

Reports of Scientific Meetings

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Anesthesia for Cardiac Surgery

Anesthesia for Cardiac Surgery was the topic for an unusual meeting sponsored by the Texas Heart Institute and Baylor College of Medicine, held in Houston, Texas, April 4-6, 1974. The Texas Heart Institute will perform approximately 2,700 open-heart operations during the coming year, and with such wealth of clinical experience, it was appropriate for the meeting to be held under such auspices. All speakers were affiliated with the sponsoring institution.

Dr. Alexander Romagnoli outlined the anesthetic management of the adult surgical patient at the Texas Heart Institute. Pre-medication consists of a barbiturate, a narcotic, and an anticholinergic drug. Thiopental is used for induction, and the patient receives either succinylcholine or pancuronium to facilitate intubation. Anesthesia is maintained with a nitrous oxide-narcotic-nondepolarizing relaxant technique. A percutaneously placed arterial cannula serves to monitor blood pressure and provides samples for blood gases, hemoglobin, hematocrit, sodium, potassium, and osmolality determinations. The electrocardiogram, electroencephalogram and esophageal temperature are routinely monitored. An attempt is made to maintain pressure during bypass between 45 and 85 torr, temperature between 35 and 38 C, and P_{aCO_2} between 35 and 40 torr. Sodium nitroprusside in a concentration of 100 $\mu\text{g}/\text{ml}$ is used to treat hypertension, since this drug produces dilation of the coronary, pulmonary, cerebral, and renal vessels without apparent toxicity. The drug appears to be eliminated rapidly, and the only difficulty relates to vasodilatation and a relative hypovolemia.

The most common postoperative complications are ventricular arrhythmias (31 per cent), supraventricular arrhythmias (29 per cent), hypertension with systolic pressure greater than 150 torr (27 per cent), hypotension with systolic pressure less than 90 torr (17 per cent), behavioral disorders (26 per cent),

respiratory complications (13 per cent), neurologic deficiencies (13 per cent), and hemoglobinuria (12 per cent). It is believed that the neurologic complications are related to hypoxia, hypoperfusion, and embolization. Emboli may be protein aggregates, fat, air, calcium, or other foreign bodies. Since foreign bodies, *i.e.*, particulate matter emboli, were ubiquitous following the use of the Bentley Temptral Oxygenator, the first prime is filtered through a 20- μ arterial filter before the patient is put on bypass. There appears to be no correlation between the duration of cardiac bypass and the occurrence of neurologic deficit. The overall 30-day mortality is 6.7 per cent.

Dr. Jerome Strong reviewed the pharmacology of drugs used to support the circulation during and after cardiopulmonary bypass and emphasized that the action of these drugs was dependent upon the state of the myocardium. There are differences between the cardiac failures of those patients who have a muscular component to their failure and those who have variations in regional blood flow within the heart. The catecholamines vary in terms of their alpha and beta responses and these actions are dose-dependent. Epinephrine, for example, has both alpha and beta properties, but in low doses the action is almost pure beta. Norepinephrine, on the other hand, stimulates mostly alpha receptors and increases diastolic blood pressure, which in turn affects coronary blood flow. Metaraminol is mostly an alpha stimulator and has the ability to increase pulmonary vascular resistance without increasing systemic vascular resistance. Calcium activates ATP-ase causing an increase in energy production within the myocardium. It also increases vascular resistance and is more than just an "instant" digitalis.

Strong also emphasized the action of digitalis in promoting diuresis, increasing oxygen consumption of the myocardium, and decreasing systemic vascular resistance, de-

creasing splanchnic circulation, and producing arrhythmias (arrhythmias are the first manifestation of digitalis toxicity in 50 per cent of patients). He recommended extreme caution during electroconversion of digitalized patients because of arrhythmias. Antiarrhythmic agents affect the automaticity of the heart, the conduction velocity, and the duration of the refractory period. Both quinidine and procainamide decrease conduction velocity, decrease automaticity, and prolong the refractory period. Dilantin, while decreasing automaticity, increases A-V conduction. One advantage is that this drug will alter the arrhythmias caused by digitalis without decreasing the contractile force of the myocardium.

Dr. Ben Daly stated that the objectives of mechanical circulatory assistance are: to maintain or increase blood pressure, to increase cardiac output, and to decrease left ventricular work and myocardial oxygen consumption. The advantages of aortic counterpulsation are that myocardial perfusion is improved, left ventricular failure is prevented because of the decrease in afterload, the extent of myocardial damage is reduced, stroke volume is increased, and peripheral vascular resistance and coronary vascular resistance are diminished. Indications for use of the intra-aortic balloon following cardiopulmonary bypass are a blood pressure of less than 80 torr and a left atrial pressure or left ventricular end-diastolic pressure of 25 torr or greater. Dr. Daly has developed an abdominal left ventricular assist device. This pump does not occupy volume in the chest and it can be removed without a subsequent thoracotomy.

Dr. Denton Cooley reviewed the evolution of current surgical practice at the Texas Heart Institute. He pointed out that the technique of hemodilution using a non-blood prime significantly reduces the number of blood units which a blood bank must supply. For example, 30 per cent of patients receive no blood during their hospital stays and may leave with a Hb of 8-10 g/100 ml. In contrast, a survey of 14 heart centers indicates an average use of 7.7 units/patient, with an incidence of 2.8 per cent symptomatic hepatitis.

Critical factors in the care of infants with congenital heart disease were discussed by

Dr. Charles Mullins. He cautioned that uncontrolled hypothermia is dangerous, since a 2°C decrease in temperature increases the infant's oxygen consumption by 40%. He recommended use of a warmer in the preoperative period in order to prevent undue temperature fall. Blood should be warmed before administration, and extreme care must be used to avoid inadvertent embolization, especially in patients with ventricular septal defects. Dr. Mullins recommends discontinuation of digitalis the night before operation.

Dr. Dan McNamara, a pediatric cardiologist, discussed the difficult decisions in recommending surgery for asymptomatic defects. Approximately 20% of children with congenital heart disease have inoperable lesions because of absent or hypoplastic structures or have diffuse involvement with anomalies of multiple systems. Operation is recommended for certain asymptomatic defects which are benign in childhood but may deteriorate in adulthood, such as a left-to-right shunt with low pulmonary resistance and moderate valvular stenosis or aortic stenosis with a left ventricular-aortic gradient of 25-60 torr. Elective operations in mid-childhood are recommended for those asymptomatic individuals who have large left-to-right shunts (2:1) or moderately severe valvular stenosis (pulmonary-valve stenosis with right ventricular pressures greater than 60-100 torr). Palliative surgery is recommended for children with tricuspid atresia, pulmonary valvular atresia with a small right ventricle, or a single ventricle.

New in the medical management of cyanotic congenital heart disease is the use of small doses of propranolol to treat cyanotic spells of tetralogy of Fallot and to prevent decreases in oxygen saturation with crying or exercise. Propranolol may relax spasm of the right ventricular infundibulum.

Dr. Guy Harrison identified four groups of patients with cyanotic heart disease who usually require pulmonary assistance in the postoperative period. These individuals are suffering from pulmonary arterial or left atrial enlargement, compression of the lung, and "dirty-lung" syndrome. If a child's trachea is intubated for prolonged periods, the nasotracheal tube is changed every three to four

days. A volume ventilator is used with carefully controlled inspired oxygen concentration. PEEP is used to prevent the use of elevated $F_{I_{O_2}}$'s or when $P_{a_{O_2}}$ is low even with an increased $F_{I_{O_2}}$. A flow-directed pulmonary-artery catheter or central venous pressure line is inserted when PEEP is used.

Dr. Paul Stevens emphasized the relationship between measured shunt and cardiac output. Low cardiac output worsens pre-existing hypoxemia caused by pulmonary disease. To aid in the differential diagnosis of postoperative pulmonary hypoxemia, Stevens recommended dividing patients with low or normal $P_{a_{CO_2}}$'s into those with "white" (opaque, cloudy) x-rays and those with "black" (dark) x-rays. Patients with "white" x-rays may have pulmonary edema, diffuse pneumonia, interstitial fibrosis, or adult respiratory distress syndrome. Those with "black" x-rays may have pulmonary vascular obstruction, low cardiac output, moderate obstructive pulmonary disease, or anatomic shunts. He recommended the use of a pulmonary-artery flow-directed catheter to help differentiate cardiac from pulmonary disease of the lung.

Dr. Jerriann Hacker presented the results of her study investigating glucose-insulin relationships during cardiac bypass. Since patients with arteriosclerotic heart disease have decreased glucose tolerance with increased sympathetic stimulation and increased insulin levels, there may be a detrimental effect of insulin on the arterial wall. Insulin exerts a protective effect as a cardiotoxic drug, and may have a direct effect on the myocardium by affecting electrolyte transport. Blood glucose levels rise while patients are on bypass, probably due to the effects of catecholamine release, hypothermia, and bypass itself. This hyperglycemia can be controlled by 20 units of regular insulin. Dr. Hacker concluded that

normal patients undergoing cardiopulmonary bypass have a hyperglycemic response which is maximal at the termination of the pump run. Diabetic patients have glucose-tolerance curves similar to those of normal individuals but displaced higher, and D5/W lactate pump-primed patients required less mannitol, albumin, and blood in the postoperative period than patients with lactate alone. In these studies serum osmolality never exceeded 320, and hyperglycemia had a beneficial effect on urinary output. There was no significant electrolyte change.

The incidences of arrhythmias during open-heart surgery range from 18 to 38 per cent. Arrhythmias are most common with halothane. According to Dr. Phiroze Sabawala, intubation causes 25 to 61 per cent of patients to develop arrhythmias, most commonly supraventricular in origin. However, only 1 per cent of these are serious enough to require therapy. Dr. Sabawala corrects slow pulse rates associated with halothane by administration of atropine. He recommends 0.3-0.5 mg propranolol for atrial fibrillation with rapid ventricular rate and for the treatment of nodal tachycardia. He does not discontinue propranolol in those patients who have become propranolol-dependent. Dr. Sabawala also uses propranolol to treat arrhythmias which occur independent of rate, such as ventricular premature contraction, multifocal ventricular extrasystole, and ventricular tachycardia. An important cause of morbidity in the intensive care unit is respiratory alkalosis ($pH > 7.55$), since the incidence of arrhythmias greatly increases with the high pH .

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