effect of ether on the myocardium may have led to arrest during induction in one case. Similarly rapid absorption of a local anesthetic from the injection site may have affected cardiac conduction in another case. In the remainder reflex stoppage of the heart was suggested by the precipitating events. Circulatory arrest followed endotracheal intubation in two and the others were associated repeatedly with intra-abdominal manipulation. Any one or a combination of the aforementioned mechanisms have led to arrest in the normal patient but the patient with heart block is particularly susceptible.

Patients with complete heart block should be prepared for operation with the drugs successful in preventing Adams-Stokes attacks before operation. Preparations should be made to monitor the electrocardiogram continuously. Adrenalin for injection and an external cardiac pacemaker of the Zoll type should be at hand. Care should be taken to avoid overdosage either with general or local anesthetics and to watch for arrest at the time of reflex stimulation. Thoracotomy need not be performed immediately if arrest occurs. Cardiac action was reinstituted in the cases reported here mostly by mechanical means. Pounding the chest, needling the myocardium and stimulating the heart through the open abdomen proved effective. In one case an external cardiac pacemaker was helpful.

Anesthetic Management of Infants and Children with Double Aortic Arch.
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DOUBLE aortic arch or constricting vascular ring was present in 2.2 per cent of the patients operated upon for congenital heart disease at The Children's Memorial Hospital in Chicago during the past ten years. Twenty-three of this group of twenty-eight patients were under one year of age. One infant died from hemorrhage, one from failure to locate and divide the anomalous constricting vessel, and four from anesthetic complications [Arch. Surg. 73: 508–516 (Sept.) 1956].

The diagnosis and surgical treatment of conditions arising from these vascular anomalies have been fully covered by Gross [Pediatrics 7: 69, 1951]. Operative and postoperative complications can be minimized only if the anesthesiologist is prepared to treat ventilatory problems arising from tracheal compression. A wide assortment of long, thin walled but firm endotracheal catheters and several sizes of polyethylene tubing must be available. The tip of the catheter or tubing must be advanced beyond the obstruction. Although we prefer a closed to-and-fro absorption technique, and light cyclopropane anesthesia, there have been times when the lumen of the trachea was so small that intubation with the smallest endotracheal tube was impossible. In these instances, we resorted to insufflation of gases through a small (18 gauge) endobronchial polyethylene tube. Moderate hypothermia (86 to 90 degrees) proved to be a valuable adjunct and reduced metabolism to the point where an inadequate, obstructed airway became adequate.

The immediate postoperative period is critical. Chondromalacia may permit collapse of the trachea, and tracheal edema may produce an acute, fatal obstruction. An oxygen tent with high humidity and Alevaire® was employed routinely. This seemed to decrease the frequency and severity of tracheal edema, tracheitis and bronchitis or pneumonitis, which are the principle causes of morbidity and mortality.

The following case report illustrates most of the more serious complications and the means used to combat them:

A six months old infant was admitted to the hospital with the symptoms and clinical findings of a vascular ring compressing the distal portion of the trachea and right main bronchus. Because of the respiratory difficulty, premedication consisting of morphine 1/60 grain and scopolomine 1/400 grain was administered intravenously in the operating room. An improvised endobronchial tube was fashioned from No. 330 polyethylene tubing. Multiple alternating holes were made along both sides of the distal two inches of this tube. Right endobronchial intubation provided an adequate airway to both lungs. Anesthesia was uneventful. Following extubation, breathing became labored with a pronounced but ineffectual expiratory effort. A progressive emphysema of the right

lung developed with a mediastinal shift to the left. Bronchoscopy revealed a collapsed right main bronchus. Tracheotomy was valueless. Reinsertion of the previously described perforated polyethylene tube through the tracheotomy and into the right bronchus immediately relieved the obstruction and permitted normal expansion of both lungs. This endobronchial tube was removed for cleaning every 48 hours. The softened condition of the cartilaginous rings of the bronchus and postoperative peribronchial reaction prevented permanent removal of the tube until the twenty-fifth postoperative day. In spite of this prolonged intubation, postintubation sequellae have not occurred.

Physiological Evaluation of Respiratory Assistors. NANCY WU, M.D., WILLIAM F. MILLER, M.D., AND IVAN E. CUSHING, M.D., The Cardiopulmonary Laboratory, Department of Internal Medicine, University of Texas Southwestern Medical School, Dallas, Texas.

INCREASING clinical application of mechanical devices for assisting respiration necessitates a thorough understanding of the nature of the apparatus. Moreover, the performance of the respiratory assistors would be expected to vary in patients with pulmonary diseases. This investigation is an effort to study the mechanical characteristics of intermittent inspiratory positive pressure apparatus and to evaluate their physiological effects on patients with normal as well as impaired ventilatory function.

Bennett, Halliburton, and Monaghan Ventalung assistors were studied for their maximal flow capacity at varying supply line pressures and also for the pressure-flow relationships of the devices against varying resistances. All three units provided instantaneous high flow rates at a resistance of less than 2 cm. of water. As resistance was increased, the flow rates on the Halliburton and Bennett machines decreased more or less linearly. The Monaghan Ventalung, on the other hand, provided a somewhat lower initial flow rate but high flow was maintained with increased resistance.

Ten individuals with impaired pulmonary function and 3 normal subjects were studied before and during intermittent positive pressure breathing by one or all three respiratory assistors at 10, 15 and 20 cm. H_2O pressures. Simultaneous recordings of air flow, intra-esophageal pressure, airway pressure at the mouth and the expiratory volume were obtained.

The pressure-volume relationship obtained from different individuals at the same pressure settings showed wide variations. In normal relaxed subjects, tidal volumes were increased with increased airway pressures up to a variable limit. Further expansion was prevented by spontaneous stiffening of the chest wall. In patients with obstructive ventilatory disturbances the tidal volume was limited by diminished flow rates owing to increased viscous resistance. In patients with restrictive ventilatory disorders, the tidal volume was usually limited by the decreased compliance of the lungs or thoracic cage. Thus, in both instances, increased pressures were required to achieve appropriate tidal exchange depending on the quantitative mechanical properties of the pulmonary apparatus.

The performance of respiratory assistors is a function of the relationship between the mechanical characteristics of the respiratory apparatus and the patient's pulmonary system. The Bennett and Halliburton valves tend to produce higher mean flows and tidal volumes in patients with high viscous resistance whereas the Monaghan valve, which produced high initial airway pressure, provided lower mean flow and tidal volume in patients with obstructive disorders.

The transmission of airway pressure and its quantitative relationship to the intrapleural pressure depends on the level of dynamic resistance of the lungs, airway and chest wall. Low resistance permits rapid transmission of applied pressure to the pleural space, and rapid return to low pleural pressure, whereas the opposite holds with high dynamic resistance.

Thus effective and safe use of intermittent positive pressure breathing devices requires understanding of the mechanical characteristics of the respiratory assistors as well as those of the pulmonary system of the patient to whom the assistor is being applied.