from the hospital. The pediatrician represents the child and his family and should be an active participant in all major discussions concerning the child. He decides when and to whom the patient should be referred for evaluation. He often initiates therapy, particularly in urgent situations. He should not decide when specialized diagnostic procedures are to be performed nor should he determine the indications for and timing of operative procedures. These are responsibilities of the pediatric cardiologist in collaboration with the pediatrician.

In this team endeavor the pediatric cardiologist has grown accustomed to rubbing shoulders with physiologists, radiologists, pathologists, and surgeons. He knows what to expect of them and they know what to expect of him. Similarly we know what to expect of the pediatrician. We hope he knows what to expect of the cardiologists.

We expect the pediatrician to be proficient in differentiating organic from insignificant murmurs. Any infant with a heart murmur which is considered to be organic requires close observation. This does not mean automatic referral to a cardiologist for evaluation. A baseline chest x-ray and electrocardiogram should be obtained. If the infant's activity is normal, if he has normal color, and he gains weight satisfactorily, referral should be postponed providing the heart is radiographically normal and the electrocardiogram does not demonstrate either marked right or left ventricular hypertrophy. Accordingly we, as cardiologists, expect the pediatrician as a participating member of the team to be able to interpret the x-ray and the electrocardiogram. The latter necessitates an appreciation of the normal patterns in the infant and young child. It is not sufficient to rely on the interpretation of an electrocardiographer who is all too frequently unfamiliar with normal childhood patterns.

The information to be presented in this symposium regarding (1) diagnostic techniques, (2) circulatory adjustments of the infant with heart disease, (3) natural history of certain congenital malformations, (4) surgical results, and (5) standards of care will be subject to revision in the future. We anticipate that these problems in the management of the child with heart disease will require re-evaluation at relatively frequent intervals.

NEW DEVELOPMENTS IN DIAGNOSTIC METHODOLOGY

Forrest H. Adams, M.D.
Department of Pediatrics, University of California at Los Angeles School of Medicine

Because of the multiplicity of diagnostic techniques in pediatric cardiology, numerous skilled individuals will be required to participate in the patient's workup and it is essential that these work together as a team. The patient's physician still maintains the all important role of obtaining an adequate history and physical examination and making the referral to the pediatric cardiologist and participating in the resultant decisions about management of the patient.

Some of the newer techniques over the past decade extensively use x-rays and radioisotopes in the diagnosis of heart disease in infants and children. Most important, however, one should be aware of minimum radiation dose when employing these techniques. Fluoroscopic examination should be reserved for evaluating specific problems and more reliance placed on conventional x-rays of the chest as well as other parameters such as the electrocardiogram. An image intensifying unit for fluoroscopy or during cardiac catheterization should be used whenever possible. Optimal exposure factors which reduce radiation to a minimum during cardiac catheterization and angiography should be employed as well as gonadal protection devices during study.
Yearly checks on radiation output of equipment should be carried out. When isotopes are used for indicator dilution studies to determine shunts and cardiac output, rapidly excreted ones should be employed with low activity and short half-life.

Recent developments in the recording of the electrical events of the heart include a battery-operated miniaturized radio broadcasting system which permits the recording of the electrocardiogram signal without the use of wires. The sender is attached to the patient and the receiver can be located as far away as 1,500 feet. The signal can be recorded on any appropriate device including magnetic tape. The technique permits the taking of the electrocardiogram during exercise and other procedures where wires would interfere. Currently, normal children and those with heart disease are being studied under conditions of play, work, and other physical activity. Vectorcardiography may give additional information to that obtained in the electrocardiogram by way of identifying chamber hypertrophy, conduction disturbances, and myocardial infarction. The three-dimensional presentation of the electrical events of the heart is mediated through an oscilloscopic recording and then photographed. Time and voltage relationships of the cardiac forces are thereby depicted as a loop in contrast to the scalar representation on the conventional electrocardiogram.

For over 20 years the functional status of the heart and great vessels has been investigated by cardiac catheterization techniques. Through catheters it has been possible to record the intracardiac pressures and remove blood samples for oxygen analysis. More recently indicator dilution techniques have been utilized during cardiac catheterization and as mentioned above employ isotopes, dyes, chemicals with electrical charges, and warm or cold solutions. These safe methods for the detection of shunts are superior to conventional blood gas studies both quantitatively and qualitatively. The disadvantages of the techniques are that they are rather complicated and sensitive equipment is required as well as considerable technical skill. Interpretation of the data obtained requires careful study and experience. In addition to the usual right heart catheterization techniques in cardiovascular diagnostic studies it is now possible to introduce catheters into the left heart by one of three routes: (1) insertion retrograde through an arterial channel such as the brachial artery; (2) trans-septal puncture of the wall between the atria; (3) direct trans-thoracic puncture to the left ventricle. Information gained by these approaches permit better understanding of the functional status of the left heart particularly in mitral and aortic valve disease.

One of the most exciting advances in diagnostic methodology is the application of both analog and digital computers to the solution of problems in pediatric cardiology. Only recently two members of the American Academy of Pediatrics, Dr. George Veasy of Salt Lake City and Dr. John Gustafson of Des Moines, Iowa, working independently have used computers as an aid in the diagnosis of heart disease in children. Besides predicting the probability of various diagnoses including the rarest of conditions from critical information, computers can also be used to evaluate such tests as electrocardiology, vectorcardiography, phonocardiography and pulmonary function.

THE INFANT WITH HEART DISEASE

Abraham M. Rudolph, M.D.

Department of Pediatrics, Albert Einstein College of Medicine, New York

In spite of great surgical advances, congenital heart disease is still a major cause of death in children, and this is particularly true in the infant age group. The magnitude of the problem may be appreciated by reviewing some data on mortality from con-
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