An Automatic Nonrebreathing Valve of New Design

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Nonrebreathing valves in common use (i.e., Fink,1 Lewis-Leigh,2 Ruben3) have been found to have at least one of the following disadvantages: (1) require sudden and relatively high closing pressure to occlude the expiratory port, (2) valves on both inspiratory and expiratory valve seats require increasingly higher opening pressures with progressive accumulation of water vapor between the valves and valve seats, (3) position sensitivity, (4) danger of over-inflation of lungs if excess gas flow or pressure closes the expiratory port and high flow rates continue, (5) potential continuous rebreathing when valve discs stick to the expiratory port because of water or mucus even if a pressure-equalizing device is incorporated, (6) deterioration of rubber valves from corrosive gases, and (7) progressive increases in respiratory resistance with duration of anesthesia. Furthermore, we have found "identical" standard nonrebreathing valves supplied commercially by manufacturers exhibit wide variability in valve opening pressure, position sensitivity, durability of valves, strength of springs, degree of rebreathing and respiratory resistance. It is our impression that at least 10 valves of the same name should be tested to disclose the "average" characteristics of each.

We have designed a new nonrebreathing valve in two models (fig. 1). It fulfills all the usual requirements and eliminates the above seven disadvantages. A schematic cross section is shown in figure 2. This unit requires a minimum range of valve-opening pressures on the inspiratory and expiratory valves. The valve-seat facing the expiratory surface of the inspiratory valve-disc is slightly curved so that the disc with its own recoiling properties eliminates part of the water membrane the rest of which can be overcome by minimal force. The force required to overcome the surface tension of water is greatest when the disc moves perpendicularly against the valve-seat as in the Ruben valve. This condition is minimized by utilizing valve-seats of large diameter and nonfixed feather-light flexible

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FIG. 1. Two models of Tashiro's valve.
discs. The valve stroke distance at the inspiratory port is made very short so as to allow instantaneous closure of the valve seats when a small pressure is applied. Both inspiratory and expiratory valves move efficiently without the weak spiral springs which are incorporated only to keep the valve-discs free of dislocation. The danger of over-filtration of the lungs during spontaneous breathing in a nonrebreathing system which depends on a high pressure source of gases, can be eliminated by turning the expiratory pipe from the 'Control' to the 'Spontaneous' position by means of the pressure-equalizing aperture. The pressure-equalizing aperture is located on the expiratory duct very close to the patient and has a large diameter. The edge of the inspiratory valve extends like a round fin beyond the valve-seat so that exhalation gas flow flaps the valve-disc back against the inspiratory port rendering the possibility of rebreathing less likely. For sustained inflation of the lungs, the finger-tip is used to occlude the outlet of the valve at the concavity, which also serves to prevent inadvertent occlusion by drapes, etc. The two models of this new automatic nonrebreathing valve have been used clinically in more than 100 patients during spontaneous or controlled respiration. The low opening pressures and small deadspace make the valve safe for infants.

The advantages of this new nonrebreathing device during spontaneous or controlled respiration are significant. The valve itself is very simple and requires no soda-lime absorber. It is the only such valve which enables quantitative administration of inhalation anesthetics, and permits the use of air as the carrier of volatile agents.

Either model of the Tashiro's valve is presently available from the Department of Anesthesia, Nagoya University School of Medicine, Showa-ku, Nagoya, Japan.

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References