PHARYNGEAL INSUFFLATION ANESTHESIA *

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In any system of ether administration by inhalation, a percentage of ether vapor is added to the tidal respiratory air and is carried to the pulmonary alveoli during inspiration. On expiration, a part of the ether vapor is expired and wasted, the proportion of waste depending on the point in the respiratory tract to which the ether vapor has been delivered. The points of delivery of the ether vapor in inhalation anesthesia, arranged in order of their efficiency are: the bifurcation of the trachea, as in tracheal insufflation; the oropharynx, as in pharyngeal insufflation, and the nasal and oral orifices, as in the usual methods of anesthesia.

ADVANTAGES OF PHARYNGEAL INSUFFLATION ANESTHESIA

When compared with the delivery of ether vapor to other points in the respiratory tract, pharyngeal insufflation has manifest advantages. The introduction of the pharyngeal tube is a simple matter, takes little time and does not require a deep initial anesthesia. After the introduction of the tube, the surgeon has a clear field for operations on the face, head, neck, chest and upper air passages. No inhaler nor mask covers the mouth and nose. The operation is not hindered by proximity of the anesthetist or of his appliances. The constant flow of air into the pharynx provides for the requirements of respiration, and permits covering the face with sheets and towels without interfering with the respiration.

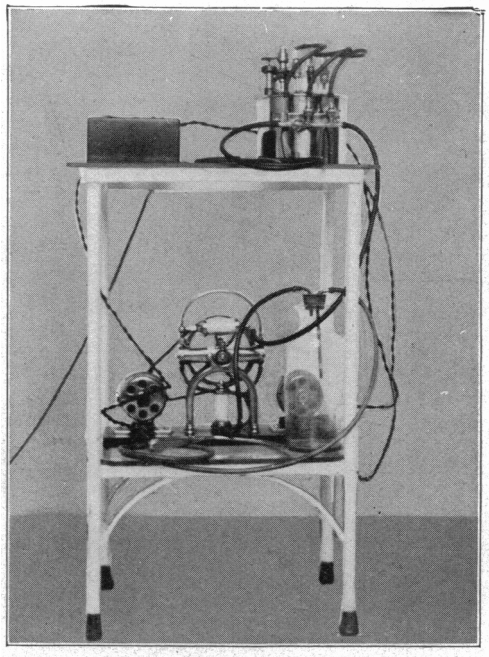

Fig. 1.—Apparatus for pharyngeal insufflation anesthesia. Above, rheostat for controlling speed of motor; constant temperature ether vaporizer. Below, motor and air pump; bottle connected with suction apparatus.

APPARATUS

The essentials for satisfactory pharyngeal insufflation are: an apparatus for delivering a current of air, capable of regulation up to 10 liters per minute; a vaporizer which will mix with the air current a constant percentage of ether vapor and which can be perfectly controlled as to the ether vapor percentage delivered, and nasal and oral tubes for delivering the ether vapor air mixture to the orophraynx.

Means for providing the current of air for pharyngeal insufflation are: an air pump actuated by an electric motor, the speed of which is controlled by a delicate rheostat; or a tank of compressed air controlled by a reducing valve; or a foot pump. If no means for controlling the speed of the electric air pump is provided, the foot pump should be chosen, as the rate of flow of the air can be roughly controlled by the speed at which the foot pump is worked. The object of this apparatus is to keep the air in motion and not to produce positive pressure.

* Read before the Section on Laryngology, Otology and Rhinology at the Seventy-Third Annual Session of the American Medical Association, St. Louis, May, 1922.

The mixture of ether vapor and air is formed by injecting liquid ether regularly, in small amounts, into the air current; by atomizing or aspirating liquid ether into the air current, or by passing the air current over the surface of liquid ether in a container. In the last of these methods, which is the one most commonly used, the rate of vaporization depends on the temperature of the liquid ether in the container. As evaporation goes on, the liquid ether constantly becomes colder, with resulting diminution in the rate of vaporization and in the anesthetic dosage. If the ether container is placed in a warm water bath of uncertain temperature, the result is uncertain, and may be either an overdose or an underdose of the anesthetic.

The constant temperature ether vaporizer is designed to overcome the uncertainty as to ether dosage resulting from variations in temperature. By means of an electric heater and thermostat, the liquid ether is kept at a constant temperature of 32 C. (90 F.). With a constant current of air passing across the surface of the ether, the percentage of ether vapor with air will also be constant. An arrangement of valves attached to the vaporizer allows the entire current of air, or any fraction of the entire amount, to pass over the liquid ether, the remainder flowing directly through a by-pass. By varying the percentage of the air current which is allowed to pass through the ether chamber, any strength of ether vapor in air, from zero to the capacity of the apparatus, may be obtained, and will be delivered constantly as long as the air current is maintained, the position of the valves is unaltered and ether remains in the container.

The diameter of the ether container is 3 inches (7.5 cm.), and the evaporating surface measures 45.6 square centimeters.

With the thermostat set for 32 C. (90 F.), and the electric air pump delivering 5.13 liters of air per minute, the ether vapor strength is 60 per cent. by weight and 29 per cent. by volume, or 220 millimeters ether vapor tension. The method of computation follows:

Period, ten minutes.

Volume of air, 51.3 liters, by direct measurement.

One liter of air at room temperature, 20 C. (68 F.) weighs 1.205 gm. Weight of air, $51.3 \times 1.205 = 62.8165$ gm.

Weight of ether vaporized, 38.27115 gm., by subtraction from total amount.

Percentage of ether to air by weight, $38.27115 \div 62.8165 = 60$.

Formula for reducing percentage by weight to percentage by volume: $X = \frac{32\,P}{32 + 83(1.00 - P)}$, when X is the percentage by volume expressed as a decimal, and P is the percentage by weight expressed as a decimal.

Substituting 0.60 for P in this equation:

$$X = \frac{32 \times 0.60}{32 + 83(1.00 - 0.60)} = 0.29.$$

Twenty-nine per cent. of $760 = 220$, the ether vapor tension in millimeters of mercury.

The nasal tube is curved to fit the cheek, with the tip bent to enter the nasal orifice. To the tip is attached a rubber tube about 5 inches (12.5 cm.) long and one-quarter inch (6 mm.) in diameter. The oral tube is bent to fit the cheek, with the tip bent to enter the mouth, and has a similar rubber tube attached. Since a single tube is sufficient, there is no advantage in the use of double tubes. The rubber tip of either the nasal or oral tube reaches to a point in the oropharynx opposite the tonsils.

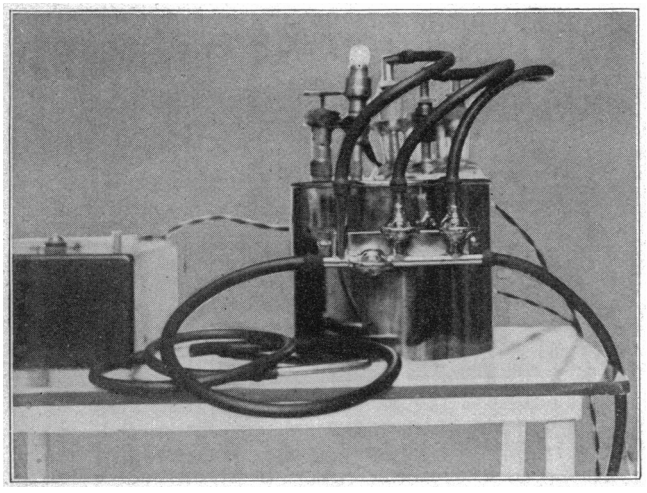

Fig. 2.—Constant temperature ether vaporizer: water-bath kept at a constant temperature by an electric heater and thermostat; Woulfe bottle partly filled with ether; valves mounted on water bath; inlet to right, outlet to left. When all valves are in horizontal position as shown, the air current passes through the by-pass and carries no ether vapor. This starting position cannot readily be mistaken.

TECHNIC OF ADMINISTRATION

Before the anesthesia is begun, the pump is started and set to deliver a current of air of from 6 to 10 liters per minute. If the amount of air delivered is not sufficient to provide for the entire respiratory need, a more concentrated ether vapor will be required to compensate for the dilution of the mixture. Until the introduction of the nasal or oral tube, the entire air current passes through the by-pass and carries no ether vapor. The initial anesthesia is secured in the customary manner and need be only deep enough to permit the introduction of the tube without resistance from the patient. The tube is lubricated and is slipped gently into the nostril or into the mouth over the tongue. The tube may be held in place by a strip of adhesive plaster across the cheek. Whether the nasal or oral tube shall be chosen depends on the nature of the operation to be performed. For operations on the nose or nasal passages, the oral tube is chosen. In most other cases, the nasal tube is used, as it does not readily become dislodged. For the tonsil and adenoid operation, the nasal tube is introduced, and it is removed when the adenoid operation is to be commenced.

After the tube has been introduced, a steadily increasing percentage of the air current is made to pass through the ether chamber until the entire current is passing over the ether. The depth of anesthesia is controlled by regulating, with the valves, the percentage of the air current which is allowed to pass through the ether chamber and not through the by-pass. After studying the patient's reaction to the anesthetic for a few minutes, the anesthetist may move away from the patient. He can judge the depth of anesthesia by the character of the respiration, the state of muscular relaxation, the movements of the extremities, especially of the fingers and toes, and the respiratory reaction on suddenly slightly increasing the ether vapor percentage. As the anesthetist may not be able to control the jaw without interfering with the operation, an artificial air way is introduced, if indicated.

In draping the patient for the operation, interference with the respiration from sheets or towels may be neglected, as the constant current of air entering the pharynx is sufficient for the respiratory need. The operation proceeds without interference due to proximity of the anesthetist or his appliances to the operative field. The principal care of the anesthetist, aside from maintaining the proper depth of anesthesia, is to see that respiration is not mechanically interfered with by the surgeon or assistant.

OBJECTIONS TO PHARYNGEAL INSUFFLATION ANESTHESIA

Theoretical objections which are raised to this form of anesthesia are based on an increased pressure in the pharynx, and the danger of postoperative pulmonary complications due to this increased pressure. The first of these objections can be readily answered by connecting a manometer in series with the tube which joins the vaporizer to the nasal or oral tube. While the apparatus is in use, the manometer registers no pressure whatever except when a lightly anesthetized patient attempts to swallow, when a pressure of 10 or 12 millimeters is momentarily indicated. One having a knowledge of the structure of the pharynx would be able to foretell this result. As the pharynx has five principal openings, it would not be sensible to suppose that an air current entering one of these openings could increase the intrapharyngeal pressure while the four other orifices remained open.

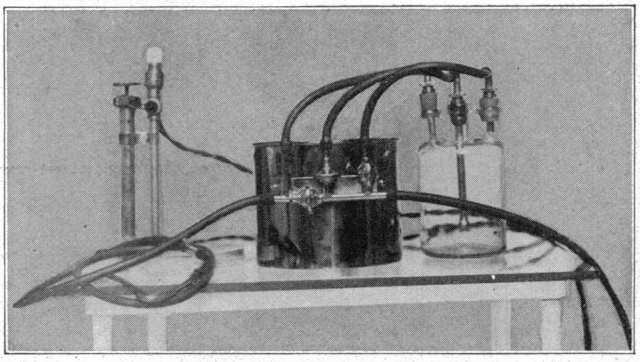

Fig. 3.—Constant temperature ether vaporizer; from left to right: electric heater and thermostat; water-bath; Woulfe bottle; inlet to right, outlet to left; tube in center opening dips into ether. When first and third valves mounted on water-bath are in the vertical position, all of the air current passes through the ether container. When the valve to the left is in the horizontal position and the one on the right is vertical, as shown, less than half of the air current passes through the container. As the left valve is turned from this position to vertical, the percentage of ether vapor is increased. With the left and central valves vertical and the right horizontal, the air current bubbles through the liquid ether and the ether percentage is considerably increased.

To determine the effect of pharyngeal insufflation in producing postoperative pulmonary complications, it is necessary to compare the results in this form of anesthesia with the results of other methods. For this purpose, I have tabulated 1,000 recent consecutive personal cases. These 1,000 operations were followed by twelve pulmonary complications, one case of pulmonary

embolism resulting fatally. The percentage of pulmonary complications is 1.2 and the mortality from these complications is 0.1 per cent. Pharyngeal insufflation was used in 188 of these 1,000 cases, with two postoperative pulmonary complications. Both of these patients developed a cough without fever, and both recovered. The percentage of pulmonary complications in these 188 cases was 1.06, with no mortality. This experience is corroborated by the records of institutions which have used pharyngeal insufflation extensively, without any increase in the proportion of pulmonary complications. It is probable that, so far as the anesthetic has any effect in the production of pulmonary complications, these unfortunate results depend on the depth of anesthesia rather than on the method employed, and that, following a light degree of anesthesia, these complications rarely occur.

CASES SUITABLE FOR PHARYNGEAL INSUFFLATION

In the 1,000 cases tabulated, pharyngeal insufflation was employed 188 times, or in 27 per cent. The accompanying table indicates the nature of the operations and the results.

NATURE OF OPERATIONS AND RESULTS

Operation	Number of Cases	Results *
Tonsil and adenoid	112	
Goiter	16	Two died of hyperthyroidism, one in ten hours, one in three days; one developed cough without fever
Nasal septum	11	One developed cough without fever
Breast	9	
Mastoid	8	Two died from meningitis, one in six days, one in thirty-three days
Sinus	4	
Brain	4	
Maxilla	4	
Cervical glands	4	
Kidney	4	
Esophageal diverticulum	2	
Laryngeal tumor	1	
Spinal cord	1	
Tongue	1	
Nose	1	
Ear	1	
Eye	1	
Other operations	4	
Total	188	

* Satisfactory except as noted.

CONCLUSIONS

Pharyngeal insufflation anesthesia is chosen for all of the operations in which the ordinary methods interfere with the work of the surgeon. In these cases, it is essential to efficient surgical work. The apparatus should be carefully chosen and intelligently used. Pulmonary complications following the use of pharyngeal insufflation are not due to the method, occurring with no greater frequency than after other forms of anesthesia.

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ABSTRACT OF DISCUSSION

DR. JOSEPH C. BECK, Chicago: Even if the instrument the author recommends is better, I believe the Beck-Mueller apparatus should not be discarded. I find no difficulty of any kind since using the motor-driven apparatus that was perfected by Dr. Mueller. The only thing I cannot agree with is to have the mouth wide open when the anesthetic is given. This anesthesia is not used at all in our clinic since we have adopted synergistic anesthesia. There is a combination of ether, olive oil and paraldehyd, the subcutaneous injection of morphin, ⅛ grain each hour, probably in combination with a 25 per cent. solution of magnesium sulphate. This anesthesia serves for all purposes in our line of work, and only in children have we thus far used anything but this rectal anesthesia, because we have not proved it to our satisfaction. Dr. Herb recommends paregoric instead of morphin. My objection to the motor-driven apparatus is the horrible smell of ether through the house, and the irritation which it causes, and then the noise it makes.

DR. EDWIN MCGINNIS, Chicago: I want to ask whether in using this motor-driven apparatus you can grade the amount of ether coming out of the end of the tube. The disadvantage of the Beck-Mueller apparatus in laryngeal surgery is that there is too much ether. If in this apparatus the control is better, if it will deliver a reduced amount of ether, I should say that it would be an advantage.

DR. ALBERT H. MILLER, Providence, R. I.: I would apologize to Dr. Beck for not having shown his very good apparatus, but I announced at the first that the forms of apparatus to be shown were selected only as types. The new apparatus shown does deliver a regular, measured dosage of ether vapor. The dosage can be regulated by varying the percentage of air which is allowed to pass through the ether chamber. The maximum capacity of the apparatus is greater than is usually required. I think that we have in this apparatus an extremely delicate, scientific sort of instrument which will maintain an exact degree of anesthesia for an indefinite period. We have found that in addition to the tonsil and septum operations, cases of goiter, diverticulum of the esophagus, tumor of the larynx, and other difficult cases which are often done under local anesthesia with great discomfort to the patient for lack of such a delicate apparatus, can be done perfectly by means of this apparatus, and for this reason I wish to introduce it.

EXPERIMENTAL STUDIES ON THE ETIOLOGY OF ENCEPHALITIS

REPORT OF FINDINGS IN ONE CASE *

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It has been my privilege to study the etiology of encephalitis during the past three years through the cooperation of Dr. Shelden and his associates of the Section on Neurology of the Mayo Clinic. From the outset of this study it was considered possible that the disease might be caused by a filtrable virus or by bacteria of more ordinary morphology but with peculiar neurotropic properties. The methods employed were such as to test both possibilities. Altogether, forty cases, representing different clinical types of the disease, have been studied. A large number of animals have been injected; the microscopic study of sections is not yet completed, and other details in the mass of experimental data are awaiting final analysis.

In order to illustrate in general the scope of the work and the results obtained, I shall report at this time in some detail the findings in one case.

Mrs. P. E., aged 53 years, first seen, March 25, 1921, complained chiefly of a nervous breakdown, the symptoms of which began in January, 1921, when, after a period of hard work and worry, she suddenly felt weak and tired, and developed noticeable trembling all over her body. This trembling lasted for about a week, and from that time on she had been either in bed or sitting in a chair most of the time. Her daughter said that her mother had been irrational for some time.

At the time of the first examination she was markedly excited. She had numerous hallucinations, marked anxiety, both motor and psychic restlessness, a rapid pulse, and slight increase in temperature. Physical examination revealed badly

* From the Division of Experimental Bacteriology, Mayo Foundation.
*Read before the Section on Nervous and Mental Diseases at the Seventy-Third Annual Session of the American Medical Association, St. Louis, May, 1922.