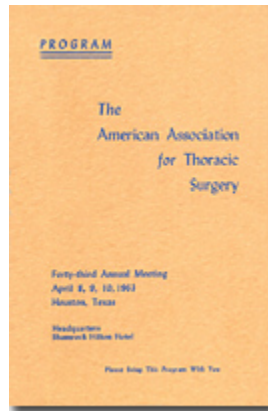


# 1963 ANNUAL MEETING PROGRAM



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**Monday Morning, April 8, 1963**

**8:30 A.M. Business Session (Limited to Members)**

**Emerald Room**

**8:45 A.M. Scientific Session: REGULAR PROGRAM**

**Emerald Room**

**1. A Continuing Clinical Survey of Adenomas of the Trachea and Bronchus in a General Hospital**

EARLE W. WILKINS, JR., R. CLEMENT DARLING (*by invitation*),  
LAMAR SOUTTER, and RONALD C. SNIFFEN (*by invitation*), Boston, Mass.

Since our initial report nine years ago, the total experience of the Massachusetts General Hospital in the management of adenomas of the trachea and bronchus has been reviewed. Over the period of years, 1909 through 1961, there have been 70 carcinoid adenomas and 6 cylindromas diagnosed by histological examination at this hospital. This series has been analyzed according to the duration and type of symptoms as well as roentgenologic and bronchoscopic findings. Transthoracic resection was carried out in 59 patients; 17 patients received either no treatment or palliative therapy in the form of repeated bronchoscopic resections or small doses of irradiation. Follow-up data are presented for all patients. Emphasis is placed on type and extent of disease encountered and mode of therapy used. Optimal and alternative methods of management are discussed.

**2. Primary Carcinoma of the Lung: Experience with 1340 Patients**

RAYMOND J. BARRETT, J. C. DAY, P. V. O'ROURKE,  
HOSSEIN SADEGHI (*by invitation*), RICHARD W. PERRY  
(*by invitation*), and WILLIAM M. TUTTLE, Detroit, Mich.

Between January 1, 1947, and April 1, 1962, the authors have seen 1340 patients with primary carcinoma of the lung. Male-female ratio was 8:1, over 80% were of the white race, and more than 65% were in the age range of 50-70 years. Approximately 50% of the tumors were of squamous cell type; "oat cell", and adenocarcinoma accounted for slightly less than 20% each. "Alveolar cell" incidence was approximately 3%. Explorability and resectability varied with the type of patient population in the respective hospital. Thus explorability ranged from a low of 21% to a high of 70%. Correspondingly, the resectability rate varied from below 5% to a high of 40% in the institution where the bulk of the resections were performed. Slightly over half the resections were pneumonectomies with a mortality rate of 7%. The remainder, consisting of lobectomies, bilobectomies, and an occasional segmental resection, had a mortality rate below 3%. An extensive follow-up of the series is underway and prognosis will be related to site of the tumor, its size and cell type, extent of the resection, incidence of positive nodes and effect of adjuvant radiotherapy.

**3. A Follow-up On Patients With Bronchogenic Carcinoma Locally "Cured" By Pre-operative Irradiation**

NORMAN H. BAKER (*by invitation*), Columbus, Ohio,  
R ADAMS COWLEY, and FERNANDO G. BLOEDORN  
(*by invitation*), Baltimore, Md.

A myriad of adjunctive procedures have been added to surgery for bronchogenic carcinoma in the past thirty years in the hope of improving long term results. Recently pre-operative irradiation followed by resection has shown some promise in the treatment of this disease. The resected lung and mediastinal nodes are reported to be sterilized (containing no viable tumor cells histologically) in fifty percent of the cases. This group should theoretically give the highest cure rate. All cases that had been receiving pre-operative irradiation followed by resection since 1956 were reviewed. There were 19 patients in whom the specimen was reported to contain no tumor. Careful re-examination of the specimens disclosed undetected tumor in two. The remaining 17 patients were followed up to the present time. The long term results in this group were disappointing. These cases will be reviewed and the operability, pathology and survival will be discussed.

**4. Hypertrophic Pulmonary Osteoarthropathy**

H. EDWARD ROLLING, GORDON K. DANIELSON,  
RALPH W. HAMILTON (*all by invitation*), and  
WILLIAM S. BLAKEMORE Philadelphia, Pa.

Pulmonary neoplasms in man occasionally are associated with pulmonary osteoarthropathy. In two of our patients with pulmonary neoplasms the first manifestations were pain in the extremities and characteristic changes in the limbs. These findings have been recognized in many patients with various pulmonary diseases. In the affected limbs there is an overgrowth of vascular connective tissue which is invaded by periosteal new bone formation. Overgrowth of tissue in the

digits gives rise to clubbing of them in man but not in other species. We have used the measurement of the increased blood flow in the limbs to follow the course of the disease. In patients where the blood flow was measured before, during and/or after operation, the blood flow was found to return to normal as the hilum was dissected, and the changes in the extremities regressed during the postoperative period. The regression has been noted following removal of the intrapulmonary lesion, vagotomy, or even exploratory thoracotomy. These observations and others made upon dogs indicate that the increased limb flow is maintained by a reflex, probably with afferent impulses arising in the pleura and traveling in the vagus nerves. Illustrative laboratory and patient observations will be presented.

#### **5. Pleurectomy in the Treatment of Pleural Effusion Due to Metastatic Malignancy**

R. JENSIK, J. E. CAGLE (*by invitation*), C. PERLIA (*by invitation*), S. TAYLOR (*by invitation*), S. KOFMAN (*by invitation*), and E. J. BEATTIE, JR Chicago, Ill.

An analysis of our patients dying from breast carcinoma with pleural metastases revealed that about 40% of them died from pulmonary insufficiency. Hence, a vigorous attack on malignant pleural effusion was begun. Fifty-one pleurectomies were done on 49 patients in the five-year period from January 1957 to January 1962. All of these procedures were done to halt the rapid accumulation of pleural effusion caused by carcinomatous invasion of the pleura. The commonest sites for the primary disease were the breast (17 cases) and the lung (12 cases). In eight patients the primary was undetermined. The ages ranged from 32 to 80 in 32 females and 17 males. The operative mortality was 5.8%. Six additional patients died of their disease within a month of their pleurectomy, and five patients have been lost to follow-up. The remaining 35 patients have had an average survival time of 9.3 months; one patient was doing well 26 months after surgery. The interval between the treatment of the primary disease and the onset of pleural effusion was not directly related to survival time after pleurectomy. Plural fluid cytology was positive in only 14 of 32 patients who had this examination.

#### **6. Spontaneous Pneumothorax**

W. G. GOBBEL, JR., W. G. RHEA, JR., I. A. NELSON (*all by invitation*), and R. A. DANIEL, JR. Nashville, Tenn.

Since the incidence of recurrence of spontaneous pneumothorax after conservative non-operative treatment has been poorly documented and the place of surgical treatment inadequately defined, 119 consecutive cases on whom follow-up data were available have been studied. General consensus seems to dictate that a patient must have several episodes of spontaneous pneumothorax before being considered for surgical treatment, suggesting that the incidence of recurrence is low and/or results of surgical treatment are poor. In this study the recurrence rate after conservative non-operative management was 52% after the first pneumothorax, 62% after the second, and 83% after the third during the follow-up period that averaged six years. Thirty-one cases were treated by parietal pleurectomy and excision or oversewing of bullae and blebs. There were no operative deaths. There have been no recurrences over an average follow-up period of five and one-half years. Bullae and/or blebs were present in all operative cases. There was no evidence that the operation impaired pulmonary function. Since the incidence of recurrence is great after conservative non-operative management as contrasted to the very satisfactory results without mortality after parietal pleurectomy with bullae and bleb excision, early surgical intervention is recommended.

#### **7. Colon Replacement of the Esophagus in Children**

WILLIAM A. HOPKINS, Atlanta, Ga.

Studies have already shown that the colon is an adequate transplant for the esophagus in children. We have had the opportunity of utilizing colon transplant to replace the esophagus in seven cases of congenital atresia of the esophagus. The colon was used in one case of stricture following repair of tracheoesophageal fistula. The first one of these children was done at the age of six, and the child is now eleven years of age and doing well. Motility studies on the transplanted colon have been carried out by cinefluorography. Surgery was performed after the children had an upper esophagostomy and gastrostomy for a period of four to six years and, in one case, after eleven years. The operation was performed with two teams; transplantation of the right colon to the anterior mediastinum was accomplished in all cases. There was no mortality or morbidity in this group of cases. The technique of surgery utilized, as well as the long-term studies on the nutrition of these children, has been completed and presented in the paper. They all, without exception, are progressing well. A movie demonstrating the cinefluorographic motility of the esophagus and its emptying function will be shown.

## **Monday, Afternoon, April 8, 1963**

**2:00 P.M. Scientific Session: REGULAR PROGRAM**  
**Emerald Room**

#### **8. Surgical Treatment of Tetralogy of Fallot: Experience with Indirect and Direct Technics**

GRADY L. HALLMAN (*by invitation*), and

DENTON A. COOLEY, Houston, Texas

The introduction of technics of direct or definitive repair of tetralogy of Fallot stimulated most surgeons to abandon the indirect or palliative procedures developed by Blalock and Taussig and by Potts. As experience has accumulated, however, the need for selectivity of operative technic has become apparent in order to reduce over-all morbidity and mortality in some patients. Clinical experience for this presentation includes 450 patients of whom 200 had open correction of the anomaly and the remainder underwent systemic-pulmonary arterial anastomosis. Among the 250 patients undergoing anastomosis, 12% died after operation. Sixty of these patients were less than one year of age and eight died after operation (13%). Systemic-pulmonary shunt is now used routinely in severely cyanotic infants. Open repair using temporary cardiopulmonary bypass in 200 patients resulted in 30 deaths (15%). In 65 patients who underwent direct repair following one or two previous operations 11 died (17%). Technical aspects of open repair in our clinical series will be discussed including the use of dextrose solution to prime the extracorporeal circuit, disposable oxygenator, normothermia, transverse ventriculotomy, patch grafts, and the method for closure of previous anastomoses.

## 9. Postsurgical Complete Heart Block: Management and Long-Term Results

C. WALTON LILLEHEI (*and by invitation*) ROBERT D. SELLERS,

and ROBERT S. ELIOT, Minneapolis, Minn.

Management of complete block following open heart surgery has passed through several stages. Early management of this complication was by sympathomimetic amines. This therapy resulted in few survivals. With the introduction of direct myocardial stimulation in 1956, there was a dramatic decrease in initial mortality. Analysis of our experience with 196 patients sustaining complete heart block has revealed important information. The reversion rate was 66%, but no patient reverted to sinus rhythm after four weeks. From 1957-1962, 37 blocked patients were discharged postoperatively in good condition and on Isuprel. Fifty-four per cent of these patients died during the *first year* despite good medical management. Another died three years and one died four years later. Further, most deaths occurred suddenly in asymptomatic patients and with complete repair of the defect at autopsy. Therefore, we believe, no blocked patient should be discharged without an implanted pacemaker. The need for a variable rate or P wave pacemaker will be substantiated by experimental and clinical data. The type of defect in which persistent block occurs, the techniques, and results obtained with pacemaker implantation in children as young as three years old, and in patients with total aortic valve replacement will also be presented.

## 10. The Surgical Significance of Hypertrophic Infundibular Obstruction Accompanying Valvular Pulmonic Stenosis

J. W. GILBERT, A. G. MORROW, and

J. L. TALBERT (*by invitation*), Bethesda, Md.

A systolic pressure gradient within the outflow tract of the right ventricle is frequently observed immediately after the relief of valvular pulmonic stenosis. This residual obstruction is generally recognized as being due to secondary muscular hypertrophy but opinion differs as to whether, under these circumstances, infundibulectomy should be performed. The presence, severity and ultimate fate of secondary muscular obstruction was evaluated in 42 patients before and after pulmonary valvulotomy. In every patient preoperative right ventricular angiocardiograms revealed abnormal systolic constriction of the infundibulum and in 21 patients this was particularly severe. The right ventricular pressure immediately after valvulotomy was 50 mm. Hg or more in 22 patients. Late study, however, indicated satisfactory regression of infundibular hypertrophy in all but five patients. Persistence of intraven-tricular obstruction was not related to age, preoperative severity of stenosis, immediate residual gradient, or the presence of a patent foramen ovale. By angiocardiography, however, the outflow tracts of these patients were characteristically deformed. It is concluded that infundibular resection is not routinely indicated at the time of pulmonary valvulotomy but should be predicated upon the presence of certain angiographic findings which may be identified preoperatively.

## 11. The Surgical Treatment of Acquired Calcine Aortic Stenosis

DONALD G. MULDER, WILLIAM P. LONGMIRE, JR., and

ALBERT A. KATTUS, JR. (*by invitation*), Los Angeles, Calif.

The objective in treating patients with aortic stenosis is to obtain complete and lasting relief from the valvular obstructive process in the safest manner possible. In some instances, debridement of obstructing and immobilizing valvular calcifications (aortic valvuloplasty) can be readily accomplished and the operative objective achieved. In those valves more extensively involved, cusp excision and prosthetic replacement will be necessary. Fifty-seven patients whose predominant lesion was calcine aortic stenosis have undergone operation at the UCLA Medical Center. Cusp debridement was the procedure in 29 cases. Cusp replacement was used in the remaining 28 cases, although debridement was frequently done in addition in this group. Patients were selected for operation on the basis of symptomatology and left heart catheterization data. None were excluded because of age, congestive heart failure, or extensive valvular calcification. The average preoperative pressure differential across the aortic valve was 90 mm. Hg, while postoperatively it was 7 mm. Hg. Operative mortality was 22%, and there were four additional late deaths. The follow-up period has ranged from two months to four years, and 28 patients have been followed for more than two years. The operative technique, including myocardial management, will also be discussed.

## 12. Clinical Experience with Total Mitral Valve Replacement with Prosthetic Valves

F. HENRY ELLIS, JR., DWIGHT C. MCGOON

ROBERT O. BRANDENBURG (*by invitation*), and

JOHN W. KIRKLIN; Rochester, Minn.

Experience with total mitral valve replacement in 42 patients between January and November, 1962, form the basis of this report. This period is selected for analysis because in it perfusion techniques, myocardial management, and criteria for case selection have been relatively uniform. Reconstructive procedures were done on 161 patients operated upon by open techniques prior to this period without uniform long-term restoration of good valve function. Recently, therefore, we have usually limited operation to patients with severe symptoms, and in the majority, total replacement has been performed. Twenty-six replacements have been done with the Starr-Edwards ball valve prosthesis and 16 with a flexible monocusp prosthesis. There were 17 hospital deaths. When patients requiring operation on more than one valve are excluded, hospital mortality rates were 13% with the small monocusp valve and 28% with the ball valve. Although mortality rates from total valve replacement are reported to be high, patients surviving without complications from the prosthesis have an excellent result even when advanced chronic congestive heart failure was present preoperatively. Our surgical experience will be analyzed with the purpose of (1) identifying the types of cases most suitable for reconstructive operations and (2) reducing the complications from mitral valve prostheses.

## 13. Surgical Treatment of Dissecting Aneurysms of the Aorta with Cardiac Tamponade

MICHAEL ROHMAN (*by invitation*), ROBERT H. GOETZ

(*by invitation*), and DAVID STATE New York, N.Y.

Over 50% of dissecting aneurysms of the aorta originate in the ascending portion of this vessel in such proximity to the aortic valve that even minimal retrograde extension may be lethal as a result of 1) rupture into the pericardium, 2) acute insufficiency of the aortic valve or 3) compression of the coronary arteries. Fortunately there frequently are a number of hours or days between onset of symptoms and death. This provides sufficient time for complete diagnostic studies and institution of corrective surgery. We have had experience with three patients during the past year who developed dissecting aneurysms of the ascending aorta. Two of the three patients had developed signs of cardiac tamponade from hemorrhage into the pericardium and all had acute aortic insufficiency. Prograde and retrograde aortography confirmed the diagnosis. All three patients underwent successful excision of the proximal ascending aorta harboring the dissection, reposition of the aortic cusps, and teflon graft replacement using cardiopulmonary bypass and iced saline cardioplegia. Slides will be shown to demonstrate the diagnostic methods and pathology encountered. A short movie will demonstrate the operative technique and document the presence of hemopericardium (350 cc.) in one of the patients, resulting in severe cardiac tamponade.

## Tuesday Morning, April 9, 1963

8:30 A.M. Scientific Session: THORACIC SURGERY FORUM

Emerald Room

## 14. Major Airway Collapsibility in the Pathogenesis of Obstructive Emphysema

W. GERALD RAINER, DAVID HUTCHISON, JAMES NEWBY,

ROGER HAMSTRA, and JOHN R. DURRANCE (*all by invitation*), Denver, Colo.

Sponsored by HENRY SWAN

Contrary to the time-honored concept that the pathology in obstructive emphysema is limited to the bronchiole-alveolar level, the generalized destructive process could be explained more readily if *central* airway obstruction could be demonstrated. *Methods*: Forty subjects (10 normal volunteers and 30 with varying degrees of emphysema) were subjected to cinefluorographic study of the trachea and main bronchi. In twenty of these subjects, additional synchronous determinations of intratracheal and intraesophageal pressure changes, and spirometric and pneumotachygraphic values were recorded for correlation with the cinefluorographic studies. Airway deformation and effects on airflow were studied under conditions of various intrathoracic pressures. Major airway collapse accompanying forced expiration and cough in emphysema is demonstrated. Pressure-flow data show high intrabronchial pressures below the point of tracheal collapse associated with severe reduction of expiratory airflow. On the basis of these studies, it is felt that, although the origin of emphysema is in the smaller branches of the tracheo-bronchial tree, the destructive effects of prolonged intermittent

increases in intrathoracic pressure produce severe changes in the *trachea and major bronchi* that are responsible for the severe airway obstruction and consequent alveolar destruction characteristic of chronic obstructive emphysema.

### **15. Evaluation of the Functional Anatomy of the Thoracic Duct by Lymphangiography**

MARVIN POMERANTZ, JEAN R. L. HERDT, DAVID S. ROCKOFF, and

ALFRED S. KETCHAM (*all by invitation*), Bethesda, Md.

Sponsored by WILL C. SEALY

Utilizing lymphangiography the anatomy and fluid dynamics of the thoracic duct has been studied. The thoracic ducts of 70 patients without thoracic disease and 30 patients with thoracic disease have been evaluated. Twenty-five patients had cinefluorography of their thoracic ducts under varying conditions. Five patients had studies prior to and following cervical thoracic duct ligation incidental to radical neck dissection. Five dogs had cervical ligation of their thoracic ducts and an additional five dogs had intrathoracic division of their thoracic ducts. Serial lymphangiograms were performed on these animals. These findings were correlated with human studies. The numerous variations in the anatomy of the thoracic duct reported from cadaver studies has been substantiated by these functional lymphangiographic studies. Thoracic duct displacement was found in two patients, one with a benign, the other with a malignant mediastinal neoplasm. Cinefluorography revealed a lack of intrinsic peristalsis, ampullary filling with inspiration, and emptying with coughing or the Valsalva maneuver. Following cervical ligation either some degree of thoracic duct lymph stasis was present or lymph returned to the blood vascular system through collateral channels. This study demonstrates visually the numerous functional anatomical variations of the thoracic duct and the dynamics of flow within the duct.

### **16. The Use of Plastic Adhesive in Pulmonary Surgery**

ROBERT J. WILDER, HERMAN PLAYFORTH, MICHAEL BRYANT

(*all by invitation*), and MARK M. RAVITCH, Baltimore, Md.

To determine the value of rapidly polymerizing adhesive in pulmonary surgery, seventy animal experiments have thus far been performed. In the first group of dogs, bronchial closures and bronchial anastomoses were made with Eastman 910 Monomer. In a second group, the pulmonary apex was amputated and the raw surface sealed either with adhesive alone or with adhesive and a free pericardial graft. In a group, the security of the bronchial closure was evaluated using (a) silk sutures, (b) tantalum staples, (c) and Eastman 910 Monomer after standard inoculation of the bronchial stump with staphylococcus aureus. The results demonstrate that with plastic adhesive alone, the dog bronchus can be satisfactorily closed or anastomosed. In addition, the raw transected lung surface is easily sealed either with pericardium and adhesive or with adhesive alone. A comparison of the three methods used for closing the bronchial stump in the face of heavy bacterial contamination has demonstrated no significant difference in fistula and death rates between silk suture, tantalum staples or adhesive closures in 30 experiments.

### **17. Pulmonary Function Studies in Canine Lung Transplantations**

KEITH REEMTSMA, ROBERT E. ROGERS (*by invitation*),

JOHN F. LUCAS, JR. (*by invitation*), FRANK E. SCHMIDT (*by invitation*),

FRANK H. DAVIS, JR. (*by invitation*), and

OSCAR CREECH, JR. New Orleans, La.

The functional status of the transplanted canine lung usually has been assessed by the survival period and x-ray appearance. In the present series of 32 lung transplants serial determinations of oxygen consumption, minute ventilation and pulmonary blood flow were performed on the normal and transplanted canine lung. Left lung homotransplantation was performed with anastomoses of the left pulmonary artery, left bronchus and left atrium. Following insertion of a bronchspirometric tube, simultaneous determinations of oxygen consumption and minute ventilation were obtained for each lung. Using the Fick principle as modified by Fishman, differential pulmonary blood flows were calculated for each lung. In the immediate post-transplantation period, oxygen consumption by the transplanted lung was markedly depressed, although minute ventilation of the transplanted lung approached that of the normal lung. Serial determinations usually showed good ventilatory function of the transplant until shortly before death, persistence of impaired oxygen transfer by the transplanted lung throughout the post-transplantation period, and moderate variation in the blood flow through the transplant. These studies suggest that the oxygen transfer by the transplanted lung is markedly impaired despite reasonably well-maintained ventilation and blood flow.

## **18. Physiological Alterations of Cardiopulmonary Function in Dogs Living One and One-half Years on Only a Reim-planted Right Lung**

SALVATORE L. NIGRO, RICHARD H. EVANS, JOHN R. BENFIELD

(*all by invitation*), and WILLIAM E. ADAMS Chicago, Ill.

Previous reports have shown that dogs can survive after reimplantation of one lung, but usually die when the contralateral lung is removed. Twenty dogs were subjected to complete removal and immediate reimplantation of the right lung. On removal, the lung was perfused with heparin-normal saline solution, chilled to 10° C and then reimplanted. Of the twenty dogs operated upon, fourteen survived. Angiocardiograms were done to demonstrate the patency of the pulmonary vascular pattern. Mean pulmonary artery pressures varied from 11 to 8 mm Hg. By bronchspirometric studies, it was found that the transplanted lung had a reduction in ventilatory function of about 10%, while the oxygen uptake was depressed by some 25%. Pulmonary compliance was decreased about 20%. When an animal thus prepared was subjected to a total left pneumonectomy, fatal pulmonary hypertension was produced with pulmonary artery pressure 55/25 and mean 33. Therefore, staged pulmonary resections combined with bronchial stenosis on the opposite side were substituted for one-stage pneumonectomy. Some of these dogs have survived on the reimplanted lung alone for one and one-half years and are living and healthy. In these dogs, the pulmonary artery pressures are elevated. The results of these completed studies, including histologic studies of the lung, will be presented and their significance discussed.

## **19. Autoimplantation and Homotransplantation of the Lung: Further Studies**

JAMES D. HARDY, (*and by invitation*) MARTIN L. DALTON, JR.,

SADAN ERASLAN, and FIKRI ALICAN, Jackson, Miss.

Successful homotransplantation of the lung would of course provide a therapeutic weapon of great value in the management of a wide variety of lung diseases which produce respiratory insufficiency. The present series of studies was designed to explore technical, physiologic and immunologic factors in lung transplantation. Initially lung *autoimplantation*, immediate or delayed, was performed in a series of over 100 dogs to evaluate effects upon respiratory reflexes, the reimplanted lung and the animal generally. The effects of late contralateral pulmonary artery ligation, contralateral pneumonectomy, contralateral pneumonectomy and reimplantation and contralateral multiple lobectomies were recorded. Respiratory reflexes originating in at least a portion of the contralateral lung must be preserved. Denervation of a lung often diminished respiratory efficiency. To prolong lung *homograft* takes (130 dogs) the following drugs or maneuvers have been evaluated: BW 57-322 (Imuran), BW 57-322 plus Actinomycin C, methotrexate, 6-mercaptopurine, and drugs plus mother-to-grown offspring homotransplants as well as offspring-to-mother homotransplants. The BW 57-322 proved to be the most effective of the drugs in prolonging homograft survival in dogs.

## **20. Prolonged Survival of Orthotopic Homotransplants of the Heart in Animals Treated with Methotrexate**

DAVID A. BLUMENSTOCK (*by invitation*), Cooperstown, N.Y.,

HERBERT B. HECHTMAN (*by invitation*), New York, N.Y.,

ALFRED JARETZKI, III, JAMES D. HOSBEIN (*by invitation*) Cooperstown, N.Y.,

WALTER ZINGC (*by invitation*), Winnipeg, Manitoba, Canada,

and JOHN H. POWERS (*by invitation*), Cooperstown, N.Y.

The survival of homografts of skin, spleen, and lung has been prolonged by treating the recipient animal with methotrexate. The effect of this drug upon orthotopic homotransplants of the heart has been studied. The hearts of 36 dogs were excised and replaced with homografts from unrelated donors. The recipient animal was given methotrexate, 0.2 mg./kg. on the day following operation and 0.1 mg./kg. on alternate days thereafter. Thirty-one animals died during the first 24 hours after transplantation. Five animals survived and were sustained 2, 10, 17, 26, and 42 days solely by the transplanted heart. The usual survival of a heart placed in an untreated animal is four to six days. These results indicate significant suppression of rejection of the transplanted heart by methotrexate. Histologic and electrocardiographic studies of these animals will be presented.

## **21. Combined Gas and Heat Exchange in Extracorporeal Circulation**

NICHOLAS P.D. SMYTH (*by invitation*), and BRIAN BLADES,

Washington, D.C.

In extracorporeal circulation there would seem to be obvious advantages in combining the functions of gas and heat exchange in one unit, since each requires the dispersion of blood over a large surface area. Priming volume of the system

would be reduced, and also the length of tubing and the number of connections used. We selected the vertical screen oxygenator for modification, firstly because of its known efficiency, and secondly because its absence of moving parts made the task theoretically easier. In the proposed modification the wire screens of the oxygenator would be replaced by thin metal plates, through the center of which the heat exchange fluid would circulate, and on the surface of which the blood would be filmed for gas and heat exchange. Using a single 30 x 45 cm. test plate, heat exchange was studied by circulating heparinized dogs' blood across the plate in a closed system. Inlet and outlet temperatures for blood and heat exchange fluid were measured serially at various flow rates. Gas exchange was studied using partial bypass in an anesthetized dog. Arterio-venous oxygen difference across the plate was measured at various flow rates. Data showing satisfactory gas and heat exchange will be presented.

## **22. Capillary Membrane Oxygenator**

BRUCE R. BODELL, JAMES M. HEAD, LOUIS R. HEAD,  
ANTHONY J. FORMOLO (*all by invitation*), and JEROME R. HEAD

Chicago, Ill.

In the past few years it has been recognized that an ideal oxygenator for use in extracorporeal circulation systems is one in which a membrane (permeable to CO<sub>2</sub> and O<sub>2</sub>) separates blood from gas. This paper reports initial experiments in extracorporeal circulation using a fixed blood volume, closed system, membrane oxygenator of new design and concept employing silastic capillary tubing (0.012" X 0.025") as a gas transport to the blood pool. The oxygenator is an assembly of disposable units which can be mass produced and distributed in presterilized packages. Cardiac bypass perfusions were carried out on ten 85 lb. sheep at flow rates of 2-3L/min. All but one animal survived the perfusions. Blood pH, pCO<sub>2</sub>, and pO<sub>2</sub> determinations were made at intervals over 45 minutes of bypass. Oxygen saturations of 99% were maintained in all animals. A problem of CO<sub>2</sub> retention was encountered. By altering design to increase gas flow in the capillary tubing, it was possible to reduce the pCO<sub>2</sub> at 45 min. from 120 mm Hg to 70 mm Hg. Further alterations of design are in progress to enhance CO<sub>2</sub> elimination and reduce priming volume from 2000 cc. to 1000 cc.

## **23. The Feasibility of Hypothermic Perfusion Under Hyperbaric Conditions in the Surgical Management of Infants with Cyanotic Congenital Heart Disease**

W. F. BERNHARD, E. S. TANK (*by invitation*), and ROBERT E. GROSS

Boston, Mass.

Experience in our laboratory indicates that administration of oxygen at an environmental pressure of 35-39 p.s.i. greatly increases the arterial O<sub>2</sub> saturation of cyanotic infants. Although the clinical improvement is temporary in nature, the possibility of performing palliative or corrective surgery during pressure therapy seemed worthy of investigation. Studies were performed in a large compression chamber which accommodated a team of five investigators. Utilizing a miniature pump-oxygenator, hypothermic perfusions were carried out in 40 dogs (3.0-8.0 Kg.) at a pressure of 35 p.s.i. Certain biochemical parameters were monitored during perfusion, which ranged in length from 60-180 minutes; pO<sub>2</sub>, pCO<sub>2</sub>, pH, CO<sub>2</sub> combining power, plasma lactate, pyruvate and free hemoglobin. Arterial pressure, venous pressure, and EKG tracings were also recorded. Oxygen consumption (under pressure) was calculated at 37°C. and at reduced temperatures (37°-15° C). These experiments indicated that the oxygen in physical solution (6.0-8.0 vols.%), along with reduced metabolic requirements, permitted either prolonged, low-flow, perfusions (5-15 cc/Kg./min.) or extended intervals of total circulatory arrest without evidence of hypoxia or acidosis. Cardiac surgery for infants, performed in a compression chamber, with low-flow perfusion at reduced temperature, appear to be feasible.

## **24. Fat Embolization with Cardiomyotomy Using Cardiopulmonary Bypass**

FEODOR CAGUIN (*by invitation*), and M. G. CARTER, New Haven, Conn.

The occurrence of symptoms indicating central nervous system damage following cardiac surgery with extracorporeal circulation led us to study a group of 92 patients undergoing 93 heart operations during the period April 1958 to January 1962. Five of the first 48 patients exhibited varying degrees of delirium, hallucinations, amnesia and tremors without localizing neurological signs. All patients recovered. Air, calcium and antifoam embolism and electrolyte changes were all deemed most unlikely causes. Fat embolism from blood aspirated via the cardiac sucker seemed a possible explanation. A second group of 45 patients were studied with 24 hour urine samples examined for fat globules before and after cardiomyotomy. Ten of these developed lipuria and all 10 had some or all of the neurological findings previously observed. Mental changes were not seen in 35 patients without lipuria. Fifteen random non-cardiac thoracotomy patients were similarly studied with negative findings. These data suggested that fat embolization probably was responsible for the reversible neurologic damage. Since this study, great care has been taken to discard all blood spilling from the interior of the heart into either the pericardium or thorax and no further cases with mental changes or lipuria have been observed.

## **25. Hemorrhage due to Fibrinolysis Occurring with Open Heart Operations**



DAVID A. TICE, GEORGE E. REED, ROY H. CLAUSS, and

MELVIN H. WORTH (*all by invitation*), New York, N.Y.

Sponsored by WALTER W. FISCHER

Hemorrhage due to fibrinolysis occurred in nine of the last fifty-five patients undergoing open heart surgery with cardiopulmonary bypass. Fibrinolytic activity was determined by a rapid method (reconstituted whole blood clot lysis) previously described. Fibrinolysis was significantly reduced and hemorrhage controlled in all patients by treatment with Epsilon Amino Caproic Acid or Trasylol. Death occurred in four of the nine patients; three due to heart failure with low cardiac output and one due to cerebral complications (air embolism). Lysis was associated with eight hypothermic and one normothermic perfusions. Three patients had less than 70 minutes and three had more than 130 minutes of perfusion. Metabolic acidosis was graded one to four plus using a nomogram previously described. No definite association of degree of acidosis with fibrinolytic activity was observed. All hypothermic patients received low molecular weight dextran (Rheomacrodex), constituting 15% of the priming volume of the pump oxygenator. Preliminary findings in ten recent patients suggest that fibrinolytic activity is associated with a rise in circulating lysosomal enzymes, acid phosphatase and beta glucuronidase.

**26. Acidosis as a Cause of Renal Shutdown During Extra-corporeal Circulation: Its Correction by the Use of Tham**

JOHN E. CONNOLLY (*and by invitation*) SAMUEL L. KOUNTZ, and

JAMES M. GUERNSEY, Palo Alto, Calif.

Renal shutdown persists as a serious complication that may accompany cardiopulmonary bypass, particularly if prolonged. In an attempt to clarify the etiology of such renal failure, we have measured renal blood flow under varying conditions. In eight experiments, dogs were connected to an oxygenator primed with fresh blood. The animal's right renal artery was encircled with an electromagnetic flowmeter providing continuous recording of renal blood flow. Frequent blood pH and pCO<sub>2</sub> determinations were made. The effects of low flow and high flow, total and partial cardiopulmonary bypass on renal blood flow were determined. Surprisingly renal blood flow paralleled blood pH, falling rapidly with development of acidosis. As others have shown, low bypass flow rates resulted in metabolic acidosis. However, acidosis with markedly depressed renal blood flow was seen with high flow rates when acidosis was induced by adding excess CO<sub>2</sub> to the oxygenator or lactic acid to the animal. THAM given during bypass rapidly corrected the acidosis returning renal flow to normal. These experiments indicate that acidosis is a cause of reduced renal blood flow and renal failure under certain conditions of cardiopulmonary bypass. Renal blood flow will remain in normal ranges if normal blood pH is maintained during bypass.

**Tuesday Afternoon, April 9, 1963**

**2:00 P.M. Executive Session (Limited to Active and Senior Members)**

**Emerald Room**

**3:00 P.M. Scientific Session: REGULAR PROGRAM**

**Emerald Room**

*Address by the President*

**Julian Johnson, Philadelphia**

**"A Surgeon and Something More"**

*Address by Honored Guest*

**Andrew Logan, F.R.C.S.**

**Reader in Thoracic Surgery, University of Edinburgh**

**Surgeon to the Royal Infirmary**

**Edinburgh, Scotland**

**"The Surgical Treatment of Carcinoma**

**of the Esophagus and Cardia"**

**27. Surgical Experience in the Management of Atypical Myco-bacterial Infections**

SAM W. LAW, DANIEL E. JENKINS, IRVING CHOFNAS, DAVID BAHAR,

FRANCES WHITCOMB (*all by invitation*), H. T. BARKLEY, and

MICHAEL E. DE BAKEY) Houston, Texas

Increasing recognition of pulmonary disease due to atypical Mycobacteria has emphasized the need for precise information about the results of treatment of these patients. The frequent drug resistance in these organisms and slow clinical response to chemotherapy in this disease has caused concern about the effects of surgical intervention. During the past ten years, 68 operations have been performed on 64 patients with pulmonary disease caused by atypical Mycobacteria. There were 56 patients with Group I infections, 2 with Group II, 5 with Group III, and one with Group IV infection. The sputum was positive pre-operatively in 47 of the 68 operations. There was no operative mortality. This experience will be evaluated in relation to the species of atypical organism, sputum positivity, surgical specimen positivity, type and duration of chemotherapy, type of operative procedure, and ultimate result. The low complication rate compares favorably with the results of surgery in typical tuberculosis, and with other reports of surgery in atypical infections. In our experience, early surgery can be recommended, and resections of less than a lobe are safe and efficacious.

#### **28. Massive Plombage Thoracoplasty Versus Pneumonectomy in the Treatment of Pulmonary Tuberculosis**

THOMAS F. BOYD (*by invitation*), and JOHN W. STRIEDER, Boston, Mass.

In the surgical treatment of pulmonary tuberculosis, the mortality rate for pneumonectomy is distressingly high, whereas that for plombage thoracoplasty is very low. If sputum conversion and a good clinical status resulted from massive plombage thoracoplasty in those cases which would ordinarily require pneumonectomy, this procedure might supplant pneumonectomy as the surgical operation to be performed for the lung destroyed by tuberculosis. In this study, 28 patients were subjected to massive plombage thoracoplasty (stripping of either 8, 9 or 10 ribs) rather than to pneumonectomy with no operative deaths. At the time of surgery, the oldest patient was 64 years and the youngest 18 years (mean of 41 years). Twenty-four of the 28 had positive sputum at the time of surgery. All of the patients were followed from 6 to 146 months (mean of 74 months in successful cases) after surgery. In 20 of the 28 patients so treated, sputum conversion and good clinical status were achieved by means of this procedure. Massive plombage thoracoplasty should always be considered before pneumonectomy is selected as the treatment of pulmonary tuberculosis.

### **Tuesday Evening, April 9, 1963**

**7:00 P.M. Banquet and Dancing**

**Emerald Room**

**Attendance limited to Members of the Association and their ladies, Invited Speakers and their ladies**

**Dinner dress preferred**

### **Wednesday Morning, April 10, 1963**

**8:30 A.M. Scientific Session: REGULAR PROGRAM**

**Emerald Room**

#### **29. Surgical Treatment of Pulmonary Embolism**

DENNIS M. L. ROSENBERG, (*and by invitation*)

CHARLES PEARCE, and JOHN MCNULTY, New Orleans, La.

During the past fifty years or so, there has been no remarkable change in the treatment of thromboembolism. Pulmonary embolism continues to be a complex disease and a threat to life. One hundred records of autopsied cases occurring at Charity Hospital and Touro Infirmary in New Orleans have been studied. Of significance in this group were 29 patients who survived for two hours after the onset of severe symptoms and 12 patients who lived more than 12 hours. For certain patients in this group who specifically develop sustained hypotension and progressive deterioration the authors propose a more direct approach, suggesting pulmonary embolectomy with the aid of extracorporeal circulation. Experience with two such cases is outlined. Details of pre-operative study and diagnosis are presented, together with the technique of surgery and suggestions for the use of rapidly available, portable and disposable pump-oxygenator units. This approach has been used successfully twice and suggests strongly that early diagnosis and treatment by embolectomy may reduce the still appalling figure of approximately 3,000 deaths each year in the United States from pulmonary embolism. Emphasis is made on cognizance of the disease, aids to earlier recognition, and energetic medical or surgical treatment.

### 30. Tricuspid Atresia: A Step Towards Corrective Treatment

SIR RUSSELL BROCK, London, England

Tricuspid atresia is the Cinderella of the surgery of congenital heart disease. This is because it is one element in a whole range of abnormalities, some so complex as to be untreatable. Operation has consisted of a shunt procedure, an excellent palliative in very ill children; the immediate results have been reasonably good, but the late results are less so. In one group the essential lesion is atresia of the inflow tract of the right ventricle but with adequate development of the outflow tract and of the pulmonary artery. In these an associated valvar or infundibular stenosis can be relieved with great improvement. A more important lesion, however, is stenosis (or small-ness) of the ventricular septal defect through which all blood to the lungs must pass. A logical treatment is deliberate enlargement of the defect by an open operation. An example of such an operation is reported. In this case the condition of the right ventricle prevented a total cure which would have involved closure of the atrial and ventricular communications and insertion of a valve between the right atrium and right ventricle. This could be a feasible procedure for which surgeons should be alert.

### 31. Hypertrophic Subaortic Stenosis: Evolution of a Surgical Technique

A.R.C. DOBELL, and H. J. SCOTT (*both by invitation*),

Montreal, Canada

Sponsored by LLOYD D. MACLEAN

We have operated upon four patients with severe hypertrophic subaortic stenosis. With each experience our surgical technique was modified and our understanding of this perplexing disease broadened. In the first operation we learned the importance of maintaining the cardiac beat in order to understand the dynamic outflow tract constriction. At the second we learned that simple incision of the involved muscle would not relieve the obstruction. For this reason muscle was resected in the third operation with a cutting current applied to a wire loop passed into the left ventricle from the aorta. Only in the fourth operation were ideal conditions achieved. Here the exposure was by way of the left atrium with bisection of the aortic leaflet of the mitral valve. Excellent exposure of the entire ventricular septum was provided and four grams of muscle was resected from the outflow tract with a wire loop. The pressure gradient was abolished. The patient was recatheterized four months later. Our understanding of hypertrophic subaortic stenosis is by no means complete. Nevertheless the advantages of the transatrial approach justify its description in detail.

### 32. Stenosis of the Branches of the Pulmonary Artery

MILTON WEINBERG, JR , MAGNUS H. AGUSTSSON (*by invitation*),

IVAN D'CRUZ (*by invitation*), JUAN P. BICOFF (*by invitation*),

MAJID BEHRAVESH (*by invitation*), JOHN RAFFENSPERGER (*by invitation*),

and EGBERT H. FELL, Chicago, Ill.

Stenoses of single or multiple branches of the pulmonary artery are frequently unrecognized and have received little attention in regard to the surgical treatment of congenital heart disease. These are, however, relatively common anomalies which may be of critical importance in patients undergoing heart surgery. Cardiac catheterization studies and angiocardiograms have demonstrated stenoses of one or more branches of the pulmonary artery in 88 patients. In 27 of these, the lesions were not accompanied by other defects. In 61 patients, the stenoses were associated with a wide variety of cardiac anomalies, the most common being ventricular septal defect (20), pulmonary valvular stenosis (16), patent ductus arteriosus (7), and tetralogy of Fallot (5). In the majority of this group of patients undergoing operation, usually for the associated anomalies, the pulmonary artery branch stenoses were either mild or limited to the branches of one lung. In eight patients, however, three of whom died, the high degree of obstruction to pulmonary blood flow resulted in persistence of severe right ventricular hypertension after correction of the associated defects. Cardiac catheterization data and angiocardiograms demonstrating the stenoses are presented, and the anatomic variations are discussed in relation to surgical significance.

### 33. Clinical Experience with Local Hypothermia in Elective Cardiac Arrest

EDWARD J. HURLEY, RICHARD R. LOWER, EUGENE DONG, JR.,

R. CREE PILLSBURY (*all by invitation*), and NORMAN

E. SHUMWAY, Palo Alto, Calif.

Prolongation of the safe period of myocardial anoxia is easily and innocuously achieved by the introduction of isotonic saline at 0-4° C. into the pericardial cradle about the heart. Experimentally, simple immersion of the heart within such a solution permits resuscitation after 7 hours of myocardial anoxia. Among the initial 210 patients operated upon consecutively at the Stanford Medical Center for congenital or acquired heart disease during cardiopulmonary bypass, 98

underwent elective anoxic cardiac arrest to facilitate repair. Lesions encountered in this group of patients included 26 ventricular septal defects, 23 Fallot's anomaly, 48 aortic valvular lesions, and one sinus of Valsalva fistula. The age range was 19 months to 65 years. Utilizing a disc oxygenator without heat exchanger, periods up to 58 minutes of anoxic cardiac arrest were tolerated with the myocardium protected by topical hypothermia. An effective heart beat was established in every instance. There were three deaths in the 98 patients, none of which was related to the method of elective cardiac arrest. The purpose of this paper is to describe the technique of myocardial protection by topical hypothermia and the results obtained.

### **34. Comparative Merits and Results of Blood Primes and 5% Dextrose in Water Primes of Heart-Lung**

#### **Machines: Analysis of 250 Patients**

NAZIH ZUHDI, JOHN CAREY, WILLIAM SHELDON (*all by invitation*),

and ALLEN GREEK, Oklahoma City, Okla.

Two series of consecutive patients had open heart surgery using moderate internal hypothermia (28-30 °C as measured in the mid esophagus) and low flow rates (20 ml per kilogram of body weight per minute). In 43 patients, the double helical reservoir bubble oxygenator was primed with blood. In 207 patients, it was definitively primed with 5% dextrose in water (using the formula: weight in kilograms x 16 ml.) producing true hemodilution. The latter series is subdivided into two groups. In the first group, banked citrated blood was used to replace the measured loss from the surgical field as it occurred. In the second group, banked citrated blood was used only if blood loss from the surgical field was excessive and then preferably administered after the termination of the cardiopulmonary bypass; establishing the fact that total cardiopulmonary bypass, per se, is safely conducted without any blood. The basic principles involved will be discussed, the relative merits outlined, and the results tabulated.

### **35. Renal Complications of Open Heart Surgery: Predisposing Factors, Prevention and Management**

THOMAS J. YEH, EDWIN L. BRACKNEY, DAVID P. HALL (*all by invitation*),

and ROBERT G. ELLISON Augusta, Ga.

One hundred and fifty-three consecutive cases of open heart surgery were analyzed for renal complications. While over 80% had abnormal microscopic urinary findings postoperatively, only 16 developed serious renal complications; 6 of these were classified as having renal tubular acidosis (high output renal failure) and 10 as acute renal failure. Statistical analysis indicates that hemolysis in excess of 200 mgm %, perfusion over one hours duration, flow rate less than 1.8 L/M<sup>2</sup>/min with or without hypothermia, and use of Magnesium-Egglugate preserved blood for priming, singly or in combination predisposed to renal damage. There were no cases of serious renal complication among 51 patients in whom flow rates were greater than 2.2 L/M<sup>2</sup>/min regardless of other factors, suggesting that renal damage may be completely preventable with use of high flow rates. Prophylactic Mannitol has been used in 30 consecutive cases with eminently good results. All 16 cases of serious renal complications were managed conservatively with or without ion exchange resin. Artificial renal dialysis was required in only one case of renal failure with survival. There was only one renal death in this series.

### **36. Endarterectomy in the Treatment of Coronary Artery Disease**

DONALD B. EFFLER, LAURENCE K. GROVES, (*and by invitation*)

F. MASON SONES, JR., and EARL SHIREY, Cleveland, Ohio

Endarterectomy has been advocated for definitive treatment of arterial disease. At present, we believe that this direct approach has limited application and should be reserved for those patients who demonstrate localized obstruction of the main arteries. Selection of the candidate for coronary endarterectomy requires precise evaluation of the coronary vessels and their disease patterns. This evaluation is accomplished by Sone's method of selective coronary arteriography. The arteries are opacined by direct injection of contrast medium; selective filling of each vessel is recorded by cine-photography. Our experience is limited to operations upon four patients who presented segmental occlusion of a main coronary artery. The area of occlusion represented at least 75% reduction in normal vessel caliber and each patient was incapacitated by angina pectoris. The operations utilized total body perfusion and cardioplegia induced by regional hypothermia. Endarterectomy was performed under direct vision and the vessel reconstructed with vein patch graft. Coronary endarterectomy is a major surgical undertaking and limits of its application are emphasized. One patient failed to survive operation; postmortem dissection demonstrated distal dissection of the intima. Follow-up study in three survivors by postoperative arteriograms is presented.

## Wednesday Afternoon, April 10, 1963

2:00 P.M. Scientific Session: THORACIC SURGERY FORUM  
Emerald Room

### 37. Evaluation of Two Prostheses for Total Replacement of the Mitral Valve

F. S. CROSS, (*and by invitation*) A. N. GEREIN, and

R. D. JONES, Cleveland, Ohio

Although significant advances have been made in the clinical use of total valve prostheses, continued research is necessary to improve designs, materials, and techniques of insertion. Two types of mitral replacements have been developed and tested. The first is a modified Starr valve, constructed entirely of silicone rubber, incorporating what are felt to be important changes in the design of the attachment ring. The second, likewise constructed of silicone rubber, eliminates the necessity of a cage, and substitutes a lens-shaped body for the ball. This latter valve is more compact and it can be constructed with a larger orifice to afford better hemodynamic relationships. Both valves have been studied in a fatigue testing apparatus. They have been inserted in 65 dogs with the longest survival being eight months to date. In vivo studies include problems of insertion, patterns of fibrin formation, pressure relationships across the valves, and cineangiocardiograms. As a result of these studies clinical use of the ball valve is anticipated prior to the meeting.

### 38. Sutureless Mitral and Aortic Valve Prostheses

GEORGE J. MAGOVERN, and HARRY W. CROMIE

(*by invitation*), Pittsburgh, Pa.

In order to simplify both the methods of insertion and fixation of prosthetic mitral and aortic valves and thereby lessen both the time of cardio-pulmonary bypass and the hazard of postoperative thrombus formation, two valves have been designed and clinically employed in the aortic and mitral positions which utilize a rapid mechanical nonsuture fixation which has not previously been described. These valves employ a cage-ball mechanism, but housed within their base are multiple curved pins which following insertion of the valve in the desired position, are simultaneously ejected through orifices in the lateral rim of the base of the valve, and engage the adjacent tissue for fixation, thus eliminating the prolonged period of time necessary for suturing the prosthesis in position. The valves have been used in the aortic position on three patients, and in the mitral position on one patient, with follow-up of four to nine months. In all patients the fixation has been satisfactory. The design and mechanism and the continued progress of the clinical application will be described. Coronary perfusion and/or hypothermia have not been necessary in the aortic replacement.

### 39. An Inverted Tricuspid Plastic Mitral Valve

RICHARD W. ERNST, and HARRY D. STOKES

(*both by invitation*), Dallas, Texas

Sponsored by DONALD L. PAULSON

Adherence to flow principles with regard to turbulence and resistance led to the development of a tricuspid valve which functions conversely to presently available valves. Suspended on three pillars the leaflets move toward the center of the valve to open, and close by approximation to the valve's annulus. The dome of the valve is located in the center of the left atrium. No space is taken up in the left ventricle. The valve is molded in one piece including leaflets and annulus thus giving added strength. Tissue in growth is permitted by cementing porous material circumferentially to the annulus. In the pulse duplicator no gradient was obtained with a flow of eight liters per minute. In the dog a pressure of 8/2 mm Hg was obtained in the left atrium with a similar valve. This valve has the following advantages: (1) absence of turbulence; (2) absence of "dead" space, thus avoiding formation of thrombi; (3) no component of the valve occupies the left ventricular lumen and thus the ventricular myocardium cannot be damaged and the diastolic filling can be maximal; (4) the valve is molded in one piece, giving it added strength.

### 40. The Implantable Synchronous Pacer in the Treatment of Complete Heart Block

SOL CENTER, DAVID NATHAN, CHANG-YU WU, and

PHILIP SAMET (*all by invitation*), Miami, Fla.

Sponsored by THOMAS H. BURFORD

An implantable synchronous pacer has been modeled to synchronize the activity of the atria and ventricles. Previous work in animals has proven the feasibility of long term pacing in the treatment of complete heart block.

Synchronous pacers have been implanted in patients with Stokes-Adams disease. Physiologic studies were obtained before and after implantation to determine cardiac function under varying degrees of activity. In its simplest form, the atrial potential is picked up from the left atrium, relayed to the pacer, delayed and amplified, and then conducted to the electrode implanted on the left ventricle resulting in a ventricular contraction. With this pacer, naturally induced speeding or slowing of the atria will cause the ventricles to follow as the heart responds to body demands. The battery life of the unit is four or five years. Safeguards have been built into the unit to prevent ventricular rates above 115 and below 60. In the event of return to normal sinus rhythm the pacer follows but does not interfere with normal rhythm.

#### **41. The Denbrillator and Cardiac Burns**

LAURENCE M. RIVKIN, San Francisco, Calif.

The deleterious effects of electrical cardiac defibrillation are primarily the result of burns. These burns are caused by heat developed as the resistance of the heart transforms electrical energy into heat. The heat produced by shocks from a defibrillator was measured after implanting micro-miniature thermocouples in the myocardium. Shocks were administered from an AC and a condenser discharge ("DC") defibrillator. The effect of increasing voltage and varying the duration (AC) or wave form (DC) was studied. In addition, hearts of varying mass were utilized. Approximately 800 determinations were made. In 20 dogs, shocks were applied to the exposed heart. The animals were sacrificed hours to days later and the myocardium examined for burns. This study suggests criteria for predicting the safety of a technic of internal cardiac defibrillation. This is particularly important in the use of the "DC" de-fibrillator where heat and burns are produced despite the small amount of power applied.

#### **42. Hemodilution Studies in Extracorporeal Circulation Employing a Rotating-Disc Oxygenator**

DONALD R. KAHN, HUGO F. HIDALGO, GEORGINE M. STEUDE

(*all by invitation*), and HERBERT SLOAN, Ann Arbor, Mich.

In order to evaluate hemodilution using a rotating-disc oxygenator with a 2000 ml. priming volume, the following concentrations were used: 1) all blood, 2) 25% Dextran-75% blood, 3) 50% Dextran-50% blood, 4) 75% Dextran-25% blood, 5) 100% Dextran, 6) 50% 5%G/water-50% blood, 7) 75% 5%G/water-25% blood, 8) 100% 5%G/water. Total cardiopulmonary bypass was instituted in dogs for one hour at 32 °C. hypothermia with flow rates between 50-85 cc/kg/minute, depending upon the amount of venous return. No extra blood was given during or after perfusion. Volume in extracorporeal circuit was unchanged. Studies were obtained before and one hour after perfusion. Selected dogs were studied at one week. During perfusion all dogs did well. Venous return was best, and, therefore, higher flow rates were maintained in the hemodilution experiments. 100% hemodilution dogs died in 24 hours. The remaining dogs stayed well after perfusion. Platelet decrease, plasma hemoglobin, PH, pCO<sub>2</sub>, and pO<sub>2</sub> were the same for all groups. Total blood volume was greater after perfusion in the hemodilution group than in the all blood group, but the red cell volume was proportionally lower depending upon the degree of hemodilution. With hemodilution the usual unaccountable blood loss after perfusion was not present.

#### **43. The Perfusion Hematocrit**

HOWARD L. GADBOYS (*by invitation*), and ROBERT S. LITWAK,

New York, N.Y.

It has been demonstrated that hypovolemia involving both erythrocytes and plasma is seen frequently following extracorporeal circulation. The purpose of this communication is present data suggesting that immediate and late blood volume alterations are not clearly reflected in the postperfusion hemaocrits. Fifty-eight patients had pre- and postperfusion blood volume studies with Cr<sup>51</sup> and RISA. Simultaneous hematocrits were done. The pump-oxygenator was primed with whole blood in 26 cases and 30% hemodilution was employed in 32. Ninety-nine determinations 4 and 18 hours *postperfusion* showed RCV fall averaging 22% from control whereas the hematocrit fell only 5%. Six observations on the second and third post-perfusion days revealed RCV and Hct drops of 32% and 22% from control respectively. Eight determinations on the fourth to thirteenth days demonstrated RCV to be only 9% less than control despite a 31% decline in Hct. Thirty-two patients perfused with *hemodilution* had 4 hour postperfusion RCV fall of 24% from control but simultaneous Hct fall of only 4%. The 26 *non-diluted* patients averaged 17% RCV decline while the hematocrit fell 3%. It is felt that these discrepancies relate to sequestrative changes of the homologous blood syndrome and that treatment of "postperfusion anemia" with blood may be unwarranted.

#### **44. Coronary Artery Flow Patterns in the Intact Dog**

SANFORD A. HEPPS (*by invitation*), BENSON B. ROE, and

BURT RUTKIN (*by invitation*), San Francisco, Calif.

A reliable, accurate electromagnetic flowmeter probe small enough to be implanted surgically on the anterior descending coronary artery has been developed to evaluate coronary artery flow patterns in the conscious, intact animal

under various conditions of exercise, drug infusion and aortic valve incompetence. Undamped coronary artery pulse curves have been obtained with simultaneous ascending aortic flow curves and electrocardiograms. A satisfactory technique has been developed for obtaining frequent zero flow baseline and for obliterating EKG interference. Mean and cyclical coronary flow changes have been measured during treadmill exercise and after infusion with a variety of pressor agents and vasodilators. Alterations in the coronary flow curve in relation to ventricular systole are demonstrated in the presence of aortic valve incompetence. Studies to date include reliable data on eight animal preparations with consistent results showing significant differences in coronary flow with several drugs commonly used to augment the coronary circulation. Further studies are in progress and will be described.

#### **45. Peripheral Vascular Responses During Hypothermia**

WILL C. SEALY, ALAN LESAGE (*by invitation*),

and W. GLENN YOUNG, JR Durham, N.C.

Alterations of the reaction of the peripheral vascular tree by hypothermia may significantly influence the development of temperature gradients and post-hypothermic metabolic acidosis. In 30 dogs cooled to as low as 7°C by a pump oxygenator, the following experiments were done: (1) Sympathetic stimulation by carotid occlusion and central vagal stimulation, (2) Peripheral vagal stimulation, (3) Injection of nor-epinephrine, (4) Injection of quinidine, (5) Studies of dilution curves. Sympathetic stimulation failed to increase the blood pressure at 18°C, though, as an indication of impulse transmission, cardiac effects of peripheral vagal stimulation continued until 10°C was reached. Norepinephrine caused an increase (110% to 180%) in blood pressure at 7°C. Quinidine not only reduced (50%) the blood pressure at 7°C, but blocked the action of nor-epinephrine. Mixing curves obtained at 7°C indicated paralysis of the peripheral vascular bed. During varying levels of hypothermia, the difference in the response of the peripheral vascular tree to stimulation and to nor-epinephrine suggests that this may be important in the development of areas of rapid and slow perfusion during induction and reversion of hypothermia. The possibility will be discussed of using these facts for instituting a more uniform perfusion during hypothermia.

#### **46. The Importance of the Azygous Vein in Superior Cava Pulmonary Artery Anastomosis**

W. STERLING EDWARDS, and L. M. BARGERON, JR.  
(*by invitation*), Birmingham, Ala.

In a series of 18 patients with tricuspid atresia treated with a superior cava right pulmonary artery shunt, there were three deaths in the first ten patients from cerebral edema. In all ten patients the azygous vein was ligated and the anastomosis made at its junction with the vena cava. In the next six patients the azygous was left open. The immediate postoperative course, especially in infants was significantly smoother, with no evidence of the "Superior Vena Caval Syndrome". One patient did not get the usual improvement in cyanosis, however, until the azygous was ligated at a second operation. This experience led to the development of a simple technique of encircling the azygous with a loose ligature which is brought out to a small subcutaneous button for azygous ligation 2-3 days postoperatively. This allows decompression of the superior cava through the azygous immediately after operation but permits azygous ligation a few days later to obtain full superior caval flow through the right lung.

#### **47. Inflow Occlusion for Coronary Arteriography: Experimental Comparison with Other Methods**

J. Y. TEMPLETON III, R. R. GREENING (*by invitation*),

C. FINEBERG, (*and by invitation*) T. G. PETERS,

J. R. GRIFFITH, C. L. REESE, and D. L. CLARK, Philadelphia, Pa.

Injection of radio-opaque material into the base of the aorta produces satisfactory opacification of the coronary arteries when cardiac output is temporarily diminished by acetyl choline cardiac arrest (Bjork) or by increasing endothoracic pressure (Nordenstrom). A third method, that of inflow occlusion by inflating the balloon of a specially devised catheter in the right atrium has been developed by us. In these experiments the three methods were used in varying sequence in each animal and the results compared. Arterial and venous pressures, electrocardiograms and electroencephalograms were recorded. Appropriate roentgenograms were made using the Franklin rapid film changer and cine radiographs were obtained using the Marconi Image Amplifier. Satisfactory visualization of the coronary arteries was obtained by all three methods. Inflow occlusion produced less disturbance of cardiac function, may be done under local anesthesia, may be readily repeated and is controllable so that cardiac output can be altered to the degree desired. Successful application of the method for coronary arteriography in patients with angina has begun and will be included in the report.

#### **48. Autogenous Vein Aorto-Coronary Bypass: An Experimental Study**

LESTER R. SAUVAGE, STEPHEN J. WOOD, and KENNETH M. EVER

(*all by invitation*), Seattle, Wash.

We have thus far done 26 coronary bypass experiments in the dog. An autogenous external jugular vein graft is run from the upper thoracic aorta to the circumflex or the anterior descending coronary artery. The procedures are done using moderate hypothermia without extra-corporeal circulation. The technical difficulties have been appreciable, but less than anticipated. Six animals are living at this time, from 6 to 77 days since operation. In all of these survivors the graft has been anastomosed to the side of the distal circumflex coronary artery. In 5 of the 6 the circumflex coronary was ligated proximal to the anastomosis. In one the left main coronary was ligated. Four of these survivors had postoperative coronary arteriography at a mean period of 43 days after operation. All grafts were patent. None showed dilatation. Excellent filling of the coronary bed was apparent. Despite difficult problems, it is our belief that bypass surgery of the coronary arteries is a feasible undertaking with considerable clinical potential. Further experimental work should resolve many of the remaining difficulties. The technic of the procedure, postoperative coronary cineangiograms, autopsy specimens and additional studies will be presented.

## **The American Association for Thoracic Surgery 1962-63**

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