an attempt to correlate these findings with those in human muscle. *Results:* Decamethonium always produces depolarization, even when the dose is so small that the resulting paralysis is negligible. With adequate doses, depolarization and the resulting first phase of paralysis are much more prolonged in isolated human intercostal muscle than the 10 to 15 minutes described by Thesleff for isolated frog sartorius and gastrocnemius muscles. The waning of the first phase is signaled by a recovery of the indirect response and a reduction of the depolarization. The gradual development of the second phase is shown only by the mechanical events, since membrane potential now returns to and remains at resting levels. (Supported by USPHS grant GM 14874.)

Postoperative Hypoventilation and Hypoxia in Man Following Hyperventilation. A. J. SALVATORE, M.D., S. F. SULLIVAN, M.D., and E. M. PAPPER, M.D., *Department of Anesthesiology, Columbia University, College of Physicians and Surgeons, and the Presbyterian Hospital, New York, N. Y.* Hyperventilation lowers PA_{CO_2} and, with time, the CO_2 stores of the body. It has been shown in dogs (J. Appl. Physiol. 21: 247, 1966) that spontaneous recovery of the depleted CO_2 content of the body requires a period of relative hypoventilation. Breathing air during this recovery period results in hypoxia. This potential cause of hypoxia in man following anesthesia with controlled hyperventilation was the subject of the present study. *Methods:* Thirteen patients, free of cardiopulmonary disease, who had been hyperventilated an average of 2¾ hours during anesthesia and operation, were studied. At the end of anesthesia the inspired mixture was changed to 100 per cent oxygen for 15 minutes, Pa_{O_2}, Pa_{CO_2} and pH_a were measured, and hyperventilation subsequently was discontinued. *Results:* Apnea lasted 6⅓ minutes, on the average, upon cessation of hyperventilation. During this time the Pa_{CO_2} rose from 18 to 38 mm Hg. When spontaneous ventilation began the patients were allowed to breathe air. Tidal volume and minute volume increased progressively throughout the remainder of the hour, $\dot{V}_E$/kg at 15 min was 63.6 ± 2.2 ml (mean $\pm$ SE) and at 60 min, 102.3 ± 12.7 ml, while Pa_{CO_2} during this time varied less than 2 mm Hg from the value obtained at the end of apnea. Twenty minutes after the onset of spontaneous respiration, Pa_{O_2} reached an average low value of 72 ± 7.3 mm Hg and then progressively increased toward normal, averaging 83 ± 4.1 mm Hg at 30 minutes and 88 ± 3.5 mm Hg at 60 minutes. At the end of the hour the patients were allowed to breathe 100 per cent oxygen for ten minutes. Pa_{O_2} averaged 587 mm Hg and was essentially unchanged from the values measured at the end of hyperventilation. *Summary:* The hypoventilation which follows a period of hyperventilation can result in a significant lowering of Pa_{O_2} in man if the inspired gas is room air. Yet, this hypoventilation, due to its occurrence in an unsteady state, is associated with normal Pa_{CO_2}.

Effect of Ethrane on the Performance of the Left Ventricle. S. SHIMOSATO, M.D., P.-Y. CHEN, M.D., J. B. GILBERT, M.D., and B. E. ETSTEN, *Department of Anesthesiology, Tufts University School of Medicine, and New England Medical Center Hospitals, Boston, Mass.* Recent studies showed that Ethrane (2-chloro-1,1,2-trifluorethyl difluoromethyl ether), a nonexplosive volatile agent, is a potent anesthetic in both animals and man. However, there is no information related to the effect of Ethrane on myocardial performance. *Methods:* The present study was designed to determine the action of Ethrane on the contractile state of the intact canine left ventricle as determined by the force–velocity relations (ANESTHESIOLOGY 29: 538, 1968) and the active state, which is a measure of the force-generating process of the contractile protein (J. Gen. Physiol. 40: 661, 1967). Thirteen dogs were studied. *Results:* Ethrane induced negative inotropism in all dogs. An average arterial concentration of Ethrane of 18 mg/100 ml produced a 50 per cent depression in peak force with relatively unchanged maximum velocity of shortening. Both maximum isovolumic pressure and the first derivative of left ventricular pressure (LV dP/dt) decreased, indicating decreases in the intensity of the active state. *Summary:* The marked decrease in maximum force as manifested by

the leftward shifting of the force–velocity curve and reduction of rate of pressure development and peak pressure indicate that Ethrane evokes a negative inotropic effect upon the intrinsic contractile state of the heart. The decreased intensity of the active state may be related to the alteration of the chemical interactions of the contractile proteins. (Supported by USPHS Grant HE-01711 from the National Heart Institute.)

Hemodynamic and Respiratory Changes during Pulmonary Lavage. J. D. SMITH, M.B., CH.B., J. E. MILLEN, B.S., P. SAFAR, M.D., and E. D. ROBIN, M.D., *Departments of Anesthesiology and Medicine, University of Pittsburgh School of Medicine, Pittsburgh, Penna.* Pulmonary lavage, defined as the introduction of large volumes of fluid into the tracheobroncheal tree and alveoli of the degassed lung or lobe and evacuation of the fluid has been used in treating various lung disorders, particularly pulmonary alveolar proteinosis. This study describes changes in hemodynamics, intrathoracic pressure and gas exchange produced by pulmonary lavage in one patient with alveolar proteinosis and in three dogs and one calf with normal lungs. *Methods:* The technique was essentially that described by J. Ramirez-R. (Dis. Chest 50: 581, 1966) using a 39 F Carlens catheter inserted under topical anesthesia. The lavaging fluid consisted of 0.9 per cent saline solution buffered to *p*H 4.5 with sodium bicarbonate and containing heparin, 7.5 units/ml. The osmolality of the solution was 293 mOsm. Ventilation with 100 per cent oxygen was assisted. Central venous pressure (CVP) and arterial blood gas tensions were measured during progressive filling and emptying of the lavaged lung. The animals were anesthetized with pentobarbital. A catheter was inserted into the pulmonary artery under fluoroscopic control and a latex esophageal balloon was inserted into the midesophagus. *Results:* A. *Man.* Rises in CVP to maximum levels of 17, 20, and 21 cm H_2O were noted with the lung full of fluid, with rapid return to control levels during emptying. During four lavages, Pa_{O_2} increased significantly (mean = 244 mm Hg) over the degassed prelavage values (mean 76 mm Hg). During emptying P_{O_2} dropped to degassed, and occasionally to lower, levels. B. *Animals.* During lavage pulmonary arterial pressure rose to maximums of 26, 26 and 30 mm Hg in the three dogs; values returned to control levels during emptying (18 mm Hg). Pulmonary arterial wedge pressure changed in a parallel fashion. Intraesophageal pressures in two dogs rose by 16 and 13.5 cm H_2O. Similar changes were noted in the calf. Chest x-rays taken with the lung filled with fluid showed the mediastinum acutely shifted away from the liquid-filled lung. *Summary:* Unilateral filling of the lung with liquid results in a sharp increase in intrathoracic pressure, which is reflected by increases in central venous, pulmonary arterial, pulmonary wedge, and intraesophageal pressures. Pa_{O_2} is low in the degassed phase as a result of nonventilation of perfused areas. Addition of liquid leads to an increase in Pa_{O_2} as pulmonary vessels become compressed and blood flow is shifted to the gas-filled lung.

The Effect of Hexamethonium on the Catecholamine Response to Nitrous Oxide in Man. N. TY SMITH, M.D., E. I. EGER, II, M.D., L. B. KADIS, M.D., and D. CULLEN, M.D., *Departments of Anesthesia, Stanford University Medical Center, Stanford, Calif. and University of California, San Francisco Medical Center, San Francisco, Calif.* We observed previously that the addition of nitrous oxide to halothane–oxygen anesthesia in man caused an increase in plasma norepinephrine levels, plus evidence of peripheral vasoconstriction. This phenomenon was investigated further in eight normal volunteer subjects. *Methods:* Halothane–oxygen was changed to halothane–oxygen–nitrous oxide (70 per cent) both before and after administration of 100 mg hexamethonium (C6). *Results:* The percentage changes in response to N_2O before C6 *vs.* after C6 were: serum norepinephrine levels (30.8, –24.4); cardiac output (dye dilution) (–2.9, 23.9); stroke volume (–4.5, 10.9); heart rate (1.6, 12.2); mean arterial pressure (11.8, 31.8); total peripheral resistance (14.8, 6.4); right atrial pressure (2.2, 0.7 mm Hg); left ventricular minute work (9.0, 64.4); left ventricular stroke work (7.8, 43.4); left ventricular stroke power (5.9, 33.6); tension–time index (7.1,