

# 1968 ANNUAL MEETING PROGRAM



## The American Association for Thoracic Surgery 1967-68

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## MONDAY MORNING, APRIL 22, 1968

**8:30 A.M. Business Session (Limited to Members)**  
**Ballrooms 1 and 2**

**8:45 A.M. Scientific Session: REGULAR PROGRAM**  
**Ballrooms 1 and 2**

### **1. Tissue Ingrowth and the Rigid Heart Valve: Review of Clinical and Experimental Experience During the Past Year**

NINA S. BRAUNWALD, and ANDREW G. MORROW, Bethesda, Md.

Previous studies in this laboratory indicated that a porous fabric lattice covering, which encouraged rapid tissue ingrowth, significantly decreased the incidence of thrombus formation on rigid prosthetic heart valves. Since February 1967, ball valves totally covered with fabric have been utilized clinically for replacement of the mitral and/or aortic valves. All aortic prostheses, and recently available mitral prostheses, have also had hollow metal poppets. To the date of this abstract, covered valves have been utilized in 26 patients for single or multiple valve replacements. Warfarin has been administered for six weeks after operation, then discontinued. There have been no operative deaths, and no patient has evidenced systemic embolization. The rationale for the use of covered prostheses, including the desirability of early anticoagulation, will be supported by recent experimental data, and the total clinical experience with these valves at the National Heart Institute will be presented.

### **2. Studies of Deaths and Failures in 300 Cases of Valve Replacement**

PIERRE GRONDIN, GILLES LEPAGE, CLAUDE MEERE,\* and  
YVES CASTONGUAY,\* Montreal, Quebec

Through May 1967, 300 patients have undergone cardiac valve replacement at the Montreal Heart Institute. Several types of prostheses were used, including those of Starr, Gott, Hufnagel, Magovern and Cutter. This group consists of 127 mitral, 124 aortic, 2 tricuspid, 46 bivalvular and 1 trivalvular replacements. A near perfect follow up and a high percentage of necropsies have permitted a complete review of the deaths and failures. These will be presented in detail. It is rewarding to note that, in 95% of instances, a specific reason was found to explain death or failure. Many of the causes of death are preventable and a high proportion of the failures are correctable by a reintervention. This emphasizes the need for complete investigation when physical incapacity persists after an otherwise successful operation.

### **3. Fresh Aortic Homografts for Multiple Valve Replacement**

WILLIAM W. ANGELL,\* ALBERT B. IBEN,\* EDWARD B. STINSON,\*  
and NORMAN E. SHUMWAY, Palo Alto, Calif.

Thromboembolism, hemorrhage, infection, and mechanical failure continue to be associated with prosthetic valve replacement. A solution to these problems may lie in the use of the fresh aortic homograft. *Experimental Results:* A total of 93 canine aortic valve transplants were placed in the subcoronary or atrioventricular position. Function was excellent with no evidence of valve deterioration. *Clinical Results:* Thirty-five patients underwent aortic valve replacement to the subcoronary position. Fresh aortic homografts were used as mitral replacement in fifteen patients. There was no instance of hemodynamic insufficiency, and no valve failure. Four patients underwent homograft replacement for multiple valve disease. Three had double and one triple valve replacement with fresh aortic homografts. In mitral and tricuspid replacement the homograft valves were secured to homograft support rings specifically designed for this purpose. All patients have done well over two to four months with no complications related to the valve homografts. *Conclusions:* Fresh aortic homografts may be used directly in the subcoronary position or with a support ring in the atrioventricular position. Hospital mortality and operative complications for multiple homograft valve replacements are no greater than with the use of prosthetic valves.

### **4. Replacement of the Mitral Valve with Reinforced Aortic Heterografts: Technique and Results**

MARIAN I. IONESCU,\* GEOFFREY H. WOOLER,\* and STANLEY H. TAYLOR,\*  
Leeds, England

Sponsored by JOHN W. KIRKLIN

Because of the disadvantages connected with the use of prosthetic valves the authors developed a technique for mitral valve replacement using heterologous aortic valves. Two types of grafts were used clinically. One of them, a reconstructed aortic valve, reinforced with a semi-rigid Teflon ring, was sutured above the mitral annulus inside the atrium. The second one, an aortic valve attached to a Dacron-covered titanium frame, was sutured to the mitral annulus. The technique of preparing and inserting these grafts is briefly described. Fifty patients were operated upon using this method. Except four, all had had one or more associated abnormalities. Eight patients died from causes not related to the graft. Two succumbed due to graft failure. Forty patients were greatly benefited by surgery. No embolisation occurred although anticoagulants were not used. Data concerning follow-up studies up to 14 months since the operation are presented to evaluate the results obtained (clinical condition, mechanograms, catheter findings, angiography). Technical and biological reasons for using this method are given. The long term fate of preserved aortic heterografts in the mitral position is discussed with clinical and experimental data.

### **5. Thoractomy on the Patient with Previous Malignancy: Metastasis or New Primary?**

PAUL C. ADKINS, CONRAD W. WESSELHOEFT, JR.,\* WILLIAM NEWMAN,\*  
and BRIAN BLADES, Washington, D.C.

Numerous reports have justified an aggressive surgical approach to the patient with a solitary pulmonary metastasis. However, not all lesions appearing in the chest of the patient who has been previously treated for a malignancy are metastatic. Forty-five patients with a past history of a primary malignancy elsewhere in the body have been seen with a solitary pulmonary or mediastinal lesion and subjected to thoracotomy. Thirty patients proved to have metastases to the lung associated with their original neoplasm. In the remaining 15 patients, or one-third of the total, the lesion was unrelated to the previous malignancy. Eight had new primary carcinomas and the remaining seven patients had benign lesions. In 14 patients with a history of carcinoma of the breast, a solitary pulmonary lesion was seen two to eleven years following mastectomy. Seven (50%) of these were metastatic, two were benign granulomas and five were new primary pulmonary carcinomas. In some instances at the time of thoracotomy, it may be difficult for the pathologist to differentiate between a primary carcinoma and a metastatic lesion on frozen section. In this situation, we believe that the extent of the resection should be predicated on the strong possibility that one is dealing with a new primary pulmonary malignancy.

## 6. Scar Cancer of the Lung

CHARLES B. RIPSTEIN, DAVID SPAIN,\* and IRWIN BLUTH,\*  
Brooklyn, N.Y.

Cancer developing in scars of the lung was first described by Rossle in 1939. Since that time examples have been reported in the literature in association with foreign bodies and the healed scars of tuberculosis, trauma and infarcts as well as pneumoconiosis. The majority of scar cancers are adenocarcinomas of the bronchiole-alveolar type and they tend to remain localized for long periods before metastases occur. The prognosis following surgical excision is relatively favorable but early diagnosis presents a serious problem. This paper analyzes our experience in the management of 20 patients with scar cancer of the lung. A definite pattern of radiological criteria for diagnosis has emerged, and the x-ray findings have been correlated with the pathological features of the resected specimens. All patients have been treated by conservative resection of the involved area and follow-up examination confirms the impression that these tumors are slowly progressive and offer a better prognosis than the usual forms of bronchogenic cancer.

## 7. Steroid Metabolism in Patients with Bronchogenic Carcinoma

J. JUDSON MCNAMARA,\* HAROLD H. VARON,\* DONALD L. PAULSON,  
INDIRA SHAH,\* and HAROLD C. URSCHEL, JR., Dallas, Texas

Plasma and urinary steroid determinations were performed preoperatively and patients with subsequent tissue proof of bronchogenic carcinoma were included in the study. Control values were patients of similar age and sex with hiatus hernia. The protocol included 8:00 am. cortisol (70 carcinoma patients, 36 controls), 24 hour urinary hydroxy and ketosteroid determinations (70 carcinoma, 30 controls), ACTH stimulation tests (27 carcinoma patients), 24 hour total urinary estrogen excretion (31 carcinoma, 25 controls) and plasma cortisol determinations at 8 am., 4 pm. and 10 pm. to evaluate daily variation in cortisol production (35 carcinoma, 25 controls). All patients had liver function studies. Those with abnormal values were dropped from study. Data was further divided with regard to sex, cell type, evidence of metastatic disease. Data shows two fold elevation in urinary estrogen excretion by male carcinoma patients (p 0.005). This difference was not observed for females. Estrogen excretion was greatest in males with squamous carcinoma and lowest with oat cell tumors. Five carcinoma patients had marked elevation of plasma cortisol values although cortisol values for the carcinoma group as a whole were not significantly elevated. The remaining pertinent data is presented in detail. The origin of the observed abnormalities and their implications on prognosis and treatment are discussed.

\*By Invitation

# MONDAY AFTERNOON, APRIL 22, 1968

2:00 P.M. Scientific Session: REGULAR PROGRAM Ballrooms 1 and 2

## 8. Ventriculomyotomy in Hypertrophies of the Left Ventricle

J. P. BINET,\* J. LANGLOIS,\* A. LEIVA-SEMPER,\* and Ph. DAVID,\*

Paris, France

Sponsored by W. G. BIGELOW

The beneficial effects of Ventriculomyotomy in abolishing obstruction in muscular subaortic stenosis are now well documented. In a number of patients with valvular stenosis, severe secondary muscular hypertrophy is known to maintain obstruction following surgical relief of the stenosis. In two patients following insertion of a Starr valve for aortic valvular disease there was persisting left ventricular outflow obstruction with a low output syndrome. This was relieved in each case by Ventriculomyotomy. This has stimulated us to study the further use and a modification of the Ventriculomyotomy operation. Thirty-three patients with primary (16) and secondary (17) muscular hypertrophy were treated by Ventriculomyotomy. In six cases with pure muscular subaortic stenosis, the localized Ventriculomyotomy described by Bigelow was utilized. In the remaining 27 cases (10 with muscular subaortic stenosis, 17 with secondary hypertrophy) the

technique was modified to include the entire length of the anterior wall of the left ventricle, from the base of the aortic valve to the apex of the heart. A combined ventriculo-aortic approach was used. Precise anatomic measurements, adequate lighting and special instrumentation are necessary. The post-operative electrocardiogram has not revealed significantly altered ventricular conduction. In summary, (a) the extension of the use of Ventriculomyotomy is recommended, (b) Evidence is presented which indicates that there is a place for a modified or "extended Ventriculomyotomy" in some cases of left ventricular outflow obstruction.

## **9. The Selection of Patients for Resection of Left Ventricular Aneurysm**

JAMES A. KEY, HAROLD E. ALDRIDGE,\* and D.C. MACGREGOR,\*

Toronto, Ontario

Review of the clinical and catheter findings in 35 adult patients with left ventricular aneurysm suggests that the best results of treatment can be achieved by proper selection and classification of the different types of lesion encountered. Patients fell into two groups - those operated upon (13 cases) and those in which operation was considered inadvisable (22 cases). In the surgical group a correct pre-operative selection was made in 10 of the 13 patients and a good clinical result was obtained with no hospital mortality. Of the 3 remaining patients the aneurysm was considered unresectable in 2 cases and attempted resection failed in the third. In the non-surgical group (22 cases) the reasons for advising against operation will be discussed. We hope that this review will, on the one hand, confirm the great benefits to be achieved and the minimal operative risk involved in resection of left ventricular aneurysms in properly selected cases, and on the other hand, will help to safeguard the merits of the operation by emphasizing the pitfalls of surgery where unwise pre-operative selection has been made.

## **10. Support of Myocardial Performance After Open Cardiac Operations by Rate Augmentation**

ROBERT S. LITWAK, LESLIE KUHN,\* HOWARD L. GADBOYS,

SALVADOR B. LUKBAN,\* and HIDEKI SAKURAI,\* New York, N.Y.

After intracardiac operations certain patients exhibit low cardiac output (CO) associated with bradycardia and impaired myocardial contractility. During the past two years 29 postperfusion patients with slow nodal rhythm or atrial fibrillation have had their ventricular rates electrically maintained between 85-115 beats/min. with epicardial wires implanted at operation (Starr) with measurable improvement of CO. Postoperative hemodynamic measurements were performed in 15 patients who were otherwise stable in the sequence: (a) pacing (85-95 beats/min.), (b) non-pacing, (c) pacing (95-115 beats/min.). Non-pacing (b) was associated with a fall in CO averaging 22.8%. Resumption of pacing at a higher rate (c) resulted in a CO rise which exceeded initial measurements (av. 32%). Thus, within the pacing range, CO varied directly with rate. Pacing was also associated with small but consistent reduction of L and R atrial pressures, LV stroke work and systemic vascular resistance. In three paced subjects isoproterenol (1 ug/min.) resulted in further rise in CO with no rate change. Relatively low ventricular rates contribute to reduced cardiac output after intracardiac surgery and pacing exerts a significant salutary effect. Prophylactic implantation of myocardial wires for rate control is suggested for all severely incapacitated patients undergoing cardiac operations.

## **11. Profound Hypothermia in Cardiac Surgery**

R. H. R. BELSEY, K. DOWLATSHAHI,\* G. KEEN,\* Bristol, England,

and DAVID B. SKINNER,\* Baltimore, Md.

In Bristol, England, from 1961 to July 1967, 304 consecutive open-heart operations were performed employing complete circulatory arrest for up to 120 minutes at temperatures between 10-20°C. This experience includes a full range of congenital (205 cases) and acquired (99) heart diseases. Preoperative status, temperatures, flow rates, and pressures during cooling and warming, duration of arrest, operative procedures, postoperative assessment of cardiac, renal, pulmonary, hepatic, neurological, and hematologic function, results, complications, and deaths have been analyzed and will be presented to show the effects of profound hypothermia in humans in relation to the technical problems and underlying diseases encountered. Specific complication rates, including neurological, appeared no higher than expected following total cardiopulmonary bypass at normal temperatures. Continuous EEG monitoring and maintenance of end-tidal CO<sub>2</sub> concentrations at 4.5% have been valuable to avoid neurological abnormalities and acidosis. Serial monitoring of serum electrolytes during cooling and warming in 98 patients identified potassium shifts requiring adjustment. Modifications in the original Drew technique facilitated cooling of patients with pulmonary hypertension. These studies demonstrate that profound hypothermia is associated with acceptable mortality and morbidity, and offers specific advantages and disadvantages which will be described.

## **12. Clinical Experiences with Computerized Monitoring of Cardiovascular Variables in the Postoperative Thoracic and Cardiovascular Patient**

JD MORTENSEN, and LYNN H. ANDERSON,\* Salt Lake City, Utah

Continuous computerized monitoring of central aortic blood pressure, pulse contour, cardiac output, stroke volume, peripheral vascular resistance, and mechanical duration of systole has been used on more than 120 selected patients in our hospital during the past year. This paper presents the findings resulting from review of these patients in whom this sophisticated new clinical tool has been used. We have found this technique to represent a significant advance in the care of postoperative cardiovascular patients. It is particularly useful in the high risk patient in whom a difficult or stormy postoperative course is anticipated. In addition, this system of monitoring can effectively detect subtle changes in cardiovascular status before these can be recognized by the usual clinical means, thus avoiding the later development of more difficult problems. We have not experienced significant complications from this method of physiologic monitoring. Details of the technique and type of data obtained from this new clinical test will be illustrated.

### **13. The Importance of Serial Blood Gas Determinations in Blunt Chest Trauma**

A. J. WISE,\* C. TOPUZLU,\* H. G. PAGE,\* and E. L. MILLS,\*

Burlington, Vt.

Sponsored by EMIL BLAIR

Serious and potentially lethal pathophysiologic changes often are not detectable in the vital early periods of blunt chest trauma, before "flail" and/or lung contusion become apparent. In a consecutive series of 100 patients seen in the Emergency Room over a 2½ year period, 20 demonstrated a low arterial pO<sub>2</sub> upon admission. At this point, there was no clinical nor radiologic evidence of hypoxia, except for rib fractures with hemo-pneumothorax in a few. In the majority, evidence of pulmonary contusion appeared later. Nasotracheal intubation with IPPB was instituted promptly, while otherwise this would have been delayed. Most of these patients subsequently developed severe pulmonary complications. In another 50 patients the injuries were so severe that intubation and IPPB were carried out immediately, before blood gas determinations could be obtained. Management included serial, frequent blood gases with adjustments in oxygen concentration and dead space to maintain blood gases within normal limits. The mortality rate was 5% from thoracic injuries alone and another 1% from associated injuries and their complications. There was not one single instance of cardiac arrest due to hypoxia in either group. Representative cases demonstrating the accuracy of serial arterial gas determinations in the assessment of early hypoxia will be presented.

### **14. Penetrating Wounds of the Heart: An Analysis of Over 320 Cases**

W. L. SUGG,\* WILLIAM J. REA,\* WATTS R. WEBB, EARL ROSE,\* and

R. R. SHAW, Dallas, Texas

In eight years over 320 penetrating heart wounds were admitted to Parkland Memorial Hospital. Approximately 70% were dead on arrival, principally from ventricular wounds. Gunshot wounds were more deadly than stab wounds. In earlier years treatment consisted of pericardiocentesis with surgery only for progressive deterioration, which proved unsatisfactory. Under a new policy started during 1965, all patients are taken immediately to the OR, though some have required pericardiocentesis or even thoracotomy in the Emergency Room. All gunshot wounds are treated operatively as are all but minimal stab wounds. The rare patient treated only by aspiration is observed until recurrent tamponade appears unlikely. A second thoracotomy is always an indication for operation. In the past two years of 35 patients admitted with signs of life, only two died (lacerated coronary artery and massive air embolism). Complications of operative and nonoperative treatment will be presented. On the basis of these results we recommend immediate thoracotomy for all gunshot wounds and most stab wounds of the heart, utilizing pericardiocentesis as a diagnostic or life-saving therapeutic measure prior to surgery.

\*By Invitation

## **TUESDAY MORNING, APRIL 23, 1968**

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

**Ballrooms 1 and 2**

### **15. Experimental Papillary Muscle Infarction**

GEORGE E. MILLER,\* KEITH E. GOHN,\* WILLIAM J. KERTH,

ARTHUR SELZER,\* and FRANK GERBODE, San Francisco, Calif.

Papillary muscle contraction occurring synchronously with that of the left ventricle has been ascribed important in maintaining mitral valve competency. Loss of this function resulting from myocardial infarction has been considered a cause of acquired mitral insufficiency. This insufficiency is explained by two mechanisms: - 1. That occurring early after infarction in which the papillary muscle loses its ability to contract with resultant prolapse of the leaflet into the atrium. 2. That occurring late due to contraction and shortening of the fibrotic papillary muscle pulling the leaflet into the ventricle. In this study, the papillary muscles of dogs, six anterior and six posterior were selectively infarcted. The animals were studied at varying periods from immediately postoperative to 20 weeks post infarction, by auscultation, left atrial catheterization and cineangiograms of the left ventricle. The completeness of infarction was verified by histological section. These studies indicate that selective papillary muscle infarction does not result in mitral insufficiency.

## **16. Experimental Coronary Artery Surgery: Long Term Follow-up of Bypass Venous Autografts, Longitudinal Arteriotomies and End-to-End Anastomoses**

MARK DEDOMENICO,\* ABBAS A. SAMEH,\* KNUTE E. BERGER,\*

STEPHEN J. WOOD,\* and LESTER R. SAUVAGE, Seattle, Wash.

In 1963 we reported the early results (6 months) of direct coronary artery procedures performed upon the branches of the left coronary artery of 69 dogs. This report detailed the results observed in 11 of these animals kept for long term study and followed up to 5 years. This series consists of 5 end-to-end bypass aorto-coronary venous autografts, 3 longitudinal arteriotomies and 3 end-to-end bypass aorto-coronary venous autografts, 3 longitudinal arteriotomies and 3 end-to-end anastomoses. This long-term study has consisted of serial arteriograms and careful sacrifice studies with particular attention to healing characteristics. In brief, these studies show: 1) Persistent patency of all grafts or anastomoses. 2) Absence of stricture formation at the anastomotic site. 3) Progressive dilatation of vein grafts to true aneurysmal proportions. We believe that these studies have clinical significance to the expanding field of direct coronary artery surgery. The arteriograms, gross specimens and histologic studies will be demonstrated by slides.

## **17. Evaluation of Cardiac Revascularization Procedures Using Tissue Lactic Acid Determinations in Induced Myocardial Infarctions**

JAMES D. WHIFFEN,\* Madison, Wis., and VINCENT L. GOTT,

Baltimore, Md.

At the present time, there is not a completely satisfactory method for the evaluation of myocardial revascularization procedures. A method has been developed by the coauthors which provides an excellent indication of the degree of new collateral channels. In this test, a small myocardial biopsy is taken in the distribution of the anterior descending artery and then this artery is occluded. After two minutes, a second biopsy is taken in the same area. The occlusion is released and then the same technique is repeated in the area supplied by the circumflex artery. The tissue is analyzed for the two-minute rise in lactic acid, thus providing an indication of hypoxia in the myocardium and direct reflection of new coronary collateral development. Fifty-five animals were studied. The average two-minute lactic acid rise in ten control dogs was  $65 \pm 3.6$  mg.% and  $56 \pm 3.3$  mg.% following occlusion of the anterior descending and circumflex arteries respectively. Evaluation of Vineberg's implant showed significant tissue perfusion in 75% of the animals. Other experimental operations were evaluated and the most significant collateral development was seen after chronic left pulmonary artery ligation. This "lactic acid rise test" appears to be a simple and accurate way of evaluating myocardial revascularization procedures.

## **18. Comparative Flow Studies of Myocardial Revascularization Grafts**

AKIO WAKABAYASHI,\* and JOHN E. CONNOLLY, Los Angeles, Calif.

Analyses of myocardial revascularization grafts were made on long-term animals including an internal mammary graft with (No. 1) or without (No. 2 and 3) in situ communicating intercostal arteries, a modified Vineberg graft with ascending aorta origin (No. 4), autologous arterial (No. 5 and 6) or reversed saphenous vein (No. 7, 8, and 9) bypass grafts implanted between ascending aorta and coronary artery. Four normal dogs were controls. Indirect revascularization grafts (No. 1-4) did not show any long term increase in mean flow and failed to respond to levarterenol, isoproterenol, and nitroglycerin, although the implant developed collaterals with the coronary arterial system and flow pattern changed from to-and-fro to coronary artery type. Contrarywise, all bypass grafts (No. 5-9) had high mean flows which were markedly increased by drugs like the normal coronary artery. Arterial grafts showed negative flow corresponding with ejection phase explained by Phot's principle. Venous grafts did not show this pattern, probably because valves were blocking retrograde flow. These studies indicate that an ascending aorta-coronary artery bypass graft can assume the function of the coronary artery, quantitatively and qualitatively, but an indirect revascularization graft can carry only a small amount of blood and cannot respond physiologically, even after it develops direct communicating collaterals.

## **19. The Use of Fluorescein for Determining the Site of Internal Mammary Artery Implantation**

CIRO ARMELLINI,\* WALTER L. MERSHEIMER,\* and SHELDON O. BURMAN,\*

New York, N.Y.

Sponsored by GEORGE J. MAGOVERN

Selection of the proper site for implantation is said to be important in determining the success of the Vineberg revascularization procedure. However, the recognition of poorly vascularized or marginally ischemic areas of myocardium is often difficult at the operating table especially when these areas appear to be at variance with the patient's electrocardiogram or coronary arteriogram. Twelve dogs underwent coronary artery ligation, the left anterior descending was ligated in four, the left posterior circumflex in three, the right coronary in three, and the right coronary and left anterior descending in two. Fluorescein 5 cc. was injected into a peripheral vein and under ultraviolet light the demarcation between vascular and avascular myocardium was clearly seen and photographed. One or two internal mammary arteries were implanted into the avascular areas and the chest closed. Thoracotomy was repeated after six months and fluorescein again given peripherally. Fluorescence of the previously avascular areas of myocardium occurred in all except two animals whose implants were thrombosed. The technique is now routinely employed to determine the site for implantation in all patients undergoing myocardial revascularization procedures. Photographs and a movie will be shown which clearly document these phenomena.

## **20. The Effects of Epicardiectomy on Ventricular Function**

R. L. REIS,\* L. P. ENRIGHT,\* H. HANNAH, III,\* and A. G. MORROW,

Bethesda, Md.

The effects of epicardiectomy on the function of the ischemic ventricle were determined. Left ventricular function curves were inscribed at fixed heart rate and constant aortic pressure in 18 dogs. In nine animals (Group I) a control curve (a) was inscribed. The left anterior descending coronary artery (LAD) was occluded and a repeat curve performed (b). The occluding clamp was removed, epicardiectomy performed and 30 minutes thereafter the LAD reoccluded and a third curve inscribed (c). LAD flow was restored and a fourth curve (d) performed. In nine dogs (Group II) curves were inscribed in an identical fashion but epicardiectomy was not performed. In four group I dogs and three group II dogs curve (b) could not be inscribed because of ventricular fibrillation. In the four group I animals curve (c) could be inscribed after epicardiectomy. Ventricular fibrillation prevented the inscription of curve (c) in the three group II dogs. In the remaining animals, curve (b) demonstrated severe depression. In group I, curve (c) showed moderate improvement in four dogs and slight improvement in one dog. In group II animals, curve (b) and (c) were identical. In all animals curve (d) and (a) were similar, dp/dt measurements corroborated these findings. These data indicate that epicardiectomy significantly improves the function of the acutely ischemic left ventricle.

## **21. Evaluation of an Everting Esophageal Anastomosis in the Puppy**

CONRAD W. WESSELHOFT, JR.,\* DONALD H. GLEW, JR.,\*

JUDSON G. RANDOLPH, and BRIAN BLADES, Washington, D.C.

In an attempt to improve the anastomotic problems of leak and stricture in the treatment of esophageal atresia, many variations in suture technique have been proposed. Recent reports describing satisfactory healing and improved lumen size in everting anastomoses of the intestine prompted our evaluation of this technique in the thoracic esophagus. Following segmental resection of the esophagus, 1) a standard two layer end-to-end, 2) the Haight anastomosis, and 3) a single layer everting anastomosis were evaluated in three groups of ten, using eight week old puppies. All surviving animals were studied at three weeks, six weeks and three months after surgery by esophagoscopy and barium esophagram. At the end of four months, all remaining animals were sacrificed. The three methods were evaluated for elapsed operating time in constructing the repair, defects in healing with the occurrence of anastomotic leak, the presence of stricture, growth of the suture line, and histology of the healed anastomosis. The results of this experience demonstrate that the everting anastomosis is simpler to perform and that operating time is shortened. Mucosal healing is quite satisfactory, there is no increased incidence of anastomotic leakage, and stricture is definitely reduced. The results of this study have been translated into clinical usage in six patients with esophageal atresia and tracheo-esophageal fistula.

## **22. Esophageal Function After Successful Repair of Esophageal Atresia and Tracheoesophageal Fistula: A Manometric and Cinefluorographic Study**

JOHN N. BUROESS,\* HARLEY G. CARLSON,\* CHARLES F. CODE,\* and

F. HENRY ELLIS JR., Rochester, Minn.

Esophageal dysfunction has been reported in patients surviving repair of esophageal atresia and tracheoesophageal fistula. The nature of this dysfunction has not been clearly defined, though some have interpreted it as congenital esophageal achalasia. In order to more clearly define the condition, 9 patients were studied by esophageal motility and cinefluorography 14 to 19 years after successful repair in infancy of this congenital abnormality. None of these patients were symptomatic when studied. All showed abnormal esophageal motility characterized by absent or feeble simultaneous postdeglutitive contractions in the body of the esophagus beginning above the anastomotic site and extending to a variable level distally in the lower esophagus. Normal peristalsis returned at this level, and there was normal sequential relaxation and contraction of the inferior esophageal sphincter in which resting pressures were normal in length and amplitude. It is postulated that the abnormal esophageal motility noted in these patients was the result of injury to the esophageal branches of the vagus nerve at the time of operation. The integrity of the vagal nerve trunks was confirmed by positive Hollander tests performed in 8 of the 9 patients, and there was no evidence of esophageal achalasia.

### **23. Prosthetic Replacement of Esophageal Segments**

JOSEPH N. LAGUERRE,\* HENRY SCHOENFELD,\* WILLIAM S. CALEM,\*

FRANCIS E. GOULD,\* and BERNARD S. LEVOWITZ, Brooklyn, N.Y.

A non-toxic, non-reactive hydrophilic polymer, hydron, has been developed and investigated in dogs for use as an esophageal substitute. Through a right thoracotomy, molded pliable, non-collapsible tubes up to 10 cm. in length and sleeved by teflon felt were used to replace segments of the mid thoracic esophagus. Postoperatively the animals were maintained on blended liquid feedings and weighed weekly. There are presently 6 long term survivors ranging from 1½ to 5 months, all of which have exceeded or maintained their preoperative weight. Interval esophagoscopy and barium esophagrams have demonstrated patent hydron conduits without proximal dilatation. Among 3 postoperative deaths one resulted at 1½ months from barium aspiration during an x-ray study and two occurred at 1 and 3 weeks because of leakage at the distal anastomosis and empyema. After two months one animal regurgitated the prosthesis and succumbed 3 weeks later with complete esophageal stenosis. At postmortem examinations the inner surfaces of the clear plastic tubes have remained free of epithelial coverage. There has been minimal fibrous ingrowth of surrounding tissues into the teflon felt. To promote more rapid and secure tissue adherence esophageal hydron cylinders sleeved with Ivalon and velour fabrics are currently being studied and the results will be reported.

### **24. A Technique for the Use of Autologous Fresh Blood Following Open-Heart Surgery**

ROBERT L. HARDESTY,\* WILLIAM BAYER,\* and HENRY T. BAHNSON,

Pittsburgh, Pa.

The present investigation concerns a technique in which fresh autologous blood is utilized as a source of platelets, factor V and factor VIII following cardiopulmonary bypass. As bypass is initiated twenty-five percent of the patient's estimated blood volume is withdrawn from the venous line into a plastic container, and simultaneously an equivalent volume is delivered from the reservoir to the patient via the arterial line. After bypass, this procedure is reversed, and the patient receives a transfusion of his own fresh blood kept at room temperature. Evaluation of this technique is favorable as judged by platelet counts and platelet adhesiveness. After withdrawal into the plastic storage container, platelet adhesiveness was normal and platelet count was fifty-one percent of the patient's circulating platelets pre-bypass. Storage during the operative procedure altered neither platelet count nor adhesiveness. Re-infusion of the autologous fresh blood at the con-operative blood loss for these patients was less than that encountered in a random series of patients undergoing extracorporeal circulation prior to utilization of this technique.

### **25. Perfusion-Induced Myocardial Injury**

EUOENE H. BLACKSTONE,\* RICHARD E. EVANS,\* FRIEDRICH A. O. ECKNER,\*

ALLAN DRAKE,\* and PETER V. MOULDER, Chicago, Ill.

Preliminary to the development of a disposable coronary perfusate for cardiopulmonary bypass is a knowledge of potential perfusion induced myocardial injury. Arrest, arrest with distension, and graded hypoxic perfusion experiments were performed and resulting injury assessed. *Groups:* 12 experiments: Graded hypoxic blood perfusion (closed circuit heart preparation), constant flow rate, 37°C. 10 experiments: Oxygenated low molecular weight dextran, dual perfusion (heart, body), 28°C and 37°C. 5 experiments: Coronary circulatory arrest with induced distention, 30-45 minutes at 30°C and 37°C. *Methods:* Serial full thickness myocardial biopsies (frozen-dried) for histology and histochemical glycogen and enzyme studies; cross-coronary bed lactate, pyruvate, glucose, and oxygen extraction; acid-base balance; and hemodynamics. Compartmental water-electrolyte concentrations were studied on the right and left myocardium. *Abnormalities noted:* Instances of generalized glycogen depletion and/or patchy loss; a reversal to lactate production when O<sub>2</sub> availability dropped below 5-8 vol. O<sub>2</sub>/minute delivery; a rapid (less than 10 minutes) development of edema, hemorrhage, and imbalance of intracellular myocardial cation concentrations (especially magnesium) with severe



oxygen depletion. When compared to previously reported arrest alone experiments, these studies suggest that an inadequate coronary perfusate is worse than arrest, and indeed may lead rapidly to irreversible myocardial injury.

## **26. The Effect of Profound Hypothermia on Preservation of Cerebral ATP Content During Circulatory Arrest**

RICHARD S. KRAMER,\* AARON P. SANDERS,\* ALAN M. LESAGE,\*

BARNES WOODHALL,\* and W. C. SEALY, Durham, N.C.

Development of an improved method for instantaneous freezing (-196°C) of sequential cerebral biopsies permits the accurate determination of ATP (adenosine triphosphate) disappearance during complete circulatory arrest and recovery. Control cerebral ATP concentrations in biopsies from 30 normothermic dogs equalled  $2.32 \pm .17$  mcM/g (S.D.). Simultaneous aortic and vena caval occlusion, for periods of 4, 6, or 8 minutes, resulted in a 50% decrease of cerebral ATP within 3.78 minutes. Electroencephalographic silence occurred at  $20.9 \pm 3.1$  seconds, coincident with the loss of < 8% of control ATP content. Reappearance of brain ATP after resumption of flow correlated inversely with the duration of circulatory arrest. Eleven dogs were cooled to 5-11°C (esophageal) using high-flow extra-corporeal perfusion for 50 minutes with attendant reduction of cerebral ATP to  $88.7 \pm 7.4\%$  of normothermic control levels. EEG silence occurred at  $16.8 \pm 3.50^{\circ}$  (esophageal), coincident with the loss of <7% of control ATP concentrations. Circulatory arrest resulted in a 50% reduction in cerebral ATP after 13.3 minutes. Recovery of ATP with re-warming was observed after 30 and 60, but not 90, minutes of hypothermic arrest. EEG recovery was associated with return of ATP concentrations to 89% of normothermic control levels. Profound hypothermia results in a 4- to 5- fold increase in survival of cerebral ATP during circulatory arrest.

## **27. A Non-Polarizing Electrode for Endocardial Stimulation of the Heart**

V. PARSONNET,\* L. GILBERT,\* G. LEWIN,\* G. MYERS,\*

and I. R. ZUCKER,\* Newark, N.J.

Sponsored by IRVING A. SAROT

A new electrode was developed which has negligible polarization, is biologically non-reactive, and permits pacing of the heart with one-twentieth of the power required with ordinary metal electrodes. When the heart is stimulated with standard metal electrodes, energy is wasted in polarization at the electrode tip. Epicardial, myocardial and endocardial electrodes were designed. The endocardial form of the electrode consists of a plastic dielectric cylinder with a hole at the end of area 1.8 mm containing a metal cylinder whose area is 3 cm. The plastic cylinder is the entire tip of a standard cardiac catheter electrode, is filled with saline, and the hole is placed in contact with the endocardium. All of the current leaving the metal passes through the small hole to the tissue, thus providing high current density at the tissue but low current density at the metal. The device thus acts as a current-density transformer, or a "differential-current-density" (DGD) electrode. The electrode has been used successfully in humans for three months, with chronic stimulus thresholds of less than one microjoule. These electrodes have been consistently superior to standard metal electrodes in animals and man, and are suitable for long-term implantation.

\*By Invitation

## **TUESDAY AFTERNOON, APRIL 23, 1968**

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

**Ballrooms 1 and 2**

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

**Ballrooms 1 and 2**

*Address by the President*

**Paul C. Samson, Piedmont, California**  
**"The Compleat Thoracic Surgeon"**

*Address by Special Guest Speaker*

**Professor Christiaan N. Barnard**  
**University of Cape Town Medical School**

**Observatory, Cape Town, South Africa**  
**"Experience with Human Heart Transplantation"**

**28. The Coronary Arteriographic Pattern in Complete Heart Block**

FRANK BEGG,\* GEORGE J. MAGOVERN, WILLIAM J. GUSHING,\*

EDWARD M. KENT, and DON L. FISHER,\* Pittsburgh, Pa.

Since January 1965 we have performed selective cine-coronary arteriography (Sones technique) on over 1,200 patients and this has provided an opportunity to review the coronary pattern to date on 25 patients with complete heart block requiring a permanent pacemaker. The clinical data and the angiographic pattern has *not* confirmed the long accepted view that the etiology of complete heart block is due to or associated with significant coronary atherosclerosis. All of the patients studied to date have had a permanent pacemaker in place for two weeks to 18 months. A dominant right coronary circulation was demonstrated in all, and the A-V nodal branch has been present in 90% of the patients studied. The septal perforator branches of the anterior descending branch of the left coronary artery have been shown in all. Although the majority of patients are in the 70-80 years age group, a similar pattern was present in one patient known to have complete block since age 14. The significance of this observation in relation to etiology, treatment and prognosis will be discussed and the angiographic technique and pattern demonstrated.

**29. Surgical Aspects of Long-Term Electrical Stimulation of the Heart**

HOWARD A. FRANK, PAUL M. ZOLL,\* and ARTHUR J. LINENTHAL,\*

Boston, Mass.

Work from many sources during the past decade has established the feasibility and usefulness of long-term electrical stimulation of the heart. Disagreement exists, however, with regard to surgical, physiologic, electrical, and mechanical aspects of the many systems proposed. In this communication we shall report our experience with 182 patients treated during the period July 1960 through November 1967 by a totally implanted, battery-powered, fixed-rate pacemaker system, with impulse source connected by conducting wires to electrodes implanted surgically into the ventricular myocardium. Case selection, the effectiveness of control of Stokes-Adams disease and congestive heart failure, and the morbidity and mortality, surgical and non-surgical, will be presented, as well as measurements of stimulus threshold at intervals up to 7 years after implantation, an analysis of the electrical and mechanical performance of the pacemaker system, a description of technics for primary implantation, for pacemaker replacement, and for recognition and correction of system flaws, and for the management of sepsis. These data will be applied to a discussion of current issues: transvenous vs. intramyocardial electrodes, and fixed rate vs. variable rate, atrial-coupled, and "demand" pacemaking.

**30. Continuous Positive Pressure Breathing (CPPB) in Adult Respiratory Distress Syndrome**

D. G. ASHBAUGH,\* T. L. PETTY,\* D. B. BIGELOW,\* and T. HARRIS,\*

Denver, Colo.

Sponsored by WILLIAM R. WADDELL

The syndrome of adult respiratory distress has been previously described and is characterized by the rather sudden onset of dyspnea, tachypnea, hypoxemia and loss of lung compliance. Pathological examination of the lungs suggests that the site of the pulmonary lesion is the alveolar capillary membrane. This lesion is characterized by interstitial edema, capillary congestion and leakage of red blood cells and plasma into the alveolus. Massive atelectasis characterizes the terminal stages of the syndrome and is probably due to inactivation of surfactant. These findings suggest that ventilation and oxygenation are impaired by a massive increase in pulmonary blood volume, pulmonary edema and loss of alveolar stability. Mortality with conventional respiratory support remains extremely high. Continuous positive pressure breathing (CPPB) implies the maintenance of positive pressure throughout the respiratory cycle and has theoretical advantages in the prevention of alveolar collapse and the reduction of intra-alveolar edema. The maintenance of effective CPPB requires absolute control of respiration. Hyperventilation alone frequently fails to control respiration in these patients and curare may be needed to maintain effective CPPB. Only 2 of 7 patients survived with conventional respiratory support, but 7 of 10 survived with CPPB support. Clinical biochemical and pathologic data will be presented to define the syndrome and to support the hypothesis that CPPB is effective treatment.

\*By Invitation

## TUESDAY EVENING, APRIL 23, 1968

**7:00 P.M. Reception**

**Ballroom 2**

**8:00 P.M. Dinner and Dancing**

**Ballroom 1**

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

**Speakers and their ladies, Invited Guests and their ladies**

**Dinner dress preferred**

## WEDNESDAY MORNING, APRIL 24, 1968

**WEDNESDAY MORNING, APRIL 24, 1968**

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

**Ballrooms 1 and 2**

### **31. Homologous Aortic Valve Transplantation: Alterations in Viable and Non-Viable Valves**

HITOSHI MOHRI,\* DENNIS D. REICHENBACH,\* ROBERT W. BARNES,\*

and K. ALVIN MERENDINO, Seattle, Wash.

Our experiments with 40 dogs demonstrated low antigenicity and satisfactory, prolonged function of the homologous aortic valve without evidence of rejection. Surviving donor cells of viable grafts and absence of host substitution of nonviable valves up to 6 months post-transplantation were noted. Most institutions are now advocating the use of fresh viable grafts although their ultimate fate is still unknown. Recent studies, however, show that fresh valves undergo a histologic alteration with the passing of time. One year after transplantation, viable grafts still demonstrated surviving donor cells although the percent of sex chromatin positive cells had decreased. Furthermore, specimens obtained one year and one specimen obtained 6 months postoperatively showed areas of segmental acellularity and thinning of the leaflet, although these valves were functioning satisfactorily. Non-viable grafts, on the other hand, demonstrated definite host substitution by one year, represented by a fibroblastic sheath over the cusp extending from the host and by fibroblastic cell invasion into the surface of the leaflet. No scarring or restricted movement of the leaflet was observed. The late fate of viable and non-viable valves is being evaluated in 17 remaining animals (8 viable and 9 non-viable grafts) up to 20 months post-transplantation. The pros and cons of each graft, including clinical specimens, will be discussed.

### **32. The Immunologic Response to Heterotopic Allovital Aortic Valve Transplants in Presensitized and Nonsensitized Recipients**

ARTHUR E. BAUE, WILLIAM J. DONAWICK,\* and WILLIAM S. BLAKEMORE,

Philadelphia, Pa.

Unrelated calves were prepared by donor-to-recipient and autologous skin grafts. After 9 day first-set rejection, recipients received donor buffy coat ( $6 \times 10^8$  cells) in multiple intramuscular sites. The recipient's pulmonic valve was then replaced by the donor's aortic valve, priming the extracorporeal system with stored autologous blood. Ten animals survived, had 7 day second-set skin rejection, were sacrificed at 7-223 days and compared with heterotopic allovital valve transplants in nonsensitized calves. In a third group, allogeneic aortic and autologous pulmonic valve leaflets alone were implanted intramuscularly after prosthetic valve substitution. Biopsies of implants at 7-14 days demonstrated progressive sensitization, massive mononuclear cell and allogeneic leaflet destruction. In situ functioning valve transplants did not show this form of allograft rejection, even in presensitized recipients. Initial minimal mononuclear cell infiltration was not found after 40 days. All transplants persisted and many leaflets were thin, vascularized, transparent and functionally normal, with viable-appearing leaflet cells. A focal histiocytic and fibroblastic cell reaction progressed through the graft, suggesting tissue restructuring and replacement. Transplanted valves did not increase in size as the animals grew and were associated with large pressure gradients and calcification at the base in presensitized recipients.

### **33. Photographic Analysis of the Active and Passive Components of Cardiac Valvular Action**

RICHARD T. PADULA,\* GEORGE S. M. COWAN,\*

and RUDOLPH C. CAMISHION, Philadelphia, Pa.

Detailed observations of the motion of cardiac valves in a living, beating heart have not been made. The movements of valves seen in pulse duplicators are only passive. Thus, it is unlikely that they are the same as those produced when the annuli, cordae tendinae, and papillary muscles actively participate in valvular function. A system we have previously described before this Association has been improved to permit in vivo, intracardiac photography in dogs. Color motion pictures were obtained through a newly developed fiber-optical lens system illuminated by a mercury vapor lamp. Intracardiac pressures and aortic flow were simultaneously recorded. During cardiac asystole, photographs were again taken while the valves were activated by an external pump which duplicated intracardiac pressures and flow. In the beating heart, rotational closure of the aortic cusps, annular contraction with narrowing of the valvular orifices and contraction of the papillary muscles were observed. Movements of the mitral leaflets during diastole, which may cause the third heart sound were seen. All these findings were absent when the valves were activated by the external pump. Color motion pictures will be shown. The implications of this preparation for in vivo study of valvular prostheses will be presented.

### **34. Long-Term Observation of the Changes in Pulmonary Vascular Resistance after Autotransplantation of the Canine Lung**

CHARLES R. H. WILDEVUUR,\* H. HEEMSTRA,\* K. TAMMELING,\*

C. HILVERING,\* H. BOUMA,\* F. TEN HOOR, and J. KLEINE,\*

Cleveland, Ohio

Sponsored by DONALD B. EFFLER

Pulmonary hypertension is a major complication after autotransplantation of the lung in dogs. Structural defects of the anastomosis are mainly found to be the cause. However, pulmonary hypertension has also been reported in dogs without structural defects. In order to evaluate the cause of these cases, a study was undertaken to investigate the extent and the course of the high vascular resistance in the reimplanted lung. In a group of 29 dogs, 18 long-term survivals were examined by pneumoangiography, bronchography, bronchspirometry, and occlusion of the contralateral pulmonary artery with a balloon-catheter. In nine dogs, no detectable structural defects were found. In this group, two dogs had a higher than normal increase in pulmonary artery pressure after occlusion with a balloon-catheter. One year after reimplantation, these nine dogs underwent contra-lateral pneumectomy. The increase in pressure after ligation of the contralateral pulmonary artery at this time now indicated a high vascular resistance in the reimplanted lungs of five dogs. Six dogs survived the contralateral pneumectomy. In the following study all of these dogs manifested a pulmonary hypertension. This study suggests that in the reimplanted lung of a dog, a slow and progressive increase of the vascular resistance takes place.

### **35. The Hemodynamic Effects of Serotonin in Pulmonary Embolism**

GEORGE R. DAICOFF, FLORENCIO R. CHAVEZ,\* AARON H. ANTON,\*

and EDWARD W. SWENSON,\* Gainesville, Fla.

The intravenous injection of serotonin (5 micrograms/kg. of body weight) in anesthetized dogs resulted in pulmonary arterial hypertension and intrapulmonary venous hypertension without a significant change in the left atrial pressure or pulmonary vein pressure measured just outside the pericardium. Premedication with the serotonin antagonist, methysergide (0.5 micrograms/kg. body weight) was capable of preventing the pulmonary arterial and venous hypertension of the subsequent administration of serotonin (5 micrograms/kg. body weight). Dogs given autologous clots (1 cc/kg. body weight) developed significant pulmonary arterial and intrapulmonary venous hypertension. The clots contained an average dose of 1 microgram endogenous serotonin/kg. body weight. These control dogs failed to survive an average dose of 1.5 cc clot/kg. Dogs premedicated with methysergide 0.5 micrograms/kg. developed a comparable degree of pulmonary hypertension with 1.75 cc of clot/kg. without intrapulmonary venous hypertension. These dogs tolerated three times the amount of clot given to control dogs and failed to develop intrapulmonary venous hypertension. The technique of pulmonary venous cannulation and pressure measurement will be described. The sustained intrapulmonary venous hypertension developed with pulmonary embolism as opposed to the transient effect with a single dose of serotonin will be discussed. The effect of methysergide administration after pulmonary embolism will be presented.

### **36. Experimental Hyperkinetic Pulmonary Hypertension: Tolerance After Biventricular Hypertrophy Produced by a Femoral Arteriovenous Fistula**

CHARLES H. DART, JR.,\* Oteen, N.C., THOMAS MONTGOMERY,\* and

RICHARD M. PETERS, Chapel Hill, N. C.

Attempts at production of significant hyperkinetic (high blood flow) pulmonary hypertension in dogs have been unsuccessful because the large shunts required lead to early pulmonary edema and death. Hyperkinetic pulmonary hypertension has been produced when shunt flow was confined to one or part of one lung. Unconditioned dogs all died within two weeks when a one centimeter dacron prosthetic graft was used as pulmonary artery - aortic shunt. When biventricular hypertrophy was produced with a 1.5 cm. long femoral arteriovenous fistula six to eight weeks prior to the insertion of the shunt, seven of nine dogs survived from one month to three and one half years. Electromagnetic probe measurements of shunt flow prior to closing the chest ranged from 1200 to 2000 cc/min. Indwelling catheters were inserted in the pulmonary artery, left atrium, and aorta for blood manometric and oxygen determinations. In the conditioned dogs mean and systolic pulmonary arterial pressure, pulmonary arterial oxygen saturations, and shunt calculations were consistent with hyperkinetic pulmonary hypertension. The systolic pulmonary arterial pressures ranged from 35 to 70. Creation of a simple peripheral A-V fistula conditions a dog so that high blood flow pulmonary hypertension can be produced.

### **37. Automatic Measurement of Tidal Volume in Postoperative Patients**

F. JOHN LEWIS, and VIJAI K. MOSES,\* Chicago, Ill.

Frequent measurement of at least some of the parameters of respiratory mechanics should help the surgeon in the early recognition of postoperative respiratory complications. To obtain this, we have developed and will describe a digital computer system which provides frequent and automatic measurement of respiratory rate, tidal volume, minute volume, and other parameters which may be derived from a continuous measurement of respiratory air flow. Air flow is estimated from transthoracic electrical impedance sensed by skin electrodes. Calibration is carried out by using the pneumotachygraph as a standard. From about 30 seconds of simultaneous impedance and pneumotachygraph signals, the computer program develops a calibration factor for the impedance signal. Following this, signals from the impedance skin electrodes alone provide the data upon which pattern identification and computation is carried out for a reporting of respiratory parameters every two or three minutes. The validity of the technique has been tested by statistical methods on the records of 15 patients. Implications of this and similar methods for obtaining maximum information with minimal disturbance to the patient through the use of engineering and computer technology will be discussed.

### **38. Assisted Circulation by Synchronous Pulsation of Extramural Pressures**

H.S. SOROFF,\* U. RUIZ,\* W.C. BIRTWELL,\* M. MANY,\* F. GORDON,\*

and R. A. DETERLINO, JR., Boston, Mass.

Assisted circulation has been carried out by introducing energy into the vascular system by synchronous pulsatile modification of external pressure on portions of the body. A system has been designed in which the lower extremities of the animal are enclosed in a double-walled seal which is in turn enclosed in a rigid housing. Water is introduced between the two walls of the seal and is subjected to synchronous pulsatile pressures. The PTM values are reduced by 15%, and the peak aortic diastolic pressure is elevated by 40%, while cardiac output is increased by 15%. The application of external cardiac assist combined with cardiac massage to animals in ventricular fibrillation for five minutes has resulted in an increase of aortic pressure and cerebral blood flow of 65% and 154% respectively as compared with external massage alone. With cardiac massage alone no successful resuscitations were achieved. The combined assist resulted in four out of five successful resuscitations. Studies in normal human volunteers show a 20% reduction in systolic pressure and a 50% increase in diastolic pressure. The results in patients in cardiogenic shock and cardiac arrest will be discussed.

### **39. Clinical Experience With Counterpulsation in Coronary Artery Disease**

JOHN ARTHUR JACOBNEY,\* Denver, Colo.

Sponsored by WILLIAM R. WADDELL

Experimental studies demonstrate that counterpulsation can provide effective circulatory assistance by lowering systolic blood pressure, and it can improve myocardial perfusion by elevating diastolic or coronary perfusion pressure. Dilatation of dormant coronary collateral circulation by counterpulsation has been experimentally demonstrated using both in vivo and postmortem coronary arteriography. Metabolic studies have not successfully evaluated counterpulsation because its two separate effects make studies of arteriovenous differences inconclusive. If counterpulsation can improve coronary circulation by opening up dormant collateral channels, it should be beneficial in chronic coronary disease as well as acute. Six patients with severe three-vessel coronary disease have been studied with pre- and post-treatment selective coronary arteriography and standardized treadmill tests when indicated. At least twelve patients should be studied before this meeting. Pre- and post-treatment arteriograms demonstrate increased coronary circulation in five patients. Standardized post-

treatment treadmill studies in three patients were normal in one with significant increase in exercise tolerance in two. Four returned to normal activity. Two patients are dead with extensive myocardial fibrosis from previous infarctions, emphasizing the need for earlier treatment. Technical aspects will be emphasized because standardization of this procedure is badly needed to clarify conflicting reports based on unstandardized experimental studies of counterpulsation.

#### **40. An Automatic Implantable Intrathoracic Total and Partial Circulatory Support System**

WILLIAM R. RASSMAN,\* SUSUMU TANAKA,\* RANDOLPH M. FERLIC,\*

Minneapolis, Minn., and C. WALTON LILLEHEI, New York, N.Y.

Circulatory support has been primarily approached by two methods: 1) Left heart bypass may benefit heart disease limited to the left side of the heart. However, if associated right heart disease or severe pulmonary vascular changes secondary to left sided lesions are present, success is unlikely with these support systems. 2) Counterpulsation, which has similar advantages and disadvantages, is said to augment coronary artery circulation. Previous investigations here revealed that there is an increase in external work with both systems. The limitations and univentricular nature of the above systems led to the development of implantable intrathoracic support system. A semi-rigid cylinder surrounds the heart and contains an inflatable bladder. Intermittent inflation of the bladder massages the heart. Cardiac output, blood pressure and rate can be partially or completely controlled synchronously. Total circulatory support of the fibrillating heart has been sustained for periods up to 17 hours with complete return of normal circulation after discontinuance of support. Significant pathologic alterations in the myocardium have not been demonstrated. Physiologic and biochemical measurements on metabolic work under normal and pathologically stressed circulatory workloads in synchronously supported hearts will be presented.

#### **41. Alterations in Fibrinolytic and Coagulation Factors During Cardiopulmonary Bypass**

JOHN M. PORTER,\* and DONALD SILVER,\* Durham, N.C.

Sponsored by DAVID C. SABISTON, JR.

This study was designed to evaluate the magnitude, rate, and duration of changes in fibrinolytic activity and coagulation factors during and after cardiopulmonary bypass. *Methods:* Blood samples were obtained pre-operatively, at 15 minute intervals during bypass, and at intervals post-operatively for 7 days from 25 patients. The samples were assayed for fibrinolytic activity, platelet counts, clotting times and prothrombin. Factors V and VII, and fibrinogen concentrations. Urokinase excretion was determined at similar intervals. *Results:* Fibrinolytic activator activity increased 350% (average) and returned to normal within 1 hour after bypass. Prothrombin, Factors V and VII concentrations, and platelet counts were reduced to 20-30% during bypass but returned to control levels within 4 hours after bypass. Fibrinogen was reduced to 30% during bypass. After bypass, fibrinogen increased to 200% of the control by Day 7. Clotting times were prolonged 25% for 4 hours. Urokinase excretion varied and appeared unrelated to circulating activator activity. *Conclusion:* Fibrinolytic activity increases at a time related linear rate while on bypass and is accompanied by significant reduction of coagulation factors. The changes return to normal within 4 hours and remain normal except for a prolonged elevation of fibrinogen. Therapeutic aspects of these changes will be discussed.

#### **42. Transthoracic Left Atrial Cannulation: A New Approach**

G. C. RASTELLI,\* JACK L. TITUS,\* and DWIGHT G. MCGOON,

Rochester, Minn.

The left atrium may be cannulated transthoracically and without fluoroscopy through a tubular graft positioned during the primary operation in those patients considered prone to develop progressive low cardiac output after cardiovascular surgery. One end of a Teflon graft 12 mm in diameter was sutured over the base of the unopen left atrial appendage in 12 dogs. The other end of the graft was led out of the chest through an intercostal space and buried under the skin. One hour to 30 days after operation a Silastic Pezzer-type cannula 6.3 mm in inside diameter, with the mushroom tip stretched over a stylet, was advanced through the exposed graft and positioned into the left atrial cavity after perforating the atrial wall. The graft was tightened over the cannula, the stylet was withdrawn, and left ventricular bypass at flow rates up to 3 liters/min was performed in six animals for 4 to 24 hours. The cannula was then withdrawn and the graft ligated. Seven dogs were allowed to recover. Morphologic observations up to 45 days after cannulation in the dog will be reported. Additional experience with left atrial cannulation in 10 human cadavers will be presented.

#### **43. Superiority of Right Heart Systolic Pressure over Central Venous Pressure Monitoring in Preventing Overtransfusion**

F. T. THOMAS,\* New York, N.Y.

Sponsored by FRANK C. SPENCER

Central venous (CV) pressure is not always a reliable guide in preventing overtransfusion in surgical patients. In search of a more reliable index of overtransfusion, experiments were performed in 13 dogs comparing CV pressure to left ventricular and end-diastolic (LVED), left atrial (LA), pulmonary artery systolic (PAS), pulmonary artery diastolic (PAD),

right ventricular systolic (RVS) and right ventricular end-diastolic (RVED) pressures during hypervolemic transfusions of 1500-2000 ml. of blood given in 500 ml. increments every thirty minutes. The degree of physiological pulmonary edema was gauged by serial monitoring of the arterial PO<sub>2</sub> and the degree of anatomical edema by weighing the lungs at the conclusion of the experiment. With overtransfusions of greater than 1000 ml., the arterial PO<sub>2</sub> fell virtually in direct proportion to the amount of Overtransfusion, reaching values of 25 - 40 mm. Hg. with 2000 ml. of overtransfusion. LVED, LA, PAD, RVED, and CV pressures transiently rose 5-12 mm. above normal for 10-20 minutes following each 500 ml. of overtransfusion. However, these values then returned to normal despite worsening pulmonary edema. In contrast, RVS and PAS pressures remained elevated 10-25 mm. Hg. above normal for periods up to one hour after each 500 ml. of overtransfusion. Monitoring of serial arterial PO<sub>2</sub> values and serial PAS or RVS pressures during rapid transfusion provides the most sensitive safeguard against overtransfusion.

\*By Invitation

## WEDNESDAY AFTERNOON, APRIL 24, 1968

### WEDNESDAY AFTERNOON, APRIL 24, 1968

2:00 P.M. Scientific Session: REGULAR PROGRAM

Ballrooms 1 and 2

#### 44. The Therapy of Cavitory Pulmonary Histoplasmosis

CHANGWOO AHN,\* JAMES W. KILMAN,\* JOHN S. VASKO,\*

and NEIL C. ANDREWS, Columbus, Ohio

Chronic cavitory pulmonary histoplasmosis is usually progressive and may result in death from pulmonary insufficiency if untreated. A critical analysis of the treatment of 42 patients with chronic cavitory pulmonary histoplasmosis has been done. The forty-two patients have been divided into groups, according to their treatment. Sixteen patients received either no treatment or incomplete treatment with Amphotericin B. All sixteen had open cavitory disease at the time of discharge with a follow-up period between 6 months and 4 years. Fourteen patients received over two grams of Amphotericin B treatment without surgical resection. Eight of these patients have cavitory pulmonary disease by x-ray and the follow-up period has been from three months to two years. Two recurrences of the disease and a 14% mortality in this group. Twelve patients received surgical resection for cavitory disease. Seven of these cases were given preoperative and postoperative adequate treatment with Amphotericin B therapy and there has been no recurrence of the disease in this group. A review of the literature reveals 120 surgical resections for cavitory pulmonary histoplasmosis. Only eight of these cases in addition to our seven cases have been treated with preoperative and postoperative Amphotericin B therapy. The mortality and morbidity rate of this group is much improved over the group having surgical resection alone. We strongly feel that the best therapy at the present time for chronic cavitory histoplasmosis is the use of preoperative and postoperative Amphotericin B and surgical resection of the cavitory lesion.

#### 45. The Management of Benign Intrathoracic Tracheal Stenosis

HERMES C. GRILLO, Boston, Mass.

Stenosis of the *intrathoracic* trachea is a formidable complication of assisted ventilation through a tracheostomy and is of increasing clinical importance with growing effectiveness of respiratory care units. Histologic studies show pathogenesis of the lesion to be destructive erosion, with attempted healing by cicatrization, at a point several centimeters *below* the tracheostomy site, at a level where the tip of the tracheostomy tube lay. Conservative treatment is ineffective in management of fully developed lesions. Definitive treatment requires resection of the stenosis and reconstruction. Thirteen patients with benign stenosis of the intrathoracic trachea are included in the present study. Eleven were explored; ten underwent resection and reconstruction - nine successfully. In eight patients reconstruction was accomplished by mediastinal tracheal mobilization with primary anastomosis (with or without adjunctive thoracotomy). Cervico-mediastinal or cervico-thoracic approach was selected in accord with level and length of stenosis. Intrapleural mobilization of the right hilus was necessary to obtain maximum length for primary repair of longer stenotic segments. In one patient who had suffered extensive loss of trachea from prior efforts at repair, reconstruction required fashioning of a cutaneous tube interstitially splinted with special plastic rings.

#### **46. Surgical Repair of Tetralogy of Fallot with a Functioning Potts Aorticopulmonary Anastomosis**

ROBERT E. GROSS, S. BERT LITWIN,\* and WILLIAM F. BERNHARD,

Boston, Mass.

Since 1960, 48 patients with Tetralogy of Fallot and a functioning Potts anastomosis underwent total surgical repair. Transpleural ligation of the shunt was carried out prior to cardiopulmonary by-pass in 7 (Group I). In the remaining 41 cases (Group II), direct suture closure of the anastomosis was performed (via left pulmonary arteriotomy during circulatory arrest at 20°C.). In Group I, there was 1 post-operative death related to Potts shunt closure (persistent Potts and hemorrhage into chest) and 1 unrelated (residual outflow obstruction). One patient died at 3 years (patent Potts anastomosis and endocarditis). Four patients are alive 4 to 7 years post-operatively. In Group II, there were 2 immediate post-operative deaths from air embolization. Three other early deaths and 5 late ones were unrelated to the Potts anastomosis or closure of same. Thirty-one patients are well ½ to 3½ years post-surgery. Other results in this series of patients will be presented. Technical steps in closing the Potts anastomosis (via left pulmonary arteriotomy) and conditions influencing the ease or difficulty of such will be emphasized.

#### **47. Atrioventricularis Communis: Recatheterization Results in 40 Patients Following Intracardiac Repair**

RAYMOND C. BONNABEAU, JR, \* RAY C. ANDERSON,\* RANDOLPH M.

FERLIC,\* Minneapolis, Minn., and C. WALTON LILLEHEI, New York, N.Y.

Between 1958 and 1967, 115 patients with the partial and complete forms of A.V. canal defect underwent intracardiac repair at the University of Minnesota Hospitals. During that same interval 40 patients, all clinically improved, have undergone postoperative cardiac catheterization. In this group, 4 (10%) had minimal left-to-right shunts, while only one (2.5%) had a significant 50% left-to-right shunt. None necessitated reoperation. Seven (17.5%) patients exhibited a trace to 1+ (maximum, 4+) degree of mitral valvular insufficiency, while one patient also had a trace of tricuspid valvular insufficiency. All other patients exhibited essentially normal cardio-vascular physiology. The preoperative and postoperative pulmonary resistances, pressures, and flows will be compared. We have used the degree of mitral valvular regurgitation demonstrated by preoperative cardiac angiography as our main indication for repair of the cleft in the mitral leaflet. We believe that the proper preoperative evaluation of this entity has contributed to the excellent results obtained in this series.

#### **48. Complete Repair of Persistent Truncus Arteriosus Defects**

ROBERT B. WALLACE,\* G. C. RASTELLI,\* PATRICK A. ONOLEY,\*

JACK L. TITUS,\* and DWIGHT C. MCGOON, ROCHESTER, MINN.

Complete surgical correction of a persistent truncus arteriosus (PTA) defect was performed in three children aged 3, 5, and 8 years. One had a type I PTA defect, one a type II defect, and one a type IV defect. Preoperative cardiac-catheterization studies suggested a favorable pulmonary vascular bed with a calculated pulmonary-to-systemic resistance ratio of less than 0.6 in each case. Surgical repair of the type I and type II defects consisted of (1) disconnection of the pulmonary arteries from the truncus and direct suture of the resulting defect in the truncus, (2) closure of the ventricular septal defect, and (3) use of a homograft of the ascending aorta including the aortic valve to reconstruct the pulmonary artery. The type IV defect was repaired similarly by anastomosing the homograft to the two large bronchial arteries supplying the lungs. All three children survived operation and were dismissed from the hospital. Postoperative catheterization studies carried out in one patient showed absence of gradients across the various anastomoses and competency of the grafted valve.

#### **49. Hemodynamic Correction of Transposition of the Great Vessels in Infancy**

A. R. C. DOBELL, and J. E. GIBBONS,\* Montreal, Quebec

Hemodynamic correction (the Mustard operation) has been carried out on five infants ranging in weight from 4.8 to 7.8 Kilograms and in age from 5 to 18 months. Four of the children had required balloon septostomy in early life and three of these had had an atrial shunt constructed surgically some months later. Nevertheless, further deterioration necessitated hemodynamic correction. None of the children had high pulmonary vascular resistance and the operation was well tolerated in all. One child died several days later and the remainder have survived and are thriving. The advent of balloon septostomy permits selected infants to avoid a palliative operation prior to hemodynamic correction. In addition, early application of the intracardiac operation may be the most effective means of preventing the pulmonary vascular obliteration that occurs so commonly in this condition.



## **50. An Analysis of Operated and Non-Operated Patients with Documented Coronary Arterial Disease up to Five Years Following Myocardial Revascularization or Angiographic Study**

EDWARD B. DIETRICH,\* JOHN E. LIDDICOAT,\* EDWARD W. DENNIS,\*

SAMUEL A. KINARD,\* and MICHAEL E. DEBAKEY, Houston, Texas

Selective right and left coronary arteriography has been employed in the evaluation of 500 patients with typical or atypical angina pectoris over the past five years. On the basis of these studies, 170 patients have undergone myocardial revascularization using either direct or indirect techniques. Revascularization was not performed in the remaining patients for a variety of reasons: too advanced coronary arterial disease for which operative treatment was not available, insignificant coronary arterial disease, associated valvular disease, congenital coronary anomalies, or patients refusal of operation. A comparison of the clinical status of operated and non-operated patients with comparable coronary disease patterns up to five years following study or operation has been made. This analysis provides information regarding the presence and severity of angina pectoris, current activity level, and the occurrence of myocardial infarction. Answers to several important questions regarding the progression of coronary arterial disease and the role of myocardial revascularization are available from these data. Such factors as the influence of revascularization on subsequent myocardial infarction and the fate of unoperated patients with documented coronary arterial disease will be discussed.

\*By Invitation

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