

The Pediatric Suction Trap for Measurement of Blood Loss

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Many methods of measuring blood loss during surgery, including measurement of suctioned blood, the gravimetric method, and visual estimation of blood on sponges, are in use today. At Mott Children's Hospital in Ann Arbor, Michigan, we have developed a simple method for measuring small quantities of blood suctioned from the operative field, which we have found quite helpful in operations on infants and children.

A trap graduated in milliliters from 0 to 100 is interposed between the main suction tubing and that coming from the operative field. It is mounted on an intravenous pole or the anesthesia machine where the anesthetist can see it easily. This allows for an accurate determination of blood loss via suction, an especially critical factor in infants and small children. Figure 1 illustrates the device, which consists of a Plexitron Buretrol 100-mm in-line burette from Travenol Laboratories,* to which the lines † from the table and suction source are connected at the ports at the top, with a clamp closing the tubing at the lower end. When the trap is full, it is easily emptied by removing the lower clamp. With this device

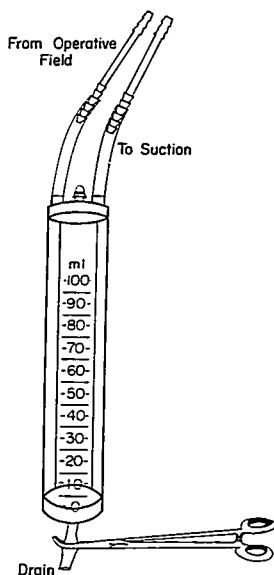


FIG. 1. Pediatric suction trap.

it is much easier to measure blood loss in infants and children, and the accuracy of the total estimate of such loss is thus increased.

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* Plexitron Buretrol, #R67M, Travenol, Morton Grove, Illinois.

† Tygon tubing, $\frac{3}{16}$ " i.d., $\frac{5}{16}$ " o.d., Norton Plastics Division, Akron, Ohio.

Calibration of Gas Flowmeters with the Bubble Burette

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The accuracy of modern gas flowmeters, achieved by careful manufacture and initial calibration, is commonly better than 1 per cent

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of full scale. Barring obvious damage from corrosion of the float or dirt in the tube, they remain accurate. Often, however, anesthetists find cause to doubt the indicated flow, warranted or not. In teaching situations questions arise as to the amount of oxygen actually delivered to a high-efficiency thermal vaporizer

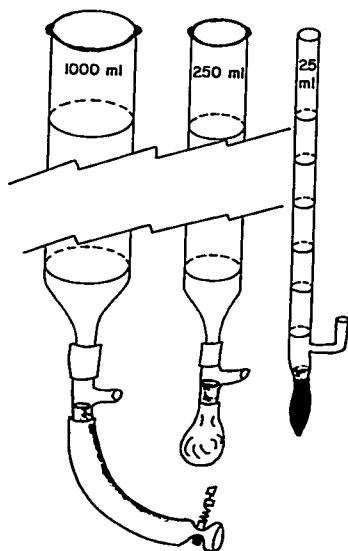


FIG. 1. Inexpensive bubble flowmeters. Each consists of a burette of appropriate volume, with a side arm for the inflowing gas and a reservoir for the soap mixture. A clamped length of gum rubber tubing, a bulb syringe, or a medicine dropper bulb serves as the reservoir. The walls of the burette must be moistened by tilting, pouring soap solution in at the top, or letting a long chain of bubbles rise in the glass. Then, with a little practice, one or two bubbles are sent up by a quick squeeze of the reservoir, and their passage between volume calibration lines is timed with a stop watch.

and the dependability of delivered oxygen concentrations in nitrous oxide anesthesia. To answer such questions the simple bubble flowmeter is unsurpassed for economy, dependability, accuracy, and availability.

THE PRINCIPLE

A flowmeter should measure a volume of gas delivered in a measured time without impeding gas flow. A soap bubble rising in a glass burette, timed by a stop watch, is such a device which loads the flow only with the weight of the bubble, surely negligible. It provides accuracy consonant with that of the watch and glassware. An ordinary chemical

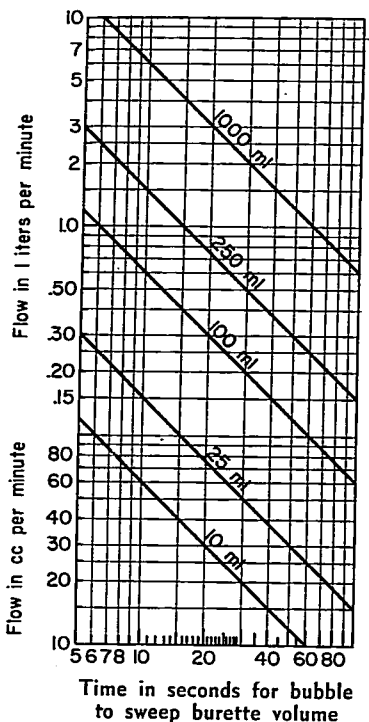


FIG. 2. Graph for calibrating rotameters with a bubble flowmeter, showing the relation between times needed to sweep out various volumes and the corresponding flows, using full logarithmic paper to give a straight line from the equation flow = volume ÷ time. The appropriate burette volume for measuring a given flow is that given by the line closest to the intersection of the nominal flow and the 20-second ordinate. For quick checks, the graph may also be used to find the flow after timing the rise of the bubble through a given volume, with a precision of 1 to 2 per cent.

burette can be used with more than 1 per cent accuracy, as can the usual stop watch, timing intervals of 15 to 30 seconds. Thus, the bubble burette flowmeter has an accuracy better than 2 per cent. Judicious choice of size, care, and replication of measurements can push the accuracy to less than 0.1 per cent if necessary.

Flow is calculated from the simple relation:

$$\dot{V} = \frac{V \times 60}{t}$$

where \dot{V} is flow in liters per minute, V the volume of the burette in liters, t time in seconds, and 60 the seconds-to-minutes conversion factor.

THE APPARATUS

Simple burettes, without stopcocks, of volumes from 10 ml to one liter are available from laboratory supply houses. Those of smaller sizes may be stocked with side arms. Most firms will insert a side arm at slightly extra cost; it should have a $\frac{1}{2}$ -inch diameter. Alternately, a glass T and rubber tubing suffice, as shown in figure 1. A soap reservoir is provided by a medicine dropper bulb, bulb syringe, or a clamped length of rubber tubing. An ordinary stop watch timing to $\frac{1}{10}$ second completes the list of necessary parts. A burette stand and apparatus clamp are useful accessories.

USE

Connect the gas delivery tube of the anesthesia machine to the burette. Choice of burette depends on the flow to be measured, assuring that the bubble does not rise either too fast or too slow for convenient timing. About 20 seconds is a convenient interval. The burette is selected according to the graph in figure 2, choosing that with a line closest to the intersection of the nominal flow and the 20-second ordinate. Thus, a one-liter burette is appropriate for a 5 l/min flow and a 25-ml burette for a 100 ml/min flow.

The reservoir is filled just to the side arm with a mixture of water and high-sudsing detergent; the mix is not critical, and almost any dishwashing detergent will do. Slight compression of the reservoir causes the inflowing gas to blow bubbles. At first they rapidly break as they rise in the dry glass, but they soon wet the walls and rise higher. Tilting the burette or rinsing the walls with solution initially speeds the process.

The measurement begins with a deft but not too violent pinch of the reservoir, so that only one or two bubbles start upward. The interval between passing the lower and upper calibration lines is timed. Repeated measurements should agree within one-tenth of a second.

The defoaming metal sponge of a disposable oxygenator can be used atop the burette to help break up excessive bubbles. With just a little practice, the four to six flowmeters of an ordinary gas machine can be calibrated at two gas flows each, in ten to 15 minutes, and the anesthesia machine cleaned with the fluid bubbled out of the burettes. The major limitation results from the surface properties of volatile agents, which cause poor bubbling with soap mixtures. I empty the vaporizers before testing their flowmeters, but a suitable bubble mixture probably could be found in the new bubble technology.¹

REFERENCE

1. Strong CL: How to blow soap bubbles that last for months or even years (The Amateur Scientist). *Sci Amer* 221:123, 1969

A Safety Modification of the Emerson Postoperative Ventilator

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The Emerson Postoperative Ventilator is valuable for many patients requiring long-term, controlled, constant-volume ventilation.

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Recently, during use of this device in our Intensive Care Units, we experienced difficulty consisting of intermittent, erratic, rapid inspiratory cycling. During these periods, the cycling rate of the ventilator would increase abruptly from 16 to approximately 45 to 50