EDITORIAL

HUMIDIFICATION IN ANAESTHESIA

Nine years ago, a leading article in this journal (Editorial, 1970) drew attention to a paucity of information on the humidification requirements for patients undergoing prolonged anaesthesia. Despite continuing research in the intervening period, we are still not in a position to be any more dogmatic.

The possible beneficial effects of humidification are twofold: prevention of lung damage and conservation of heat. It is clear that drying of the respiratory tract with subsequent epithelial desquamation will be minimized and the secretions moved more easily by humidification of the inspired gas. However, humidification is not without potential disadvantages, including bronchoconstriction, energy losses at the gas-liquid interface and swelling of secretions producing an increase in airways resistance. Water intoxication may occur with ultrasonic aerosol nebulizers, although modern apparatus may be operated at less than maximum output.

Traditionally, humidification has been used during general anaesthesia to prevent both thermal and water loss from infants and small children. However, even when high-flow non-rebreathing systems are used, water loss may be countered easily by oral or i.v. administration of fluid and, in any case, is tolerated easily by the well-hydrated infant (Graff, 1975). Heat loss may be prevented by the use of modern efficient systems of conduction or radiation heating of the infant.

Heat loss in adults has been reduced by the use of heated humidity or a soda-lime absorber, a heat and moisture exchanger (HME), or both, in the anaesthetic circuit, particularly in the U.S.A. Although theoretical benefit may be expected from humidification in prolonged operations with a wide surgical exposure, for example during major vascular surgery, it is difficult to define the duration or extent of surgery which warrants humidification either to aid in the control of thermal loss (Lunn, Mapleson and Hillard, 1971) or to promote ciliary activity and mucous flow, and thereby protect the underlying mucosa during ventilation.

In clinical practice, there is no clear criterion of the effectiveness or otherwise of humidification during anaesthesia, if the misuse of aerosol nebulization is discounted. It was suggested that the absence of humidification caused an increase in chest complications after operation (Stevens and Kennedy, 1968) but this has not been confirmed (Knudsen, Lomholt and Wisborg, 1973). It may be that potential benefits of humidification during anaesthesia are too small to be detectable by relatively insensitive tests of pulmonary dysfunction.

Recently, there have been studies of penetration by aerosols as a more efficient means of softening and loosening mucus plugs. (Such studies are clearly more appropriate to the intensive therapy unit and may not be useful in elucidating the role of humidification in anaesthesia.) Early theory, based on experimental evidence concerning the behaviour of dusts, suggested that small particles (1 μm) would penetrate as far as the alveoli and, if small enough (0.5 μm or less), possibly return to more proximal airways in the carrier gas stream. However, the fate of dusts may not be the same as that of water. Water droplets exist in equilibrium with water vapour, some of which is derived from vaporization from the reservoir of water (especially when it is heated) and the remainder from evaporation of the droplets themselves. Nonetheless, it is possible to calculate from the size of the droplets and the size of the airways the likely extent of penetration of the respiratory tract by aerosols. Despite such theoretical calculations showing that penetration should be excellent, doubts
about the clinical effectiveness of aerosols have led to studies of particle penetration at various levels in the bronchial tree using radioactive tracer techniques.

With such methods, Avery, Galina and Nachman (1967) could find no persistence of water in the droplet phase beyond the third generation of bronchi, and they questioned the rationale of mist therapy when the patient had disease affecting the smaller airways predominantly. It was shown that the mist from ultrasonic nebulizers penetrated only to a very limited degree if the mist was directed through the pharynx and larynx rather than through an endotracheal tube or tracheostomy. Because of fears of over-hydration on the one hand, and apparent clinical failure on the other, mist therapy has become less popular in recent times except in conditions where tenacious secretions are a predominant feature, as in mucoviscidosis.

Heated water vapour remains the most popular form of humidification of the respiratory tract. The average heated water bath humidifier is capable of an output (relatively independent of ventilatory flow rates) of 60–85% relative humidity at body temperature, corresponding to water contents of 26 and 37 g m\(^{-3}\) respectively. The maximum output may be boosted to 90% or even 100% by attention to the design of the vaporization chamber and its outflow. Clearly, the aim has been to mimic the condition of saturation at body temperature (44 g m\(^{-3}\)) which is assumed to obtain normally in the human respiratory tract (Déry, 1973; Shanks and Sara, 1973). However, doubts have been cast on the wisdom of applying such high humidity at or around body temperature. From examination of the canine airway using electronmicroscopy, Tsuda and his co-workers (1977) have concluded that the least epithelial desquamation and damage was associated with the application of 100% relative humidity at only 25 °C (corresponding to a water content of about 24 g m\(^{-3}\)) whilst pulmonary dysfunction occurred at temperatures in excess of 30 °C (Noguchi, Takumi and Aochi, 1973). Although it has been shown in intensive therapy that an association between high humidity and pulmonary dysfunction could be a complication of aerosol therapy (Modell et al., 1968), it is postulated that a reduction in arterial Po\(_2\) in association with high inspired humidity was a result of water vapour alone (Josenhans, Melville and Ulmer, 1969).

The role of humidification in anaesthesia remains uncertain. Those who advocate its use do so not by virtue of a weight of scientific data, but by the desire to mimic a natural process. Those who choose not to employ humidification question the evidence for its value and point to the hazard of excessive humidification. Clearly this is an area which is important to all anaesthetists and one which warrants further study.

**References**


