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An Improved Ventilator System for Delivery-room Management of the Newborn

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A ventilatory system for the newborn infant must, we believe, have the following characteristics:

1) Adjustable inspired oxygen fraction ($F_{I_{O_2}}$)
2) Mechanism to limit positive airway pressure
3) Airway-pressure manometer to guide application of positive pressure
4) Ability to apply continuous distending airway pressure
5) Ability to humidify inspired gases
6) Ability to apply high airway pressures when needed
7) Light, compact, inexpensive, easily understood and applied

Resuscitation and stabilization of the newborn may take one or two hours before transfer of the newborn to a neonatal intensive care unit. The occurrence of retrolental fibroplasia after only two to four hours of hyperoxemia (arterial oxygen tension 150 torr)[1] dictates the need for a system with a variable $F_{I_{O_2}}$ in the delivery room.

Excessive airway pressure may cause rupture of the lung with pneumothorax and pneumomediastinum. To prevent accidental build-up of excess airway pressure, the system must include a manometer to show airway pressure and a pressure-releasing mechanism. However, the ideal apparatus should also have the ability to apply high pressures, to ventilate the occasional newborn who needs such high pressures. Thus, a pressure-releasing valve must either be adjustable over a very wide range or be capable of being phased in or out of the system at will. The manometer also makes us more aware of high inflation pressures and more alert to the possibility of complications.

Continuous distending airway pressure, either as continuous positive airway pressure (CPAP) or positive end-expiratory pressure (PEEP), is a valuable technique in the management of idiopathic respiratory distress syndrome.[2] CPAP has also been shown to stabilize the soft, easily-distorted chest wall of the small premature infant,[3] thereby increasing the efficiency of breathing efforts. Consequently, both CPAP and PEEP should be available to the infant from the earliest possible age, to facilitate gas exchange and reduce the risk of pulmonary oxygen toxicity.[4] Furthermore, the use of continuous distending airway pressure may be expected to accelerate the development of the functional residual capacity, as it speeds expansion of the initially airless lung of the newborn. This should be particularly beneficial in newborn infants, since they probably have large closing volumes, which, with small functional residual capacities, would

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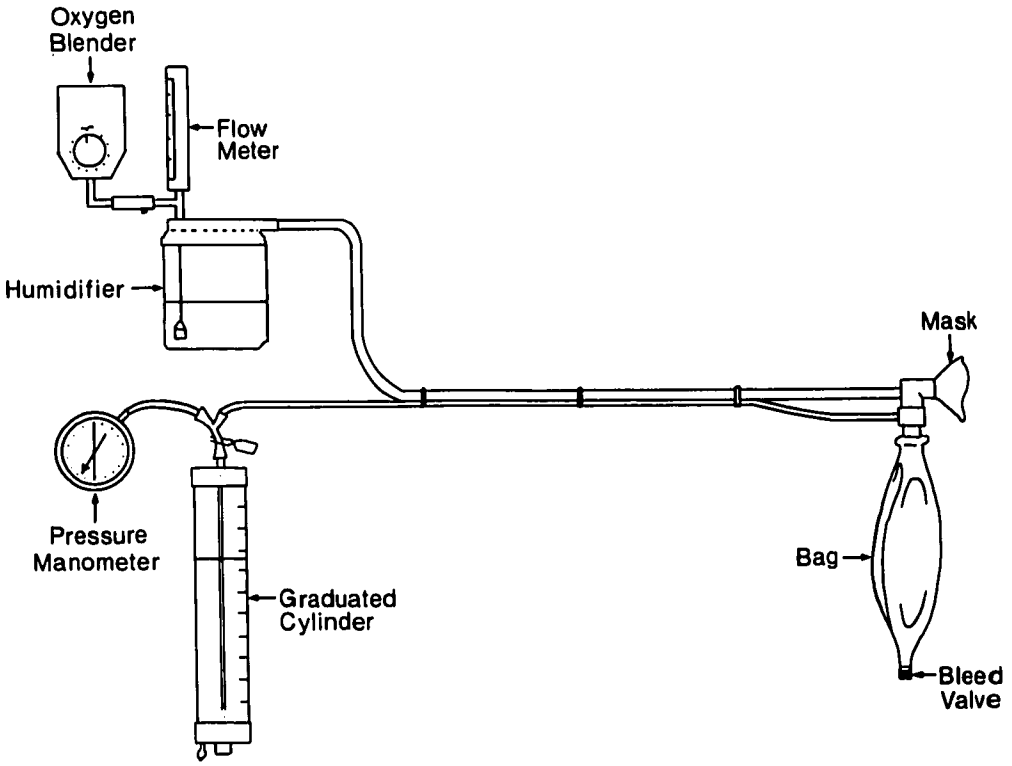

FIG. 1. Diagrammatic representation of ventilatory apparatus. The mask may be detached from the T-piece elbow, which accommodates a standard 15-mm endotracheal tube connector.

produce significant arterial hypoxemia.[6] The increased lung volume and improved arterial oxygenation so produced should also hasten the transition to a low pulmonary arterial resistance and an adult type of circulation.[7]

Humidification of inspired gases reduces inspissation of secretions,[8] improves ciliary function,[9] and reduces heat loss from the lungs.[10]

To incorporate the features outlined, we have adapted a system designed by Gregory and coworkers,[11] and installed it in our hospital delivery rooms.

The system (fig. 1) is a T-piece with fresh gas inflow from an oxygen–air blender. The gas composition is adjustable from 21 to 100 per cent oxygen, and the flow variable to as much as 12 l/min. The bag-tail bleed valve can be adjusted with the fresh gas flow to provide whatever level of PEEP or CPAP is desired. Another T-piece, glued to the first, is connected by tubing to the manometer, which shows airway pressure. It is also connected via a Y-connector to an underwater pressure-limiting valve, set to blow off when airway pressure exceeds 25 cm H_2O. The pressure-limiting valve can be excluded from the system when high pressures are needed by simply clamping the tubing at the site shown in the diagram.

By the use of plastic components, and eliminating the corrugated tubing of the familiar "MIE" T-piece, we kept the system light and compact. It was fashioned entirely from equipment already present in our Respiratory Technology Department, thus adding nothing to our budget.

The circuit is changed weekly, and the water in the pressure-release column and the humidifier is changed daily. Water, humidifier, and tubing were cultured every two weeks for two months. They are now cultured randomly, every month. There has been no positive culture.

The system has been used in our hospital for eight months in management of more than 2,000 infants. No complication attributable to the apparatus was found. In one premature infant with severe idiopathic respiratory distress syndrome, who needed high inflation pressures, pneumothorax developed. The pneumothorax was probably due to the severity of the pulmonary disease, rather than a reflection on the apparatus used. No case of unexplained infection has occurred. The system is well accepted in our hospital by the anesthesiologists who are responsible for resuscitation of all newborn infants.

We believe that the system described offers a significant improvement in the immediate care of the newborn infant.

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An Anaphylactoid Response to a Small Dose of *d*-Tubocurarine

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The release of histamine has been a recognized side effect of *d*-tubocurarine for many years. Since Alam *et al.*[1] demonstrated in 1939 that intra-arterial injections of *d*-tubocurarine in dogs resulted in the release of histamine from muscle, bronchoconstriction and hypotension occasionally observed with use have been attributed to this phenomenon.[2,3] There are isolated reports of anaphylactoid reactions to large doses of *d*-tubocurarine, presumed to represent exaggerated histamine release.[4,5] We recently encountered a case in which bronchospasm, generalized erythema, and circulatory collapse followed a small, preintubation dose of *d*-tubocurarine.

REPORT OF A CASE

A 26-year-old white woman, was admitted for vaginal hysterectomy. The medical history was significant for heavy smoking, previous intravenous drug abuse, and several gynecologic procedures, for which the patient had received general anesthesia by mask, as well as spinal anesthesia, without difficulty. Results of physical examination were unremarkable.

Preanesthetic medication consisted of diazepam, 10 mg, orally, morphine, 12 mg, im, and pentobarbital, 120 mg, im, given an hour prior to arrival of the patient in the operating room. Blood pressure of 110/70 torr was obtained during preoxygenation. There was no change in blood pressure following a test dose of thiopental, 50 mg, iv. The patient was then given *d*-tubocurarine, 3 mg, iv, in anticipation of endotracheal intubation with the use of succinylcholine. She immediately began to complain of itching and difficulty in breathing. There was an audible wheeze, and a generalized erythematous reaction was noticed. Blood pressure dropped to 70/40 torr. Since the patient had become quite agitated, it was elected to give thiopental, 100 mg, iv, and administration of halothane, 1 per cent by mask, was started in an effort to relieve bronchospasm. Immediately thereafter the blood pressure became unobtainable, the ECG showing sinus tachycardia at a rate of 140 beats/min. Halothane was turned off, less than a minute after its initiation, and the patient was given 100 per cent oxygen. Ephedrine, 25 mg, iv, was administered, whereupon the blood pressure became measurable at 50/30 torr. Over the next 15 min the patient received three additional doses of ephedrine, 25 mg, each, as well as 1,000 ml of lactated Ringer's solution containing hydrocortisone, 100 mg, and diphenhydramine, 25 mg. At this point the blood pressure was 90/60 torr, and the patient was breathing easily but remained erythematous.

The operation was cancelled and the patient taken to the recovery room, where her condition remained stable, with a blood pressure of 110/70 torr and a pulse rate of 100 beats/min. A blood sample drawn in the operating room within minutes of cardiovascular collapse for determination of histamine level was not processed due to laboratory error. A second sample drawn two hours later in the recovery room showed a histamine level of 2.2 μg/dl (normal 4–7 μg/dl).

Vaginal hysterectomy was performed the next day by use of spinal anesthesia and intermittent doses of thiopental for sedation (425 mg in 90 min), without complication. Due to inadequate surgical hemostasis, the patient was returned to the operating room 18 hours later and underwent an emergency pelvic laparotomy for evacuation of blood clots and hemostasis during general anesthesia, using thiopental for induction of anesthesia, succinylcholine for endotracheal intubation, pancuronium for abdominal relaxation, and halothane and nitrous oxide for maintenance of anesthesia. There was no complication during this anesthetic experience.

DISCUSSION

The patient showed no hemodynamic change in response to a 50-mg test dose of thiopental, but experienced generalized erythema, wheezing, and a reduc-

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