

Standardization of Inhalation Anesthetic Equipment

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The adaptability and interchangeability of anesthetic equipment remains a perennial problem^{1,2}; it seems that parts which should not be connected fit together easily, but when a proper fitting is desperately needed only an odd-dimensional part is available and the correct attachment nowhere to be found. A great deal of progress has been made in eliminating some of the sources of this confusion, by the manufacturers of anesthetic equipment, and through the efforts of the United States of America Standards Institute and The American Society of Anesthesiologists. A great deal remains to be done, however.

There are several objectives in a standardization program. If anesthetic equipment is standard and interchangeable, great savings of money and time can be realized by eliminating reduplication of parts. Patient safety can be enhanced appreciably by eliminating confusion and by discarding odd-fit parts which can lead only to trouble. With the introduction of flexibility, the individual practitioner may rearrange and modify his own equipment.

The gas-sequence standard which has been proposed³ to eliminate the possibility of placing in a circuit two sets of valves which oppose each other does not prevent the assembly of a circle system with no valves—a situation every bit as dangerous. Furthermore, the gas-sequence fittings required both a male and a female fitting on the Y piece of the circle, a clumsy arrangement.

To achieve sound standards, the components of an anesthetic system must be defined and the objectives of standardization stated.^{6,7} A rational system of standards must begin with the total picture of how anesthetic equipment and its various parts are logically related. The standards should permit maximum interchangeability of the ele-

ments in the anesthesiologist's set of parts, while preventing, as much as possible, dangerous combinations of elements.

The proposed format is not the only such approach, but it represents what is necessary to establish a total system of interchangeable standard parts. In this system, every anesthetic system is divided into three components (fig. 1). The first, the "power source" (power for respiratory assistance) is either the reservoir bag or a ventilator. The second, the "CO₂-removal system," may be a circle with a CO₂ canister, a nonbreathing valve or a "T piece." The third component is the "dead-space system," which connects the patient to the point of CO₂ removal. Carbon dioxide removal systems are of two varieties, those with valves and those without. Stated another way, there are valve systems (circle and nonbreathing) and there are T piece systems. The T piece systems include the Rees, which uses a connecting tube with a reservoir bag for the expiratory arm of the T, and the To-and-Fro system, which provides CO₂ absorbant-containing canisters as connecting links in the expiratory limb. Tubing or adapters which connect one system to another are called "connecting elements."

Some fundamentals can be appreciated immediately.

1. The "power source" should not be connected to the "dead-space" without a "CO₂-removal system."
2. Valves should be arranged to prevent their being assembled in opposition to one another.
3. No circuit should be assembled with more than one of any system, *i.e.*, two CO₂-removal systems, or two sets of valves.
4. The patient must be connected to the CO₂-removal system at the deadspace point only.

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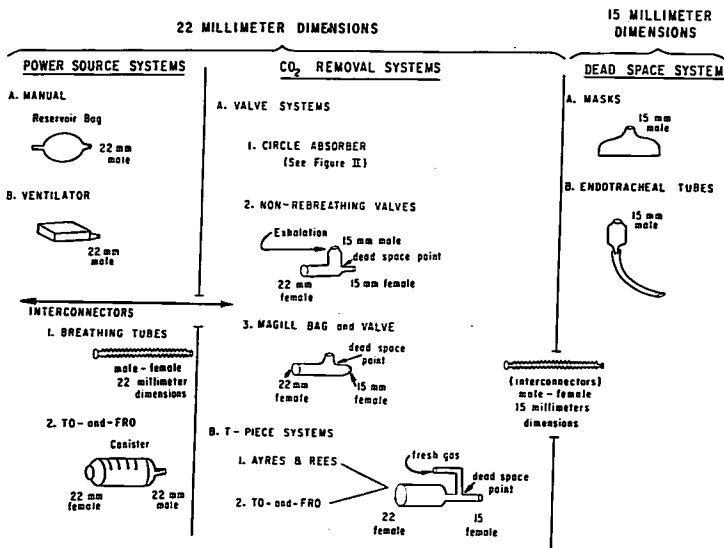


FIG. 1. Components of inhalation anesthetic equipment.

To accomplish these requirements, the following rules are proposed:

1. All valve systems must be designed so that the valves cannot inadvertently be placed backwards or in opposition to one another. If necessary, valves must be constructed in an integral unit to prevent such malpositioning.

2. Safety as well as flexibility can be obtained only by having all interconnecting elements (breathing tubes, to-and-fro canisters) male-female, *i.e.*, male at one end and female at the other. No double-male or double-female connectors could be standard.

3. All valve connections and all T piece elements will be female. All non-valve elements, such as Y piece and absorbers without valves, will be male.

4. All power-source connections will be male.

5. To assure that the patient can be connected to the anesthetic system (the CO₂-removal system) only at the appropriate (dead-

space) point, the deadspace system should have a different dimension than the power source or the CO₂-removal system. For example, if the CO₂-removal apparatus and the power source for respiratory assistance were 22 mm and the dimensions from the dead-space point to the patient 15 mm, inappropriate or dangerous connections would be prevented.

6. The machine will never be connected directly to the patient.

It is easiest to discuss the application of these rules to the circle system to see the advantages obtained. It must be remembered that all connecting elements are male-female, so that whenever a breathing tube is connected to a female outlet, the connection remains a female fitting. That is, the terminal will always be of the same sex as the fitting to which the connecting element is attached. Also, since all breathing tubes are male-female, they may be joined in series to obtain

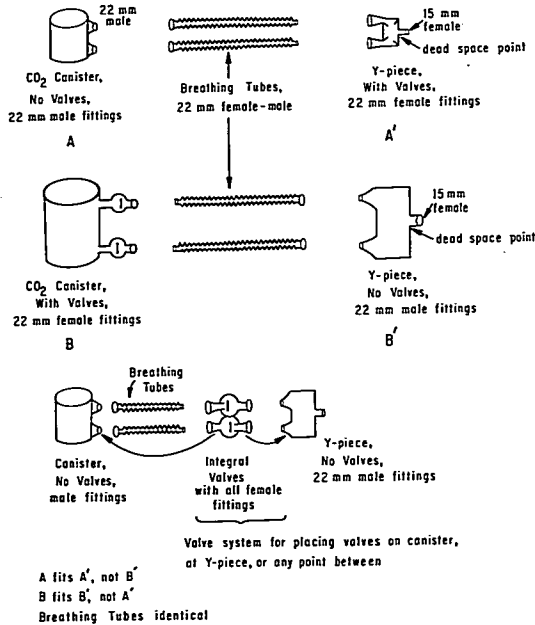


FIG. 2. Circle absorber CO₂-removal system, illustrating the inherent safety and flexibility of the proposed system.

any length desired or used in setting up any anesthetic system.

Figure 2 indicates the variations possible. The valveless CO₂ canister and the valveless Y piece have male fittings (except that the Y piece should be 15 mm female at the dead-space connection). The CO₂ canister with valves and the Y piece with valves have female fittings only. It is apparent no circle can be arranged with more than one set of valves, and no system can be arranged without valves. Furthermore, each part will have fittings of one sex only. Conceivably, a machine could be designed with removable valves. The anesthesiologist might elect to leave the valves on the CO₂ canister, to remove them to the patient, or perhaps to place them halfway between the canister and the patient.⁵ In any event, the rules and principles stated would apply.

In nonrebreathing valves, the fitting to the patient must be 15 mm female, and the fitting between the power source and the valve must be 22 mm female. This element cannot then be combined inappropriately with another CO₂-removal system (such as a circle) or reversed in its connection to the patient. It is suggested that the exhalation port be 15 mm male for attachment to a spirometer.

Certain elements, such as the Sommers attachment for use with the Rees system, are essentially nothing more than a pipe with a side-port nipple for connection to a fresh gas source. Nevertheless, such a device functions as a CO₂-removal system when used as a T piece, and would necessarily be 22 mm female on one end and 15 mm female on the other.

Since the above designs, fittings and sizes are now widely used, little change would be necessary. Valve outlets would have to

be changed to female, connecting elements (breathing tubes) changed to male at one end; mask fittings would become 15 mm male, rather than the present 22 mm female; breathing bags and ventilators would be given 22 mm male fittings.

It is suggested that such an approach toward derivation of a system of standards for anesthetic circuits is rational and provides both flexibility and safety. The safety factors depend on having established sizes and fittings for all parts used in inhalation anesthesia. It is obvious that adapters which convert from one size or sex to another would defeat this entire concept; furthermore, such adapters can be made unnecessary only if an overall plan is derived to begin with. The male-female arrangement could be reversed or the dimension altered, if there were good reason, without changing the idea. It would also be feasible to develop an entirely new infant system, utilizing the same approach and construction, but using 15 mm dimensions, if this were considered necessary. This would probably be best derived if the power source and CO₂ removal system had 15 mm dimensions and the deadspace were of an entirely new gauge. In such a system, everything including bag size, valve sizes and endotracheal sizes would be made exclusively for use in pediatrics.

The objective here is to derive the Platonic archetype of anesthetic systems, upon which

standards may be based. The particular application of these standards may be modified by the manufacturers or applied to future techniques and improvements with a minimum of restriction. By establishing standards in the abstract, specific applications may be given the greatest latitude for development. This approach is submitted for consideration with the hope that new and constructive ideas may be stimulated.

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Surgery

TRACHEAL INTUBATION Pharyngeal and laryngeal complications in a total of 409 patients were studied for as long as 24 hours after operation and anesthesia. Of the total, 317 patients had been intubated and 92 had not. No causal relationship with duration of operation and intubation, frequency of attempted intubation, use of lubricants or topical anesthetics, nasogastric tubes or suctioning, type and size of endotracheal tubes, or anesthetic agents or techniques was found. Anatomic site of operation and position of the patient on the operating table, movement of the head after intubation, the prone position, and ear, nose and throat operations seemed to be involved as a source of complaint of sore throat. Plastic endotracheal tubes and pharyngeal airways sterilized with ethylene oxide were found to be covered with a film of ethylene glycol. (Jones, G. O. M., and others: *Survey of Acute Complications Associated with Endotracheal Intubation, Cleveland Clinic Quart.* 35: 23 (Jan.) 1968.)