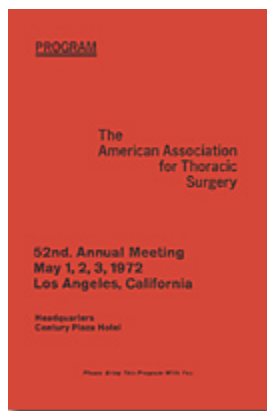


# 1972 ANNUAL MEETING PROGRAM



## The American Association for Thoracic Surgery 1971-1972

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# MONDAY MORNING, MAY 1, 1972

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

**8:45 A.M. Scientific Session: REGULAR PROGRAM**  
**Los Angeles, Ballroom**

## **1. A Five-Year Study of Viable Aortic Valve Homografts**

WILLIAM W. ANGELL\*, Palo Alto, California and  
NORMAN E. SHUMWAY, Stanford, Calif.

In a series of 378 patients, fresh aortic homografts were implanted into all intracardiac positions. Function of the 408 grafts has been followed over a five-year period. The technique of preparation appears to account for a failure rate which is low when contrasted to most reported series of tissue valves. We have attempted to utilize the grafts in a viable state and tissue culture and histology support the concept that there are persistent viable cells in the homograft cusp.

Viability is determined at the time of procurement and again at implantation by *in vitro* tissue culture of the valve cusp fibroblasts. Preoperative frame mounting is employed in all cases except those patients with a small aortic root. Three percent of patients died of valve related causes. Actuarial curves show 5-year survival at 86%. Eight percent more of patients have required reoperation for valve failure, making a total 5-year valve survival of 89%.

Analysis of these data and correlated experimental work leads us to three conclusions: 1) the fresh aortic homograft still holds promise as the best and safest cardiac valve replacement; 2) the low valve failure rate over a significant interval is probably related to use of fresh homografts; 3) the influence of viability on long term function remains to be further elucidated.

\*By Invitation

## **2. Aortic Fascia Lata and Pericardium Valve Replacement: 3 Years' Experience With 100 Cases**

MARIAN I. IONESCU\*, BROJOESH C. PAKRASHI\*,  
MICHAEL P. HOLDEN\*, GEOFFREY H. WOOLER\*, Leeds, England  
Sponsored by Harris B. Shumacker, Jr.

One hundred patients had aortic valve replacement with a three-cusp, frame-mounted graft made of autologous or homologous fascia lata or of heterologous pericardium.

The follow-up period extends over 36 months. The incidence of both hospital and late mortality was 10%, with myocardial failure and bacterial endocarditis as significant etiological factors.

Considerable symptomatic improvement was obtained by all but 3 surviving patients. There was a statistically significant reduction in card 10-thoracic ratio and in the voltage of the E.C.G.

An aortic diastolic murmur was noted in 1 case within 10 days of surgery. It is considered to be due to insertion of a mechanically imperfect graft. The graft was removed 8 months later.

Eight patients developed aortic diastolic murmurs between 1 and 8 months post-operatively. The murmurs are non-progressive and regurgitation is haemo-dynamically insignificant.

Thrombo-embolic complications and haemolysis have been absent. Anticoagulants were not used.

The performance of the grafts was evaluated by angiography and pressure recordings and by "in vitro" hydrodynamic studies, high-speed cinematography, compression and tensile strength measurements and biochemical investigations. Relevant data from these studies is presented.

These grafts in the aortic position have shown good performance, with no emboli and no graft failure, over a period of 3 years.

\*By Invitation

## **3. Long-term Evaluation of Cloth-Covered Metallic Ball Prostheses**

O. WAYNE ISOM\*, C. DAVID WILLIAMS\*, EMILY A. FALK\*,  
and FRANK C. SPENCER, New York, New York

Over a period of four years (October 1967-September 1971), 318 cloth-covered Starr-Edwards metallic ball prostheses (aortic models: 2300, 2310, 2320 and mitral models: 6300, 6310, 6320) were inserted in 281 patients. Most were Class III or Class IV (NYHA). Patients requiring additional cardiac procedures were not included in this analysis. A uniform operative technique, including a Temptrol bubble oxygenator, moderate hemodilution and hypothermia, induced ventricular fibrillation, and intermittent coronary per fusion was employed.

Operative mortality (within 30 days) and late mortality were:

	Cases	Op. Mort. (%)	Late Mort. (%)
Mitral	102	9	5
Aortic	122	5	16
Mitral-Aortic	40	15	3
Mitral-Tricuspid	17	0	2

Over one-half of the late deaths were in Class IV patients from heart failure or arrhythmias.

A continuous semi-annual followup has found that most patients have an excellent functional result. Complications are few: thromboembolism 2%; severe hemolysis 1.5%; endocarditis 2%, perivalvular leakage 2%, and cloth erosion 1%. A Dacron pledget buttress technique has virtually eliminated perivalvular leakage. Results and complications have improved even further with the 2320 and 6320 model valves. These experiences and results will be presented in a statistical life-table form.

\*By Invitation

#### **4. Spinal Cord Complications Following Surgery for Co-arcetation of the Aorta**

LYMAN A. BREWER, ID, Los Angeles, Calif., RICHARD G. FOSBURG\*,  
San Diego, Calif., JOSEPH J. VERSKA\*, and  
G. ARNOLD MULDER\*, Los Angeles, California

In 1968 one of us (LAB) successfully defended a medical legal suit in a case of paraplegia following resection of a coarctation of the aorta. At that time, few such cases had been reported. Since the experience of any one surgeon with this complication is thankfully limited, a broad survey was undertaken, resulting in the accumulation of important data made possible by the generosity of colleagues throughout the world.

To date 56 surgeons or groups have reported approximately 11,000 surgical cases with 41 cord paralyses. Of the 20 cases of paraplegia associated with coarctation of the aorta identified in the literature, 6 have occurred without operation. The modifying factors discussed include variations in the anterior spinal artery, state of collateral circulation, number of intercostals divided, and cross-clamping time.

The role of hypothermia, left heart by-pass, and jump grafts employed to protect the spinal cord is given. Observations on possible causal factors, prevention, and management are made from this world-wide survey and the literature. To the practicing surgeon, one very significant observation emerges: In certain instances paraplegia will occur in spite of every effort to avoid it, apparently from deficiencies of the anterior spinal artery.

\*By Invitation

#### **5. The Role of Mediastinoscopy in the Selection of Treatment for Bronchial Carcinoma with Superior Mediastinal Lymph Node Involvement: A 7 Year Experience**

GRIFFITH F. PEARSON, WILLIAM M. NELEMS\*, ROBERT D.  
HENDERSON\*, and NORMAN C. DELARUE, Toronto, Ontario, Canada

In 454 patients with presumably operable bronchial carcinoma, mediastinoscopy disclosed spread to superior mediastinal nodes in 143 instances (31.5%). In the remaining 311 patients with "negative" mediastinoscopy the resectability rate was 95%, operative mortality 2.9%.

In 113 of 143 patients with "positive" mediastinoscopy, the nature of mediastinal spread was considered evidence of "biological inoperability" for the following reasons: small cell carcinoma (38), extranodal spread and local fixation (30), high right pretracheal spread (25), contralateral spread (20).

30 patients with ipsilateral mediastinal node involvement were selected for preoperative irradiation and resection. 13 of 30 were irradiated but never resected. 9 developed recognizable hematogeneous spread in the interval preceding resection, and 4 refused operation. 12 of these 13 died of tumour (median survival 9 months), and one is alive at 72 months. 17 patients reached thoracotomy, and of 16 resected 2 died postoperatively, 8 died of tumour (median survival 21 months), 5 are living and well, and 1 is living with local recurrence. In 26 patients selected for irradiation and resection, who had ipsilateral spread from squamous carcinoma, the 5 year survival was 20%.

These findings support the use of mediastinoscopy in assessing operability. Resection is recommended for squamous tumours with ipsilateral mediastinal spread.

\*By Invitation

#### **6. Factors Influencing Survival After Resection for Bronchial Carcinoma**

THOMAS W. SHIELDS, Chicago, Illinois, GEORGE A. HIGGINS\*  
and ROBERT J. KEEHN\*, Washington, D.C.

One thousand eight hundred and three patients in the VA Surgical Adjuvant Lung Cancer trials underwent a curative resection during the first ten years of study. These patients have been evaluated for factors predictive of recurrence within five years of the operation. Thirteen characteristics found in an earlier study to be significantly associated with five year survival were examined for independent predictive information using stepwise multiple regression analysis. Prediction of outcome was equally as good when based upon only four of the more important variables; extension of the tumor beyond the lung, involvement of mediastinal nodes, age of the patient, and the presence of another pulmonary disease.

The four variable predictive scores were computed and correlated with long-term survival. There were 752 patients whose predictive scores were less than the mean (more favorable), 696 patients with scores equal to or greater than the mean (less favorable), and 355 patients who had information missing for one or more of the four variables. Survival rates in patients with the more favorable scores were 37 per cent at five years and 24 per cent at 10 years compared with 19 and 11 per cent respectively in patients with less favorable scores. Survival rates in patients with unknown scores were slightly above that for patients with less favorable scores.

Of interest was the failure of cell type or size of the lesion to influence long-term survival. The significance of these findings will be elaborated upon.

\*By Invitation

## **7. Sleeve Lobectomy for Carcinoma - A Ten-Year Experience**

ROBERT J. JENSIK, L. PENFIELD FABER, FRANK J. MILLOY\*  
and JOSEPH J. AMATO\*, Chicago, Illinois

Since 1961, 53 patients have undergone sleeve bronchoplasty resections for bronchogenic carcinoma. Three basic procedures were utilized: Right upper lobectomy sleeve resection in 26; left upper lobectomy sleeve resection in 19, left lower lobectomy sleeve resection in 8.

Thirty-seven patients received preoperative irradiation without significant effect upon morbidity and mortality.

In this group, there are 12 survivors, 8 over 5 years. In the non-irradiated group of 16 patients, there are 7 survivors, 3 beyond 5 years.

Indications for the application of this special resective procedure, morbidity and mortality data, and technical considerations will be discussed.

Salvage of lung tissue and the accomplishment of a five-year survival, ranging from 30% to 35% as plotted on an actuarial curve make this technique feasible and worthwhile.

## **8. Atypical Carcinoid Tumors of the Lung**

PHILIP E. BERNATZ, MARCO G. ARRIGONI\* and  
LEWIS B. WOOLNER\*, Rochester, Minnesota

A review of 215 patients with carcinoid tumors of the lung revealed that 23 had "atypical" tumors; the classification was based on a combination of features such as increased mitotic activity in a recognizable carcinoid pattern, nuclear abnormalities, disruption of architecture, and areas of necrosis. An association between these "atypical" carcinoma and aggressive biologic behavior was evident, 70% of the patients with the "atypical" form had metastasis, as compared to 6% of the patients with the typical carcinoid. This metastasizing potential has obvious implications for surgeons who may have been impressed with the benign nature of bronchial adenomas. The clinical, gross, and microscopic features in these cases support the concept that certain atypical carcinoids have great metastasizing potentialities and should be treated aggressively.

\*By Invitation

# **MONDAY AFTERNOON, MAY 1, 1972**

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

**Los Angeles Ballroom**

## **9. Evaluation and Surgical Management of Acute Evolving Myocardial Infarction**

STANTON N. SMULLENS\*, LESLIE WIENER\*, HRATCH KASPARIAN\*,  
ALBERT N. BREST\*, BENJAMIN BACHARACH\*, PAUL H. NOBLE\*  
and JOHN Y. TEMPLETON, III, Philadelphia, Pa.

This study describes a method of defining the early acute infarction state and the effective management offered by emergency coronary revascularization. Eighteen patients with crescendo angina were deemed candidates for emergency coronary revascularization on the basis of controlled preoperative metabolic and angiographic studies. All patients had chest pain of greater than forty-eight hours duration and electrocardiographs changes suggestive of ischemia. Systemic arterial to coronary sinus venous blood lactate and CPK gradients were measured, and coronary blood flow was determined by constant antipyrene infusion. Myocardial lactate production in sixteen of the eighteen patients, elevation of coronary sinus CPK in all patients and reduction of coronary blood flow in all patients were considered diagnostic of acute evolving myocardial infarction. Emergency cine coronary arteriography and left ventriculography were then performed to precisely define the anatomic lesions. Immediate coronary artery repairs were then made with aorto coronary vein grafts and internal mammary anterior descending anastomoses. An average of 2.5 coronary artery repairs were done per patient. Sixteen of these eighteen high risk patients survived operation. Metabolic studies were repeated in all, two to seven days later. Normal lactate utilization, normal coronary sinus CPK and increased coronary blood flow were observed in every case. All surviving patients have been free of chest pain, arrhythmia or heart-failure for one to seven months following operation.

\*By Invitation

## **10. Aorto-Coronary Bypass for Acute Myocardial Infarction**

LAWRENCE H. COHN\*, RICHARD GORLIN\* and  
JOHN J. COLLINS, JR.\*, Boston, Massachusetts

Sponsored by Ernest Barsamian

Recent reports have demonstrated the benefits of coronary bypass grafts for pre-infarction angina but the value of such grafts for acute myocardial infarction (MI) is as yet unclear. This report presents the results of immediate operative intervention in five patients who developed acute coronary occlusion during coronary angiography.

The 3 males and 2 females ranged in age from 32 to 55 years, averaging 45. Acute obstruction of the right coronary (RCA), occurred in 4 and the left anterior descending (LAD) in one patient. In all five, because of multiple lesions, coronary

bypass was carried out to both the RCA (plus distal endarterectomy in three) and LAD within 3 hours of coronary obstruction documented by angiography.

There were no operative or late deaths nor significant complications. The preoperative clinical symptoms and ECG abnormalities consistent with acute MI were ameliorated in all 5 patients. The average hospital stay was 10 days.

We conclude from this initial experience that immediate coronary bypass for acute MI in this clinical setting is not only feasible but the treatment of choice. It further suggests that earlier diagnosis and treatment may result in improvement in overall mortality from MI.

\*By Invitation

## **11. Endarterectomy as a Supplement to Coronary Saphenous Vein Bypass Surgery**

LAURENCE K. GROVES, FLOYD D. LOOP\*, and  
GARY M. SILVER\*, Cleveland, Ohio

In performing vein bypass surgery to the coronary arteries, one on occasion encounters an artery much more diseased than suggested angiographically. Endarterectomy is logical under such circumstances. Early experience with such "fortuitous" endarterectomies led to extension of their use and to surgery on vessels which previously were considered unacceptable. The procedure is most applicable to the right coronary artery, particularly when totally obstructed and associated with a coincidental, more surgically favorable lesion of the left coronary artery. Most endarterectomies have been done without gas and it is not clear that gas improves the ease or extent of endarterectomy. The procedure has always been done through a small coronary arteriotomy to which a vein graft from the aorta is then anastomosed. One hundred and two endarterectomies have been performed in ninety-seven patients since July, 1970. There has been one hospital mortality. At the date of this abstract 17 of 19 restudied vessels are patent. At the meeting a much larger followup will be reported.

\*By Invitation

## **12. Secondary Surgical Procedures for Myocardial Revascularization**

DUDLEY W. JOHNSON, ROBERT J. FLEMMING\*, ALFRED J.  
TECTOR\*. GEORGE W. BEDDINGFIELD\*. JAMES F. HOFFMAN\*,  
and DERWARD LEPLEY, JR., Milwaukee, Wisconsin

Thirty-six patients having had one to three previous myocardial revascularization attempts have required further revascularization surgery. Recurrent angina which necessitated the secondary surgery was a result of inadequate previous Vineberg procedure (14 patients); late saphenous vein graft closure (11 patients); unsuccessful Beck operation (two patients); and failure of a vein patch graft (one patient). Of special interest is the fact that seven patients in whom further progression of disease in coronary arteries other than those previously successfully revascularized necessitated further surgical intervention.

Angiography is essential to determine whether the recurrent angina is due to new coronary disease or closure of the vein graft. If the problem is "late closure," the initial vein graft flow measurements and condition of the recipient myocardium will help determine feasibility of secondary surgery. Success has been achieved despite previous subintimal fibrosis of the vein.

Technical problems are sometimes considerable in secondary surgery and the various coronary arteries have different degrees of accessibility. This fact has prompted us to bypass lesser degrees of stenosis in the circumflex coronary which is highly inaccessible at reoperation. Technique at initial operation and during secondary procedures which would facilitate and increase safety will be discussed in detail as well as the rationale leading to the original bypass of arteries with lesser degrees of stenosis.

\*By Invitation

## **13. Early Thoracotomy for Empyema**

JEAN E. MORIN\*, LLOYD D. MACLEAN and  
DARRELL D. MUNRO\*, Montreal, Quebec, Canada

Thoracotomy was used as primary treatment or in preference to open thoracostomy in 23 patients with empyema over the 11 years, 1960-1971. These patients had not responded to antibiotic therapy, thoracentesis or closed chest drainage. All were severely ill and febrile. At time of operation, a fibropurulent empyema was found. Concomitant pathology consisted of pneumonia, emphysematous bullae, rheumatoid nodule, bronchopleural fistula, and gangrene of the lung. Decortication with removal of the fibropurulent exudate was performed in 12 patients. A combination of decortication and pulmonary resection was required in the other 11 patients. Clinical improvement was prompt and the average duration of hospitalization after operation was 14 days. There was no recurrence of empyema in any patient. One death occurred in a 76-year-old patient who had sustained multiple injuries leading to his empyema. Recovery was uneventful in the others. The temperature returned to normal, as an average, on the fourth postoperative day.

The prompt recovery seen in these patients suggests that this treatment can be used earlier and more frequently for thoracic empyema.

## **14. The High Velocity Pulmonary Injury - Relation to Traumatic Wet Lung Syndrome**

HAROLD WANEBO\* and JAN VAN DYKE\*, New York, New York  
Sponsored by Edward J. Beattie, Jr.

In a study of 104 battle casualties who required thoracotomy for penetrating chest injuries, 60 patients required surgical intervention for major pulmonary wounds. Indications for thoracotomy were hemorrhage, extensive chest wall damage, and

severely contused and lacerated lung, frequently accompanied by hypoxemia. Complicating factors included shock in 67 percent and multiple injuries (extra thoracic) in 80 percent of these patients. The operative procedures performed included pneumonectomy in 7 patients (none survived), lobectomy in 33 patients (17 survived), wedge resection in 8 (7 survived), and oversewing of bleeding pulmonary sites or bronchial repair in 12 patients 10 of which survived. The overall mortality was 43 percent.

Pulmonary insufficiency was the major post-operative complication and occurred in 44 patients. 28 developed traumatic wet lung syndrome, and 17 of these expired. Contributory causes of this syndrome were high velocity chest-lung injury, massive infusion of blood and saline, intra-bronchial hemorrhage and long term respirator care. Suggestions to improve survival include early exploratory thoracotomy and conservative resection of traumatized lung when clinical signs warrant. Pneumonectomy is usually contraindicated. Intraoperative use of a Carlens Tube, judicious administration of blood and saline and frequent changing of blood filter sets, careful post-operative use of the volume respirator monitored according to patients arterial gases, and use of appropriate diuretics, steroids, digitalis and antibiotics should improve patient survival in high velocity chest injuries.

### **15. Acute Respiratory Insufficiency: Treatment Using Prolonged Extracorporeal Circulation**

JOHN D. HILL\*, MARC DELEVAL\*, MOGENS L. BRAMSON\*,  
ROBERT EBERHART\*, ROBERT FALLAT\*, JOHN J. OSBORN\*  
and FRANK GERBODF. San Francisco, California

Twelve patients dying from acute respiratory insufficiency were treated using long-term extracorporeal oxygenation. The diseases treated were: viral pneumonia, 4 cases; pulmonary trauma, 3 cases; respiratory burn, 1 case, pulmonary fat emboli, 2 cases, and 2 cases of aspiration pneumonia. The duration of the bypasses were 12 hours to 9H days. Seven of the twelve patients were taken off extracorporeal circulation with improved and acceptable pulmonary function. Two of these seven cases, having perfusions of 3 and 5 days, were long-term survivors. Five patients died while on extracorporeal circulation.

Two cannulation methods were used. Veno-veno perfusion diverted 48% of the cardiac output through the oxygenator. Venoarterial perfusion oxygenated 65% of the cardiac output and, by reducing the pulmonary artery pressure and the necessary FIO<sub>2</sub> and tidal volume, provided a better environment in which the lung could recover.

Successful reversal of pulmonary pathology related primarily to the time lapse from pulmonary insult to the beginning of perfusion. Patients rapidly developing acute severe hypoxemia following a pulmonary insult who were placed on extracorporeal circulation early during the inflammatory and exudative stages of their disease, had more rapid reversal of their pulmonary pathology.

\*By Invitation

### **16. Effect of Alterations in Arterial Pressure on Cardiac Performance Early After Open Intracardiac Operations**

NICHOLAS T. KOUCHOUKOS\*, LOUIS C. SHEPPARD\*  
and JOHN W. KIRKLIN, Birmingham, Alabama

Since arterial pressure is one of the main determinants of ventricular wall tension during systole (afterload) and has been previously shown to affect ventricular performance in patients with diseased myocardium, this study was undertaken to assess the effects of acute reductions in arterial pressure on cardiac performance early after open intracardiac operations employing Arfonad (tri-methaphan) infusions. Mean left atrial pressure (LAP), mean aortic pressure (MAP) and stroke index (SI) (indicator dilution technique) were measured before and after infusions of Arfonad to produce reductions in MAP while heart rate remained constant. In 8 patients with pre-infusion MAP of  $109 \pm 6$  mm Hg, elevated LAP ( $25 \pm 5$  mm Hg) and low cardiac index ( $1.76 \pm .32$  L/min/M<sup>2</sup>) reductions in MAP (average 19 mm Hg) produced a statistically significant ( $p < 0.01$ ) fall in LAP (8.2 mm Hg) and an 18% increase in stroke index ( $p < 0.05$ ). In 5 patients with MAP of  $139 \pm 10$  mm Hg, normal LAP ( $10 \pm 3$  mm Hg) and more normal cardiac index ( $2.78 \pm .81$  L/min/M<sup>2</sup>) reductions in MAP (average 31 mm Hg) produced a significant ( $p < 0.01$ ) fall in LAP (3.6 mm Hg) and a 19% decrease in stroke index ( $p < 0.05$ ). The data indicate that in patients with normal or elevated MAP, low SI and elevated LAP, SI can be increased significantly by decreasing arterial pressure, and that this may be an effective method of treatment for some patients with impaired cardiac performance following open intracardiac operations.

\*By Invitation

## TUESDAY MORNING, MAY 2, 1972

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

#### Los Angeles Ballroom

#### 17. Perfusion of the Brain with Venous Blood During Human Heart Lung Bypass

STANLEY GIANNELLI, JR.\*, EDWARD F. CONKLIN\*, STEPHEN

M. AYRES\* and THOMAS F. NEALON, JR., New York, New York

Microemboli to the brain are considered to be the major source of postoperative electroencephalographic changes in open-heart patients. Pre- and postoperative EEG tracings were obtained in 150 consecutive patients perfused without microfilters and in 50 subsequent patients employing Swank filters in the arterial line. Each group had a 50% incidence of EEG slowing. In the filter group, however, the severity was reduced from 1.5 to 0.5 cycles per second.

To improve filtration further, the brain was perfused with venous blood, ultrafiltered by the patient's own capillary bed. A double lumen catheter was employed, inserted into the aortic arch. The brain was perfused with one-third of total venous flow. The rest of the body was perfused with oxygenator blood. Hypothermia to 30° C was employed. The oxyhemoglobin saturation of the cerebral perfusate varied from 60 to 80%. The five patients so perfused to date have all survived without EEG alteration. A prospective, randomized study is being initiated to evaluate EEG and behavioral function. The results of this study and cerebral metabolic data from both groups will be presented.

\*By Invitation

#### 18. Subendocardial Ischemia Following Cardiopulmonary Bypass

GERALD D. BUCKBERG\*, BERNARD TOWERS\*, DONALD E. PAGLIA\*.

DONALD G. MULDER and JAMES V. MALONEY, Los Angeles, California

Subendocardial necrosis in the absence of coronary artery obstruction is reported to cause half the patient deaths following cardiopulmonary bypass (Najafi, Taber). The cause of this necrosis is unknown. This study (56 dogs, 18 patients) demonstrates the etiology of the lesion and shows that its incidence is higher than suspected.

Blood flow to endocardial and epicardial muscle was measured with radio-nuclide microspheres in dogs during various states of cardiac work created by aortic stenosis, patent ductus, artificial pacing, arteriovenous fistula, and isoproterenol administration. Subendocardial damage occurred whenever blood flow to the endocardium was deficient, this deficiency could always be predicted from the interrelation between two easily monitored pressures.

The hearts of 18 consecutive patients (patent coronary arteries) who died after bypass were examined by a special histochemical technique which allows detection of damaged myocardium before it is visible grossly or microscopically. Subendocardial necrosis was identified grossly in five patients, microscopically in two patients, and histochemically in 9 of the remaining 11 (five control hearts were normal). The clinical records show that Subendocardial ischemia occurs with either high or low cardiac output.

Routine monitoring of aortic and left atrial pressure can, with special calculation, be used to warn of impending subendocardial ischemia.

\*By Invitation

#### 19. Disseminated Intravascular Coagulation Following Ex-tracorporeal Circulation

ARTHUR D. BOYD\*, RICHARD M. ENGELMAN\*, REGENT L.

BEAUDET\* and HENRIETTE LACKNER\*, New York, New York

Sponsored by Frank C. Spencer

Disseminated intravascular coagulation (DIG) has been recognized with increasing frequency following sepsis and trauma, but has seldom been detected after extracorporeal circulation. A year ago a 45 year old woman developed gangrene of all four extremities from DIG complicating a low cardiac output after mitral valve replacement. She recovered but amputation of all four extremities was necessary.

Subsequently DIG has been recognized in seven other patients with a low cardiac output after prosthetic valve replacement. Four of the seven died. Recently developed hematologic tests for fibrin split products now permit an early and

more accurate diagnosis of this syndrome. This is of great importance as prompt treatment with Heparin may prevent grave complications. Clinical features of DIG emphasizing early diagnosis and treatment will be presented.

\*By Invitation

## 20. Magnesium and Open Heart Surgery

EDGARD TURNIER\*, JOHN J. OSBORN\*, FRANK GERBODE

and ROBERT POPPER\*, San Francisco, California

The metabolism and clinical importance of magnesium was studied in 31 patients undergoing cardiopulmonary bypass. The following measurements were made: serum and urine magnesium, calcium, sodium, erythrocytes and muscle magnesium. The muscle magnesium determination showed a low level before surgery and a slight increase during cardiopulmonary bypass. Erythrocyte magnesium was at a normal level preoperatively and did not change after surgery. A significant drop in serum magnesium was found during the first one half hour of perfusion. The duration of bypass up to four hours did not increase the initial fall of the serum magnesium value. An increase in tubular reabsorption of magnesium was found in the postoperative period.

A similarity in the mode of excretion existed between magnesium, sodium, calcium and phosphorous preoperatively. Postoperatively, a significant inequality was found between sodium and magnesium. A difference of less significance was present between calcium and magnesium and no change was noted for phosphorous. Clinically, no instance of anythmia could be directly attributed to low serum magnesium value. A low incidence of mental aberrations was found to result in spontaneous recovery.

It is suggested that the intracellular level of magnesium is the most reliable way to diagnose a deficiency state.

\*By Invitation

## 21. The Effect of Deep Hypothermia and Circulatory Arrest on the Distribution of Systemic Blood Flow in Rhesus Monkeys

L. W. RUDY\*, J. K. BOUCHER\* and

L. H. EDMUNDS, JR., San Francisco, California

We studied the distribution of systemic blood flow during deep hypothermia before and after 60 minutes of circulatory arrest (C.A.) at 15°C (rectal temperature). Eleven rhesus monkeys weighing 3 to 4.5 kg were anesthetized with phencyclidine HCl (I.M.) and morphine (I.V.). The bypass circuit from the right atrium to the ascending aorta included a membrane oxygenator and was pruned to produce a mixed venous hematocrit of 24%. Arterial and central venous pressures, ECG, and rectal temperature were continuously monitored. Arterial pO<sub>2</sub>, pCO<sub>2</sub>, pH, blood chemistries, and urine output were measured intermittently. We measured the distribution of systemic blood flow on 5 occasions in each monkey with batches of microspheres (15  $\mu$ ), each labeled with a different radionuclide. Total systemic blood flow was measured by microsphere reference samples and pump calibration. The monkey was then killed and all organs and tissues weighed and counted. Total systemic blood flow (200 ml/kg/mm) at the 5 microsphere injections did not differ within each experiment. Mean changes in systemic blood flow (percentage of total flow  $\pm$  1 standard deviation) were: flow to the heart decreased from 3.5  $\pm$  1.2 (control) to 1.7  $\pm$  0.7 during rewarming; flow to the kidneys decreased during hypothermia before (11.4  $\pm$  3.8) and was greatly reduced after C.A. (4.5  $\pm$  2.1), but returned to control levels during rewarming; cerebral blood flow decreased from control (9.2  $\pm$  1.1) to 5.8  $\pm$  1.8 at 15° C, and to 5.4  $\pm$  1.4 during rewarming; flow increased to the gastrointestinal tract during hypothermia before (17.9  $\pm$  5.7) and after (17.2  $\pm$  4.8) C.A. compared to the control level (8.2  $\pm$  2.2); flow to skeletal muscle greatly increased after C.A. at 15° C from 6.2  $\pm$  1.6 (control) to 13.1  $\pm$  3.1. These changes observed during and after deep hypothermia and circulatory arrest will help to explain some of the clinical observations seen in patients treated similarly.

\*By Invitation

## 22. Perfusion Without Donor Blood

ROBERT S. LITWAK, BENNETT A. MITCHELL\*, MELVIN KAHN\*,

SAMUEL BERGER\*, LOUIS ALEDORT\*. ROY A. JURADO\*

and SALVADOR B. LUKBAN\*, New York, New York

The high incidence of hepatitis (18.3%) following cardiopulmonary bypass at this institution has stimulated attempts to develop a technique in which donor blood is not used. The current protocol involves withdrawal of 500 ml of blood from the patient (a) 4 days prior to surgery and (b) after anesthetic induction (during (b) an equal volume of 5% pasteurized human serum albumin (PHSA) is administered). Perfusion (2.2 L/M<sup>2</sup> at 37.5 C) is conducted with a minimally pruned



Bentley oxygenator (precautionary low level "pump off" switch installed). Priming perfusate is a NaHCO<sub>3</sub>, buffered mixture of PHSA (49.5 g/L), electrolytes (Na 150, K 4.9 and Cl 107 mEq/L) and glucose (5.7 g/L). Osmolality is 340 mOsm/L. During perfusion a 5% solution of NaHCO<sub>3</sub> is administered at 2.5 ml/Kg/hr.

24 cases have been operated in which an attempt was made to avoid donor blood. Cardiac index (5 patients) fell 13% and systemic pressure 12% after blood withdrawal and replacement with PHSA. Perfusion hematocrit (hct) averaged 22 and was 24 two hours post-perfusion (PP). Residual perfusate and previously collected autologous blood was administered PP. Supplemental PHSA was given for volume loading. Acid-base stability was maintained. Hct averaged 27 two weeks PP and most patients had a marked reticulocytosis (8%) by the 6th PP day. Coagulation studies were normal by the 2nd PP day except for low platelets which became normal by day 6.

It has been necessary to break the protocol in 4 of the 24 cases (3 required additional volume loading in the O.R., 1 had a HCT drop to 16 three days pp). 20 of the 24 patients survived and none have developed hepatitis from the PHSA. One patient died of ventricular arrhythmias despite K supplementation. The other 3 deaths were believed to be unrelated to the perfusion technique.

A practical method of perfusion in which only autologous blood would be employed has obvious advantages. Although not uniformly successful, the approach described appears to be promising.

\*By Invitation

### **23. Early Complications of Long-Term Respiratory Support**

WILLIAM H. FLEMING\*, Decatur, Georgia,

JOHN C. BO WEN\*, Cleveland, Ohio

Sponsored by Charles R. Hatcher

A prospective study of 128 consecutive patients receiving mechanical ventilatory support for an average of nine days each showed that central nervous system injury and pulmonary sepsis each accounted for 36% of the 59 deaths. Stress ulcer (10%) was next in frequency as a cause of death. The necrotizing organisms *Pseudomonas Aeruginosa* and *Staphylococcus* accounted for the rather surprising 15% incidence of non-traumatic pneumothorax which occurred in these patients, as well as causing all the 21 deaths due to pulmonary sepsis. Wet lung syndrome occurred in 16 patients, but was not a cause of death. Bronchoscopy consistently improved both the arterial oxygenation and effective lung compliance in 35 patients with atelectasis. There were no hemorrhages from major arteries associated with the 128 tracheostomies, and only one tracheoesophageal fistula in nearly 1200 patient-days of respirator use.

\*By Invitation

### **24. The Management of Interstitial Pulmonary Edema - Significance of Hypoproteinemia**

JOSEPH M. GIORDANO\*, HERMAN KLINGENMAIER\*, WILLIAM L. JOSEPH\*

and PAUL C. ADKINS, Washington, D.C.

Pulmonary insufficiency secondary to nonthoracic trauma has become an important clinical problem and is being recognized more frequently as a major complication following stress. In the past delayed recognition has often led to eventual respiratory failure and death.

Nine patients are presented with the findings of interstitial pulmonary edema. The diagnosis was made on the basis of the characteristic radiographic changes, a low pO<sub>2</sub> despite a high FIO<sub>2</sub>, decreased lung compliance and the absence of other pulmonary problems to account for a decreased oxygen saturation. In addition, all of the patients demonstrated a serum albumin less than 50 per cent of normal. Treatment consisted of restriction of intravenous saline and water, massive amounts of intravenous albumin to elevate oncotic pressure, Lasix to remove mobilized fluid and continuous positive pressure ventilation to maintain alveolar patency during exploration. All of the individuals responded to this regimen with improvement in respiratory function providing physicians with valuable time to treat their primary problem.

The pathophysiology of this disease and results of an experimental model emphasizing the significance of hypoalbuminemia in the etiology of this lesion will be discussed.

\*By Invitation

### **25. The Clinical and Experimental Evaluation of a Controlled Pressure Intratracheal Cuff**

GEORGE J. MAGOVERN, JOHN G. SHIVELY\* and

DAVID C. FECHT\*, Pittsburgh, Pennsylvania

The complications of prolonged tracheal intubation with cuffed tracheostomy tubes are well known. This paper presents a biomedical engineering analysis of the physical factors at the cuff-trachea interface and confirms the dangerously high interface pressures that can be expected when even relatively soft extensible cuffs are used.

As a result, a simple and practical cuff system has been developed for automatic pressure regulations not exceeding 20 mm. of mercury in the endotracheal balloon cuff which still effectively controls sealing pressure. The system employs a specially designed *extra* tracheal balloon whose physical factors determine the internal pressure in the spherical shaped endotracheal balloon cuff. This control pressure balloon permits conventional and safe installation procedures in that too much air cannot be injected, since the excess volume will be retained in the control balloon as a reservoir of inflating gas at the correct pressure for continuous inflation of the endotracheal cuff. The system may accept as much as 100 centimeters of gas without significant effect on the tracheal cuff interface. This system has undergone extensive laboratory testing as well as routine clinical application for the past eight months in fifty patients. These results will be presented with endoscopic pictures of the tracheal cuff interface of patients on prolonged ventilation.

\*By Invitation

## 26. The Effect of Transpulmonary Pressure on Airway Smooth Muscle Tone

WALTER G. WOLFE\*, J. A. NADEL\*, PAUL GRAFT\*

and DAVID C. SABISTON, JR., Durham, North Carolina

Airway smooth muscle tone during mechanical ventilation may have an effect on the distribution of ventilation and gas exchange. To determine if smooth muscle tone contributed to a change in airflow resistance with varying lung volume, measured transpulmonary pressure (Ptp), and airflow resistance ( $R_L$ ) were determined and correlated with measured differences in airway diameter on bronchograms.

Twenty dogs were anesthetized with chloralose (50 mg./kg.) and urethane (500 mg./kg.), tracheostomy performed, and the lungs ventilated following induced paralysis with succinylcholine. Following bilateral cervical vagotomy, inflation of the lungs had an insignificant effect on  $R_L$ , but electrical stimulation of the peripheral ends of the vagi increased  $R_L$  to 10 times above control levels at FRC. Increasing Ptp decreased the effect of vagal stimulation and at 30 cm. of water it was not possible to increase the resistance. Tantalum bronchograms were obtained at various levels of Ptp during vagal stimulation and airway dimensions were compared at each Ptp with the control non-stimulated state. Bronchograms demonstrated uniform constriction of airways from the trachea, bronchi, and down to 2 mm. airways with vagal stimulation at FRC while at elevated Ptp's the airway diameter did not change.

From these studies the following conclusions may be drawn: (1) changes in airflow resistance which occur during ventilation at different lung volumes are due primarily to smooth muscle tone, a factor which has a profound effect upon the physical properties of the airways, and (2) contraction of smooth muscle in the airways is progressively inhibited with increasing Ptp.

\*By Invitation

## 27. Pathophysiology and New Problems in Total Artificial Heart

TETSUZO AKUTSU\*, HISATERU TAKANO\*, HIROYUKITAKAGI\*,

MANSON D. TURNER\*, EDMOND C. HENSON\* and

JACK W. CROWELL\*, Jackson, Mississippi

Sponsored by James D. Hardy

Thirty hours of average survival time in our laboratory in the previous year has been prolonged to one week this year. Air-driven total artificial hearts (TAH) were implanted in 12 calves weighing around 160 lbs. One calf survived a little longer than 10 days. Cardiac output was maintained between 75 to 135 ml/kg/min. The initial pulse rate was set at 70, and was increased later with the increase of venous return. Mean pulmonary artery pressure ranged between 15 and 35 mmHg. Pulmonary function was not affected being indicated by 98% of  $O_2$  saturation in arterial blood. Plasma free hemoglobin concentration decreased to 10-20 mg% following transient increase resulted from extracorporeal circulation. Postoperative animals were quite alive and behaved normally. No calf died by thromboembolism, and no calf showed specific syndrome related to TAH. Blood culture was positive in three out of four longest survivals. Since the TAH model has about a dozen of tubes and wires coming out through the chest wall for driving, monitoring and blood sampling, infection has now become a serious problem as the survival time became long. Durability of the device is another problem in prolonged pumping.

\*By Invitation

## **28. Our Experience in Making Heart Prosthetics**

B. V. PETROVSKY\* and V. I. SHOUMAKOV\*, Moscow, U.S.S.R.

Sponsored by John H. Kennedy

For several years we studied the problem of heart prosthesis. We developed several different models of an artificial heart implanted in thorax or paracorporally. These were pumps of diaphragm or sack type, and were equipped with various valves of ball or disk type to ensure blood flow in one direction. In a number of models the pump surfaces contracting with blood were coated (graphite-benzalkomum-heparme complex, synthetic velours) to prevent thrombosis. The models were driven pneumatically, hydraulically, electrohydraulically and electropneumatically. All prostheses were checked on stands imitating hydrodynamics of greater and lesser circulation. Thereafter, they were implanted in dogs and calves in conditions of artificial blood circulation in more than 100 experiments. During these experiments we mastered the surgical technique of prosthesis implantation, systems of control, and chose parameters of prosthesis operation. We studied hemodynamics, acid-alkali state, blood trauma and other data to make a conclusion about adequacy of operation of some prostheses. Survival time was several hours. The experience accumulated made it possible to develop a prosthesis construction and an automatic control system which we feel is suitable for short time use in clinical practice to maintain an organism vitality of a patient before heart transplantation or for preservation of organs.

\*By Invitation

### **TUESDAY AFTERNOON, MAY 2, 1972**

**2:00 P.M. Scientific Session: REGULAR PROGRAM**  
**Los Angeles Ballroom**

*Address by the President*

**AESCULAPIUS CONTEMPLATES THORACIC SURGERY**  
**John W. Strieder**  
**Newton Lower Falls, Mass.**

*Address by the Honored Speaker*

**SPECIALIZATION IN MEDICINE**  
**C. Rollins Hanlon**  
**Chicago, Illinois**

**3:30 P.M. Executive Session (Limited to Active and Senior Members)**  
**Los Angeles Ballroom**

### **TUESDAY EVENING, MAY 2, 1972**

**7:00 P.M. President's Reception**  
**Santa Monica Ballroom**

**8:00 P.M. President's Dinner and Dancing**  
**Los Angeles Ballroom**  
**Attendance open to all physicians and their ladies. Tickets must be obtained at the registration desk by 5:00 P.M., Monday, May 1, 1972.**  
**Dinner dress preferred**

## WEDNESDAY MORNING, MAY 3, 1972

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

#### Los Angeles Ballroom

#### 31. Normothermic Anoxic Arrest of the Heart: Is There a Means for Estimating the Safe Period?

DAVID C. MACGREGOR\*, VIRENDRAMEHTA\*, MILAN KRAJICEK\*,

JAN KRYSPIN\* and ALAN S. TRIMBLE, Toronto, Ontario, Canada

Normothermic anoxic arrest of the heart has been widely used in open-heart surgery. There is a considerable amount of concern that this technique has a deleterious effect on the myocardium. We have attempted to develop a method of predicting the "safe period" of such an arrest by applying a polarographic technique.

Fifty mongrel dogs were placed on total cardiopulmonary bypass and normothermic anoxic arrest was produced by cross-clamping the ascending aorta and venting the left ventricle. Using a unipolar platinum electrode inserted into the left ventricular myocardium, a biphasic constant current pulse was applied at one minute intervals and the resulting decay curves were recorded graphically. It was noted that a steady state was reached within 15 minutes. The maximum estimated tolerance time for 100% resuscitability of the heart was found to be a multiple of five times the period taken for the curves to reach a steady state. At a multiple of six times, only 50% of the hearts could be resuscitated and at eight times, none.

We feel that this technique may provide an estimate of the safe period of anoxic cardiac arrest clinically. Preliminary studies have shown that similar types of decay curves can be produced in the human heart.

\*By Invitation

#### 32. The Reversibility of Acute Myocardial Ischemic Injury by Restoration of Coronary Flow

CHARLES M. O'BRIEN\*, MARY CARROLL\*, P. T. O'ROURKE\*,

E. L. RHODES\*, OTTO GAGO\*, JOE D. MORRIS and

HERBERT E. SLOAN, Ann Arbor, Michigan

The role of time in the reversibility of acute myocardial ischemic injury by restoration of coronary blood flow was studied in 20 dogs. The anterior descending coronary artery was occluded for one and two hours followed by release of the occlusion for two hours. Control animals were sacrificed after either one or two hours of occlusion. Rubidium<sup>86</sup> was injected into all animals prior to sacrifice, and specimens of left ventricular wall were examined to determine the uptake of Rb. Left ventricular specimens were examined histochemically to demonstrate various aerobic enzymes. None of the dogs with gross infarcts demonstrated by nitroblue tetrazolium (NET) stain revealed any significant histochemical changes when compared to non-ischemic myocardium. The metabolic injury responsible for the demonstration of infarction by NBT stain within two hours of coronary occlusion is not due to decreased activity of the enzymes studied. The metabolic injury produced by one hour of ischemia as determined by Rb<sup>86</sup> uptake is reversed by restoration of coronary flow for two hours. Although the metabolic injury produced by two hours of ischemia is not reversed by two hours of restored circulation, the lack of histochemically demonstrable enzyme changes leaves open the possibility of the reversibility of this ischemic damage with a longer period of restored coronary flow.

\*By Invitation

#### 33. Changes in Vein Grafts Following Aortocoronary Bypass Induced by Pressure and Ischemia

WILLIAM R. BRODY\*, Stanford, California, WILLIAM W. ANGELL\*

and JON C. KOSEK\*, Palo Alto, California

Sponsored by Norman E. Shumway

Several reports of histologic changes in saphenous vein grafts used for aortocoronary (A/C) bypass have described proliferative and fibrotic changes leading to graft sclerosis and eventual thrombosis. This study reports the influence of pressure and ischemia in producing similar changes in A/C grafts in dogs.

Thirty dogs underwent A/C bypass with autologous vein grafts, with specimens obtained from one to 360 days post-op and studied with light and electron microscopy. Serial changes in these grafts consisted of (1) necrosis of medial smooth muscle cells, (2) medial fibrosis, and (3) intimal proliferation.

To isolate the relative contributions of pressure and ischemia to these changes, twenty experimental vein grafts were interposed into the femoral artery or vein in one of four groups

	Femoral Artery Bypass (high pressure)	Femoral Vein Bypass (low pressure)
Ischemic Graft (non in-situ)	Group A	Group B
Non Ischemic Graft (in-situ)	Group C	Group D

Graft ischemia was produced by interruption of the vasa vasorum by complete dissection of the vein from its surrounding bed. Microscopic examination of graft specimens from Groups A and B (ischemic grafts) showed changes (1) and (2) described above, while Groups A and C (systemic pressure grafts) demonstrated intimal proliferation. Only Group A (both ischemia and systemic pressure) showed all three changes observed in the A/C grafts.

These findings suggest that ischemia, secondary to interruption of the vasa vasorum, is responsible for early necrosis and medial fibrosis observed in A/C grafts, while intimal proliferation appears to be induced by "arterialization" of the vein from systemic pressure.

\*By Invitation

### 34. Graft Flow and Reactive Hyperemia in the Human Heart

NEVILLE BITTAR\*, GEORGE G. ROWE\*, WILLIAM P. YOUNG,

GEORGE M. KRONCKE\*, JOHN D. FOLTS\* and

DONALD R. KAHN, Madison, Wisconsin

Graft flow and myocardial reactive hyperemia (MRH) responses were measured in 27 patients following completion of coronary by-pass surgery. MRH was produced by temporary occlusions of the graft and, in several instances, the proximal coronary artery, for periods of 10 and 20 seconds. Fifty-two saphenous grafts were studied. Of 18 grafts to the right coronary artery (RCA), MRH occurred in 11. Average RCA flow was 63 cc/min. There were 23 grafts to the left anterior descending, MRH occurred in 11, and average flow was 88 cc/min. The circumflex graft flow averaged 80 cc/min. and 9 of the 11 grafts showed MRH response. MRH occurred in 18 patients where obstruction was judged on arteriograms to be greater than 90%. MRH was absent with obstruction less than 90%, suggesting this is the degree of critical stenosis at rest. However, there were 9 instances without MRH in spite of 90% obstruction which may be due to inability of resistance vessels to respond further to anoxia, distal obstruction, or errors in judging degree of stenosis. These preliminary studies suggest that MRH responses can be used to test the vasodilator capacity of the coronary beds and may assist in determining the adequacy of revascularization procedures.

\*By Invitation

### 35. Norepinephrine Induced Augmentation of Myocardial Contractility as a Means for Assessing the Immediate Efficacy of Aorta to Coronary Artery Bypass Grafts

ANDREW S. WECHSLER\*, CARL GILL\*, FRANKLIN ROSENFELDT\*,

NEWLAND H. OLDHAM\* and DAVID C. SABISTON, JR.,

Durham, North Carolina

In the non-stressed myocardium, it is difficult to demonstrate the immediate effects of an acute aorta to coronary artery bypass graft. By studying the intrinsic contractile response of the myocardium to norepinephrine (NE) infusion with an acute bypass graft open and occluded, it was possible to discern salutary effects on the graft not evident in the control state.

Ten dogs were studied 3-5 weeks after placing an ameroid constrictor about the left circumflex coronary artery and ligating a branch of the left anterior descending artery. Myocardial contractility was assessed by the ratio of instantaneous rate of left ventricular pressure rise to a common developed left ventricular pressure ( $dp/dt / CDLVP$ ) and by extrapolating the plot of contractile element velocity ( $dp/dt / 32.P$ ) against left ventricular pressure to a point of zero load ( $V_{max}$ ).

In each dog studied, contractility was unchanged with the graft open (mean flow  $27 \pm 2.6$  cc/min) or dosed in the control state. However, when NE 0.3 Mg/kg/min was infused, there was a 68% ( $dp/dt / CDLVP$ ) and 46% ( $V_{max}$ ) greater

increase in contractility ( $P < .01$ ) with the graft open (mean flow  $76 \pm 4.3$  cc/min) than with the graft closed, without other demonstrable hemodynamic differences.

This highly sensitive test is currently being applied to intraoperative assessment of aorta to coronary artery bypass grafts in man.

\*By Invitation

### **36. An Assessment of Intra-Aortic Balloon Pumping (IABP) in Hypovolemic and Ischemic Heart Preparations**

KARL T. WEBER\*, JOSEPH S. JANICKI\*,

ALFRED A. WALKER\*, Birmingham, Alabama

Sponsored by John W. Kirklin

IABP has been proposed in the treatment of cardiogenic shock following myocardial infarction. The balloon is positioned in the thoracic aorta and inflation-deflation, or timing, synchronized with the electrocardiogram. The effect of several variables on IABP were examined in seven dogs and fifteen calves and included mean arterial pressure (20-100 mmHg), heart rate (50-180 beats/min), balloon volume (20, 30, and 40 cc) and timing. Inflation was initiated at the aortic notch and continued into early, middle or late isometric systole. Hypovolemia was accomplished with right heart bypass or phlebotomy and acute ischemia with coronary occlusion. IABP evaluation criteria included the augmentation of mean arterial diastolic or coronary perfusion pressure (MADP) and peripheral coronary pressure (PCP) distal to the occlusion, left ventricular stroke volume and mean ejection rate; the control or abolition of premature ventricular contractions, the reduction of tension time index, mean impedance to ejection, and left ventricular end diastolic pressure.

Our findings indicate (1) maximum hemodynamic effectiveness ( $p < 0.01$ ) occurred with inflation extending into middle to late isometric systole, (2) MADP augmentation was dependent on mean arterial pressure and balloon volume, (3) heart rate did not affect pump performance, and (4) in the acutely ischemic heart, PCP and arrhythmia control during IABP appeared dependent on the collateral bed and MADP.

\*By Invitation

### **37. Hemodynamic and Angiographic Evaluation Following Mustard Procedure for Transposition of the Great Arteries (TGA)**

JOHN R. MORGAN\*, B. LYNN MILLER\*, GEORGE R. DAICOFF,

and E. JAMES ANDREWS\*, Gainesville, Florida

Between August, 1967, and September, 1970, 24 patients ranging in age from six months to 18 years had correction of TGA by the Mustard procedure and the following associated lesions: nine ventricular septal defects (VSD), ten instances of valvar and subvalvar pulmonary stenosis (PS). The operative mortality rate was 29%.

Sixteen of the 17 survivors underwent postoperative cardiac catheterization and angiography. Only one patient showed significant superior vena cava obstruction by catheterization study which was unsuspected clinically but which led to modification of the surgical technic. One patient had a moderate sized, Indirection shunt about the atrial baffle. No patient had pulmonary venous obstruction. Six of the 12 patients had modest elevation of the left atrial pressure. Mild tricuspid valve incompetence was demonstrated in only one of nine patients having right ventricular angiography. Two of four patients with repaired VSD's had small residual shunts. The left ventricular pressure was reduced by surgical relief of the PS. Three patients had evidence of pulmonary vascular disease, two of which had uncomplicated TGA with Blalock-Hanlon procedures performed early in life.

An unexpected and previously undescribed finding was diminished blood flow to the left pulmonary artery in four patients, two of which had near total occlusion.

\*By Invitation

### **38. Replacement of Portions of Canine Esophagus with Composite Prosthesis and Greater Omentum**

WILLIAM A. BARNES\* and SAVERIO F. REDO, New York, New York

A five centimeter segment of the esophagus was excised and replaced with a polyurethane tube encased in stainless steel mesh. Greater omentum as (1) a free graft and (2) in a vascularized, intact state was sutured completely around the composite prosthesis.

In five animals with free omental graft, the graft necrosed and dogs died in 6-10 days. Until time of death these animals had an apparently unremarkable post-operative course. Of the five animals with vascularized (intact) omentum two died 28 and 69 days after surgery as the result of herniation through the incision in the diaphragm used to bring the omentum into the chest. There was no evidence of leakage at the anastomoses. The composite tube was in place and the omental wrap was intact. Two animals who had been eating well were killed 38 and 75 days postoperatively. The omental wrap was firmly attached to the composite tube, healing was excellent and the esophagus patent throughout. The fifth animal continues to do well 120 days after surgery.

The results indicate that segments of the esophagus may be successfully replaced with the composite tube described, utilizing vascularized (intact) omentum as an omental wrap sutured about the prosthesis. Free omental grafts do not survive and should not be used.

\*By Invitation

### **39. One-Stage Bilateral Allotransplantation of the Canine Lungs: Early Rejection and Prolonged Survival with Immunosuppression**

YOSHIO KONDO\*, EROL ISIN\*, JOHN V. COCKREL\*

and JAMES D. HARDY, Jackson, Mississippi

The technical and physiological feasibility of one-stage bilateral lung auto-transplantation has been proven recently in our laboratory. Five dogs are presently alive at 20-24 months postoperatively with only slightly depressed respiratory function ( $PO_2$  65-76,  $PCO_2$  25-31, pH 7.38-7.45). These experiences have encouraged us to expand the procedure to include allotransplantation. Of 45 dogs receiving bilateral lung allografts simultaneously from unrelated donors, 34 survived over 48 hours, eight received no immunosuppression (control group), and 26 received various combinations of immunosuppressants including azathioprine, methotrexate, prednisolone, methylprednisolone and ALG (treatment group). In the control group, all dogs died between 3-6 days postoperatively with clinical signs and gross findings of lung edema. Histologic studies revealed extensive evidence of rejection reaction markedly different in grade from the rejection seen in unilateral allografts. In the treated group, onset of rejection was delayed with initial adequate ventilation, 12 of 26 survived 6-177 days, the longest survivor died of late acute rejection, and another is active at 5½ months. Beneficial effects and hazards of immunosuppression, specific for obligatory lung allografts, were demonstrated by functional studies (blood gases, spirometry, cardiac catheterization, ECG, perfusion scan), complications, and biopsy and autopsy studies.

\*By Invitation

### **40. Serial Observations on Immunologically Matched Lung Homografts**

JOHN R. BENFIELD, KOICHIRO SHIMADA\*, MICHAEL E. PETER\*,

BERNARD GONDOS\* and GILDON BEALL\*, Torrance, California

Differentiation of rejection from infection is a major barrier to successful human lung transplantation. To facilitate this critical differentiation, we have adapted a multi-discipline approach to observing failing lung allografts. Rejection was studied in 12 Immunologically matched immunosuppressed beagle recipients. Serial lung biopsies were examined by light and electron microscopy (EM) and searched for immunofluorescent antibodies. Endobronchial changes were followed by fiberoptic bronchophotography and pulmonary function studies included inhalation and perfusion scanning. An in vitro cytotoxicity assay was developed using donor cells labeled with Cr as targets for recipient effector cells.

Important changes in Type I and Type II alveolar cells were observed by EM. Progressive V/Q derangement with disproportionate deterioration of ventilation was noted as a physiological hallmark of failing transplants. Cytotoxicity assays have not yet reliably correlated with the microscopic criteria of rejection but seem likely to do so. Bronchophotography was helpful in identifying pneumonia and during rejection, characteristic terminal bronchial edema of the recipient's own lung was seen.

We shall show characteristic findings of failing lung transplants with inhalation-perfusion scanning, bronchophotography and lung biopsies. Currently available immunologic aids to identifying pulmonary homograft rejection will be reviewed.

\*By Invitation

### **41. Usefulness of Echocardiography in Patients Undergoing Mitral Valve Surgery**

MICHAEL L. JOHNSON\*, JOSEPH H. HOLMES\*, RICHARD D. SPANGLER\*

and BRUCE C. PATON, Denver, Colorado

Echocardiography is of particular value in determining movement of the mitral valve leaflets. Its non-invasive, non-mjunos qualities lend itself to sequential observation in patients undergoing cardiac surgery. Preoperative determination of significant mitral insufficiency of non-rheumatic etiology is possible. Following attempted annuloplasty in one patient with anterior leaflet prolapse, echocardiographic tracings obtained within one hour post-surgery demonstrated persistent mitral insufficiency. Prosthetic replacement of the mitral valve was performed at which time dehiscence of the repair was noted. Echocardiography utilizing a gas sterilized transducer applied directly to the heart during mitral commissurotomy in two patients demonstrated a change from severe mitral stenosis to mild stenosis without evidence of prolapse of the anterior leaflet of the mitral valve. In addition, examination of the aortic and tricuspid valve, and the right and left ventricular chambers was obtained during surgery. Disc excursion, opening and closing velocities were determined in 30 patients with normally functioning mitral valve prostheses. Dysfunction of two disc valves was detected by ultrasound and thrombus formation was confirmed at reoperation. Measurement of disc movement is accurate to within 0.6 mm. to 1 mm.

\*By Invitation

## **42. The Clinical Application of Low Output Pacemakers**

SOL CENTER and PETER TARJAN\*, Miami, Florida

A five milliamper demand pacemaker with a proven life expectancy of 30-33 months has been used clinically for the past three years in 112 patients. Sixteen patients received low output pacemakers at the time of initial peravenous implantation, 96 others at the time of reimplantation. Because of the confusion which persists regarding acute and chronic stimulation thresholds, 12 patients had stimulation thresholds measured for 12 days post initial implantation. Current thresholds below 4.0 milliamperes were measured in all. Thresholds 30 days postoperatively measured 1.3-2.6 milliamperes. Chronic stimulation thresholds were measured in 165 patients during a six year follow-up period. Thresholds of 4.0 milliamperes or less were found in 93% of patients at the time of first, second, and third reimplantations. Of 112 patients receiving low output pacemakers, only two required reimplantation of a 10 milliamper demand pacemaker because of rising thresholds.

Aside from the practicality of low output pacemaker implantation initially, 93% of patients now carrying standard 10 milliamper demand pacemakers could have low output pacemakers at reimplantation. The advantages are obvious: 1) Longer intervals between operations, 2) lower infection rates which are directly proportional to the number of reimplantations; and 3) decreasing costs.

\*By Invitation

## **WEDNESDAY AFTERNOON, MAY 3, 1972**

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

#### **Los Angeles Ballroom**

## **43. Perforation of the Esophagus: A Thirty Year Review**

B. EUGENE BERRY\* and JOHN L. OCHSNER, New Orleans, Louisiana

Thirty-two cases of esophageal perforation were collected since the inception of the Ochsner Clinic in 1942. During this thirty-year period the incidence steadily increased, paralleling the frequency of endoscopic examinations which accounted for over 75% of perforations. The prevention of endoscopic injuries as well as diagnostic and treatment modalities are of prime importance in this distressing complication. Predisposing conditions to instrumental perforation in our series included benign and malignant strictures, esophageal rings, achalasia, hiatus hernia, and "lipping" of the anterior cervical spine. These patients constituted a high risk group who must be evaluated carefully before endoscopy.

Diagnosis was usually made with the history of endoscopy or trauma, subcutaneous air on physical examination, and free air visible on chest or abdominal roentgenograms. Esophagram confirmed the diagnosis and localized the site of perforation. Prompt diagnosis and treatment is essential. Our experience indicates that some patients can be managed conservatively, however, in the majority, surgical treatment appears most advantageous. Simple drainage of cervical esophageal perforations was sufficient. Suture closure and drainage are recommended for perforations of the intrathoracic esophagus. Concomitant correction of pre-existing pathology is possible when surgical treatment is instituted early following perforation. The overall mortality in this series was 15%.

\*By Invitation



#### **44. Surgical Management of Lymphatic Tumors of the Mediastinum in Children**

STEPHEN LA FRANCHI\* and ERIC W. FONKALSRUD,

Los Angeles, California

Thymic and lymph node tumors constitute the most common neoplasms of the anterior and middle mediastinum in infants and children.

Thirty-four patients less than 20 years of age underwent resection or biopsy of lymphatic tumors of the mediastinum at the UCLA Hospital during the past 15 years. Sixteen had malignant neoplasms of the lymph nodes, including Hodgkins disease, lymphosarcoma, reticulum cell sarcoma, and acute lymphatic leukemia. There were 18 thymic tumors of which 14 were benign, the majority being thymic hyperplasia. Three children had malignant thymomas and one had a granulomatous thymoma.

Cervical or scalene lymph node biopsies provided the diagnosis in 13 of 14 lymph node tumors, whereas bone marrow examination gave a diagnosis in only 4 patients.

Only one of the lymph node tumors was resectable. The remainder were treated with a combination of irradiation and chemotherapy. Four patients are alive an average of 3½ years after diagnosis, 9 are dead, and 3 were lost to followup.

Thymectomy was performed for each of the thymic tumors. Two of the 3 children with malignant thymomas are alive. Twelve of 14 patients with thymic hyperplasia had myasthenia gravis, and all but one are alive an average of 7 years postoperatively. Each of these patients experienced improvement in their myasthenic symptoms postoperatively.

\*By Invitation

#### **45. Longterm Evaluation of Aortic Valvuloplasty for Aortic Insufficiency and Ventricular Septal Defect**

FRANK C. SPENCER, EUGENIE F. DOYLE\*, DELORES A.

DANILOWICZ\*, N.Y., N.Y., HENRY T. BAHNSON, Pittsburgh, Pa.,

and CLARENCE S. WELDON, St Louis, Missouri.

In 1961 a technique of aortic valvuloplasty used in 3 patients for aortic insufficiency with ventricular septal defect was reported. The technique has not been generally adopted, however, and prosthetic valve replacement has been found necessary in many centers. The 2 patients surviving operation 10 years ago remain well with minimal diastolic murmurs. A total of 16 patients have subsequently been operated upon and treated in three different institutions. Prolapsing aortic cusps were repaired in 15 of these with excellent results in 14. Several have mild hemodynamically insignificant diastolic murmurs, but there have been no changes in physical signs of aortic insufficiency after the first few postoperative weeks. One asymptomatic patient had moderate regurgitation. The one postoperative death followed fascia lata replacement of the prolapsed cusp. Followup is now longer than 2 years in 10 patients. Techniques of valvuloplasty have varied with the pathologic findings, and a recent important modification developed by one of the authors (C.S.W.) will be described in detail.

Several crucial principles of technique will be presented. These experiences indicate that aortic valve replacement is rarely needed for this disease.

\*By Invitation

#### **46. The Pulmonary Artery After Debanding**

ANTHONY R. C. DOBELL, DAVID A. MURPHY\*, NORMAN L.

POIRIER\* and JAMES E. GIBBONS\*, Montreal, Quebec, Canada

Thirty-two pulmonary artery bands were partially or completely removed at the time of VSD closure. Three children with complex abnormalities died postoperatively.

Eight children have been re-catheterized some time after debanding. Four had persistence of their VSD and RV systolic pressures were close to 100 mm. Hg. in three of them, with pulmonary flow about twice systemic and normal pulmonary artery pressures.

Four children without residual VSD have been re-studied and resting gradients up to 56 mm. Hg. have been found. We intend to study most of the remaining patients in the next few months. Five children have had a second intracardiac procedure to reconstruct the PA and close the persistent VSD if present. Fibrosis about the pulmonary artery in some of

them has been appalling and the reconstruction has been difficult and unsatisfactory in some cases despite attempts to excise scar widely and interpose patches or do transverse arterial repair.

The indications for pulmonary artery banding should be narrowed because of permanent deformity of the pulmonary artery after debanding. Intracardiac repair should be considered in those infants with VSD who continue to deteriorate despite aggressive medical treatment. Banding should be reserved for dying babies deemed unsuitable for intracardiac repair.

\*By Invitation

#### **47. Spontaneous Breathing With Continuous Positive Airway Pressure (CPAP) After Open Intracardiac Operations in Infants**

SCOTT STEWART, III\*, L. HENRY EDMUNDS, JR.

and JOHN W. KIRKLIN, Birmingham, Alabama

We have performed intracardiac correction in 14 infants using profound hypothermia and circulatory arrest, and have managed their pulmonary subsystem during the postoperative period with the technique of spontaneous breathing and CPAP. 6 patients had transposition of the great arteries, 3 ventricular septal defect, 2 total anomalous pulmonary venous connection, 2 tetralogy of Fallot, and 1 truncus arteriosus Type I. The ages ranged from 5 weeks to 30 months, and weights from 2.9 to 13 kilograms. One death occurred, in an 8 month old child with ventricular septal defect.

Postoperatively the endotracheal tube has been left in place, the babies have breathed spontaneously, and the system of CPAP described by Gregory has been used. This was discontinued between 18 and 96 hours postoperatively, and the patients extubated. No respiratory complications have occurred, although 1 baby did not tolerate the system and required use of a ventilator. Tracheostomy has not been needed, and no baby has required reintubation. The combination of control of the CPAP and of the  $F_{iO_2}$  has allowed ideal control of arterial  $pO_2$ . Arterial  $pCO_2$  has been normal in all babies.

This technique has provided respiratory care which is superior to any we have used previously, ranging from immediate early extubation to prolonged use of volume regulated ventilators.

\*By Invitation

#### **48. Total Correction of Tetralogy of Fallot in Infancy**

ALBERT STARR, LAWRENCE I. BONCHEK\*

and CECILLE O. SUNDERLAND\*, Portland, Oregon

We have performed total correction of tetralogy without prior shunts in 19 patients under two years (including 12 under one year) with two deaths. Seventeen survivors are asymptomatic, take no medications, and are developing normally. Only one required tracheostomy, and none have heart block. Of 12 shunts in this period, there were five deaths.

The most important criterion in selecting patients for correction is the size of the pulmonary artery, severe hypoplasia precludes successful correction in infancy. Preoperative clinical evaluation usually correlates with angiographic findings. Intermittent or mild cyanosis at rest with frequent "spells" often occurs in this age group and usually indicates dynamic, muscular right ventricular outflow tract obstruction without severe pulmonary hypoplasia. This can usually be relieved by infundibular resection alone, and only two of 11 patients in this clinical category required patches across the pulmonary annulus.

The high incidence of good anatomical candidates for total correction in infancy indicates that right ventricular outflow obstruction can be progressive, due to increasing fibrosis of the infundibulum and undergrowth of the pulmonary artery. The policy of early total correction should permit more satisfactory anatomic correction, with less pulmonary insufficiency.

Discussion will include catheterization findings up to four years postoperatively.

\*By Invitation

#### **49. Open-Heart Surgery in the First Year of Life**

IAIN M. BRECKENRIDGE\*, HELLMUT OELERT\*, GERALD R. GRAHAM\*,

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Sponsored by John W. Kirklin

120 infants under 12 months of age have undergone intracardiac surgery using cardiopulmonary bypass at the Hospital for Sick Children, Great Ormond Street, London, between February 1963 and October 1971. Half the series dates from the beginning of 1970. Mean age of all patients was 5.6 months (youngest 4 days), and mean weight 5.5 kg. (range 2.5 to 10 kg.). A disc oxygenator primed with blood was used in most cases, but lately circulatory arrest with perfusion cooling to 22°C. has been successfully employed. Principal diagnostic groups were total anomalous pulmonary venous drainage (TAPVD) (54 cases), transposition of the great arteries (TGA) (39), aortic stenosis (6), V.S.D. (4) and cardiac tumours (3). All were emergency operations, except for the increasing use of elective Mustard procedures for infant T.G.A.'s. Of the 120 children, 62 (51%) have survived, 23 from the first 60 and 39 from the second. The youngest survivor followed aortic valvotomy at 10 days, while another survived emergency Mustard operation at 7 weeks. Of 37 under 3 months, only 8 survived, and all were operated on in 1971. Further details of this clinical experience will be presented.

\*By Invitation

## 50. The Rastelli Operation: Its Indications and Results

DWIGHT C. McGOON, ROBERT B. WALLACE

and GORDON K. DANIELSON, Rochester, Minnesota

The results of the first 100 Rastelli operations performed by the authors are reviewed. The procedure, which involves connection of the right ventricle to the pulmonary artery by a homograft aorta and valve, is applicable for truncus arteriosus, transposition of the great arteries (with pulmonary stenosis), and pulmonary arterial atresia, listed in the order of descending frequency.

Although one fourth of the procedures have not been successful, the experience has identified an optimal age range for operation (5 to 12 years, 11% mortality rate), the acceptable degree of pulmonary vascular obstructive disease ( $R_p/R_s < 0.65$ ), and certain anatomic prerequisites.

Numerous associated anomalies, including absence of a pulmonary artery, interrupted aortic arch, pulmonary arterial banding, anomalous drainage of the right pulmonary veins below the diaphragm, and previous Baffes procedure have posed interesting technical challenges but have not adversely affected results. One patient required subtotal sternectomy to allow room for the graft. Homograft valvular insufficiency is occasionally noted early after operation. Homograft calcification has not resulted in discernible ill effect. Only one late death has occurred (3 months).

The procedure promises to remain a valuable addition to the operations useful in the treatment of congenital heart disease.

\*By Invitation

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