

Reports of Scientific Meetings

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Symposium on the Anesthetist and the Lung

A new format for scientific intercourse is hard to envisage in the present over-conferred international medical community. Keith Sykes managed the trick of pleasing a select group of investigators and a 400-plus group of practicing anesthetists by arranging the four-day seminar held in London, November 1-5, 1971. The first two days involved only the investigators. The invited speakers, in Ciba-symposium style, heard each other out, and if need be, tore each other to shreds, more or less in private. This rehearsal over, the gates were opened to paying listeners (to help defray the expenses of the meeting) for a presumably polished and corrected replay, with some of the livelier controversy deliberately retained.

Four half-day sessions were devoted to respiratory regulation, lung mechanics, pulmonary circulation, and pulmonary edema, respectively. Passing over the necessary didactic repetition of the known (or perhaps better termed, "published") information, I elect to report some of the relatively new ideas presented.

Loeschcke, who participated in the localization of the medullary chemoreceptor a decade ago, has now found unique and rare large neural cells—about 60 per cat—within 200 mm of the surface of the medulla in the chemosensitive area. Each has many synapses and seems qualified, albeit not established, as the respiratory chemoreceptor cell. Schläfke and Loeschcke located two other ventral areas, one called "L" near the XII nerve root, where acid also causes hyperpnea, and another between the two, called "S," where local anesthesia causes apnea and electrical stimulation causes hyperpnea, but acid is ineffective. These findings suggest that all of the chemoreceptor nerve traffic converges at this medullary macula before dipping into the underlying medulla. Although Schläfke has sought evidence for active inhibition of ventilation by chemoreceptors in response to medullary-sur-

face alkalinity, none has been found to date to explain the ability of hyperventilation far below the apneic P_{CO_2} threshold to offset other (*i.e.*, hypoxic) respiratory stimuli.

M. Purves reported three quite new studies of the carotid-body chemoreceptors. With Biscoe, his laboratory has established that efferent nerves run from the brain to the Type I (so-called "chemoreceptor") cells, which, when stimulated, decrease carotid-body chemoreceptor impulses. These nerves are activated by cerebral hypoxia, even when peripheral chemoreceptors are denervated. To deepen the mystery, Mitchell has shown that after excision of the carotid body, the regenerating nerve endings are responsive to hypoxia and acidosis. And finally, in collaboration with Acker and Lübbers in Dortmund, Purves reports that micro-oxygen electrodes inserted into the carotid body indicate an astonishingly low tissue P_{O_2} —about 10 torr, in the periphery, higher near the arterial inflow. This barrage of new evidence, taken with Tramazini's claim that the carotid body secretes erythropoietin, makes this tiny structure one of the body's hottest topics.

The legendary resilience of the carotid body in the face of anesthetic respiratory depression was laid to rest by Whitman and by Raymond, Weiskopf, and Wright. In both man and dog, the respiratory response to hypoxia at constant P_{CO_2} is attenuated by halothane at least as much, and probably more, than the response to CO_2 . By collecting slides from all my colleagues at the University of California, San Francisco, I was able to present a rank of inhalational anesthetics as respiratory depressants (worst first); Forane, halothane, methoxyflurane, cyclopropane, fluroxene, and diethyl ether, all studied at 1.5 MAC. Surprisingly, in terms of the slope of the ventilatory response to CO_2 , cyclopropane was the least depressant of these agents.

Widdicombe clarified the complex field of lung reflexes for the audience. Lung inflation causes active bronchodilation by stimulating

pulmonary stretch receptors. Irritant receptors are located in bronchial epithelium, are stimulated mechanically or by embolism or pulmonary congestion, and cause reflex bronchoconstriction. Irritation of the nose and epipharynx causes bronchodilation, a possibly valuable minor bit of wisdom to remember.

During expiration, dependent alveoli collapse to their closing volume first. Closing volume increases with age, such that some airways close (trapping gas in alveoli) at FRC in lung bases of men over 42! At age 65, this event occurs even sitting, and by extrapolation, at age 100, airways close at total lung capacity. Hulands and Nunn reported supporting evidence of the resulting shunt, and noted the difficulty of reopening such closed airways.

Gwenda Barer and her colleagues have completed a most persuasive series of experiments quantitating the local effects of P_{O_2} and P_{CO_2} on the pulmonary circulation. Using an innervated, perfused lobe of the lung of a live cat, she observed that collapse of the lung does not increase vascular resistance if the inflowing blood is arterial (*i.e.*, normoxic). Of the vasoconstriction caused by perfusion with mixed venous blood, flow is reduced 46 per cent by the decrease in P_{O_2} and 6 per cent by the increase in P_{CO_2} . Flow approaches zero as P_{O_2} approaches 20 mm Hg. But the flow decrease is easily overcome by pulmonary hypertension. The clinical lesson for anesthetists, as Hill and Finley pointed out several years ago, is that the useful diversion of blood flow away from atelectatic lung is easily overridden by overenthusiastic ventilation of the remaining, open lung. Sykes, Loh, and Seed reported that halothane dilates pulmonary vessels, while trichloroethylene, ether, N_2O and cyclopropane increase pulmonary vascular resistance (isolated, denervated perfused lung). The response to hypoxia was abolished by methoxyflurane, but the halothane-hypoxia interaction has not yet been tested.

Laver reported that the experiences with PEEP (positive end-expiratory pressure) in the intensive care unit at the Massachusetts General Hospital were generally favorable, and only rarely had resulted in air leaks or tension pneumothorax (a more troublesome problem in other hands).

E. Weibel's superb electron micrographs of lungs fixed by vascular perfusion disclosed several features new to most listeners. First, the basement membranes of the two cells separating gas from blood are fused—*i.e.*, there is no potential alveolar wall interstitial space. Hence, the old idea that edema should first thicken this diffusion pathway is untenable. Edema, when induced, collects around intermediate vessels and airways rather than in alveolar walls. Second, 95 per cent of the alveolar wall surfaces are thin (0.1 to 0.2 μ), and only 5 per cent contain alveolar epithelial or capillary endothelial nuclei. Third, alveolar epithelial cells have tight junctions in all places—no open networks in the corners as postulated by Staub. Fourth, capillary and vascular endothelial cells have "kissing" junctions, which are more open and easily permit passage of macromolecules, including proteins in some places. Fifth, using special fixation methods Weibel has obtained pictures of the surfactant layer. The alveolar macrophages are always found submerged in surfactant.

Strang presented new evidence that there may be pores as large as 150 Å in radius in lung vascular endothelial cell junctions. In contrast, alveolar wall pores, if they exist, do not exceed 5.5 Å.

Pulmonary edema can be quantitated by a double-indicator-dilution method, a simple procedure at the bedside. This involves an intravenous bolus injection and collection of a series of arterial samples for later counting and analysis. The principle is that tritiated water, in passing through the lungs, comes near diffusion equilibrium with all lung water (experimentally about 70 per cent of it) and hence is delayed in passing compared with iodinated serum albumin. Marshall presented a new method for obtaining actual lung water (after death) by weight, the crucial problem being how to correct for residual blood in the lungs. His solution is to use radiolabeled erythrocytes or plasma.

This reviewer concluded the conference with a discussion of pulmonary edema caused by hypoxia, typically on ascent to high altitude, but believed to occur clinically in heroin deaths and in other forms of severe prolonged clinical hypoxia. The mechanism is clearly not left-heart failure, pulmonary venous hyper-

tension, or damage by hypoxia. It is always associated with severe pulmonary-artery hypertension. The patchy, generally hilar distribution, periarterial hemorrhages, alveolar hyaline membranes and predilection for high-altitude-native healthy young men (who presumably have the most reactive pulmonary arterioles) all suggest an overdistention and traumatic rupture at the arterial level. A second possibility is overperfusion of some capillary beds whose arterioles are forced open by the severe hypertension. Milledge, Iliff and I succeeded in obtaining perivascular edema by hypoxic pulmonary hypertension in a dog lung even after complete unilateral blockade of the distal arterial bed with polystyrene microspheres 12 to 35 μ in diameter such that no capillary flow or hypertension was possible. However, the mechanism still needs study, since the microspheres could have been responsible for damage and leakage. The possibility of pulmonary edema and hemorrhage following severe hypoxia should be considered, since adequate ventilation and oxygenation are generally sufficient therapy.

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Meeting of the Austrian, German, and Swiss Societies of Anesthesiology and Reanimation

The Twelfth Joint Meeting of the Austrian, German, and Swiss Societies of Anesthesiology and Reanimation was held in Berne, Switzerland, September 1-3, 1971. In his introductory comments, B. Tschirren (Berne) noted the increased recognition of anesthesiology as a university discipline, manifested by the recent proliferation of medical school chairs of anesthesiology. He stressed the need for anesthesiologists to demonstrate their role in patient care by making themselves active rather than passive members of the surgical team, and by actively making patients aware of their participation.

A round-table discussion of Anesthesia and Respiration began with a review of respiratory

physiology by J. P. Haab (Fribourg), whose O_2 -flow diagrams clarified many factors involved in oxygen transfer from ambient atmosphere to tissues. He emphasized that oxygen flow is a function of gas conductance to the alveolus as well as of pressure differences across alveolar, vascular, and tissue membranes. H. Benzer (Vienna) reviewed the characteristics of mechanical ventilators and showed that volume-limited machines were more effective than pressure-limited ones in maintaining adequate ventilation when compliance or resistance was increased. The best machines are volume-regulated with pressure plateaus. H. Waversit (Heidelberg) discussed monitoring in the operative and postoperative periods and made a plea for attention to ventilation, hemodynamic status, blood-gas and air-gas studies, fluid balance, and electrolyte replacement. A similar emphasis on total patient care was underscored by P. Safar (Pittsburgh) in describing his experiences with prolonged artificial respiration in 2,000 intensive-care-unit patients and in 36,000 general anesthetics. Prolonged artificial ventilation must be tailored, depending upon whether a "healthy" or "sick" lung is involved. The healthy lung does well with most types of ventilation. Ventilation of the "sick" lung, for example, associated with massive trauma, must take into account and correct changes in the renal, circulatory, and central nervous systems.

G. Hössli (Zurich) directed a round-table discussion on Anesthesia and Circulation and reviewed normal circulatory physiology and the impact of cardiocirculatory abnormalities on anesthetic management. The importance of the preoperative visit in cardiovascular evaluation was emphasized. The postoperative death rate from a fresh infarction is less than 10 per cent in patients with minimal angina or one-year survival following a previous myocardial infarction. However, the presence of severe angina or a recent myocardial infarction increases this rate to 40-60 per cent. It was the view of the panel that prophylactic digitalization is rarely indicated.

Among the 100 individual papers presented, Y. Kapanci *et al.* (Geneva) discussed electron microscopic and morphometric changes in oxygen pneumonitides in humans. The earliest changes are seen within a few hours and con-