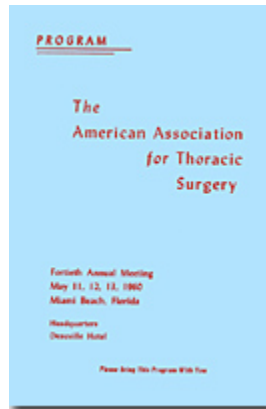


1960 ANNUAL MEETING PROGRAM



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Wednesday Morning, May 11, 1960

8:30 A.M. Business Meeting (Limited to Members) Napoleon Room

8:45 A.M. Scientific Session: REGULAR PROGRAM Napoleon Room

1. The Use of Direct Myocardial Stimulating Electrodes in Complete Atrioventricular Block.

BERNARD S. LEVOWITZ (*by invitation*), WILLIAM B. FORD,
and JAMES W. SMITH, JR. (*by invitation*), Pittsburgh, Pa.

Direct stimulation of the heart through a myocardial electrode has been used in three cases of acquired atrioventricular block associated with Stokes-Adams seizures. Each of these cases failed to respond to an extended trial of medical management in conjunction with extracardiac ventricular stimulation. Our experiences with this technique are described.

The first case was a 77 year old male who had been on an external pacemaker for 2 months. Direct stimulating myocardial electrodes were successfully implanted. His postoperative course was complicated by a delayed splenic rupture attributed to prolonged use of the extracardiac stimulator. In the second case, a 58 year old male, the stimulating electrode broke on the 17th postoperative day. The patient reverted to his idioventricular rate of 30 which subsequently slowed to 10 and then went into cardiac standstill. Following thoractomy, massage and re-implantation of a second pair of electrodes, the patient recovered uneventfully. The third patient was a 69 year old male in poor condition who exhibited progressive deterioration under medical management. His remarkable recovery and rehabilitation after placement of direct stimulating electrodes was most encouraging.

Molar lactate and sympathetic amines were used to combat postoperative hypotension in these cases. The anesthetic management and considerations governing choice of electrode and pacemaker are discussed

2. Surgical Correction of Transposition of the Great Vessels - A Five-Year Survey.

THOMAS G. BAFFES, MAURICE LEV (*by invitation*), MILTON H. PAUL
(*by invitation*), ROBERT A. MILLER (*by invitation*),
WILLIAM L. RIKER (*by invitation*), ARTHUR DEBOER
(*by invitation*), and WILLIS J. POTTS, Chicago, Ill.

The first case of transposition of the great vessels was operated upon at The Children's Memorial Hospital in March, 1955. Since then, 117 cases have been done by the technique of partial correction, with 34 deaths - a mortality rate of 29.0%. However, the mortality has been markedly reduced during the past two years. In 1955-1957, the mortality was around 50%. During 1958 and 1959, it dropped to 11.4% and 8.3% respectively. The factors responsible for this marked drop in mortality are discussed. Primarily, they revolve around a better understanding of proper management of the high pulmonary artery pressure during the operative procedure.

The 83 survivors from March, 1955 until September, 1959, have been followed from five years to six months. The clinical results were graded as follows: Good 70%; Fair 22%; Poor 2%. Six per cent, or five cases, were lost to follow-up to this date. The method of grading is described.

Special attention is paid to the infant group - those children less than six months of age. It is noted that the greatest improvement in mortality and most dramatic clinical improvement has occurred in the infant group, offering a good chance for survival to those most critically ill patients.

The pathology of transposition has been re-evaluated, and a more accurate classification has been devised by Dr. Maurice Lev. This is included and is evaluated in terms of the available physiologic data on the autopsied specimens and our operative cases.

In closing, we describe our efforts in the laboratory to develop total correction of the transposition defect and our version of some of the problems still to be solved.

3. Surgical Palliation in Patients with Ebstein's Anomaly and Congenital Hypoplasia of the Right Ventricle.

MILTON WEINBERG, JR. (*by invitation*), JUAN P. BICOFF
(*by invitation*), LAWRENCE LUAN (*by invitation*),
Zwi STEIGER (*by invitation*), BENJAMIN M. GASUL
(*by invitation*), and EGBERT H. FELL, Chicago, Ill

Ebstein's anomaly of the heart is characterized hemodynamically by an obstruction to right atrial emptying, a result of displacement of the tricuspid valve and a consequent reduction in the volume and functional capacity of the right ventricle. A similar physiologic obstruction is also seen in the rarer congenital hypoplasia of the right ventricle. At the time of presenting this summary, anastomoses between the superior vena cava and the right main pulmonary artery have been performed in two children with Ebstein's anomaly and in one child with congenital hypoplasia of the right ventricle, thereby effecting a partial by-pass of the right side of the heart. Significant clinical improvement has been observed in the two

surviving children, and post-operative studies indicate that the procedure is a physiologically sound method of achieving palliation in these anomalies.

End-to-end anastomoses were done on two of the patients and an end-to-side anastomosis, distal right main pulmonary artery to distal superior vena cava, was done on the third patient. Specific complications resulting from temporary superior vena caval occlusion, a necessary step in performing the end-to-end anastomosis, were observed in one of the patients, and the end-to-side technic is preferred, with division of the cava after completion of the anastomosis.

The possible desirability of closure of an accompanying atrial septal defect is suggested by study of the pre- and post-operative hemodynamic data. Although the effectiveness of the procedure in accomplishing a satisfactory degree of right atrial decompression during the years of growth and increasing cardiac output has not been established, the early favorable results would seem to justify its continued use in these patients with progressive disability.

4. Myocardial Infarction in Infancy: The Surgical Management of a Complication of Congenital Origin of the Left Coronary Artery from the Pulmonary Artery.

DAVID C. SABISTON, JR., SALVATORE PELARGONIO (*by invitation*),
and HELEN B. TAUSSIG (*by invitation*), Baltimore, Md

The diagnosis of myocardial infarction in infancy is being made during life with increasing frequency. In most instances this condition is the result of the congenital origin of the left coronary artery from the pulmonary artery. Under these circumstances the right coronary artery arises normally from the aorta and is supplied with oxygenated blood at systemic arterial pressure. The left coronary artery arises from the pulmonary artery which contains blood of diminished oxygen saturation and with lower pressure. After birth the left ventricle becomes progressively more ischemic and infarction occurs. A study of the reports in the literature as well as our own experience shows that the mortality in untreated cases approaches 100% with death usually occurring in the first year.

Coronary injection and perfusion studies on autopsy specimens were performed and the results showed that flow in the left coronary artery is *retrograde*. Determinations of pressure, flow, and oxygen saturation at operation have confirmed the fact that blood in this vessel drains into the pulmonary artery. These observations led to the conclusion that ligation of the left coronary artery, a procedure previously advocated by others, is a logical and effective method of therapy.

Twelve infants with this condition have been studied at The Johns Hopkins Hospital. Of these, seven had no surgical therapy and died within a year. The five remaining patients were operated upon with ligation of the left coronary artery or de-epicardialization or both. Three are alive and essentially asymptomatic. Two others with severe myocardial damage died at the time of thoracotomy. The diagnostic, physiologic, and pathologic features will be presented and the cardiodynamics illustrated by cine-angiocardiology

5. Diagnosis and Surgical Treatment of Intracardiac Myxoma and Rhabdomyoma.

RODMAN E. TABER and CONRAD R. LAM, Detroit, Mich.

Open heart surgery with the pump oxygenator has made resection of intracardiac tumors practical and safe. This report presents our experience with three such tumors, each of which presented a different clinical picture. Two patients had right atrial myxomas which produced obstruction of the tricuspid valve. One patient was cyanotic due to a right-to-left shunt through an atrial septal defect while the other exhibited signs of severe tricuspid stenosis. The tumor had prolapsed through the tricuspid valve in both instances. Resection of the tumors accompanied by closure of the atrial septal defect in the first patient was followed by prompt recovery.

Ginecardiography and cardiac catheterization demonstrated obstruction in the right ventricular outflow tract of the third patient. At the time of open heart surgery, the tumor mass was found to arise in both the ventricular and atrial septa. Resection of the right ventricular portion of the tumor was carried out to relieve the obstruction. The tumor proved to be a rhabdomyoma. Recovery followed with relief of the preoperative symptoms. This patient represents the first reported case of preoperative diagnosis and surgical treatment of cardiac rhabdomyoma.

6. Vasomotor Activity During Total Body Perfusion.

PAUL W. SANGER, FREDERICK H. TAYLOR, and FRANCIS ROBICSEK
(*by invitation*), Charlotte, N. C.

Observations made during open heart operations indicate that there are changes of unknown origin in the circulatory dynamics during total body perfusion. The perfusion pressure fluctuates despite unchanged flow-rate; on the other hand, if effort is made to keep this pressure constant, the flow has to be adjusted repeatedly. There are also unexplained shifts in blood volume from the patient to the extracorporeal circuit and vice versa.

To investigate these phenomena the authors recorded arterial and venous perfusion pressures, systemic circulatory resistance, and flow-rate in 35 human total body perfusions. They conclude their observations as follows:

The circulatory system shows vasomotor activity during cardio-pulmonary by-pass. In most of the cases there is a vasodilatory phase at the beginning of the perfusion which is followed by generalized vasoconstriction. If the total body perfusion is prolonged, these phases are usually followed by a vasoparalytic state.

Description of two flowmeters, one especially designed to measure the blood flow through the arterial (return) line, the other to measure free discharge (gravity venous outflow), is given.

Wednesday Afternoon, May 11, 1960

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

7. Studies of Peripheral Vascular Resistance Associated with Total Cardio-Pulmonary By-Pass. I. Peripheral Resistance Under Condition of Normothermia and Normotension.

A. ROBERT CORDELL (*by invitation*), MERRILL P. SPENCER
(*by invitation*), and JESSE H. MEREDITH (*by invitation*)
Winston-Salem, N. C

Peripheral vascular resistance (PVR), expressed as cc/min. peripheral flow per millimeter of arterio-venous pressure difference, was determined in 10 dogs before, during and after a 30 minute period of by-pass, using a disc oxygenator.

Cardiac output from the ascending aorta and extracorporeal flow were measured with the Bowman Gray Square-Wave Magnetic Flowmeter.

Normal rectal temperature was maintained within two degrees centigrade. Mean arterial pressure was controlled during by-pass at pre-operative values by pump adjustment. Control cardiac output averaged 87.7 cc/Kg/mm.

Pump output (peripheral flow) during by-pass averaged 70 per cent of control under these conditions. Venous pressure remained around 5 millimeters Hg. except on two occasions when it rose to 15 millimeters Hg for a short period. PVR increased steadily during by-pass.

Cardiac output immediately following by-pass was usually below pre-by-pass values. A-V oxygen difference and blood pH were measured from blood samples throughout the experiments. Total oxygen uptake was calculated from serial A-V oxygen difference and peripheral flow and dropped sharply during the period of by-pass. Interpretation of these data will be made and a short movie shown to demonstrate techniques of the experiments.

8. Lipuria and Lipasemia after Thoracic Surgical Procedures.

F. PRICE COSSMAN (*by invitation*), FEDERICO ADLER (*by invitation*),
and C. FREDERICK KITTLE, Kansas City, Kan.

The occurrence of fat globulemia has previously been demonstrated in patients after severe extremity trauma or major soft tissue operations. Most recently our laboratory has studied postoperative changes in serum lipase and the occurrence of lipuria in patients undergoing a variety of thoracic operations including extracorporeal procedures.

In 19 patients to date 11 have had significantly elevated serum lipase (above 2.0 mgm%) and all have shown lipuria of varying extent in the immediate postoperative period. Six of 8 patients following extracorporeal perfusion have had lipasemia while all have had lipuria. A review of autopsy material in patients dying after perfusion has revealed intravascular fat-staining material in the lungs and kidneys in several instances.

The significance of these observations will be interpreted in respect to the magnitude of the operation, the operative trauma to soft tissue, possible nitrogen release from tissues during extracorporeal perfusion, and effect of the extracorporeal apparatus on circulating chylomicrons.

9. Analysis of 50 Cases of Pulmonary Emphysema, Blebs, and Bullae Treated Surgically.

JEROME R. HEAD, THEODORE R. HUDSON, LOUIS R. HEAD
(*by invitation*), and JAMES M. HEAD (*by invitation*),
Chicago, Ill

Experience with this group of patients is described. They are analyzed with regard to respiratory physiology, pathology, surgical therapy, and immediate and late results.

The respiratory physiology is altered by three pathologic states: (1) a space-occupying lesion, (2) a generalized process and (3) a combination of the two.

Solitary cysts, blebs, and bullae alter respiratory physiology as space-occupying lesions; obstructive emphysema as a generalized process; and emphysema with cysts, blebs and bullae as both.

The surgical therapy of these conditions has included Monaldi suction, surgical resection, or a combination of the two. At the present time Monaldi suction is reserved for those cases whose respiratory function prohibits resection. This is rapidly being replaced by pre- and post-resection respiratory assistance. Excellent results are obtained in cases of solitary cysts, blebs and bullae by means of resection with or without respiratory assistance. Excellent immediate results but discouraging long term results are obtained in cases of generalized emphysema with cysts, blebs or bullae by means of a combination of surgical procedures. Overall poor results are obtained in cases of generalized emphysema by all modes of surgical therapy.

The cases are tabulated and each group is illustrated by means of clinical course, x-ray findings, pulmonary function studies, surgical pathology and long term follow-up.

10. Lung Abscess in Japan.

KINGO SHINOI (*by invitation*), Tokyo, Japan.

Since 1938, 550 cases of lung abscess have been treated by the Department of Surgery of Tokyo Medical College. Among these there are 338 cases which belong to the pre-antibiotic age. The author reports on some characteristics of this disease in Japan and the results obtained.

1. Analyses have been made of the etiology in our cases. Lung abscesses following dental operations or tonsillectomy are relatively few in Japan when compared to the world literature.

2. Since the discovery of chemotherapy, we find marked changes in the clinical picture of this disease. The patients who visit our surgical clinic have either a "silent" abscess or a far advanced chronic relapsing form. The picture has changed from the fuso-spirochetal type to the drug resistant staphylococcal lung abscess.

3 As the result of biochemical study of sputum and histologic study of the specimen, it was revealed that sputum in the chronic stage is produced by secretion from increased goblet cells formed in the epithelial layer in the pyofibrotic lesion. Furthermore, the relationship between the degree of hyperplasia of goblet cells and the quantity of sputum were studied in comparison with bronchiectasis. The author concluded that bronchiectasis associated with inflammation and chronic lung abscess should be handled as one and the same disease.

4. Based on studies made upon the cardiopulmonary function in relation to surgical operation, it is found that in patients with excessive expectoration decreased ventilatory and alveolar function develops, leading to latent anoxia and subsequently to pulmonary hypertension. At this point I should like to point out the defect of cardiopulmonary function in a "wet" case and to propose the criteria for operation.

5. The results of treatment in 202 cases belonging to the post-antibiotic age showed a cure rate of 65% by pneumotomy and 96% by lung resection.

11. A Study of Essential Hemoptysis.

RAYMOND J. BARRETT and WILLIAM M. TUTTLE, Detroit, Mich

Essential hemoptysis is a term used to cover those instances where no significant lesion can be found to account for the patient's symptom. Use of the term presumes a negative chest roentgenogram, negative bronchoscopic and bronchographic findings and negative psychology. Where indicated, angiocardiology and cardiac catheterization must also be utilized and should, of course, yield normal results, to allow use of the term "essential hemoptysis." One hundred cases which meet such criteria have been followed for periods ranging from one to eight years. These are analyzed in regard to subsequent recurrence of hemoptysis, later development of serious disease, and survival.

12. Ligation and Division of the Bronchus in the Surgical Treatment of Cavitory Tuberculosis.

J. MAXWELL CHAMBERLAIN, and THOMAS M. MCNEILL
(*by invitation*), New York, N. Y.

Auto-occlusion of the bronchus is one mechanism which leads to closure and healing of a tuberculous cavity. In the pneumothorax era, the dramatic closure of a "tension cavity" occasionally occurred, and on several occasions we had similar experiences when the bronchial dynamics were altered sufficiently by thoracoplasty or phrenic nerve paralysis.

Aware of this method of healing, W. E. Adams attempted in the early 1930's to produce bronchial occlusion endoscopically in animals by silver nitrate cauterization. In 1934, Adams and Vorwald reported their experimental results, and mentioned the use of silver nitrate cauterization in four clinical cases of tuberculosis. In general, the clinical use of endoscopic methods to occlude a bronchus has had little success, yet we believe the fundamental concept is sound.

Auto-occlusion of the bronchus that occurs as the end result of endobronchial tuberculosis is a fortuitous incident in the patient's course. We have observed such occlusions clinically in the main bronchus, and also in lobar, segmental and sub-segmental bronchi.

Operative occlusion of the draining bronchus can mimic successfully the naturally occurring event, and provide selective pulmonary collapse. In the last 10 years we have elected to ligate and divide the bronchus in 25 cases, including several bilaterally. These were mostly far-advanced, poor-risk cases, whose organisms were resistant to the standard anti-tuberculous drugs. In spite of this, the operative morbidity was surprisingly low, and the end results in properly selected cases were remarkably good. Space problems, with attendant complications and chest wall deformities, are eliminated.

This single-stage, non-deforming operation will find its greatest usefulness in the far-advanced, poor-risk case whose organisms are drug-resistant, and in whom even a minor surgical complication might prove disastrous.

13. The Culture of Tubercle Bacilli from Resected Specimens of "So-called" Negative Patients.

WILLIAM P. COOHLAN (*by invitation*), GEORGE S. WILLAUER,
CHARLES FINEBERO (*by invitation*), and ROBERT G. JOHNSON
(*by invitation*), Philadelphia, Pa.

There has been some hesitancy to recommend surgical resection for the patient who shows maximum clearing on X-ray and whose sputum has converted with antimicrobial therapy. Despite the negative sputum, we believe that such lesions contain viable tubercle bacilli. The high relapse rate in such patients is thought to be due to reactivation of these quiescent lesions. With reactivation and spread, the patient's prognosis is not as favorable as it would have been at original target point.

With these facts in mind, the following program was instituted in October, 1952, at the Eagleville Tuberculosis Sanatorium. Following surgery, the resected specimen was routinely opened by the operating surgeon, and smears made directly onto culture media. In 123 consecutive pulmonary resections, 22 patients who have had negative sputum cultures preoperatively, have had positive growth from their resected specimens.

The authors feel that this demonstrates significant viability of tubercle bacilli in lesions from "so-called" negative patients. Pulmonary resection in this group of patients offers a more favorable prognosis for permanent cure.

Thursday Morning, May 12, 1960

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

Napoleon Room

14. The Subcoronary Implantation of a Flexible Tricuspid Aortic Valve Prosthesis.

BENSON B. ROE, MERVYN F. BURKE (*by invitation*), and

HARRY ZEHNER (*by invitation*), San Francisco, Calif.

A satisfactory, low-resistance, totally competent, flexible tricuspid aortic valve prosthesis has been developed in our laboratories and was reported earlier. Its material and mechanical characteristics have undergone long-term testing in the ascending aorta of the experimental animal. Despite many improvements in material and production, the valves implanted more than two years ago are continuing to function and have produced no clotting.

The cylindrical housing of the originally reported valve has been reduced to the shortest possible axial length and a plastic sponge jacket has been incorporated in the outside wall to promote tissue fusion with the endocardium. A satisfactory technique has been developed for placing this valve in the left ventricular outflow tract transaortically so that it is secured with accurately placed sutures below both coronary ostia. This maneuver now requires less than 25 minutes of extracorporeal circulation, including the time for total excision of the anatomic leaflets, three interruptions for intermittent coronary perfusion, and closure of the aortotomy. Twelve consecutive animals have recovered from the maneuver sufficiently to restore normal cardiac function with satisfactory systolic and diastolic pressures. Death has occurred between 6 and 12 hours from hemorrhage and shock, but in each instance the valve is seen to lie in a satisfactory position without interference with mitral valve function.

15. Experimental Production of Aortic Stenosis.

ANTHONY J. MUNOZ (*by invitation*), and SAM E. STEPHENSON, JR

(*by invitation*), Nashville, Tenn.

The development of lesions simulating acquired valvular heart disease in animals has presented a major problem. In an attempt to evaluate surgical procedures for aortic stenosis lesions of early aortic stenosis have been obtained in mongrel dogs.

Two groups of animals have been studied. One group was rendered euthyroid with I_{131} . They were then fed toxic doses of vitamin D and a high cholesterol diet. These animals promptly developed high cholesterol blood levels and in as short a time as thirty days were developing arteriosclerotic-like plaques around the aortic annulus. Dogs sacrificed at 3 to 6 months develop plaques completely encircling the aortic annulus and fusion of the commissures occurs.

The second group of animals demonstrated the same findings. The only variation in the procedure was that propylthiouricil was used instead of I_{131} .

Photographs of the specimens obtained along with catheter data and pressure gradients representing early aortic stenosis will be presented. Animals sacrificed after one year will also be discussed.

16. Evaluation of a New Nonwetable Macroporous Membrane with High Permeability Constants for Possible Use in a Membrane Oxygenator.

JAMES S. MCCAUGHAN (*by invitation*), RICHARD WEEDER (*by invitation*),

JOHN G. SCHUDER (*by invitation*), and WILLIAM S. BLAKEMORE,

Philadelphia, Pa

A recently developed method of producing plastic membranes has made possible the production of membranes with predetermined pores which can be selectively ranged from 3 to 300 micra. These can be prepared either wettable or nonwetable and the per cent of plastic lattice work and pores can be varied by adjusting the relative amounts of filler and plastic in the formulation. A nonwetable polyethylene membrane with pores 10 micra in diameter and representing 80 per cent of the volume was prepared and tested for gas permeability. Since it is nonwetable, liquids will not pass through it and due to its high porosity, gases flow across it rapidly. A simple apparatus and technique were devised for measuring the relative permeability of polyvinyl, polyethylene, Teflon, ethycellulose, and Silastic for comparison with the new macroporous membranes. Under controlled temperature, pressure and flow rate, carbon monoxide (CO) was passed on one side of the membrane which divided a chamber into two parts and oxygen (O₂) was passed on the other side. The amount of CO that diffused into the oxygen stream was then measured with a Stalex CO analyzer which will measure one part of

CO per million. From these data and the thickness of the membrane, the permeability constants of the membranes were computed and compared. The membranes that have the highest permeability to CO also have the highest permeability to O₂.

Our results indicate that the new macroporous membranes are over 2000 times as permeable as Teflon, the membrane which is currently in use in membrane oxygenation.

Animal studies using these membranes in an experimental oxygenator are now in progress.

17. Temperature Compensated, Self-Calibrated Oxygen Monitoring Device.

JESSE H. MEREDITH (*by invitation*), JOHN H. ARTESANI (*by invitation*),
and JOSEPH MAMLIN (*by invitation*), Winston-Salem, N. C.

Control of the oxygen content in both the venous and arterial blood during cardiopulmonary by-pass has been difficult. This has been from a single obstacle, the inability to monitor the amount of oxygen in the arterial and venous blood. The development of an electrode for the polarographic determination of oxygen by Leland Clarke was a great step in the monitoring of oxygen. This device, however, is sensitive to changes in temperature and must be calibrated with each use and is not auto-clavable.

This paper describes a transistor circuit in which the temperature changes are automatically compensated for and which is self calibrating Autoclavable probes which can be inserted into the venous or arterial lines of the cardiopulmonary by-pass are described. The results of a series of perfusion experiments, during normothermia and severe hypothermia, during which the blood flow was controlled by monitoring the venous oxygen content, will be described.

18. Pulmonary Arterial Hypoxia versus Inspiratory Hypoxia in Relation to Increased Pulmonary Vascular Resistance.

PETER V. MOULDER, JOSEPH LANCASTER (*by invitation*), ROBERT
W. HARRISON (*by invitation*), STEPHEN MICHEL (*by invitation*),
and RICHARD G. THOMPSON (*by invitation*), Chicago, Ill.

An experimental set-up has been devised with the use of an extra-corporal pump-oxygenator with venous by-pass to control pulmonary arterial oxygen saturation while varying inspired gas oxygen concentrations. Continuous measurement of cardiac output, pulmonary artery and left atrial pressures has been used to calculate pulmonary vascular resistances during the experimental runs. Central aortic pressure and electrocardiogram are monitored to judge normalcy of heart action; right ventricular pressure is monitored to rule out any period of right ventricular failure to be evidenced by elevation of the diastolic pressure. The right atrial pressure is used to monitor inflow pressure in some experiments while in others a constant pressure reservoir has been used to allow the animal to adjust the atrial inflow volume. Pulmonary wedge pressure has been measured in some experiments to rule out any role of pulmonary venospasm. Pulmonary arterial, mixed venous ("well") and aortic oxygen saturations were determined in each run. Inspired gas oxygen concentrations of 40%, 10%, 5% and 3% have been studied.

Spectacular increases in pulmonary arteriolar resistance have been obtained with severe pulmonary arterial hypoxia, inspiratory gas hypoxia and even with pulmonary arterial hyperoxia (with the oxygenator). When severe hypoxia has been produced with low inspiratory gas oxygen concentrations, the increased vascular resistances can be decreased somewhat by rapidly oxygenating the pulmonary arterial blood with the oxygenator but the reversal is not to normal.

19. Treatment of Bank Blood by Resins.

EDWARD D. MCLAUGHLIN (*by invitation*), THOMAS F. NEALON, JR.
and JOHN H. GIBBON, JR., Philadelphia, Pa

The use of cation exchange resins to reduce abnormally high levels of ammonium and potassium in stored blood has been reported from this laboratory. Blood so treated still has an abnormally low pH chiefly due to the citrate preservative. Using a combination of anion and cation-exchange resins, it has been possible to return the ammonium and potassium to normal levels and also to substitute chiefly bicarbonate for the added citrate and the other increased anions. The harmlessness of large transfusions of old bank blood so treated has been demonstrated by exchange transfusion in dogs.

Pooled canine blood was collected in siliconized glass bottles containing 75 ml. of ACD solution per 500 ml. of blood. Twelve liters were stored at 5°C. for 14 days and a like amount for 21 days. After storage the blood was passed over the resin. The changes were similar in the 24 liters of blood and are averaged in the following table:

	At Collection	After Storage	After passage over Resins
ph	7.35	6.16	7.10
NA mEq/L	141	163	136
K mEq/L	4.1	19.5	0.6
NH ₄ mcg%	135	412	126
Ca mg%	9.4	1.7	4.6
Cit. mg%	1.5	449.0	2.0
PO ₄ mg%	3.7	7.3	2.8
Lact. mg%	16.8	157.0	63.0
Pyruv. mg%	1.37	7.26	1.25
Plasma Hb mg%	9.8	49.0	61.3

This blood was then used in exchange transfusions of greater than 200% of the calculated blood volume in eight consecutive dogs without a fatality. All blood electrolyte values were normal 24 hours after transfusion. All dogs were sacrificed and autopsied after two weeks observation. No deleterious effect from the transfusions was observed.

The passage of stored ACD blood over combined anion and cation-exchange resins may reduce the danger of massive transfusion of bank blood and facilitate the procurement of blood for use in heart-lung machines.

20. Gas-Exchange Dynamics of Glycerolized Frozen Blood.

THOMAS G. O'BRIEN (*by invitation*), Chelsea, Mass., and

ELTON WATKINS, JR., Boston, Mass

Over one thousand units of glycerolized, frozen, thawed, deglycerolized red blood cells resuspended in their original or a 5% albumin solution have been administered as blood volume replacement to patients at the Chelsea Naval Hospital. All measured factors would indicate that blood processed in this fashion functions as normal blood *in vivo*. The units were frozen at minus 80 or minus 120 degrees for periods of from one to 40 months.

Recent work in our laboratory gives every indication that blood, collected in heparin and processed in the above fashion and stored at minus 80 degrees, is very suitable as priming volume in pump-oxygenators. Cell loss following three hours of closed circuit perfusion was negligible in *in vitro* studies.

The gas exchange characteristics of these frozen red cells have never been determined. It is apparent that they take up oxygen normally. Their oxygen releasing capacities are unknown. This problem is being studied by conventional methods of blood gas analysis utilizing tonometric equilibration of reconstituted deglycerolized red cells with oxygen at varying oxygen tensions within the physiologic range. Dissociation curves are to be compared with control curves for fresh blood and ACD preserved blood. Ancillary studies of plasma electrolyte concentrations, pH and carbon dioxide exchange dynamics are to be included.

In view of the fact that the clinical use of frozen blood is an actuality and that frozen blood would seem to tolerate the trauma of perfusion in pump oxygenators at least as well as fresh blood, it is felt that a detailed report of the dynamics of gas-exchange characteristics of frozen blood would be pertinent.

21. The Relationship of the Sympatho-Adrenal System to Potassium Flux and Cardiac Irritability Induced by Alterations in Blood pH.

BERNARD GOOTT (*by invitation*), J. ROSENBERG (*by invitation*),

R. C. LILLEHEI (*by invitation*), FLETCHER A. MILLER

(*by invitation*), and OWEN H. WANGENSTEEN,

Minneapolis, Minn.

Previous investigations in our laboratory have demonstrated that following prolonged inhalation of high concentrations of carbon dioxide, ventricular fibrillation frequently occurs in the immediate post-hypercapnic period. During the phase of respiratory acidosis the animal exhibits a significant increase in serum potassium, inorganic phosphorus and blood glucose. These changes are consistent with increased sympatho-adrenal activity, which we have confirmed by demonstrating elevated

catecholamine levels during hypercapnia. Infusion of epinephrine produces a similar rise in serum potassium levels. This can be prevented by exclusion of the liver from the circulation, thereby suggesting that the liver is a major source of the potassium increase, the stimulus for such increase being the sympatho-adrenal system. Simultaneous sampling of arterial and coronary sinus blood following rapid injection of epinephrine or nor-epinephrine in control animals indicates that this produces an immediate uptake of potassium by the heart. Tissue analysis demonstrates a 15-20% increase in myocardial potassium content during the period of respiratory acidosis. With rapid return of the arterial pH to normal by ventilation with air, the heart loses this excess potassium rapidly, as demonstrated by simultaneous arterial-venous samples. This loss bears a temporal relationship to disturbances in cardiac rhythm and is associated with a precipitous drop in serum catecholamine levels. When epinephrine is infused during the critical post-hypercapnic period, the sudden loss of this excess myocardial potassium has been demonstrated to be inhibited and ventricular fibrillation does not develop. Data will be presented to substantiate these statements.

22. Bronchoscopy and Bacteremia.

SHELDON OSCAR BURMAN (*by invitation*), Pittsburgh, Pa

A majority of patients subjected to bronchoscopy exhibit mild fever beginning about an hour following the procedure and lasting occasionally for two days. The etiology of the fever is obscure, being variously attributed to the stress of the procedure, traumatic inflammation and minute laceration of the bronchial mucosa, the presence of blood within the lumen, or the excitation of pre-existing pulmonary infection. Fever associated with the bacteremias following urethral intubation are commonplace, and, recently, sigmoidoscopic manipulation has been shown to cause transitory bacteremias. The question arose whether the fever of bronchoscopy likewise was attributable to transbronchial dissemination of pyogens into the blood stream.

Careful antibiotic records were obtained from each patient studied. Just prior to bronchoscopic examination a 10 cc "baseline" blood sample was collected using sterile technique from an antecubital vein. During bronchoscopy a second blood sample was withdrawn and four hours later a third 10 cc sample was obtained. Following bronchoscopy, rectal temperatures, pulse, and respiration rates were recorded every four hours for two days and whenever a fever of one degree or more occurred a further 10 cc sample was withdrawn. Aerobes and facultative anaerobes were incubated at 37°C. in trypticase-agar slant bottles also containing 50 cc of trypticase-agar broth. Each blood sample was halved and duplicate inocula planted. Cultures were inspected daily for 21 days and all growth was suitably sub-cultured and characterized. Cultures evidencing any contamination whatever were excluded from the series. To date, unequivocal, pure cultures in moderate to heavy growth have been obtained from four of 24 patients studied or 17 per cent. The organisms isolated were streptococcus in two cases, staphylococcus aureus coagulase positive in one case, and staphylococcus citreus in one case. All these patients exhibited one degree or more of fever and all positive cultures were obtained from the aliquot drawn four hours following bronchoscopy. The rather striking clinical significance of these findings will be discussed.

23. Altered Hemodynamics in the Pulmonary Circulation Following Reaeration of an Atelectatic Lung.

EDWIN TUTT LONG (*by invitation*), ARTHUR F. REIMANN (*by invitation*),

TAKAMARU MIKOUCHI (*by invitation*), JOHN R. BENFIELD

(*by invitation*), and SALVATORE L. NIGRO (*by invitation*),

Chicago, Ill.

The physiologic shunting of venous blood through an atelectatic left lung in a dog has been shown to average approximately 15% of cardiac output. Surgical reaeration of the lung eliminates the shunt and returns oxygen saturation to normal. However, the reaerated lung cannot permanently sustain life if the opposite, normal, lung is removed. In our laboratory all such animals have died within 48 hrs. with a boggy, edematous condition in the reaerated lung.

An experiment, pertinent to this observation, was performed using twenty-six mongrel dogs from 10-15 Kg each. Six animals were normal controls. Twenty animals were subjected to chronic atelectasis of the entire left lung for 1 to 68 weeks. The lungs were then surgically reaerated. Eleven animals have been studied 4 to 120 weeks later, using broncho-spirometry. The ventilation and oxygen uptake abilities of the reaerated lungs were found to average 22% to 16% respectively of the total. Since shunting was small or absent in all cases studied it was assumed that the left lung's oxygen uptake of 16% of the total was somewhat indicative of left pulmonary artery flow (% of total), and thus reaeration did not increase left pulmonary artery flow markedly compared to the 15% shunt flow of complete left atelectasis.

To demonstrate the reduced left pulmonary arterial flow (increased resistance) the pulmonary artery circulation to the right lungs was curtailed in various ways forcing up to 100% of cardiac output through the reaerated left lungs. In every instance studied this has resulted in elevated pulmonary artery pressures averaging 31 mm Hg. mean. This average is 50% greater than pressures found after right pneumonectomy in a normal animal and 100% greater than resting pressures in a normal animal. The results of these completed studies including a comparison of normal and reaerated lung histology will be presented.

24. Selective Chemotherapy of the Lung During Unilateral Pulmonary Arterial Occlusion with a Balloon Tipped Catheter.

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

Washington, D. C.

The use of pulmonary arterial carcinolytic agents, administered either by trapping in the lung or by selective perfusion of the lung, has been previously reported.

The present technique was devised to permit selective, and possible repeated chemotherapy without thoracotomy

A balloon tipped double or triple lumen cardiac catheter is inserted into a peripheral vein and positioned in the right or left pulmonary artery. The balloon is inflated until the artery is occluded, and the carcinolytic agent injected into the blood stream distal to the occlusion.

Indicator dilution studies with T 1824 (Evans Blue Dye), Cr₅₁ tagged red cells, and Methylene Blue Dye show that a substantial amount of the indicator is retained in the lung and is well distributed during the 10 to 15 minute period of arterial occlusion. A progressive leak of the indicator into the systemic circulation occurs during this period.

Preliminary studies suggest that the tolerance of the lung for the carcinolytic agent will be the limiting factor in dosage rather than the leakage of the agent into the systemic circulation.

Experimental and clinical experience with various carcinolytic agents will be discussed.

25. An Experimental Study of Pulmonary Artery Replacement.

JOSEPH W. GILBERT, JR. (*by invitation*), WILLIAM P. CORNELL

(*by invitation*), and THEODORE COOPER (*by invitation*),

Bethesda, Md.

The correction of certain congenital cardiovascular malformations such as truncus arteriosus, atresia of the main pulmonary artery and transposition of the great vessels, may be contingent upon effecting communication between the right ventricle and the pulmonary arterial tree. An experimental study of replacement of the pulmonary artery has been undertaken in the dog.

Edwards-Tapp teflon grafts of 5/16" to 3/8" diameter were inserted between the right ventricular outflow tract and the distal end of the divided right or left pulmonary artery. Brief inflow occlusion permitted attachment of the prosthesis to the right ventricle after suture anastomosis to the pulmonary artery had been performed. The proximal end of the graft was adapted to a polyethylene stent, inserted through a stab wound in the outflow tract of the ventricle and secured by a purse-string suture.

The procedure was carried out in 20 dogs. Two died at the time of operation from technical faults and 7 at later periods, from sepsis or secondary hemorrhage. The graft was found to be patent in each of these dogs. The patency of the grafts in the 11 surviving animals has been determined by angiocardiograms and the physiologic effects of the valve-less prostheses studied by means of right heart catheterization.

26. A Simple Device for the Mechanical Anastomosis of Blood Vessels.

TIMOTHY TAKARO, Oteen, N. C.

An instrument for the anastomosis of blood vessels has been constructed which is considerably simpler in design than the Soviet vascular stapler. Consisting of but 8 pieces (compared with 26 or more parts in the Russian instrument), the device is essentially a cylindrical vascular clamp, bivalved to permit removal after use. Staple shafts and drivers are carried on one jaw, and clinchers are engraved on the opposing jaw. When a removable circular nut is tightened, the drivers press eight tiny stainless steel staples simultaneously across the interval between the two jaws, in which lie the vessels or grafts to be joined. Two bolts which fit into perforated, slotted wings on the jaws make possible adjustment of the distance between the jaws.

Using this device, dacron grafts were implanted in the thoracic aorta of 15 animals. There were 13 long term survivors. Since the average period of occlusion of the thoracic aorta was only 6 minutes, neither shunts nor hypothermia were necessary. Vessels from 13 to 20 mm in diameter were successfully sutured. In some animals, multiple rows, the staples of which were staggered with respect to each other, were placed. Because relatively long cuffs of vessels and grafts remain in apposition by this technique, remarkably few staples as compared with sutures are required to effect a blood-tight anastomosis, and there is therefore minimal foreign material in contact with the blood stream at the anastomotic site. This fact, plus the reproducible technical excellence of each anastomosis suggests the usefulness of small-sized models for small vessel anastomoses and organ transplantation work.

27. Experimental Left Coronary Artery Perfusion Through an Aortotomy During Cardiopulmonary Bypass.

JAMES B. LITTLEFIELD (*by invitation*), EDWARD M. LOWICKI

(*by invitation*), and WILLIAM H. MULLER, JR.,

Charlottesville, Va

A direct surgical approach on the aortic valve often necessitates a prolonged aortotomy and the maintenance of myocardial nutrition is therefore necessary. In this study, perfusion of the left coronary artery *alone* with oxygenated blood through an aortotomy during Cardiopulmonary bypass is investigated.

Employing total pump dependency with ascending aortic occlusion, a 1.5 cm. vertical aortotomy was made above the aortic valve. A perfusion cannula, connected either to the arterial line of the pump (Group I) or to a suspended bottle (Group II), was inserted into the left coronary ostium. Continuous perfusion rates varied from 50 ml. to 100 ml./min for periods of 15 to 60 minutes at 32° to 35° C. Aortic pressures, continuous electrocardiographic tracings (before, during and after operation), coronary venous flows and coronary arterial-venous oxygen saturations were recorded.

RESULTS: Control dogs tolerated an open aortotomy *without coronary perfusion* for 8 5 minutes (mean) before ventricular fibrillation occurred.

Continuous perfusion of the left coronary artery alone was performed for periods from 15 to 60 minutes without evidence of ventricular fibrillation. A coronary flow of 50 ml./min. proved adequate. The coronary venous oxygen saturation averaged 64% (Control: 44%) during perfusion. The factor limiting adequate perfusion in the dog is the anatomical variation of the left coronary artery characterized by its early bifurcation or trifurcation. This limitation necessitated the use of specially designed cannula tips. Long-term survivors include animals from both Group I and II. Postoperative aortotomy bleeding was a serious problem early in this study.

SUMMARY: The left coronary artery *alone* may be continuously perfused in the dog for as long as 60 minutes without the development of ventricular fibrillation. Left coronary artery perfusion in patients has proven satisfactory.

28. Growth of Cardiovascular Chambers Following Cardiac and Aortic Surgery.

SIGMUND A WESOLOWSKI (*by invitation*), LESTER R. SAUVAGE

(*by invitation*), PHILIP N. SAWYER (*by invitation*), and

KARL E. KARLSON, Brooklyn, N. Y.

The development of intracardiac surgery for the correction of human congenital cardiac defects has been so rapid as to outstrip the available knowledge from the experimental laboratory concerning the long-term fate of the intracardiac procedures themselves. This has been disturbing to certain surgeons and represents the basis of criticism, with some justification, from our medical colleagues.

In our studies of over 500 growing pigs over the past five years, we have come to rely upon the changes of cavity mensuration and the ventricular myocardial weights as sensitive indices of hemodynamic changes with growth in the cardiac outflow tracts, and of the attraction and deposition of calcium salts as an index of degenerative change at the operative site. The present communication presents the results of the changes of these indices in 300 experimental animals bearing various degrees of stenotic thoracic aortic grafts, and various mild abnormalities of the outflow tract of the right ventricle.

We have found that lesions considered clinically insignificant produce statistically significant changes in the above-mentioned indices as follows—mild degrees of stenosis (between 0 and 50% diameter loss) of grafts in the *descending thoracic aorta* produce absolute increase in the left ventricular weight; mild degrees of right infundibular stenosis, pulmonary valve regurgitation, and insertion of patches of Ivalon and of pericardium in the outflow tract lead to moderate to marked increase in right ventricular weight.

The presentation will include the detailed results and will relate them to (1) the problem of arterial graft selection in the growing human, (2) the selection of materials for outflow tract widening, and (3) the application of the preparation for screening of new intracardiac procedures

Thursday Afternoon, May 12, 1960

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

3:00 P.M. Scientific Session: REGULAR PROGRAM
Napoleon Room

ADDRESS BY THE PRESIDENT
WILLIAM E. ADAMS, Chicago, Ill.

ADDRESS BY HONORED GUEST
ALFONSO TOPETE, Guadalajara, Mexico
Chairman, Department of Surgery
University of Guadalajara

"New Findings in the Coronary-Encephalic Perfusion in Depressive Surgical Cases"

29. Coarctation of the Aorta with Particular Emphasis upon Improved Technics of Surgical Repair.

GEORGE C. MORRIS JR. (*by invitation*), DENTON A. COOLEY,
MICHAEL E. DEBAKEY, and E. STANLEY CRAWFORD,
Houston, Tex

During the fifteen year period since successful surgical correction of coarctation of the aorta was first reported, extensive experience with this lesion has provided the basis for new concepts of surgical repair. The primary goal in treatment should be to relieve hypertension proximal to the coarctation and to provide a more adequate circulatory status distally. The major complications of the lesion, including left ventricular strain, hypertensive encephalopathy, renal ischemia and uremia, are effectively controlled by eliminating the obstructive process. When surgical treatment was first introduced, certain somewhat arbitrary limitations were placed upon selection of patients for operation based upon age, length of the aortic occlusion, presence of associated arterial disease, presence of myocardial ischemia, etc. Moreover, end-to-end anastomosis with an occasional homograft replacement was the only technic of repair that was recommended. The purpose of this report is to present current concepts of treatment based upon improvements in technic of arterial repair.

Many operative accidents and late complications of surgical treatment of aortic coarctation are the result of attempts to perform end-to-end anastomosis in the presence of anatomic and pathologic limitations. Although excision of the occluded segment of aorta with end-to-end anastomosis remains the treatment of choice in favorable cases, more liberal use of synthetic vascular grafts has not only removed limitations placed upon application of corrective technics but has contributed to a lower risk of operation. Aortic anastomoses which are made under tension frequently disrupt, leading to hemorrhage or late aneurysm formation. The caliber of aortic anastomosis may be controlled accurately to provide an optimum size for the individual case when synthetic grafts are used. In older patients who have extensive atherosclerotic changes in the aorta, possible myocardial ischemia, valvular lesions, etc., a bypass of the coarctation provides a simple and safe solution to an otherwise difficult technical problem. These and other considerations of technical and physiologic nature will be presented with an analysis of 150 surgical cases. Present indications and contraindications for operation will be presented based upon experience with current technics of surgical repair.

7:00 P.M. Banquet and Dancing

Casanova Room

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

Dinner dress preferred.

Friday Morning, May 13, 1960

9:00 A.M. Scientific Session: REGULAR PROGRAM Napoleon Room

30. A Five Year Follow-up Study of Closed Mitral Valvulotomy.

J. GORDON SCANNELL, JOHN F. BURKE (*by invitation*), and FARROKH SAIDI (*by invitation*), Boston, Mass.

In the past there have been a number of reports on the technique and immediate post operative results following closed mitral valvulotomy. These reports as a rule have not discussed the long term results which can be expected following closed operation. Evaluation of the closed operation is clearly important in establishing the present indications of open-heart procedures in mitral stenosis.

In order to gain a clear picture of long term results that might allow prediction of an unsatisfactory outcome, the present status of 100 consecutive patients, who survived mitral valvulotomy at the Massachusetts General Hospital more than five years ago, has been reviewed. Particular attention has been given to those patients who have required reoperation, suffered late emboli and had reactivation of rheumatic heart disease.

Preliminary survey indicates a five year recurrence rate of 5% - 10% and excellent long term results in two-thirds of the patients. There have been a certain number of late emboli. The problem of recurrence is particularly important since at the present time this has become an indication for open-heart repair.

31. Valvuloplasty for Acquired Aortic Stenosis.

DONALD G. MULDER (*by invitation*), ALBERT A. KATTUS (*by invitation*), and WILLIAM P. LONGMIRE, JR., Los Angeles, Calif.

Notable advances have been made in the past few years in the surgical treatment of heart diseases. Satisfactory techniques are available for the correction of most cardiac lesions. Although many procedures have been advocated for the treatment of patients with acquired aortic stenosis, none has been consistently successful. Any operation which does not restore mobility to the heavily calcified and relatively fixed aortic valve will be of limited value.

A new technique is presented by which the major obstructing and immobilizing encrustations of calcium can be removed from the valve cusps. This valvuloplasty not only increases the size of the aortic valve orifice, but even more important from the functional standpoint, it restores mobility to the valve cusps.

Eleven patients with acquired aortic stenosis have been operated upon using this technique. There have been no operative or late deaths. Several patients had been in congestive failure and all had been symptomatic prior to operation. The systolic gradient across the aortic valve preoperatively ranged from 36 mm. Hg. to 190 mm. Hg. with an average of 89 mm. Hg. The gradient was completely abolished by operation in eight patients, with an average residual gradient in the entire group of 7 mm. Hg. One patient with associated severe aortic insufficiency has two prosthetic cusps reinforcing and replacing his degenerated valve tissue. All patients have been symptomatically improved and, except for those most recently operated upon, have returned to work. The duration of follow-up is from two to eleven months.

The early results of the treatment of acquired aortic stenosis by the technique of valvuloplasty have been most encouraging. Until such time as a suitable aortic valve prosthesis is available, we feel this procedure warrants further trial.

32. Partial and Complete Aortic Valve Prostheses in Advanced Aortic Insufficiency.

DWIGHT E. HARKEN, WARREN J. TAYLOR (*by invitation*), HARRY S. SOROFF (*by invitation*), ARMAND A. LEFEMINE (*by invitation*), SUSHIL K. GUPTA (*by invitation*), and STEVEN LUNZER (*by invitation*), Boston, Mass.

Aortic insufficiency associated with minor degrees of left ventricular chamber enlargement has had encouraging correction with partial and elsewhere even complete valve prostheses at open operation.

The problem of prostheses and open correction of aortic insufficiency when the ventricle is markedly dilated and in failure presents a very difficult and much more formidable challenge. A primary consideration is that the increased chamber diameter aggravates the failure promptly if any resistance is added at the valve site. La Place's law ($P = T/r^2$) explains this difficulty when any valve resistance (a function of P) markedly increases intramural tension (T) due to a large chamber radius (r). Thus prompt failure can be expected to follow some of the currently described plastic techniques and our experience supports this. This knowledge and experience influences the type of prostheses, be they partial or complete. It has particular relevance to the technique of extending cusps with Teflon and the hinge at the base.

A second cardinal problem is that of circulatory support while the heart is resuming function after the repair. The conventional constant flow arterial pump return results in the fragile dilated ventricle having to work against ("buck") the pump. Left auricular "sumping", coronary perfusion, etc., have made it possible to correct the aortic incompetence associated with some of the more severe grades of myocardial insufficiency. The "bucking" problem can only be overcome by a combination of complete surgical correction of valvular incompetence and coordinated pulsatile arterial pump return. Such a pump is available in the Davol Birtwell pump. Experimental and clinical application of this type of pump-oxygenator and valve prostheses in advanced grades of myocardial dilatation and failure constitute the basis of this communication.

33. The Results of Surgical Treatment for Ventricular Septal Defect.

JOHN W. KIRKLIN, DWIGHT C. MCGOON, and JAMES W. DUSHANE (*by invitation*), Rochester, Minn.

By the date of the meeting of the Association, five years of experience with the surgical treatment of ventricular septal defect will have been had at the Mayo Clinic. At the time of submission of this abstract, this comprises an experience with 355 cases.

In this study all cases are reviewed except those in which the ventricular septal defect was a part of the tetralogy of Fallot or of the complete form of common atrioventricular canal. Classification is into the following groups:

1. Ventricular septal defect with mild pulmonary hypertension.
2. Ventricular septal defect with moderate pulmonary hypertension.
3. Ventricular septal defect with severe pulmonary hypertension.
 - a. high pulmonary blood flow/systemic flow ratio
 - b. moderately elevated pulmonary blood flow/systemic flow ratio.
 - c. low pulmonary blood flow/systemic flow ratio (one or less).

The clinical and hemodynamic criteria for classification are discussed in detail. Sixty per cent of the cases in this series had severe pulmonary hypertension.

Over-all data on hospital mortality rate are presented. In the year 1955, the hospital mortality rate was 20.0 per cent for all cases of ventricular septal defect repaired while in the year 1959 (until November 1), it was 5.3 per cent. Factors contributing to the reduction in hospital mortality are analyzed.

Complications following the repair of ventricular septal defect include the development of complete heart block and the persistence of residual shunt after repair. Their incidence and methods by which their occurrence can be minimized, are detailed.

34. The Closure of Atrial Septal Defects Utilizing General Hypothermia: The Effectiveness of Treatment as Determined by Cardiac Catheterization.

ANDREW G. MORROW, JOSEPH W. GILBERT, JR. (*by invitation*),
R. ROBINSON BAKER (*by invitation*), and N. FERRYMAN COLLINS
(*by invitation*), Bethesda, Md.

Thirty-six patients were operated upon at the National Heart Institute during the period in which general hypothermia was employed to permit the repair, by direct suture, of atrial septal defects. Cardiac Catheterization was carried out postoperatively in 32 patients and the hearts of three others, who died in the early postoperative period were examined at autopsy. Of these 35 patients, 10 were demonstrated to have residual or recurrent left-to-right shunts into the right atrium.

The repair was found to be incomplete in all of the four patients who had sinus venosus defects with associated partial anomalous pulmonary venous drainage. Five patients with residual shunts had ostium secundum defects 4 cm. in diameter or larger. In the remaining patient an unsuspected incomplete A-V canal was present.

The brevity of the period of circulatory interruption permitted by hypothermia, even with coronary perfusion, was found to impose severe technical limitations. It is considered that in the patients with ostium secundum defects the failures of surgical treatment could have been obviated had sufficient time been available for the insertion of a prosthesis, permitting closure of the defects without tension. In the patients with sinus venosus defects the pulmonary venous drainage could have been diverted into the left atrium in this manner.

This high incidence of incomplete repair has led to the abandonment of hypothermia and the adoption of cardiopulmonary bypass in the surgical management of all patients with atrial septal defects. The value of detailed postoperative studies in assessing the effectiveness of a cardiac surgical procedure is also illustrated.

35. Elective Cardiac Arrest Using Selective Cardiac Hypothermia.

DAVID M. LONG, JR. (*by invitation*), LAURENCE P. STERNS (*by invitation*),
VINCENT L. GOTT (*by invitation*), ROBERT H. DERIEMER (*by invitation*),
and C. WALTON LILLEHEI, Minneapolis, Minn.

Selective cardiac hypothermia has been employed successfully experimentally and clinically as a method for providing routine elective cardioplegia and as a method for providing maximum protection to the myocardium during aortic valvular surgery. Only short periods of anoxic arrest or chemical cardioplegia are tolerated without the production of myocardial insufficiency or necrosis. Uneven distribution of the coronary perfusate and certain technical factors limits the usefulness of continuous retrograde and antegrade coronary perfusion. Extensive clinical experience has demonstrated by objective measurements the significant superiority of selective cardiac hypothermia as compared with the above methods.

The method is simple. Cardiopulmonary bypass is employed using the bubble oxygenator and Sigmamotor pump. A separate line from the bottom of the oxygenator is used to pump oxygenated blood through a disposable cooling unit which will be described. The temperature of the arterial blood is lowered to 5° to 12° C. After clamping of the ascending aorta, cold blood is perfused through the coronary arteries. The exact method utilized depends upon the lesions present and these will be described. The myocardial temperature is decreased to 15° to 17° C within 3 to 5 minutes.

Animal experiments were designed to evaluate the tolerance of the myocardium to coronary perfusion with cold blood and to test effects of interruption of the coronary flow of the hypothermic heart for intervals up to one hour. Combinations of selective cardiac hypothermia and chemical cardioplegia were also studied. Comparisons of these methods were made by measuring coronary venous pH and lactic acid levels before and after hypothermia. The methods were also compared with regard to survival of the dogs and histologic changes in the myocardium.

Selective cardiac hypothermia has been employed to date in 100 patients with a wide variety of cardiac lesions. Myocardial biopsies of human hearts subjected to potassium citrate arrest and selective cardiac hypothermia have been analyzed for lactic acid, glucose, adenosine tri-phosphate and phosphocreatine levels before and after cardioplegia.

36. Open Heart Surgery Using Deep Hypothermia Without an Oxygenator.

ARCHER S. GORDON (*by invitation*), BERTRAND W. MEYER, and
JOHN C. JONES, Los Angeles, Calif.

The ultimate goal in extracorporeal circulation for intracardiac surgery is to reduce and simplify the mechanical equipment to its bare essentials. We have accomplished this by performing all types of prolonged open heart surgical procedures using only two mechanical pumps and a heat exchanger (no oxygenator or special monitoring equipment is required). Using temperatures down to 10° C., this has allowed us to operate in a completely quiet, bloodless field for

periods up to one hour on such lesions as ventricular septal defects, tetralogy of Fallot, total anomalous pulmonary venous drainage, aortic stenosis, etc.

The advantages of this technique include the following: (1) Requires a minimum amount of equipment (only two pumps and heat exchanger), (2) Requires only 1200 cc. of blood to prime the system; (3) Cardiac arrest results from cold - neither cardioplegic drugs nor anoxic arrest are used; (4) Circulatory standstill is used during the intracardiac surgery and provides an absolutely quiet, bloodless field; (5) Periods up to several hours can be used safely, if required, for intracardiac repairs.

Laboratory and clinical studies reveal freedom from problems associated with hemolysis, acidosis, perfusion rates, clotting mechanisms, and blood volume balance. Blood aspirated from the open heart is minimal and may be discarded or reused.

Studies of oxygen utilization have provided a determination of the safe period of circulatory occlusion at any given temperature. Thus, the temperature can be selected for each patient on the basis of the time requirements for his case. If it becomes necessary for circulatory occlusion to exceed the time allowable at the temperature selected, brief reperfusion allows prolonged extension of this period.

This simple, versatile, safe procedure appears to provide the best approach for the correction of most intracardiac lesions.

Friday Afternoon, May 13, 1960

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

37. Clinical Experiences with Fifteen Patients with Traumatic Rupture of the Thoracic Aorta.

FRANK C. SPENCER, PAUL F. GUERIN (*by invitation*), HU A. BLAKE (*by invitation*),

Washington, D. C., and HENRY T. BAHNSON,

Baltimore, Md.

Fifteen patients have been seen with a ruptured aorta from injury in an automobile accident or other thoracic trauma. Seven were seen shortly after injury; eight were seen with a thoracic aneurysm six months to sixteen years after injury. Six of the seven patients treated shortly after injury had rib fractures but only four were hypotensive. The chest roentgenogram showed widening of the mediastinum in every patient and a hemothorax in four patients. The diagnosis was delayed or missed in all but one of the patients because of the absence of signs of serious injury and erroneous interpretation of the widened mediastinum on the chest roentgenogram; in one patient the diagnosis was made by emergency aortography. Five patients who did not receive any definitive treatment died suddenly from massive hemorrhage 3, 12, 14, and 24 hours and 3 weeks after injury; two patients were operated upon, one of whom recovered.

Seven of the eight patients with a thoracic aneurysm were successfully treated by excision of the aneurysm and replacement with a plastic prosthesis while the distal blood flow was maintained with left atrial-femoral bypass. One fatality resulted from hemorrhage during attempted excision of a huge aneurysm which had suddenly enlarged and occluded the left main bronchus sixteen years after injury.

The aortic injury in all fifteen patients was a partial or complete transverse tear just distal to the left subclavian artery. The consistent location and nature of the injury makes it readily amenable to surgical treatment if the correct diagnosis can be made

The presentation includes clinical and roentgenologic findings that suggest the diagnosis, photographs of the area of rupture of the aorta, and experiences with the operative management of these patients

38. Surgical Management of Penetrating Injuries of the Ascending Aorta and Aortic Arch.

WALTER L. DIVELEY, ROLLIN A. DANIEL, JR., and

H. WILLIAM SCOTT, JR., Nashville, Tenn.

We have encountered three patients with penetrating injuries of the aorta. These include:

- 1 A patient with a traumatic ductus arteriosus produced by a pistol wound.
2. A patient in whom a piece of heavy wire was propelled into the ascending aorta by a rotary lawn mower.
3. A patient who was stabbed with a knife sustaining a traumatic aorticopulmonary fistula and also a fistula between the proximal pulmonary artery and the left atrium.

The diagnostic methods used and the surgical management of each patient will be discussed. The lesion was corrected in each instance and all of the patients recovered from the operative procedure.

39. Antibiotics and Extracorporeal Surgery.

C. FREDERICK KITTLE, and WILLIAM A. REED

(*by invitation*), Kansas City, Kan

Since the advent of antibiotics their use in many surgical instances has become prophylactic. The occurrence of antibiotic reactions and the development of antibiotic-resistant organisms have focused attention on this problem and demanded scrutiny of indications for antibiotic administration.

Our data are derived from the use of antibiotics in consecutive patients undergoing extracorporeal operative procedures for a variety of conditions (both congenital and acquired heart diseases).

Antibiotics were used routinely in patients undergoing extracorporeal circulation until April 1959; subsequently no antibiotics have been given without specific indications. In the 86 consecutive patients studied to date (those surviving for one week or more) 34 received broad spectrum antibiotics prophylactically; 40 received no antibiotics nor were antibiotics used in preparation of the blood; and in the remaining 12 patients antibiotics were given postoperatively for various reasons

In the group receiving antibiotics prophylactically there were three hemolytic staphylococcal wound infections (minor), two with pneumomia who subsequently died, and one with a *Pseudomonas* bacteremia who died. In those who received no antibiotics there was one hemolytic staphylococcal wound infection (minor). Twelve patients received antibiotics for the following indications: pneumonia or pneumonitis - 3, wound abscess - 1, staphylococcal septicemia - 1, and fever, cause undetermined, 7

The average duration of postoperative fever was essentially the same in the group receiving no antibiotics as in the group receiving them prophylactically

These studies are continuing but there seems no evidence to warrant the use of or to suggest that prophylactic antibiotics are advantageous in patients having extracorporeal perfusion. Specific indications of an active infectious process should be present before use of these agents. A similar conclusion has been reached after evaluating antibiotics in other types of cardiovascular procedures not employing use of the extra-corporeal machine.

40. Achalasia of the Esophagus in Children.

ORVAR SWENSON, and CHRIS T. OECONOMOPOULOS (*by invitation*),

Boston, Mass.

Achalasia or cardiospasm is a rare condition in children and little concerning the condition in this age group is available in the medical literature. We have reviewed our experience with six cases.

Strip biopsies were secured from the lower esophagus in two patients and these contained no ganglion cells. Similar strips of tissue were removed from the normal esophagus at post-mortem and these contained numerous ganglion cells. Peristaltic studies were made and these demonstrated good propulsive function in the esophagus.

The similarity of this condition to that in adults is indicated. Pathologic studies in adults have been made by several investigators and a degenerative lesion of Auerbach's plexus of the lower esophagus has been demonstrated. It is postulated that in children the defect is the same except that the lesion is congenital in origin.

The problem of diagnosis in this obscure condition is discussed. The effectiveness of dilatation in four cases and surgery on the lower esophagus in two cases is given on the basis of two to eight year follow-up studies.

41. Objective Evaluation of Surgery for Hiatus Hernia and Esophagitis.

LUCIUS D. HILL, and KYLE W CHAPMAN (*by invitation*),

Seattle, Wash

In spite of the increasing frequency with which hiatus hernia and peptic esophagitis have been attacked surgically, there have been few attempts made to objectively evaluate these conditions with reference to the effect of surgery on the underlying pathophysiology.

In reviewing the data on over 175 patients operated upon for hiatus hernia and esophagitis, it was difficult to objectively determine the severity and degree of esophagitis present preoperatively and the actual effect of surgery on the underlying disease.

This paper presents the results of studies of the mechanisms of reflux esophagitis and the effect of surgery on these mechanisms. A method of simultaneous measurement of pH and pressure in the esophagus, and the pH and

pressure changes at the gastroesophageal junction will be described. Over 40 patients have been studied by this method. In this group we have studied both the normal subject and patients with esophagitis ranging in severity from the mild forms to stenosing esophagitis with obstruction. Patients with recurrent hiatus hernia and esophagitis following surgery have also been studied. Both pre- and postoperative measurements of pH and intraesophageal pressures have been obtained in patients with various types of operations ranging from simple repair of the diaphragmatic hiatus to complex operations utilized for correction of severe stenosing peptic esophagitis. These determinations give the surgeon an objective measurement of the degree of underlying pathology and the effect of surgical operations upon the disease.

On the basis of over 175 operations, as well as experimentation, recommendations are made relative to the adequacy of various surgical operations. Certain procedures can be shown to be definitely inadequate by these direct measurements.

42. Instrumental Perforation of the Esophagus.

THOMAS F. NEALON, JR., JOHN Y. TEMPLETON III, VINCENT D. CUDDY (*by invitation*),

and JOHN H. GIBBON, JR., Philadelphia, Pa

Even in the hands of expert endoscopists an occasional instrumental perforation of the esophagus occurs. With antibiotics available, some surgeons and endoscopists have advocated nonoperative treatment, or have delayed surgical intervention. Our experience with this complication does not support this point of view.

During the past six years 18 instrumental perforations of the esophagus occurred at the Jefferson Medical College Hospital. The perforation was produced by an esophagoscope in 12 patients, by a gastroscope in 3 and by a bougie in 3. The ages of the patients ranged from twenty months to 74 years. All patients were operated upon between two hours and 21 days after the perforation occurred. The surgical procedures ranged from simple drainage to esophagectomy. Five of the 18 patients died as a result of the perforation. One death occurred among the 11 patients operated upon within 24 hours of the perforation. Four deaths occurred in the 7 patients operated upon more than one day after the perforation. This experience leads us to believe that conservative treatment by antibiotics, nasogastric intubation, or gastrostomy is dangerous, and that early operative intervention is indicated.

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