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THE AMERICAN ASSOCIATION

For

THORACIC SURGERY

1955 - 1956

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MONDAY MORNING, MAY 7, 1956

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Monday Morning, May 7, 1956

8:30 A.M. Business Meeting.

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

1. Congenital Diaphragmatic Hernia and Hypoplastic Lung: A Clinical Evaluation.

BENSON B. ROE, San Francisco, Calif.

Congenital diaphragmatic defect through the foramen of Bochdalek is described as a surgically correctible lesion with encouraging results and low mortality. The author has gathered and analyzed 43 cases with an overall mortality rate of 60.5%, suggesting that the total experience is far from satisfactory. A large proportion of the cases diagnosed immediately after birth did not survive long enough to reach surgery; the operative mortality in the others was exceedingly high (66%). In sharp contrast were the excellent surgical results in the group operated at three weeks or more of age (8%), many cases having survived without significant pulmonary or gastrointestinal embarrassment for periods of months to years. These groups are not separated in most of the published series and emphasis is placed on so doing for more honest evaluation of surgical indications and results in the neonatal period.

Evidence is presented to suggest that these patients fall into separate categories on the basis of possessing at birth adequate or inadequate pulmonary parenchyma to support life. Analysis of the autopsied cases reveals a very high incidence of hypoplastic lung-not only on the hernia side where vestigial unexpandable lungs are common but also in terms of significantly subnormal total lung weights.

On the basis of this information the problem will be reassessed as to the optimal operating time and post-operative management of the unexpanded hypoplastic lung.

2. Critically Crushed Chests: A New Method of Treatment by Internal "Pneumatic" Stabilization with Continuous Mechanical Hyperventilation.

EDWARD E. AVERY (*by invitation*), E. THIER MÄRCH (*by invitation*)
and DONALD W. BENSON (*by invitation*), Chicago, Ill.

A new method of stabilizing the flail thorax is presented. Hyperventilation is used by means of a specially designed respirator delivering a fixed volume of gases for intermittent positive pressure endotracheal ventilation.

Methods of external stabilization frequently fail to provide adequate air exchange because of the patient's inability to consciously ventilate himself due to extensive bond, muscle, nerve and brain damage. Mechanical ventilation has not been effectively applied in the past because of improperly designed apparatus, mechanical breakdowns, sticking valves, fluctuating stroke volumes, etc.

A deterrent to the application of prolonged passive (mechanical) hyperventilation has been the time honored fear of the adverse effects of the active hyperventilation syndrome as seen in hysteria, volunteers, and metabolic acidosis. None of these ill effects has been seen with continuous passive hyperventilation continued for periods of more than a month. Another deterrent to this new method of treating crushed chests has been the numerous references in the literature regarding deleterious response of the circulation to intermittent positive pressure insufflation. The circulation in our patients has not been disturbed when the pressure variations within the trachea have the correct amplitude and time profile.

Experimental studies on animals and the clinical application of mechanical hyperventilation to patients with crushing injuries of the chest are presented with slide and movie illustrations.

3. Complete Traumatic Rupture of the Left Main Bronchus Successfully Repaired Eleven Years After Injury.

DANIEL E. MAHAFFEY (*by invitation*), OSCAR CREECH, JR., HOLLIS G. BOREN
(*by invitation*) and MICHAEL E. DEBAKEY, Houston, Texas

This is a case report dealing with an adult male who sustained a crushing injury of the chest in 1944 while on active duty with the Navy. Following hospitalization he was discharged from the service with a diagnosis of atelectasis of the left lung.

Upon admission to the hospital in 1955, a diagnosis of traumatic rupture of the left main bronchus with complete occlusion was made and confirmed by bronchoscopy, bronchography and pulmonary function studies. At operation the involved segment of bronchus was excised, bronchial continuity restored and the left lung re-expanded. Serial differential bronchspirometric determinations have been performed to determine the evolution of pulmonary function since operation. This appears to be the first late case of traumatic bronchial rupture studied in this way. A brief motion picture will be shown to demonstrate the operative technic.

4. Congenital Atresia of Esophagus.

GEORGE H. HUMPHREYS, BRUCE M. HOGG (*by invitation*) and
JOSE FERRER (*by invitation*), New York, N. Y.

This report reviews the results of treatment of 136 infants with congenital esophageal atresia with or without fistula, seen at Babies Hospital or born in Sloane Hospital in the half century between 1903 and 1953. The history of the evolution of diagnosis and treatment is briefly reviewed. This parallels the experience in other clinics and brings out the lag between the first clinical and pathological description two centuries earlier, the first accurate clinical diagnosis in 1923, and the first patient to survive operative correction in 1942. The increasing frequency of admission of correctly diagnosed infants in subsequent years is thought to indicate that the incidence is not as low as formerly thought. In this group it is about one in 3,000 births.

Factors influencing survival are shown to be the size and degree of prematurity of the infants; the presence of other severe malformations; the awareness of doctors and nurses caring for newborn infants of the possibility of the condition and their alertness in recognizing the characteristic symptoms; the promptness with which such patients are referred for operation; the care in pre and post-operative management; and the technical aspects of the operation itself. The first two factors are uncontrollable; the others can be better controlled than is often the case. While occasional cases will present anomalies requiring multiple procedures, in the majority swallowing can be restored by end-to-end anastomosis of the esophagus. Results of every procedure are analyzed.

5. Torek Esophagectomy: "The Case Against Segmental Resection for Esophageal Cancer".

WILLIAM L. WATSON, JOHN T. GOODNER (*by invitation*), THEODORE P. MILLER (*by invitation*) and GEORGE T. PACK (*by invitation*),
New York, N. Y.

Longitudinal spread of esophageal cancer by way of the submucosal lymphatics occurs in a high percentage of cases and leads to tumor outcroppings, sometimes three or more centimeters distant from the palpable and visual limits of the primary cancer. Recognizing this feature of the disease as a common cause of our failure to cure we have again resorted to the subtotal (Torek) type of esophagectomy for cancers located in the upper two-thirds of the esophagus.

Forty-eight patients have been subjected to a Torek type of esophagectomy and in 31 cases the swallowing function has been re-established in one of a number of different manners. The major objection to the Torek procedure has been the postoperative problem of restoring adequate continuity between the hypopharynx and the gastrointestinal tract. We have attempted reconstruction of alimentary continuity by a number of different methods.

Although our experience so far has been limited to 6 cases, we are of the present opinion that for cancer of the upper two-thirds of the esophagus a subtotal esophageal resection is our most successful cancer operation and the right colon substernal transplant reconstruction is our most satisfactory procedure.

6. Cardiac Surgery with Hypothermia and Acetyl Choline Arrest.

PETER V. MOULDER (*by invitation*), RICHARD THOMPSON (*by invitation*),
CURTIS SMITH (*by invitation*) and WILLIAM E. ADAMS, Chicago, Ill.

Hypothermia *per se* has been found to have little deleterious effect upon the heart when a relatively normal acid-base relationship is maintained. This has been monitored with the use of a constant recording carbon dioxide meter sampling the intratracheal tube. It has been found that low volume respirations at the rate of only 3 per minute are needed to maintain normalcy at 22-25° C. The hypothermia under these circumstances has been found to protect the heart considerably, but when total circulatory arrest is produced, this is incomplete. Arrest or profound slowing of the heart adds further needed protection. Intracoronary acetyl choline produces a profound slowing of the heart during occlusion and its effect can be routinely reversed with the use of intra-coronary atropine.

The following operative procedures have been performed on 43 dogs using this method of preparation: 1. Circulatory arrest alone; 2. Right atriotomy with or without formation and closure of septal defects; 3. Right ventriculotomy with or without formation and closure of septal defects; 4. Left atriotomy with direct procedures on the mitral valve; 5. Occlusion of the coronaries, opening of aorta and direct procedures on the aortic valve; 6. Direct incision and suturing of the coronary arteries.

At the present time only right atriotomy with repair of interatrial septal defects has been successfully performed in humans with this method, and it appears to be as promisingly useful as it has been in dogs.

MONDAY AFTERNOON, MAY 7, 1956

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Monday Afternoon, May 7, 1956

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

**Symposium on Anesthesia and Related Problems
(Papers 7-11, inclusive)**

7. Contrast of Two Systems of Anesthesia for Thoracic Surgery.

HENRY BEECHER, Boston, Mass.

There is widespread agreement that anesthesia is a problem of crucial importance in the completion of successful thoracic surgery. Opinions differ widely as to what basic elements are essential in the field of anesthesia. An attempt will be made to review briefly what seem to the author to be the fundamental requirements for success in this area and then to pit recent developments against these matters. Particular

emphasis will be given to contrasting the advantages and disadvantages of two prominent systems of anesthesia: ether vs. pentothal with a muscle relaxant.

8. A Consideration of Proper Methods in Thoracic Anesthesia.

E. M. PAPPER, New York, N. Y.

Consideration will be given to harmful influences upon the circulation which may result from anesthetic manipulations that are commonplace during thoracic surgery. The circulatory effects, during general anesthesia, of laryngospasm, endotracheal intubation and suction, assisted and controlled respiration, and insufficient alveolar ventilation will be discussed. A conclusion which may be drawn is that these maneuvers must be executed properly to avoid cardiocirculatory changes. Some comment on what is proper and what is poor in the management of anesthesia will also be offered.

9. The Cardio-Respiratory Dynamics of Controlled Respiration in the Open and Closed Chest.

ARCHER S. GORDON (*by invitation*) and CHARLES W. FYRE (*by invitation*),
Chicago, Ill.

The physiologic evaluation of controlled respiration has important practical applications in open or closed chest surgery. Careful analysis of the underlying cardio-respiratory dynamics provides criteria for optimal manual (bag) or mechanical (machine) control of respiration.

Detailed studies of circulatory and respiratory mechanisms have been carried out under controlled conditions on a series of open chest and closed chest human cases. Ventilatory effects were measured by determination of arterial oxygen saturation and $p\text{CO}_2$. Circulatory effects were monitored by means of continuously recording central arterial blood pressure as well as beat-to-beat analysis with a bristle flow meter.

In the closed chest, positive-negative controlled respiration proves most physiologic. However, there is no advantage to the use of a negative phase in the open chest. The ideal pressure breathing curve should show a fairly steep rise to a short inspiratory plateau followed by a precipitous drop to a prolonged expiratory plateau; the ratio of inspiration: expiration should be 30:70. Pressure-volume diagrams of the lungs and thorax indicate that about 12 mm. Hg positive pressure is required to provide adequate alveolar ventilation during intermittent positive pressure breathing. More positive pressure is required for positive-negative breathing but the negative pressure need not exceed -6 mm. Hg.

The inspiratory plateau provides optimal oxygenation and CO_2 elimination; the short duration of the positive phase exerts a minimal effect on beat-to-beat circulatory dynamics; and the prolonged expiratory plateau aids circulation by lowering the mean airway pressure.

10. The Significance of the Lung-Thorax Compliance in Ventilation During Thoracic Surgery.

WILLIAM E. BROWNEE (*by invitation*) and FRANK F. ALLBRITTEN, JR.,
Kansas City, Kansas

The measurement of $p\text{O}_2$, $p\text{CO}_2$ and pH of arterial blood during thoracic surgical operations has previously shown that pulmonary ventilation provided is frequently inadequate to maintain the normal partial pressure of carbon dioxide in arterial blood. It has been shown that a significant decrease in the efficiency of ventilation occurs and adequate ventilation can be obtained only by increasing the total volume of pulmonary ventilation.

The change of the volume of gas in the respiratory system per unit increase of the intratracheal pressure is a measure of the ease of the distensibility of the lung and the restriction to expansion imposed by surrounding structures. This relationship of airway pressure to the volume of gas within the respiratory system is termed lung-thorax compliance, a factor directly related to the total volume of pulmonary ventilation during anesthesia requiring pulmonary inflation. Compliance measurements have been accomplished in anesthetized and unanesthetized patients with normal and diseased cardiac and respiratory systems.

Many factors produce significant changes in the lung-thorax compliance. The findings suggest the intratracheal pressure required for the inflation phase of ventilation during anesthesia will vary considerably. The changes demonstrated in lung compliance indicate the intratracheal pressure required to produce an adequate total volume of ventilation with an inflation phase alone may be sufficient to decrease significantly cardiac output. These changes in lung-thorax compliance may compromise pulmonary ventilation during intrathoracic operations.

11. Inefficient Carbon Dioxide Absorption Requiring Increased Pulmonary Ventilation During Operations with an Open Thoracotomy.

THOMAS F. NEALON (*by invitation*), GEORGE J. HAUPT (*by invitation*),
HAROLD CHASE (*by invitation*) and JOHN H. GIBBON JR., Philadelphia, Pa.

Two or three times the resting rate of ventilation has proved necessary to avoid respiratory acidosis during surgical operations. We have found that one of the chief causes of the increased ventilatory requirement results from the incomplete removal of carbon dioxide by the currently available anesthetic circuits and soda-lime canisters.

An infrared gas analyzer was used to measure the inspired and expired carbon dioxide concentration by the technique of Collier. These gases were sampled continuously through a small polyethylene tube connected to the endotracheal tube. A negative pressure was used to draw gas through the plastic tube and the micro-analyzer at a metered rate of 500 ml. per minute. Total ventilation was measured with a dry-test gas meter. The carbon dioxide tension of arterial blood was calculated from appropriate blood-gas analyses.

The results obtained indicate that with the commercially available anesthetic machines and carbon dioxide canisters studied, there was an appreciable concentration of carbon dioxide in the gas mixture inspired by the patient from the closed rebreathing circle-system circuit. These concentrations in some instances reached the amazing figure of 2.0 per cent. In every instance in which the patient rebreathed significant concentrations of carbon dioxide, pulmonary ventilation had to be markedly increased in order to prevent development of respiratory acidosis. The increase in pulmonary ventilation required was found to be roughly proportionate to the concentration of CO₂ in the inspired gas.

Employing a specially designed, very large soda-lime canister (designed by Brown) in place of those in the conventional anesthetic apparatus resulted in the complete elimination of CO₂ from the inspired gas and a marked diminution in the pulmonary ventilation necessary to prevent acidosis.

12. Aortic Valvulotomy Under Direct Vision During Hypothermia.

F. JOHN LEWIS, NORMAN E. SHUMWAY (*by invitation*), SUAD A. NIAZI (*by invitation*) and ROBERT B. BENJAMIN (*by invitation*), Minneapolis, Minn.

Since blind technics for the correction of aortic stenosis either through the left ventricle or the aorta have not been altogether satisfactory, efforts to develop a direct vision operation are justified. Hypothermia provides a logical technic for it has already proved to be satisfactory for open operations on the atrial septum and the pulmonary valves.

After experiments on dogs showed that it was possible to operate on the aortic valves under direct vision, the technic has been applied successfully in human patients with aortic stenosis. To do the operation the chest is entered bilaterally from the front after the patient has been cooled. Following inflow occlusion of the cavac and the pulmonary veins the aorta is opened just above the valves. All three commissures are cut under direct vision. To avoid air embolism, blood flow through the heart is restarted and fluid is injected into the left atrium before the aortic wound is finally closed. A distal aortic clamp is released just as the aortic wound is closed.

Though the valves cannot be restored to normal, a more accurate and complete division of the fused commissures can be obtained with this open method than is possible with blind technics. All three commissures can be opened without tearing the valve cusps.

Our clinical experience with the method will be reported.

13. The Indications for Lobectomy in the Treatment of the Lung.

JOSEPH L. ROBINSON and JOHN C. JONES, Los Angeles, Calif.

The increasing proportion of patients with peripheral pulmonary lesions which X-ray survey and screening techniques are bringing to the thoracic surgeon, justifies another appraisal of the place lobectomy is playing in the surgical treatment of carcinoma of the lung.

In our own practice we have found ourselves electing to perform lobectomy on more and more patients. The conditions which have produced this change and the indications which we have adopted for the selection of patients for lobectomy are discussed. Followup statistics of our pulmonary resections (lobectomy and pneumonectomy) of three or more years will be presented.

Finally, in order to gather information concerning the extent of the present day use by thoracic surgeons of lobectomy in treating pulmonary carcinoma, we have conducted a survey among the members of this Association and have summarized the results of that questionnaire.

14. Common Factors in Lung Cancer Survivors.

RICHARD H. OVERHOLT and JAMES A. BOUGAS (*by invitation*), Boston, Mass.

An appraisal has been made of 55 five-year survivals of patients treated for primary cancer of the lung. Common denominators in the studies of these fortunate individuals were these: 1. All had an abnormal shadow by X-ray; 2. In all, the extent and character of the lesion was settled by thoracotomy; 3. All had been treated by surgical excision.

Other factors were not constant. Bronchoscopic and cytologic examinations were helpful in some but in many, results were negative. No significant difference in these factors could be found when this group was compared with the other cases who succumbed to the disease within a five-year period. No verified case, untreated, or treated by other methods, such as, radiation or chemotherapy or combinations, survived five years.

An analysis of patients treated in the years 1950, 1951 and 1952 has been made in order to compare a more recent three-year salvage with the three-year results of those treated prior to 1950. From 1938 through 1952, 50 cases of bronchial adenoma were treated surgically and salvage figures will be presented.

Most thoracic surgeons have elected to employ radical pneumonectomy with extensive mediastinal lymph node dissection in the treatment of pulmonary carcinoma. There has been general agreement for limiting the resection to a lobe in the patient with low pulmonary reserve. Salvage studies indicate that other situations call for a more limited resection: 1. "Coin" or peripheral lesions without evidence of node involvement; 2.

Bronchiolar carcinoma limited to lobes; 3. In palliative surgery, when gross tumor must be left behind in vertebra, great vessels, heart or contra-lateral mediastinum.

6:30 P.M.-8:30 P.M. COCKTAIL PARTY. Informal.

Hotel Fontainebleau.

TUESDAY MORNING, MAY 8, 1956

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Tuesday Morning, May 8, 1956

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

15. Introducing a Simple Surgical Method for the Correction of Mitral Regurgitation Using the Finger Ring Valve Elevator.

ARAN S. JOHNSON (*by invitation*). Sponsored by WILLIAM M. TUTTLE,

Detroit, Mich.

A careful examination of over 100 necropsy specimens of hearts with residual rheumatic mitral valvular lesions reveals the following pathology. In 70 per cent of the hearts with mixed mitral stenosis and regurgitation, or pure mitral regurgitation, the regurgitant defect was found constantly in the posterior leaflet of the mitral valve. With this nearly constant pathological finding in mind, a simple surgical technique was developed to correct the existing defects in the posterior mitral leaflets. With the aid of the Finger Ring Valve Elevator, the posterior wall of the left atrium is invaginated and sutured over the anterior surface of the posterior leaflet of the mitral valve. This maneuver corrects the existing valvular defect satisfactorily.

Clinical cases of mitral regurgitation treated surgically will be presented and discussed.

16. Further Experiences with the Method of Controlled Unilateral Pulmonary Artery Occlusion in the Study of Lung Function.

PAUL NEMIR, JR., H. H. STONE (*by invitation*), H. R. HAWTHORNE (*by invitation*)

and T. N. MACKRELL (*by invitation*), Philadelphia, Pa.

In 1953 we presented a preliminary report on the method of unilateral pulmonary artery occlusion for the study of lung function in patients who were candidates for pulmonary resection. Since that time, the method has been employed in several other clinics and the number of patients now studied has become sufficiently large to allow significant conclusions. Study has now been carried out by us on approximately 35 patients. With our continuing experience, refinements in technique have occurred. Moreover, analysis of the data has yielded information which has allowed us to concentrate on the observations which are the most significant. Special triple lumen balloon-tipped cardiac catheters have allowed simultaneous pressures and gas analyses at various levels of the pulmonary system and have allowed a study of bronchial artery blood flow in normal and diseased lungs. Analysis of the results in this larger group of patients has confirmed the earlier observations with respect to the relationship between sustained elevation of pulmonary artery pressure following occlusion and occurrence of dyspnea following resection. There is evidence that study of the pressures and blood gases distal to the occluding balloon may give similar important information on resection tolerance and on bronchial artery blood flow in certain disease states. Responsiveness of the pulmonary circulation to various drugs has been demonstrated.

17. Oxygen Availability to the Brain During Inflow Occlusion of the Heart in Normothermia and Hypothermia.

SAMUEL KAPLAN (*by invitation*), EDWARD C. MATTHEWS (*by invitation*),

LOIUS SCHWAB (*by invitation*) and LELAND C. CLARK (*by invitation*).

Sponsored by JAMES A. HELMSWORTH, Cincinnati, Ohio

Many of the surgical techniques used in the therapy of intracardiac anomalies under direct vision depend on the application of either one or the other of two principles: the reduced metabolism associated with hypothermia, or a low flow rate (azygos principle). These two principles were tested by measuring oxygen available to the brain (tension) by the polarographic technique.

Dogs were prepared by placing a polarograph cathode in the brain. After the cathode had "healed", continuous records of brain oxygen availability were obtained at normal temperatures before, during, and after the occlusion of the inferior vena cava and the superior vena cava above the azygos vein. In vivo calibration of the cathode was obtained by allowing the animals to breathe 100%, 20%, 9.8% and 4.8% oxygen while the circulation was intact. Galvanometer readings obtained during the venous occlusion were the same as those obtained during the breathing of about 10% oxygen.

Further records were obtained after the animals' temperature had been reduced to 26° - 28° C. by extracorporeal cooling. After complete inflow venous occlusion, there was a precipitous fall of the oxygen available to the brain, followed by a return to pre-occlusion levels after the circulation had been re-established. In vivo calibration showed that in hypothermia, the measurable oxygen available to the brain during venous occlusion was the same as while breathing less than 4.8% oxygen.

These studies indicate that there is a rapid and significant reduction of oxygen available to the brain during reduced flow rates as in the "azygos principle" and is exaggerated in hypothermia with complete inflow occlusion.

18. The Effect of Somatotrophin on Ventricular Fibrillation of Arterioclusive and Hypothermic Origin.

DAVID H. WATKINS (*by invitation*), S. ROTHMAN (*by invitation*), ARTHUR

E. PREVEDEL (*by invitation*) and GORDON A. MUNRO (*by invitation*).

Sponsored by WILLIAM B. CONDON, Denver, Colorado

Bovine Somatotrophin was administered to a series of dogs prior to the attempted induction of ventricular fibrillation by right ventriculotomy under hypothermic conditions or by one-stage coronary artery ligation in normothermic animals. Under control conditions such hearts fibrillate readily. However, those animals which had been premedicated were remarkably resistant to fibrillogenic stimuli.

The hypothermic heart has been defibrillated in other ways: prolonged massage, electric current, acetylcholine, potassium chloride and infiltration of the sinoauricular node. Thus, the trigger mechanisms inducing ventricular fibrillation apparently may be modified by several modalities.

The protection by pre-treatment with Somatotrophin of dogs which are subsequently exposed to stimuli usually provocative of ventricular fibrillation leads us to believe that the mechanisms producing fibrillation may be modified on the metabolic level. The early local metabolic derangements produced by myocardial infarction are of special interest because of the production of ventricular fibrillation, a frequent cause of early mortality. Similar relationships exist with reference to cardiac arrest. Conditions known to provoke cardiac arrest conceivably alter membrane permeability and the intrinsic cellular metabolism of the myocardium.

19. Physiologic Responses in Man to Total Body Perfusion for Open Intracardiac Surgery.

RICHARD A. DEWALL (*by invitation*) and RAYMOND C. READ (*by invitation*),

Minneapolis, Minn.

In this clinic a simple disposable artificial oxygenator is being employed together with a standard pump for direct vision intracardiac reparative surgery. To date, fifty patients ranging in age from 16 weeks to 37

years have had intervals of total cardiac and pulmonary by-pass at normal body temperatures for intervals up to 50 minutes at various rates of perfusion utilizing this oxygenator.

Detailed biochemical data has been obtained in these patients before, during and after the by-pass interval in regard to their physiologic response to this total body perfusion. These data will be presented.

20. A Method for Controlled Cardiac Arrest as an Adjunct to Open Heart Surgery.

W. GLENN YOUNG (*by invitation*), WILL C. SEALY,

IVAN W. BROWN, JR. (*by invitation*), WILMER C. HEWITT, JR. (*by invitation*),

HENRY A. CALLAWAY, JR. (*by invitation*), DORIS H. MERRITT (*by invitation*) and

JEROME S. HARRIS (*by invitation*), Durham, N. C.

Induced cardiac arrest would seem to be desirable as an adjunct to intracardiac surgery. Since no work is performed during standstill, cardiac metabolism theoretically would be so decreased that long periods of aortic and coronary artery occlusion would be possible. It also has the advantage of preventing air embolism, diminishing blood loss, and providing a motionless operative field.

In this study a series of experiments with the Langendorf perfusion apparatus were performed to determine the best agents for causing rapidly reversible cardio-plegia. Among the substances tested alone or in various combinations were potassium, magnesium, antihistaminic drugs, cholinergic drugs and barbiturates. A solution containing magnesium sulphate, potassium citrate, and prostigmine was found to be satisfactory. This cardioplegic agent has been used in a series of acute and survival experiments on both hypothermic and normothermic dogs. The solution was injected into the coronary arteries through the occluded aorta until cardiac contractions stopped. Then a right ventriculotomy was made and repaired. This was followed by perfusion of the coronary vascular tree until normal cardiac activity was resumed. In acute experiments, the cardioplegic drug was washed out with an oxygenated balanced electrolyte solution. Normal cardiac activity in survival experiments was restored by perfusing the coronaries with oxygenated blood. In the latter group, the systemic circulation was maintained by a simple oxygenating system and a Sigmamotor pump.

21. The Neutralization of Heparin by Protamine in Extracorporeal Circulation.

MR. RAYMOND HURT, Traveling Fellow of the Association (*by invitation*),

London, England. Sponsored by FRANK L. GERBODE.

At the conclusion of heart-lung bypass with an extracorporeal circulation, it is necessary to neutralize the anticoagulant action of the heparin with protamine. This protamine, in addition to neutralizing the heparin, has three other effects if given in excess. It will cause a shock-like syndrome (characterized by a fall in blood pressure and a bradycardia), a haemorrhagic tendency, and thrombocytopenia. A method of protamine titration has been developed in order to estimate the correct dose and reduce the severity of these undesired side-effects.

Data will be presented which demonstrate that the severity of the shock-like syndrome that occurs following the administration of protamine is much greater if the blood has previously been passed through an extra-corporeal pump.

22. Experience with a Disposable, Artificial Lung.

D. B. EFFLER, W. J. KOLFF (*by invitation*), L. K. GROVES (*by invitation*),

F. M. SONES, JR. (*by invitation*) and G. PEEREBOOM (*by invitation*),

Cleveland, Ohio

Acceptance of the azygous flow principle and cross-circulation procedures in open heart surgery have emphasized the need for a safe and practical blood oxy-genator. Research and clinical experience with an artificial kidney (Kolff) led to the development of an artificial lung. The Kolff lung employs the membrane principle of oxygenation. This artificial lung, using polyethylene tubing (.001 inch thick) permits ready exchange of carbon dioxide and oxygen without bubbles, foam or alteration in the clotting mechanism. The present apparatus will oxygenate 300 cc. of venous blood per minute up to 95% saturation. In addition to these features, the artificial lung is disposable and should be relatively cheap to manufacture.

Experience in over one hundred dog operations has been encouraging. Open heart surgery in dogs (10 kilo.) is permitted by utilization of these disposable prostheses; with the venae cavae occluded, auricular and ventricular septal defects may be created and sutured under direct vision. Neither hypothermia nor supplemental drugs (e.g., chlorpromazine) are used in adjunct. Description of techniques and recovery rates will be presented.

The schedule of initial experimental work with the Kolff lung will be completed in the very near future. The authors anticipate clinical application of this simple blood oxygenator. A report of all clinical experience will be included.

23. An Artificial Lung Dependent upon Diffusion of Oxygen and Carbon Dioxide Through Plastic Membranes.

GEORGE H. A. CLOWES, JR., AMOS L. HOPKINS (*by invitation*) and

WILLIAM E. NEVILLE (*by invitation*), Cleveland, Ohio

A new type of blood oxygenator has been developed to prevent direct exposure of blood to gaseous oxygen and the formation of foam. We wish to present this apparatus, the preliminary work on evaluating the characteristics of thin plastic membranes, and the results of perfusions employing this oxygenator.

Sixteen varieties of plastic films ranging in thickness from .0004 to .003 inches were tested to determine their capacities of oxygen transmission directly to venous blood. Of these ethyl cellulose and polyethylene have proven to be the best.

Using these films, an apparatus has been constructed to permit blood to flow in a very thin layer between them with oxygen circulating outside the plastic. At the same time an effort has been made to make the apparatus as efficient as possible and to minimize the amount of blood held within it. In operation this device transmits oxygen to flowing blood in quantities of up to 80% of the maximum calculated value for a given membrane and surface area. A unit capable of oxygenating 1,000 cc. of blood per minute holds approximately 650 cc.

Recovery of dogs perfused up to one hour and the absence of electroencephalographic depression suggest that embolization and other untoward changes in blood elements are not taking place.

24. Extracorporeal Circulation for Open Heart Surgery.

RUSSELL M. NELSON (*by invitation*), HANS H. HECHT (*by invitation*),

RICHARD W. HARDY (*by invitation*) and JOE BURGE (*by invitation*),

Salt Lake City, Utah

An apparatus has been developed for extracorporeal circulation permitting open heart surgery in a dry field. It has been employed successfully in laboratory and clinical work. It consists of a Sigmamotor pump and a bubble-oxygenating device consisting of two concentric lucite plastic cylinders. Oxygenation and elimination of carbon dioxide are accomplished in the center bubbling chamber. The bubbles are eliminated by contact with stainless steel mesh coated with antifoam. The oxygenated blood is then collected in the outer reservoir chamber and returned. Blood aspirated from the cardiotomy incision is returned. The entire apparatus is sterilized by autoclaving.

With total by-pass of the heart and lungs for 30 minutes or more, long incisions have been made into the right ventricle and/or the right atrium in twelve dogs with ten surviving the procedure. One died of an error in anesthesia technique, and one of the first dogs died of hemorrhage. Since the substitution of plastic for glass in the oxygenating chamber, no further wound oozing has been observed.

Measurements of oxygen, carbon dioxide and plasma hemoglobin concentrations have all been within satisfactory limits. pH determinations at first showed a rise during perfusion; this now being controlled by the addition of 5% CO₂ to the gas mixture. Pulse pressure curves and electrocardiograph tracings have been monitored throughout each experiment. Flow rates have averaged 20 to 30 cc/kg/min.

Brief reference to clinical application will be presented.

25. A Mechanical Pump-Oxygenator for Direct Vision Repair of Atrial Septal Defects.

BERNARD S. LEVOWITZ (*by invitation*), MELVIN M. NEWMAN, JACKSON H.

STUCKEY (*by invitation*), MARIE C. KERNAN (*by invitation*), HARRY

N. ITICOVICI (*by invitation*) and CLARENCE DENNIS, Brooklyn, N. Y.

A simplified mechanical pump-oxygenator has been developed in this laboratory which permits a direct-vision approach to infracardiac defects with relative safety. The present communication describes this apparatus and its application in the experimental creation and repair of atrial septal defects. The heart and lungs were totally bypassed in 31 dogs ranging in weight from 10 to 35 kilograms for intervals of 10 to 63 minutes. During this period atrial septal defects from 1.5 centimeters to 3 centimeters were made and repaired in a single stage. Twenty-two dogs were long term survivors.

The causes of death were: air embolism, 3 dogs; uncontrollable bleeding, two dogs; dissecting aneurysm of thoracic aorta, one dog; technical error, one dog; undetermined causes, two. Techniques for avoiding the major hazards have been studied. The physiologic alterations in acid-base balance, oxygen transport, and protein fractions of the blood have been determined in detail during each perfusion. Similarly, changes in the clotting mechanism have been followed and will be presented.

The results of a successful clinical application of this apparatus to a case of a large foramen ovale-septum secundum defect in an 18 year old female are included in this report.

26. Elimination and Transport of Mucus in the Lung: An Experimental Study in the Dog.

EDWARD G. HUPPLER (*by invitation*), O. THERON CLAGETT and

JOHN H. GRINDLAY (*by invitation*), Rochester, Minn.

A study was undertaken on dogs in an attempt to answer the following questions: 1. Can mucus be absorbed in the lobule of the lung when the proximal bronchus is transected and the ends closed? 2. Can a bronchial cyst be produced by isolating a segment of bronchus but leaving the blood and nerve supply intact?

In one group of dogs the right upper lobe bronchus was transected and both ends of the divided bronchus were closed by suture. In these animals mucus secreted into the right upper lobe bronchus could not be removed through the trachea by coughing or movement by the cilia but it could flow into the alveoli.

In a second group of animals, following right upper lobe bronchus transection, the first four secondary bronchi were doubly ligated, thus producing an isolated segment of bronchus. Mucus secreted into this segment could not be removed through the trachea nor could it flow into the alveoli. The secondary bronchi distal to this isolated segment were not ligated; hence, mucus secreted into the primary bronchus distal to the isolated segment could flow into the alveoli but not into the trachea.

An animal from each series was sacrificed at intervals varying from 2 to 48 weeks after operation. In both groups of animals endobronchial mucus dilated all portions of the bronchial tree but a bronchial cyst

was not produced. In animals sacrificed 16 to 48 weeks after operation the degree of dilatation of the bronchial tree and the quantity of mucus in the lung lobule were decreased.

The findings are discussed in relation to cases of traumatic rupture of a bronchus and in relation to the various theories of etiology of bronchogenic cysts.

27. Surgical Treatment of Ventricular Septal Defects: A Method Utilizing Selective Coronary Perfusion and Hypothermia.

JOHN B. GROW, CHARLES V. DEMONG (*by invitation*) and CHARLES R.

HAWES (*by invitation*), Denver, Colo.

The closure of interatrial septal defects utilizing hypothermia and cardiac occlusion has proved to be a successful procedure. Study of ventricular septal defects in museum specimens and at the Children's Hospital autopsy table indicates that such defects can be closed by suture technique but not in the relatively short periods of occlusion thought safe and proved applicable to the atrial septal defects.

Failure of laboratory animals to survive closure of septal defects under hypothermia and cardiac occlusion results from: (1) Ventricular fibrillation; (2) coronary air embolism; (3) uncontrollable capillary bleeding following surgery. A combination of perfusion of the coronary arteries with oxygenated blood as suggested by Shumway et al and sino-atrial node blockade as described by Shumacher offers an uncomplicated method of increasing the safe limits of cardiac occlusion to at least 20 minutes. This is considered sufficient for closure of ventricular septal defects.

A simplification of this technique has been devised in which the coronary arteries are perfused by syringe with oxygenated donor blood from a reservoir, thereby obviating both mechanical pump and oxygenator.

Successful closure of ventricular septal defects with survival of four of the five patients to date (December 1, 1955) suggests that this method may be useful in the surgical repair of intracardiac defects which necessitate more than five minutes of occlusion time. Details of technique, summaries of clinical cases, and postoperative management with particular regard to hematologic changes will be discussed.

28. A Report on Heterologous Vascular Shunts (Bovine Brachiocephalic) in Experimental Aortic Arch Resection.

RALPH D. ALLEY, WILLIAM H. SEWELL (*by invitation*), ALLAN STRANAHAN,

HARVEY W. KAUSEL (*by invitation*), THOMAS S. REEVE (*by invitation*) and

ALAN S. PECK (*by invitation*), Albany, N. Y.

Surgical resection of the aortic arch poses two major unsolved problems: (a) a practical method for by-passing the aortic arch during the period of occlusion, and (b) a suitable graft for its reconstruction. This report concerns progress in the solution of the first of these problems.

Since our preliminary report of a heterograft external shunt for by-passing the aortic arch (1954), further technical refinements have reduced the operative mortality in experimental aortic arch resection to negligible levels. In brief, the shunt is fashioned from the bovine brachiocephalic trunk which is oversewn as a manifold, preserving its carotid and subclavian branches as limbs of the shunt.

The features which recommend it are: (a) availability of the material; (b) its physiologic elastic properties; (c) adequate caliber; (d) absence of thrombosis; (e) mobility in the operative field; (f) basic simplicity of application with no premium on speed or critical dexterous maneuver. Although more rapid methods for experimental resection of the dog's normal aortic arch have been described, the advantages of the bovine brachiocephalic shunt would appear to offer greater promise of adaptability to the unpredictable operative problems presented by clinical vascular pathology.

Because others have reported difficulty in obtaining intact specimens, an expeditious method for procuring bovine brachiocephalic arteries will be described and illustrated by a short motion picture. The technique ensures intact subclavian and carotid branches of adequate length without mutilating the carcass or otherwise hampering the work of the abattoire.

29. Arterial Homograft Substitution and Bypass in Superior Vena Caval Obstruction.

JOHN F. HIGGINSON, Portland, Ore.

Superior vena caval obstruction syndrome is usually the result of malignant tumors invading the superior vena cava and/or the innominate veins. Ordinarily extirpative treatment is not possible. Occasionally, however, the tumor is benign or, if malignant, is resectable. Even if not resectable, relief of the superior vena caval obstruction would be most desirable since the symptoms are extremely distressing and often the immediate cause of death.

The use of arterial homograft substitution or bypass in these situations is one means of effectively solving the problem as is the reverse of the earlier treatment of arterial defects by the use of segments of veins.

Three cases will be presented. In one an aortic-iliac bifurcation homograft was substituted for the resected innominate veins and superior vena cava. In two a bypass arterial homograft shunt was established between the left innominate vein and the right auricular appendage.

30. Experiments with Substitute Esophagus.

LAURENCE RUBENSTEIN (*by invitation*), Chicago, Ill.

Much work has been done in the patient in an attempt to alleviate obstructive lesions of the esophagus. The problem in most cases has been that either forbiddingly hazardous operations or inadequate replacements of portions of the esophagus have yielded relatively unsatisfactory results. In the past few years, we have attempted to remove portions of the esophagus in dogs and to replace them with various substitutes, including living tissue as well as prostheses. Although we have been successful in replacing segments of esophagus, a serious complication has been stricture formation with interference of the propulsion of food through the esophagus. In recent experiments, using new type prostheses which can be easily sutured, we have been successful in reconstructing esophageal defects with a minimum of disturbance to the physiological mechanism of swallowing. This work has been encouraging enough so that we feel justified in translating our results to humans.

Various portions of the esophagus have been removed and replaced with this prosthesis. The main advantages are: (1) The ease and rapidity with which it may be inserted; (2) the firm yet yielding nature of the material; (3) the absence of postoperative strictures in the area of surgical intervention when the prosthesis is left in place.

TUESDAY AFTERNOON, MAY 8, 1956

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Tuesday Afternoon, May 8, 1956

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

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

Address by the President, Richard H. Meade, Grand Rapids, Michigan.

"Some of the Forgotten Men in the Field of Thoracic Surgery"

Address by Honored Guest, Mr. Philip Allison, Ch.M., F.R.C.S., Nuffield Professor of Surgery, Oxford, England.

"Observations on a Conservative Approach to Non-Malignant Lesions of the Cardia"

31. Reconstruction of the Trachea.

JOHN M. KESHISHIAN (*by invitation*), BRIAN BLADES and
EDWARD J. BEATTIE, JR., Washington, D. C.

Recommendations will be made on the clinical application and surgical technique of reconstruction of the trachea. Experiences gained in laboratory experiments on over 100 dogs will be described. Results with prosthetic devices will be reported. A review of the literature touching on both the experimental and clinical status of tracheal reconstruction is made.

Indications for reconstruction of the trachea vary depending on the site of the lesion. Moreover, consideration must be given for the type of lesion: Stenosis due to tuberculosis; involvement with tumor; stenosis resulting from long standing inflammation; stenosis or damage resulting from trauma.

A classification of the various types of tracheal defects will be presented. Selection of cases, preparation for the operation and management in the postoperative phase will be discussed. Several representative cases with accompanying illustrations will demonstrate the magnitude of even the simplest derangement of respiratory physiology. Cases will also be described dealing with the definitive treatment of tumor, trauma and inflammatory stricture of the trachea.

32. The Solitary Pulmonary Nodule -A Ten Year Survey.

EDGAR W. DAVIS, J. WINTHROP PEABODY, JR. (*by invitation*) and
SOL KATZ (*by invitation*), Washington, D. C.

This paper represents the culmination of a study initiated by the senior author in 1946. Over the intervening decade 200 patients with solitary, non-calcified, pulmonary nodules have undergone thoracotomy; another group with single nodules containing radiographic evidence of calcification, therefore presumably benign lesions, have for one reason or another also been resected and are available for comparison. Apparently these two groups comprise the largest personal series of solitary lung tumors so far collected. Not only do they afford an unusual opportunity for correlating roentgenologic impressions with pathologic findings, but permit a statistically significant analysis of the relative frequency and ultimate prognosis of the many different lesions encompassed in this study.

To date the main theme of all papers on this subject pertains to the malignant propensities of the group as a whole and the lack of significant radiographic distinctions between the benign and malignant nodule. Important questions remain unanswered, however. Chief among these are: (1) *Survival rates of resected bronchogenic carcinoma presenting as a solitary pulmonary nodule*. Resolution of this question is imperative in view of recent indictments of the value of X-ray surveys in influencing the number of long-term survivals; (2) *Reliability of calcification as an indication of benignancy*. Instances of calcine deposition within proved bronchogenic carcinomas will be presented and attention directed to the importance of the pattern of calcification in determining its significance; (3) *Identification of the specific etiology of the various granulomas*. One of the most revealing aspects of this study has been the demonstration of Histoplasma, Coccidioides, Cryptococcus, etc., in a large percentage of these supposedly non-specific lesions.

7:00 P.M. Cocktails, Banquet and Dancing, Hotel Fontainebleau.

**Attendance limited to Members of the Association and their ladies, Invited
Speakers and their ladies.
Dinner dress preferred.**

WEDNESDAY MORNING, MAY 9, 1956

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**Wednesday Morning, May 9, 1956
9:00 A.M. Scientific Session: REGULAR
PROGRAM.**

33. Pulmonary Resection for Tuberculosis:

A Five to Ten Year Follow up Study.

JAMES D. MURPHY and JAMES M. DAVIS (*by
invitation*), Oteen, N. C.

At the 1948 meeting of this Association we discussed the evaluation of pulmonary resection for tuberculosis in 70 streptomycin-protected patients. The study indicated that early results were highly satisfactory but that a permanent appraisal could not be made until a long period of postoperative observation had been completed.

We are now presenting a five to ten year followup study of 148 patients who had 150 resections: 83 pneumonectomies and 67 lobectomies or less during the period 1946 to 1950. Developments in the field of chemotherapy and surgery have been so dramatic that data gathered from the early group cannot accurately reflect the experiences being encountered today. It is felt, however, that this data is of great value as an account of the results achieved by excisional surgery during the pioneer days of streptomycin therapy.

The study reveals that 72% of 148 patients are at home with inactive disease from five to ten years after surgery. The road to this happy state, however, has been fraught with many hazards. The operative mortality was 2.7% but the total mortality has been 17.3%. In an effort to determine whether morbidity and mortality rates following resection have been reduced by changes in drug therapy we have also reviewed 100 consecutive resections done in 1954 and compared the results with those obtained in the original series.

34. The Role of the Chronic Occult Postresection Bronchial Fistula in the Reactivation of Tuberculosis: Pathogenesis and Treatment.

JOHN W. BELL (*by invitation*) and E.
M. MEDLAR (*by invitation*)

Sunmount, N. Y.

Little attention has been given to the association of chronic occult postresection fistulas and the reactivation of tuberculosis. Eight cases are described with fistulas presenting from three months to three years following segmental resection for tuberculosis.

The Clinical, Radiologic and Bacteriologic features essential for the diagnosis of chronic fistulas are discussed. The outstanding finding in each patient was the absence of overt signs and

symptoms characteristic of the ordinary bronchopleural fistula. These occult fistulas occurred in the presence of known or unsuspected resistant bacilli in the resected tissues. Further, they were associated with the reappearance of persistence of bacilli in the sputum and, in most instances, with the phenomena of implantation tuberculosis in a pseudo cavity formed at the resection site.

With the exception of the first patient who died of pulmonary hemorrhage three months following primary resection, each of the remaining patients was successfully treated with secondary resection. Two specimens, therefore, were available in each case for the study or bacteriology and pathology. In particular, the age and behavior of the new tuberculosis process could be determined.

The significance of uncontrolled implantation tuberculosis is discussed. A surgical policy is suggested which avoids segmental resection in the presence of drug resistant organisms.

35. Extraperiosteal Plombage Thoracoplasty. Operative Technique and Results with 161 Cases with Unilateral Surgical Problems.

NORMAN J. WILSON, ORLANDO ARMADA (*by invitation*), WILLIAM V.

VINDZBERG (*by invitation*) and WILLIAM B. O'BRIEN (*by invitation*),

Boston, Mass.

Between August, 1949, and June, 1954, extraperiosteal plombage thoracoplasty was performed upon 161 patients with unilateral surgical problems. A follow-up study of this group was done in June, 1955. Eighty-six were of the two-stage-type operation and 74 were the one-stage-type, the plombage being left in place. The longest follow-up in the latter group is three and two-thirds years. Ages of patients varied from 16 to 66 years. Thirty-six (22%) were over 50 years of age.

Preoperative X-rays revealed definite cavity in 141; honeycombing in five, three of which had positive sputum; no cavity in fifteen, nine of which were positive. Preoperative sputa were

positive in 113 (70%). Forty-eight had negative sputa, but 40 of this group had definite cavity.

Tuberculous complications occurred postoperatively in one case (0.6%). Late complication occurred in 18 patients (11%). There were no postoperative deaths. Five have since died, three of coronary occlusion, one of metastatic carcinoma, and one of a severe unexplained enteritis.

Subsequent surgical procedures have been necessary in 23 (14%); 20 on the same side and in five on the contralateral side.

Follow-up in June, 1955, revealed five dead and 156 (97%) living. Of the 156 living patients, 145 (93%) are completely well. Four patients were lost to follow-up but are known to be alive.

These results indicate this to be a simple, safe and effective surgical procedure. It is possible that such collapse procedures are not being used often enough in this era in which resection has become so popular. In our experience results have been so good that this procedure occupies an important place in the surgical program and is the procedure of choice in certain types of cases.

36. Bronchographic Studies as a Guide in the Surgical Treatment of Pulmonary Tuberculosis.

F. J. PHILLIPS, ANTHONY LALLI (*by invitation*) and WALTER BUHLER (*by invitation*),

Bartlett, Alaska

The average case of pulmonary tuberculosis seldom poses a treatment problem with the present antimicrobials. The pathological ravages of the older inadequately treated cases stimulate medical interest and create baffling problems in surgical judgment. At the Seward Sanatorium where an active surgical program is carried out, bronchography has been employed almost routinely in presurgical diagnostic evaluation procedures. More than 250 such cases have been so studied. There have been no serious reactions. Various radio-opaque substances have been used. With the use of post bronchogram bronchial dilators, retention of the opaque material has not been a problem. The technical problems of doing the procedure have been eliminated. Patients are routinely bronchoscoped and, when desired, bronchograms are done under fluoroscopic

control by means of introduction of a rubber catheter through the bronchoscope while the patient's respiratory tree is still under the influence of the same topical anesthetic. The added diagnostic information has resulted in doing resections on many cases that would have been discharged without proper surgical treatment or left inadequately treated otherwise. Representative cases will be presented showing unanticipated cavitary and bronchiectatic cystic formations that would have precluded complete recovery.

37. A Clinical Evaluation of Decortication.

DAVID H. WATERMAN, SHELDON E. DOMM and

WILLIAM K. ROGERS (*by invitation*), Knoxville,
Tenn.

In the eleven year period since the work of Burford and Samson revived interest in decortication and introduced new techniques, the worth of the procedure has been well established and widely recognized. Originally envisioned for empyema, hemothorax, and later for the unexpandable lung in pneumothorax, the indications for the procedure have been broadened to include a wide variety of conditions.

The authors have applied the technique in over 160 patients, a good number of which are cases having no residual pleural space, as in so-called "false re-expansion". It is the opinion of the authors that considerable clinical improvement can be brought about in patients in this latter category. Several cases of bilateral decortication are included in the series, as are cases in which the lung has been imprisoned for as long as 19 years. The results of pulmonary function studies including bronchspirometry in a representative group have corroborated the gratifying subjective clinical improvement reported by most of the patients in the series. Many individuals who were previously incapacitated have returned to full time activity with no demonstrable dyspnea.

The widened indications for the procedure are discussed and the clinical results of the series reviewed. It is felt that extensive utilization of the procedure is warranted.

WEDNESDAY AFTERNOON, MAY 9, 1956

Wednesday Afternoon, May 9, 1956

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

38. Observations on the Surgical Pathology of Congenital Intra-cardiac Defects Made During Direct Vision Repair.

HERBERT E. WARDEN (*by invitation*), RICHARD L. VARCO and
C. WALTON LILLEHEI, Minneapolis, Minn.

More than 100 patients with congenital intracardiac anomalies have undergone direct vision repair of their defects during total cardiac by-pass by means of controlled cross circulation, the arterial reservoir, biologic (dog lung) oxygenator, or a mechanical (bubble) oxygenator perfusion techniques.

The most common congenital defects approached with these methods have been interventricular septal defect (65%), tetralogy of Fallot (20%), and atrioventricularis communis (7%). This experience in the corrective surgical treatment of these lesions has emphasized certain features of the pathologic anatomy of these anomalies which are of utmost importance to successful repair and recovery of the patient.

In addition, as experience has grown during the course of treatment of these patients, several important modifications in the technique of repair have evolved. These as well as the details of the pathologic anatomy of the most common congenital intracardiac defects will be presented.

39. Technique for Repair of Ventricular Septal Defects Utilizing Extracorporeal Circulation.

JOHN W. KIRKLIN, H. G. HARSHBARGER (*by invitation*), D. E. DONALD (*by invitation*)
and J. E. EDWARDS (*by invitation*), Rochester, Minn.

A new operative procedure undergoes changes in technical details with the accumulation of experience. It is the purpose of this presentation to present the details of the surgical aspects of closure of ventricular septal defects.

Thirty cases with ventricular septal defect, twenty-one as an isolated lesion, two as a part of common atrioventricular canal, and seven as part of the tetralogy of Fallot have been operated at the Mayo Clinic by open cardiectomy utilizing the Gibbon-type pump-oxygenator for extracorporeal circulation. Data from these cases and from cases operated subsequent to submission of this abstract will be presented.

The pathologic anatomy of the various types of ventricular septal defects encountered in this series will be discussed. Three types of defects have occurred in patients with this as an isolated anomaly. The type of defect seen in the tetralogy of Fallot is different from any of these.

Details pertinent to the closure of each of these types of defects are emphasized. The actual steps in the operative repair which has been found to be best for these defects will be illustrated. Studies pertaining to the completeness of the closure will be presented.

40. The Use of the Heart-Lung Apparatus in Human Cardiac Surgery.

F. D. DODRILL, NORMAN MARSHALL (*by invitation*), JAN NYBOER (*by invitation*),
ELSIE NOE (*by invitation*), C. H. HUGHES (*by invitation*)
and A. B. STEARNS (*by invitation*), Detroit, Mich.

We have previously reported our experimental results of the heart-lung apparatus. We have demonstrated that the blood can be well arterialized and can be returned to the arterial system with maintenance of a satisfactory blood pressure. Two innovations have since been instituted in the plan of the

surgical procedure: (1) Removal of a portion of the circulating blood, keeping it outside the circulation while the body is maintained on donor blood; (2) Arterialized blood is returned directly to the recipient's aorta without the use of the subclavian artery.

After the pumping period is over, the original blood of the patient is returned to the circulation while the used blood is simultaneously removed. Blood volume studies show that at least one-third of the blood volume may be removed. The removal of the patient's own blood is done simultaneously with the administration of donor blood to maintain the blood pressure. Likewise, as the used pump blood is removed from the vascular system, the original blood is simultaneously returned to the body.

Using the apparatus which we have previously described and with the above changes, we have successfully applied these methods to human cardiac surgery. A more detailed analysis of the human surgery will be given.

41. The Treatment of Mitral Insufficiency by the "Purse-String" Technique.

ROBERT P. GLOVER, JULIO C. DAVILA (*by invitation*) and

O. HENRY JANTON (*by invitation*), Philadelphia, Pa.

The concept for reducing the size of the annulus in valvular insufficiencies as a method for the correction of this dysfunction has been presented in previous publications. Compared to the principle of replacement of occluding valvular elements, the reduction of the valvular ring by circumferential suture has several theoretical and practical advantages. This is especially true when applied to the mitral valve. These advantages are: This procedure does not require the introduction of foreign materials across the cardiac chambers; it makes use of all remaining valvular substance capable of function; the effective orifice of the atrioventricular communication is not encroached upon by plugs or sutured cusps; it involves no more intra-cardiac manipulation than does a commissurotomy and results in no significant myocardial trauma; it is plausible to expect that the size of the atrioventricular ring will not progressively enlarge.

This principle, with or without concomitant commissurotomy, appears applicable to most forms of mitral insufficiency. Having demonstrated the anatomical feasibility of circumferential suture of the mitral ring and tested its application experimentally both on the normal and regurgitant valve over a period of two years, a thorough clinical trial seemed indicated. Therefore, the procedure has been performed on twenty patients, the oldest two of which are now over a year postoperative. Only stage IV patients were selected, each having been in marked chronic congestive failure for several years (most of them terminal cases). It was realized from the outset that such patients in the main could not possibly obtain outstanding results but it seemed imperative to study the efficacy of the procedure applied to the Rheumatic Heart and some hope of reasonable salvage was likewise entertained.

The technique used, the results obtained and the indications for further employment of the operation will be discussed.

42. Mitral Insufficiency-Treatment by Polar Cross-Plication of the Annulus Fibrosus.

HENRY T. NICHOLS (*by invitation*), Philadelphia, Pa.

During the past six years, efforts have been made by various investigators to correct or relieve mitral insufficiency by various surgical methods. These have included attempts to overcome the effective deficiency of valvular substance by placement of prosthetic forms within or alongside the valve structures; by grafting new living tissue to the shortened leaflets; by suturing together the divergent portions of the shortened cusps. More recently others have attempted by suture plication, by circumferential constriction, and by deformation of the annulus fibrosus to favor coaptation of the partially retracted free leaflet margins. It is believed by the author that this latter principle is sound but that the technique of application may be improved upon.

The logical attack upon the annulus must be designed to reduce selectively the diameter of the ovoid channel bounded by the ring across the incompetent pole of the valve (usually the posterior). This effectively brings the bases of the shortened leaflets closer together. Hence, the divergent free margins are brought

closer together thus being rendered more capable of systolic coaptation. A simple and apparently safe technique has been worked out for suturing together suitable selected points upon the mural and septal portions of the annulus.

On August 16, 1955, the first clinical attempt was made in a patient with a serious grade of mitral insufficiency. Since then, 16 other patients have been operated by this method. In every one it was possible to demonstrate a remarkable immediate reduction in the size of the digitally palpable regurgitant jet. There have been three postoperative deaths, each from an apparently avoidable complication. With one exception the initially obtained auscultatory improvement has been maintained and in this latter group the clinical benefit has been striking. These patients have been investigated carefully both pre and postoperatively and the objective evidence of benefit, so far, have been corroborative.

43. Patent Ductus Arteriosus in Infancy.

S. RICHARD BAUERSFELD (*by invitation*), PAUL C. ADKINS (*by invitation*)

and EDWARD M. KENT, Pittsburgh, Pa.

The typical case of patent ductus arteriosus causes little or no trouble during infancy. Occasionally, however, a large patent ductus may produce severe strain on the circulation during early infancy. Here, specific diagnosis is essential and prompt surgical closure of the patent ductus is indicated. During infancy and under certain other circumstances, the pressure differential between aorta and pulmonary artery is slight and only a systolic murmur is heard. Hence, a diagnosis of patent ductus arteriosus is difficult to establish without special studies.

In 65 cases of confirmed patent ductus arteriosus during the past three years, 19 (29%) were under the age of 24 months and were subjected to operation. All 19 showed poor weight gain, had intermittent respiratory difficulty, and showed evidence of cardiac enlargement. In ten of these infants, a continuous murmur was not audible and a systolic murmur alone was heard. Differentiation between patent ductus arteriosus and interventricular septal defect often could not be made on the basis of the usual examinations. Ductal patency was established by retrograde aortagrams.

No surgical deaths occurred although two infants died three months after leaving the hospital.

Postoperative follow-up of the remaining cases shows that all except one of these infants have gained weight. All have been less prone to respiratory infections and in general have done well.

ALPHABETICAL ROSTER

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William Branower	Morris Manges
Harlow Brooks	Walton Martin
Lawrason Brown	Rudolph Matas
Kenneth Bulkley	E. S. McSweeney
Alexis Carrel	Samuel J. Melter
Norman B. Carson	Willy Meyer (Founder)
J. Frank Corbett	James Alexander Miller
Armistead C. Crump	Robert T. Miller
Charles N. Dowd	Fred J. Murphy
Kenon Dunham	Leo S. Peterson
Edmond Melchior Eberts	Eugene H. Pool
Max Einhorn	Walthor I. Rathbun
Herman Fischer	Martin Rehling
Albert H. Garvin	B. Merrill Ricketts
Nathan W. Green	Samuel Robinson
John R. Hartwell	Charles I. Scudder
George J. Heuer	William H. Stewart
Chevalier Jackson	Franz Torek
H. H. Janeway	Martin W. Ware
James H. Kenyon	Abraham O. Wilensky
Adrian V. S. Lambert	Sidney Yankauer

ANNUAL MEETING DATES

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Meetings of the American Association for Thoracic Surgery

1918-Chicago..... President, Samuel J. Meltzer
1919-Atlantic City..... President, Willy Meyer
1920-New Orleans..... President, Willy Meyer
1921-Boston..... President, Rudolph Matas
1922-Washington..... President, Samuel Robinson
1923-Chicago..... President, Howard Lilienthal
1924-Rochester, Minn..... President, Carl A. Hedblom
1925-Washington..... President, Nathan W. Green
1926-Montreal..... President, Edward W. Archibald
1927-New York..... President, Franz Torek
1928-Washington..... President, Evarts A. Graham
1929-St. Louis..... President, John L. Yates
1930-Philadelphia..... President, Wyman Whittemore
1931-San Francisco..... President, Ethan Flagg Butler
1932-Ann Arbor..... President, Frederick T. Lord
1933-Washington..... President, George P. Muller
1934-Boston..... President, George J. Heuer
1935-New York..... President, John Alexander
1936-Rochester, Minn..... President, Carl Eggers
1937-Saranac Lake..... President, Leo Eloesser
1938-Atlanta..... President, Stuart W. Harrington
1939-Los Angeles..... President, Harold Brunn
1940-Cleveland..... President, Adrian V. S. Lambert
1941-Toronto..... President, Fraser B. Gurd
1944-Chicago..... President, Frank S. Dolley
1946-Detroit..... President, Claude S. Beck
1947-St. Louis..... President, I. A. Bigger
1948-Quebec..... President, Alton Ochsner
1949-New Orleans..... President, Edward D. Churchill
1950-Denver..... President, Edward J. O'Brien
1951-Atlantic City..... President, Alfred Blalock
1952-Dallas..... President, Frank B. Berry
1953-San Francisco..... President, Robert M. Janes
1954-Montreal..... President, Emile Holman
1955-Atlantic City..... President, Edward S. Welles