be turned, the advantages of the small dead space would be lost.

The middle piece (fig. 1, A and C) is made in two different models, one with a smaller sidepipe through which the air mixture can be led and the other piece without this sidepiece. The tube is made as light as possible by using a short, thin pipe (weight about 25 Gm.). The conus which fits into the absorber is solid to reduce the dead space. The dead space from the catheter to the absorber is no more than 2 to 3 ml. To avoid too much increase of weight, the conus is made of aluminum. The end of the conus is hollowed out to obtain an even transition of gas from the pipe to the absorber and thus the slightest possible turbulence. The other end of the middle piece fits the connection of either the mask or the catheter.

The mask (fig. 1, I) is much like Foregger's model of children's mask. It is made of a flat plastic hemisphere around which is a rubber air ring. As mentioned previously, the conus of the mask fits the middlepiece. This shape of mask is most suitable for small children, who unlike adults, have flat faces. It provides the smallest dead space, less than 30 cc., and is very light. The transparency is of less importance.

The catheter pieces (fig. 1, H) are made in five sizes, with diameters of 4, 5, 6, 7 and 8 mm. They consist of a thin brass tube which goes through a solid aluminum conus the diameter of which is 11 mm. Thus they are very light (the heaviest of the pieces weighs 7.6 Gm.) and are not able to pull out an endotracheal catheter. The catheter pieces generally used will often do this. For patients who require it, a catheter piece is connected with a bent or straight piece (fig. 1, C and G), which by means of a

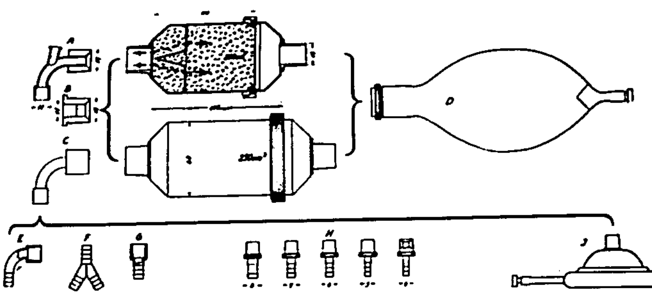

FIG. 1.

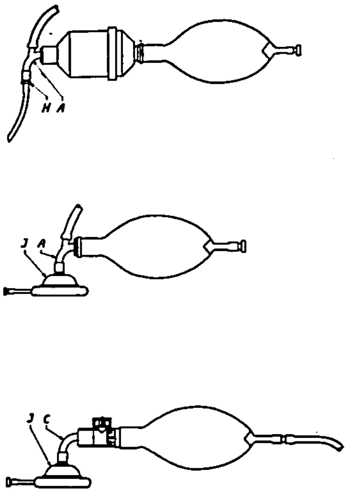

FIG. 2.

rubber tube is attached to the "Y" piece (fig. 1, F) or a Flagg canister.

In figure 1, B still another piece is marked which can be used to connect the catheter and the absorber directly in cases in which further reduction in dead space is desirable. This, too, is made of aluminum, so that it is light in weight.

The three sketches in figure 2 show the equipment completely assembled. At the top a to-and-fro system is shown. The air flows in either at piece A or at the end of the bag, and the excess air flows out at the opposite end. In the middle sketch, the mask and bag are assembled. In the sketch at the bottom, the systems are joined with a Ruben's nonrebreathing valve (2).

The equipment described has been used satisfactorily in this department for about one year. It seems to fulfill the demand for this kind of equipment. Whether a to-and-fro system or a nonrebreathing system for very small children is desirable is a matter of opinion, but with this equipment a to-and-fro system can be used without any danger of accumulation of carbon dioxide. In this department it has been used for children of all ages, from newborn on. When using a relatively high flow for these small patients carbon dioxide will not accumulate and we still have the advantage of a to-and-fro system instead of a system with an Y piece or a nonrebreathing valve.

The equipment described has its greatest utility in anesthesia for infants. Since we have used this equipment, technical difficulties and, carbon dioxide accumulation have been reduced to a minimum. Also, the need for light equipment has been proved convincingly.

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