

and cardiac subjects. In some cardiac patients blood levels seemed adequate but buffering capacity, poor. Alveolar CO_2 is said to be low in such subjects—this is being investigated. Test results showed poor buffering capacity in some normal individuals, in patients with congenital heart disease and restrictive or fibrotic pulmonary insufficiency. Good buffer capacity was found in most patients with cardiac valvular disease and pulmonary emphysema. Work completed to date has dealt with the blood chemistry changes only. Observations during this study tend to support our hypothesis that if blood buffer capacity can be shown to be impaired, thresholds for important clinical effects such as the cardiovascular response to changes in CO_2 balance may be directly related. We have observed marked intolerance to minor increases in CO_2 as evidenced by weakness and dyspnea greatly out of proportion to the stimulus in some of our subjects who had very low blood CO_2 content. Our present work is designed to evaluate this hypothesis.

Intravenous Lidocaine as an Adjuvant to General Anesthesia: A Clinical Evaluation.

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nearly as possible 500 mg. of this drug for the entire procedure. An intravenous infusion was then started, containing 500 mg. of succinylcholine (0.05 per cent) and a coded vial of either lidocaine 1 Gm. (making a 0.1 per cent solution) or water. Nitrous oxide and oxygen, 6 liters to 2 liters, were given in a semiclosed system, an endotracheal tube being used at the discretion of the anesthesiologist. *Results.* This blind study included 214 patients undergoing minor perineal procedures and 227 patients undergoing major intraperitoneal pelvic procedures. Preoperative medication, sex, weight, age and duration of anesthesia were either controlled or comparable. In the minor group the amount of thiopental necessary to accomplish smooth anesthesia was reduced by 52 mg. when lidocaine was used as contrasted to the placebo. In the major group the amount of succinylcholine necessary was reduced by 62 mg. when intravenous lidocaine was used. These differences are statistically significant, though not striking. The incidence of uneven anesthetics was lower in both groups in which lidocaine was used, and this suggests that lidocaine contributes to the smoothness of anesthesia. There were no significant differences between the lidocaine and placebo groups with regard to blood pressure changes, reaction time, and postoperative analgesia requirements. The results of this study of 441 patients showed that lidocaine used intravenously made a significant, though not dramatic, contribution to the maintenance of a thiopental nitrous oxide-succinylcholine anesthesia, that adverse effects on the circulation were not evident, and that the postoperative reaction time and analgesic requirements were not affected. [Mr. Frazier is Director, Bureau of Biostatistics, The Baltimore City Health Department.]

Comparative Effects of Anesthetic Agents on Toothpulp Thresholds in Rabbits.

C. B. PITTINGER, M.D., H. H. KEASLING, M.D., AND R. L. WESTERLUND, M.D. *Division of Anesthesiology, Department of Surgery and Department of Pharmacology, College of Medicine, State University of Iowa, Iowa City, Iowa.* Clinical experience with halothane anesthesia suggested a deficiency of the drug as an analgesic agent. This impression prompted the comparative study of the analgesic potencies of

halothane, chloroform, ether, divinyl ether, trichloroethylene, cyclopropane and nitrous oxide. Elevation of toothpulp threshold in rabbits was the criterion of analgesic action. Electrical stimulation consisting of single, square wave pulses of one millisecond duration and variable voltage was delivered from a Grass Model S-4 instrument to insulated spring clip electrodes inserted into burr holes placed laterally in the upper incisors. A Foregger double kettle machine and Fluotec apparatus were employed for delivery of the gases and vapors. Simultaneous distribution of the agents to 4 animals was provided through a manifold connected to transparent plastic masks fitted with valves allowing a nonbreathing system. The voltage necessary to induce minimal chewing or licking responses characteristic for each rabbit was recorded as the threshold. Control levels ranging from 1.5 to 3.5 volts were determined during oxygen inhalation. Thresholds were redetermined after 10 minute periods of breathing successively higher concentrations of drugs. At least 12 animals were studied for each agent; individual animals were used only once. The data were plotted semi-logarithmically as elevations of toothpulp threshold against actual inhaled concentrations. Curves for all agents were characterized by two slopes—a lesser initial and a greater terminal one. The flexures between the two slopes of the curves were associated with changes in the physical appearances of the animals. Threshold elevations along the lesser slopes occurred in apparently alert rabbits presumably in a state of "analgesia"; those along the steeper slopes were recorded in apparently depressed or "anesthetized" animals. Halothane, vinyl ether, ether and cyclopropane were similar in that low levels of threshold increases persisted until concentrations capable of producing apparent "anesthesia" were used. In contrast, trichloroethylene and chloroform induced appreciable threshold increases in apparently alert animals. Comparison of the effects of halothane and chloroform indicated the greater "anesthetic" potency of chloroform. Elevations of threshold did not occur after inhalation of an 80 per cent concentration of nitrous oxide with oxygen for periods up to twenty minutes. An interesting potentiation between nitrous oxide and pentobarbital so-

dium was suggested by significant increases in thresholds which occurred when "nonanalgesic" doses of both agents were employed. Subsequent research includes investigations of analgesia in nitrous oxide-barbiturate combinations, of relative analgesic potentialities of the various gaseous and volatile agents under equilibrium conditions, and of the predilection, if any, of trichloroethylene for the trigeminal nerve. [Supported by USPHS Grant B-1079.]

Resuscitation From Drowning—A Laboratory Evaluation. JOSEPH REDDING, M.D., G. CARL VOIGT, AND PETER SAFAR, M.D. *Department of Anesthesiology, Baltimore City Hospitals, Baltimore, Maryland.* An attempt was made to determine whether water in the lungs, and gastric distension with water hinder resuscitation in dogs. The following modalities were monitored: ECG, breathing movements (pneumograph), pressures in aorta, inferior vena cava and superior vena cava, arterial oxygen saturation and CO₂ content, and hematocrit. *Water in the lungs:* (1) Pilot experiments on 13 awake dogs confirmed the results of others. Direct flooding of the lungs through a tracheotomy tube with fresh water (not with sea water) caused massive absorption of water into the blood stream and ventricular fibrillation in 1 to 2 minutes. In both fresh water and sea water drownings the breathing movements continued until after circulatory arrest; spontaneous recovery occurred, if sea water flooding was stopped before the arterial pressure dropped, and if fresh water flooding did not lead to ventricular fibrillation. (2) Human victims of submersion seem to first develop obstructive asphyxia (laryngospasm), followed by flooding of the lungs and apnea, without immediate cardiac arrest. This condition was simulated by obstructing the tracheal tube of lightly anesthetized dogs (pentobarbital) to the point of apnea. Then the lungs were flooded for 30 seconds either with fresh water (5 dogs), or with sea water (5 dogs), or apnea was permitted to continue for a comparable period without flooding (5 control dogs), and finally resuscitation was attempted with Intermittent Positive Pressure Breathing (IPPB) with air. All control dogs (obstruction without water) survived. Fresh water drowning caused in all dogs mild arterial hypotension,