cent NaCl in 99 per cent D_2O by the same schedule resulted in a mean liver water deuterium concentration of 14 per cent and increased the AD_{50} to 1,338 (1,288–1,396). This reduction in potency relative to saline controls was statistically significant (relative potency 1.06, 95 per cent limits 1.01 to 1.11). The AD_{50} of these animals fell progressively toward normal over the next month on normal water intake. Repetition of the study after a four-month interval was performed using oral deuterium oxide feeding. The control AD_{50} for nitrous oxide at this time was 1,230 mm. of mercury (1,160–1,302) and for animals maintained on 5 per cent dextrose in water, unchanged at 1,236 mm. of mercury (1,154–1,297). Feeding of 5 per cent dextrose in 60 per cent D_2O for 96 hours altered the AD_{50} to 1,296, with a mean liver water deuterium concentration of 23 per cent. This increase was not statistically significant. Unlike animals injected with D_2O, these animals developed marked hyperirritability, anorexia, and oligodipsia. [Supported by USPHS Grants RG9069 and B31C.]

A Ventilation-Blood Acid-Base Diagram. B. Raymond Fink, M.B., *Department of Anesthesiology, Columbia University, College of Physicians and Surgeons, New York, New York.* The ventilation ratio stimulated by H^+ and CO_2, expressed in the Gray equation: $V = 0.22\ H + 0.262\ CO_2 - 18$, can be represented on the same graph as the acid-base balance of blood, if the latter is expressed in terms of (H^+) rather than pH, in the Henderson buffer equation for bicarbonate. On the H^+–P_{CO_2} diagram so derived, a series of parallel ventilation isopleths is obtained for $V = 0, 1, 2, 3 \ldots$, on each of which all combinations of (H^+) and P_{CO_2} theoretically stimulate the same ventilation. The slope of the isopleths, −0.262/0.22, shows the relative effectiveness of H^+ and CO_2 as stimuli of ventilation. This ratio appears to be about the same in pentobarbital-anesthetized dogs and cats as in unanesthetized man. The spacing of the isopleths, 1/0.22 units on the H^+ axis and 1/0.262 units on the CO_2 axis, expresses the sensitivity of the ventilatory mechanism to acid-base stimulation. Wider spacing (smaller coefficients) would show reduced sensitivity, as observed for example in general anesthesia. The constant term, −18, defines the intercepts. The H intercept of an isoventilation isopleth is found by putting $CO_2 = 0$, when $0.22 = V + 18$ and $H = (V + 18)/0.22$. The H^+–P_{CO_2} diagram contributes some new insights to the evaluation of respiratory and metabolic acidosis. Respiratory acidosis, or retention of carbonic acid, is ordinarily considered to exist when the arterial CO_2 tension exceeds 40 mm. of mercury. This definition is too rigid, since 40 mm. of mercury is the appropriate reference P_{CO_2} only when metabolic acid-base disturbance is absent. In metabolic acidosis, acid-induced hyperventilation tends to lower (H^+) toward 39.8 nE/l (pH 7.40). The consequent fall in P_{CO_2} is self-limited, because it decreases the stimulus to hyperventilation, equilibrium being reached when $F_{A_{CO_2}} \cdot V = k \cdot M_{CO_2}$, or $V = k \cdot M_{CO_2}/F_{A_{CO_2}}$. Here k is a proportionality constant such that $V = 1$ when $F_{A_{CO_2}}$ corresponds to 40 mm. of mercury. The calculated values of V are greater than unity and form a "CO_2 isoelimination curve" along which the volume of CO_2 eliminated in the waking steady state would be constant. This curve shows the physiological limit of ventilatory compensation for metabolic acidosis. The CO_2 tensions on this line are below 40 mm. of mercury, the divergence increasing with the base deficit. Thus, in metabolic acidosis a P_{CO_2} of 40 mm. of mercury would constitute CO_2 retention and represent a partial failure of the physiological compensatory process. The extent of the disturbance can be gauged from the difference between the H^+–P_{CO_2} diagram-predicted ventilation ratio and the ventilation ratio actually observed. In a typical case of 1 per cent halothane anesthesia, the observed V was 0.7, whereas the H–P_{CO_2} diagram-predicted V was 4.0. The acid-base ventilation response was, therefore, 0.7/4.0 = 0.18 of normal. With 2 per cent halothane, the response fell to 0.5/5.5 = 0.09 of normal. With ether anesthesia, the acid-base balance on the H–P_{CO_2} diagram often predicts a V below zero, although the observed V may actually be greater than unity. Presumably, a potent respiratory drive other than the acid-base drive is also present. In metabolic acidosis in the waking state, excess ventilation is usually observed. This can be

safely depressed to $V = 1$ by infusion of base, since $V = 1$ suffices for normal oxygenation. In principle, the permissible rate of administration can be calculated. [Supported by Grant No. RG-9069 USPHS.]

Cardiopulmonary Resuscitation: A Laboratory Evaluation. LEROY C. HARRIS, JR., M.D., HERBERT G. KUNKEL, M.D., and PETER SAFAR, M.D., *University of Pittsburgh School of Medicine and Presbyterian-University Hospital, Pittsburgh, Pennsylvania.* *Method and Results:* Controversial points of cardiopulmonary resuscitation, *i.e.,* intermittent positive pressure ventilation (IPPV) plus external cardiac compression (ECC) were evaluated in 31 anesthetized dogs with ventricular fibrillation (produced by electric shock), utilizing standardized experimental protocols. Sternal pressures, 60 per minute, were kept regular and constant by the use of a Beck-Rand machine. All lung inflations were kept constant (15 ml./kg.; air), produced by compression of a Ruben bag or a piston respirator synchronized with the Beck-Rand machine. It has been shown that ECC alone can not be relied upon to ventilate the lungs adequately (Dis. Chest *41:* 1, 1962). *Coordination of IPPV and ECC:* (1) One lung inflation interposed after each two sternal compressions was compared with one lung inflation simultaneous with every second sternal compression. Carotid blood flows were higher with simultaneous than with interposed lung inflations in 7/15 observations, the same in 5/15, and lower in 3/15. Arterial oxygen saturations remained normal (85 to 97 per cent) with interposed inflations, but dropped to an average of 65 per cent with simultaneous inflations. The progressive drop in arterial *p*H during ECC was less during interposed inflations. (2) Oxygenation with IPPV/ECC ratios of 3/15 and 6/30: During 3/15 ratios, the arterial O_2 saturation was maintained at control levels. During 6/30 ratios, the arterial O_2 saturation dropped to an average of 74 per cent at the end of 30 seconds without ventilation. Arterial *p*H and P_{CO_2} values remained closer to control levels with the 3/15 than with the 6/30 ratio. These data support our clinical recommendation to use the 3/15 ratio, at least in the nonintubated patient, where frequent interposing is difficult and brief interruptions of ECC for inflation allow recognition of airway patency. *Augmentation of Blood Flows during ECC by Pressure over the Abdomen:* Continuous pressure over the abdomen increased the artificial carotid blood flows during ECC by 25 to 50 per cent in 17/18 comparisons. This was not due to aortic compression, since both the carotid and femoral arterial pressures increased. (3) *Epinephrine and Norepinephrine during ECC:* Intravenous injections of epinephrine (0.25 mg., 0.5 mg.) given during ECC increased the artificial aortic pressures in all observations. Carotid flows did not increase in 9/14 observations and increased only minimally in 5/14. After defibrillation, intravenous epinephrine always significantly increased spontaneous aortic flows and pressures. Intravenous norepinephrine gave similar results. Subcutaneous injections of epinephrine 2 mg. given over the sternum never increased blood flows or pressures significantly in 20 minute observations. *Blood Volume Expanders during ECC:* Dextran, 25 per cent of estimated blood volume, given intravenously within five minutes to normovolemic dogs, increased the artificial carotid blood flows by 15 to 80 per cent in 7/10 and increased the arterial pressures slightly in 8/10 observations. Blood flows were more improved by intravenous dextran than by intravenous epinephrine.

Measurement of Bronchomotor Tone in Man. LAMAR P. JACKSON, M.D., and ARTHUR S. KEATS, M.D., *Division of Anesthesiology, Baylor University College of Medicine and Jefferson Davis Hospital, Houston, Texas.* Our knowledge of the action of many commonly-used anesthetic agents and adjuvants (such as narcotics and barbiturates) upon the bronchial musculature of man is tenuous. The literature revealed that many of our operational concepts regarding these actions are derived solely from *in vitro* or animal studies. These results may not represent the pharmacological actions *in vivo* and, more particularly, in man. The paucity of information seems to result from the lack of a quantitative, yet simple, method of measuring changes in bronchomotor tone in man. We have adapted a method used in dogs by Harasawa and Rodbard (J. Pharma-