Correspondence

Controlling Relative Humidity

To the Editor:—Dr. Loew, Dr. Klein, and Professor Chalon describe a technique for achieving a precise 60 per cent relative humidity (ANESTHESIOLOGY 36:181–184, 1972). They claim that this level was adequate to prevent cytologic changes in the tracheobronchial mucosa, and confirmation of this statement would provide the first standard for minimal supplementary humidification of the fresh gases.

As gas enters the airway, its temperature rises, and the same water content now represents a lower relative humidity. At their range of room temperatures, an exact 60 per cent saturation represents an absolute humidity of 11.5 to 14.6 mg/l, and moisture content of this order can be supplied by much simpler apparatus.

They predict that humidification of fresh gases supplied to anesthetic systems will become mandatory. But the patient's expiration shares some of the airway with inspiration, and moisture exchange occurs, increasing the inspiratory water content above that of the fresh gases. So information about optimum tracheal conditions, and the concentrations of inspired gases necessary to maintain them, is still needed.

C. A. SARA, F.F.A.R.A.C.S.
C. A. SHANKS, F.F.A.R.A.C.S.
Department of Anaesthetics
Royal Prince Alfred Hospital
Missenden Road
Camperdown, N.S.W. 2050
Australia

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To the Editor:—The vaporizer was constructed in order to administer anesthetic gases with *precisely* 60 per cent relative humidity at room temperature (22–26 C) to a group of patients being studied for cytomorphologic changes in the ciliated cells obtained by bronchial lavage during general endotracheal anesthesia. Other groups included patients inhaling dry anesthetic gases and gases saturated with water vapor at body temperature (37 C).

We agree wholeheartedly about what happens to gases once they flow past the inhalation segment of the nonrebreathing valve. If 60 per cent humidity at room temperature represents an absolute humidity of 11.5 to 14.6 mg/l, then by the time the gases have been warmed to body temperature they will have a water content represented by only 25–33 per cent saturation, since at 37 C saturated gases will hold 44 mg/l of water vapor. It is also true that exhaled gases will lose some of their moisture owing to decreases in temperature once they reach the portion of the endotracheal tube that protrudes from the mouth and the nonrebreathing valve. Some of the water of condensation will, at later stages, gradually increase the humidity of inspired gases not already fully humidified.

We are not concerned, at present, with what the humidity of the gases we administer becomes when they reach the tracheobronchial tree. We have found in our cytologic studies [1] that patients who breathed dry gases through an endotracheal tube connected to a nonrebreathing valve yielded bronchial washings that contained ciliated columnar epithelial cells with significant cytomorphologic changes when anesthesia lasted more than an hour. Patients placed on a humidified nonrebreathing system delivering gases with a 60 per cent relative humidity at room temperature, or placed on the system described by Weeks and Broman [2] and receiving gases saturated with water vapor at body temperature, did not develop significant cytologic changes at the end of three hours. What we know is that inhaled gases that contain 11.5 mg/l or more of water vapor are safe by our standards. We therefore believe that, in time, it will become mandatory to control closely the inspired humidity

delivered by every anesthesia system. This is what we have endeavored to accomplish with the vaporizer described in our article.

JACK CHALON, M.D.
Department of Anesthesiology
Albert Einstein College of Medicine
Yeshiva University
Bronx, New York 10461

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Experience Using the F. & P. Humidifier for Pediatric Patients

To the Editor:—The description by Spence and Melville (ANESTHESIOLOGY 36:89–93, 1972) of the F. & P. humidifier prompts us to describe its use in pediatric intensive care. This humidifier has been used for all infants needing mechanical ventilation in the pediatric intensive care unit at The Prince of Wales Hospital, Sydney, in the last 12 months. Most patients so treated have been newborn infants with respiratory distress. The gas flow in these circumstances was lower than those described by Spence and Melville. The humidifier has been used with the Starling Ideal Pump, the Harvard Dog Respirator, and the Drager Spiromat with an infant head. It has been necessary to place a length of tubing between the end of the heated delivery hose and the point where the tubing enters the humidicrib, to allow temperature to fall to dewpoint. The temperature of the gas is continuously monitored using a thermocouple at the end of the heated delivery tube and another just before the tubing enters the humidicrib. It has been necessary to adjust the temperature of the heater plate and humidifier chamber so that the temperature at entry to the humidicrib when condensation is just visible at this point is about 36 C. The thermometer at the end of the delivery hose is checked to ensure that the temperature there is well above dewpoint.

Under these circumstances, once the apparatus is satisfactorily adjusted, the temperature of the gas delivered to the humidicrib has remained remarkably stable for days on end, in contrast to our experience using the more conventional heated humidifiers. Although the internal gas volume is much greater than that of the apparatus described by Epstein (ANESTHESIOLOGY 35:532–536, 1971), this has not prevented satisfactory ventilation with the ventilators we have used. The humidifier compartment and delivery tube in these patients was replaced only at weekly intervals. Attempts to culture organisms from the apparatus at the time of change have been unsuccessful.

The humidifier has also been used in a similar fashion to humidify the fresh gases supplied to the Jackson Rees modification of an Ayre's T-piece in the operating theater during anesthesia for neonates and infants.

C. C. FISK, F.F.A., R.A.C.S.
J. B. VONWILLER, F.F.A., R.A.C.S.
Departments of Anaesthesia and Paediatrics
The Prince of Wales Hospital
Randwick, N.S.W. 2031
Australia

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The Advantages of Giving *d*-Tubocurarine before Succinylcholine

To the Editor:—Three studies recently published in ANESTHESIOLOGY have attempted to evaluate the disadvantages of preceding succinylcholine (SCh) with a small dose of non-depolarizing muscle relaxant.[1-3] The differences between two of these studies were emphasized in an editorial by Wollman.[4] I believe, however, that the similarities in all