centration. Halothane vapor of clinically common concentration, usually below 4 percent did not form any droplets within a few hours.

Methoxyflurane dissolves into DOP approximately 4.6 times more than halothane at 31°C, according to our experiments. This may be the cause of the difference.

Extensive studies are now in progress about this problem by Dr. K. Wakisaka of our department and Prof. F. Kometani, School of Pharmacy, Tokushima University.

**Reference**


---

**GADGETS**

**Equipment for Respiratory Resuscitation (2)**

**JOHN W. PEARSON, B.M., AND JOSEPH S. REDDING, M.D.**

In a previous communication we pointed out that one model of self-inflating bag for respiratory resuscitation delivered a low volume of air per squeeze.

The Western Anesthesia Equipment Company (Palo Alto, California) has made yet another model of Pulmonator bag. It is interesting to consider what would be the desirable characteristics of such a bag, and to see to what extent available equipment meets these standards.

Variables that can be studied include “single breath” or tidal volume, refill time, force needed to squeeze, durability, and cost. Although resuscitation victims may not need a large tidal volume, many rescuers are inexpert at achieving a snug fit with a mask and large leaks occur. We believe that the required tidal volume of the bag should be at least 1,000 ml. Refill time governs the maximal rate of ventilation of the victim, and the maximal minute volume. To control ventilation in some patients with dyspnea, such as those with pulmonary edema, we believe that a rate of at least 40 squeezes per minute should be possible. Considerable force should not be needed to squeeze the bag because resuscitation may be prolonged and arm and hand cramps may develop in the rescuer. Durability and cost are of lesser, though sometimes significant, importance.

A study was undertaken to evaluate four available types of self-inflating bag. One bag was the large-size old model Pulmonator, a thin rubber bag filled with sponge rubber. Another was a newer model Pulmonator consisting of a thick shell of black neoprene. A new model Pulmonator was also tested: this consists of a thin shell of red polyvinyl and polyethylene plastic. The fourth model was a new Ambu bag (Air-Shields Inc., Hatboro, Pennsylvania).

**Evaluation of Four Types of Self-Inflating Bag**

<table>
<thead>
<tr>
<th></th>
<th>Tidal Volume, ml. (mean and range)</th>
<th>Rate Per Minute (mean and range)</th>
<th>Minute Volume, Liters (mean and range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulmonator—old model</td>
<td>1451 (920–1,800)</td>
<td>30.4 (21–39)</td>
<td>44.2 (32.6–49.8)</td>
</tr>
<tr>
<td>Pulmonator—neoprene shell</td>
<td>703 (500–870)</td>
<td>75.4 (63–98)</td>
<td>53.0 (34.9–84.9)</td>
</tr>
<tr>
<td>Pulmonator—polyvinyl shell</td>
<td>1212 (825–1,000)</td>
<td>57.8 (47–84)</td>
<td>70.2 (54.1–76.3)</td>
</tr>
<tr>
<td>Ambu</td>
<td>1256 (720–1,400)</td>
<td>40.0 (24–67)</td>
<td>50.2 (33.4–55.1)</td>
</tr>
</tbody>
</table>

* Baltimore City Hospitals, Maryland.
Nine persons participated, each using all four types of bag in random order. The bags were connected to a 'Waeo' nonbreathing valve, and thence to a Wright Respirometer. Each person was told to do his or her best for a full minute. The number of squeezes and the total volume of air moved in the minute were recorded. Average tidal volumes were calculated from these data.

The results are recorded in the table. The mean figures for each piece of equipment have been plotted on the graph. This shows how the bags compare both as to rate, tidal volume, and volume delivered in one minute.

One can see that the old Pulmonator gave the highest volume per squeeze, but that the maximal rate was quite slow; this model was also not durable. The neoprene shell type of Pulmonator delivered volumes that are considered too low for acceptance; although its refill time was short, it was so stiff that all subjects complained of severe fatigue within one minute. The new red plastic Pulmonator has both a good tidal volume and a short refill time: it delivered considerably more air per minute than the other models tested. From its construction one would expect it to be durable; it is about half the cost of other complete units. The Ambu bag has a satisfactory tidal volume; but the rate of refill is only barely sufficient. It is easy and comfortable to squeeze.

It would seem that this is the first attempt to define characteristics for this type of resuscitation equipment. It appears to us that the new red plastic Pulmonator bag is superior to the other models tested.

Mean values of tidal volume and rate for the four bags tested. The curves show the minute volumes. (△ = old model, Pulmonator. ● = neoprene shell, Pulmonator. ▲ = polyvinyl shell, Pulmonator. ○ = Ambu.)

This investigation was supported by research grant H-5439 from the National Heart Institute, P.H.S.

Reference

V-Tube for Manual Assisted Ventilation

W. Forrest Powell, M.D.*

The simplicity of the Ayre's T-tube technique for endotracheal pediatric anesthesia is generally accepted as one of its major advantages. Intermitent occlusion of one arm of the T or Y piece during insufflation effectively assists or controls ventilation. However, only limited information regarding pulmonary congestion, hypoventilation, or airway resistance is available while using this method. If a reservoir bag is incorporated to improve the sense of

* University of Tennessee Memorial Research Center and Hospital, Knoxville, Tennessee.