

"WORK IN PROGRESS" ABSTRACTS

Following are abstracts of papers that were scheduled for the WORK IN PROGRESS Program at the 1958 annual meeting of the American Society of Anesthesiologists, Inc., in Pittsburgh. Although this meeting was canceled, some of these papers were presented at the rescheduled limited annual session in Chicago, November 20, 1958.

Postoperative Disturbances in Ventilation Following the Use of Muscle Relaxants in Anesthesia. HENRIK H. BENDIXEN, M.D., A. DENNIS SURTEES, M.D., TSUTOMU OYAMA, M.D., AND JOHN P. BUNKER, M.D. *Department of Anesthesia, Harvard Medical School and Massachusetts General Hospital, Boston, Mass.* The demonstration by Beecher and Todd (*Annals Surg.* 140: 2, 1954) that use of muscle relaxants in anesthesia may carry an increased rate of mortality, the numerous case reports of deaths and "near misses" (particularly from the British literature) following the use of muscle relaxants, and our own clinical experiences were important factors in prompting the present investigation. Paton's picturesque emphasis on the "long pharmacological tail" left in the body following the administration of muscle relaxants together with Cohen's (*Anesthesiology* 18: 300, 1957) observation of high blood levels of *d*-tubocurarine remaining after apparent clinical recovery supported our interest in the immediate postoperative period as a critical one for the safety of the patient. While serious degrees of hypoventilation or other impairment of mechanics of breathing are easily recognized, mild degrees may go unnoticed. This would probably be well tolerated by normal patients but it might represent a serious hazard in poor risk patients. An initial series of 19 patients was studied approximately 15 minutes postoperatively (8 had had nitrous oxide-ether anesthesia, 11 thiopental-nitrous oxide anesthesia with succinylcholine for relaxation). After the anesthetist was satisfied with the adequacy of the ventilation we measured minute ventilation (\dot{V}), respiratory frequency (f), fraction of O_2 in expired air ($F_{E_{O_2}}$), fraction of CO_2 in expired air ($F_{E_{CO_2}}$), arterial oxygen saturation (Sa_{O_2}), concentration of carbon dioxide in arterial blood (Ca_{CO_2}) and pH. The R

value and tension of carbon dioxide in arterial blood (Pa_{CO_2}) were calculated. In this series the ventilatory studies were within normal limits in all patients. In spite of this we were left with the clinical impression that a difference between the groups existed which we had failed to demonstrate. Cohen had correlated blood levels of *d*-tubocurarine with vital capacity measurements (in conscious human volunteers). Such measurements necessitate the conscious cooperation of patient and are not applicable in the unconscious or noncooperative patient immediately postoperatively. The measurement of inspiratory force, on the other hand, which is an expression of ventilatory capacity in terms of pressure rather than volume, can be carried out in the conscious and the unconscious with ease and with a minimum of equipment. A second series of patients was consequently studied, including 8 cases where muscle relaxants were used and 3 cases without muscle relaxants. The measurements included all made in the first series together with measurements of inspiratory force. For the latter a simple technique was employed: a Y-piece was connected to the anesthesia mask or endotracheal tube, one arm attached to a manometer or a pressure transducer, the other left open (to be occluded at end expiration when testing). The negative pressure read on the manometer thus represented the patient's maximal capacity of inspiratory effort against a completely occluded airway. The results of the second series have shown all patients to have normal minute ventilations, but measurements of inspiratory force at intervals in the postoperative period have demonstrated a suggestive difference between cases with and without muscle relaxants. It has been possible to follow the gradual recovery of inspiratory force. Several factors may influence the inspiratory force, such as

neuromuscular block and central depression from anesthetics. The finding of a decreased inspiratory force despite an adequate minute ventilation suggests a ventilatory handicap to the patient. This may cause a decreased ability of a patient to overcome even mild airway obstructions, to cough effectively and to take the occasional deep breath essential for the maintenance of normal pulmonary compliance. Apart from studying the inspiratory force we use this measurement clinically and find it useful in supplementing our evaluation of a patient's ventilatory capacity and recovery from the effects of muscle relaxants. We have established that an inspiratory force of 20 to 25 cm. of H₂O is necessary for adequate ventilation. Our experience suggests that the inspiratory force measurement may be a valid expression of ventilatory capacity, a "vital capacity measurement in the unconscious," and a useful and simple diagnostic tool.

The Combined Use of Narcotics and Narcotic Antagonists for Premedication. HENRY M. BRUNN, JR., M.D., FRANCIS F. FOLDES, M.D., PEARL G. McNALL, M.D., AND LUDWIG R. KOUKAL, M.D. *Department of Anesthesiology, Mercy Hospital and Section on Anesthesiology, Department of Surgery, University of Pittsburgh School of Medicine, Pittsburgh, Pa.* Forty unselected surgical patients (group 1) received intramuscularly 1.5 mg./kg. meperidine, 0.3 to 0.4 mg. scopolamine and 100 mg. of pentobarbital sodium about two hours before induction of anesthesia. Forty other patients (group 2), besides these drugs, were also given intramuscularly 0.02 mg./kg. levallorphan at the same time. At zero time, after topical anesthetization of the pharynx with 1 per cent tetracaine, pulse rate, blood pressure and respiratory rate were recorded and thiopental sodium 5.0 mg./kg. was injected in 2 minutes through the rubber sleeve of an intravenous infusion. At 2 minutes, the administration of a 4 liter to 1 liter nitrous oxide-oxygen mixture was started through a face mask. At 4 minutes, the same parameters, together with the respiratory minute volume, measured with a Bennett ventilation meter, were again recorded. At 5 minutes, 20 patients each of group 1 (subgroup 1A) and group 2 (subgroup 2A) received 0.4 mg./

kg. alphaprodine and 20 others of group 1 (subgroup 1B) and group 2 (subgroup 2B) 1.0 mg./kg. meperidine, intravenously, in 30 seconds. At 8 and at 12 minutes, pulse rate, blood pressure, respiratory rate and minute volume were again recorded. If at the time of the 8 minute reading, the patient was apneic, additional 0.02 mg./kg. levallorphan was injected intravenously. The administration of 5.0 mg./kg. thiopental caused little change in pulse rate, blood pressure or respiratory rate. The only difference observed between group 1, premedicated with meperidine alone, and group 2, premedicated with meperidine plus levallorphan was an 8 per cent decrease of the respiratory rate in the former and a 5 per cent increase in the latter. Levallorphan used with the premedication offered some protection against the respiratory effects of both alphaprodine and meperidine; for example, apnea developed in 12 out of 20 patients of subgroup 1A as contrasted with 2 out of 20 in subgroup 2A. Similarly incidence of apnea was 3 and 0 in subgroups 1B and 2B respectively. The depression of the respiratory rate and respiratory minute volume in the patients who did not develop apnea after intravenous alphaprodine (subgroups 1A and 2A) or meperidine (subgroups 1B and 2B) was also less in subgroups 2A and 2B premedicated with levallorphan plus meperidine. The results presented indicate that the intramuscular injection of 0.02 mg./kg. levallorphan afforded some protection against the respiratory depressant effects of large doses of narcotic analgesics administered intravenously 2 hours later. This protection, however, was less than that obtained when identical doses of levallorphan were injected intravenously immediately prior to, or after, the intravenous administration of identical doses of narcotic analgesics.

Effects of Muscle Relaxants on the Lungs and Circulation in Man. THOMAS J. DEKORNFELD, M.D., CHUNG J. PARK, M.D., AND PETER SAFAR, M.D. *Department of Anesthesiology, Baltimore City Hospitals, Baltimore, Md.* The effects of *d*-tubocurarine (0.3 mg./kg.) and gallamine (1.5 mg./kg.) upon lung-thorax compliance, airway resistance, radial artery pressure, heart rate, electrocardio-