History of cardiology at Baylor University Medical Center

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Dedicated to all the many people who have worked in the Division of Cardiology over the years

In 1903, when the Texas Baptist Memorial Sanitarium was founded, the Wright brothers flew their airplane and Professor Willem Einthoven developed the electrocardiogram. During the century that the sanitarium grew into a large health care system, the specialty of cardiology became a separate branch of medicine and made spectacular progress—with Baylor often being an early incorporator of advances (Table 1). This article begins with a review of some major developments in the field and then provides my recollections of the growth of cardiology at Baylor University Medical Center.

DEVELOPMENTS IN CARDIOLOGY

Einthoven, professor of physiology at the University of Leiden in Holland, recognized the potential of the string galvanometer invented by Adler in 1897 (1). The galvanometer worked on the principle that an electrical current generates a magnetic field, acting at right angles to its course, which varies with the strength of the current, thus exerting a varying attraction or repulsion upon a second magnet in its vicinity. Einthoven constructed a new, more sensitive instrument that recorded tiny voltages from the heart and documented the changes in voltage during the cardiac cycle. He eventually determined the potential difference produced by the heartbeat at any instant in its cycle. He devised the standard limb leads (I, II, and III), coined the term “electrocardiogram,” and was awarded the Nobel Prize in 1924 for his discovery of electrocardiography. His work on volume conductors and the potential difference between the arms and legs led to the postulation of Einthoven’s triangle, which generated 30 years of intensive electrical studies around the world. Among the prominent studies were those of Frank Wilson of the University of Michigan, who in the 1930s described the laws that govern the distribution of electromotive force in solid conductors as applied to electrocardiography (1).

While Einthoven was working on electrocardiography, others were gaining insights into the understanding of both coronary artery disease (2) and congenital heart disease (3). In 1912, John B. Herrick described the symptoms of a sudden occlusion of a coronary artery and suggested that it might be compatible with life. Many advances followed, with leaders such as Paul Dudley White at the Massachusetts General Hospital and Samuel A. Levine at the Peter Bent Brigham Hospital teaching the world about the symptoms and signs of coronary disease. In 1940, Schlessinger and Blumgart published a report of 125 postmortem hearts with coronary disease that they had studied by making

Table 1. Some advances in cardiology and cardiovascular surgery first applied in North Texas at Baylor University Medical Center*

First temporary transvenous catheter pacemaker
First permanent pacemaker implantation
First transseptal left heart catheterization
First retrograde brachial left heart catheterization
First coronary angiography
First selective pulmonary angiography
First elective DC cardioversion for arrhythmias
First phonocardiogram
First vectorcardiogram
First use of a beta-blocker (Inderal) for idiopathic hypertrophic subaortic stenosis
First use of a beta-blocker (Inderal) for cardiac arrhythmias
First coronary care unit
First cardiac rehabilitation unit for post-heart attack patients
First coronary balloon angioplasty
First vascular balloon angioplasty
First abdominal aortic aneurysm surgery
First carotid endarterectomy for stroke prevention
First vascular venous stent
First implantable defibrillator
First coronary atherectomy
First combined heart-lung and heart transplantation “domino” in Texas
First combined heart/kidney transplant in North Texas and fifth in the world
First implantation of St. Jude stentless valve in the USA after Food and Drug Administration approval
First gamma radiation seed implant for coronary stent restenosis
First percutaneous transmyocardial revascularization
First Medicare-certified cardiac rehabilitation program
First modular aortic endovascular stent graft
First biventricular pacemaker defibrillator for heart failure
First 3-dimensional computer mapping system for arrhythmia diagnosis and management
First iliac artery stent
First renal artery stent

*Source for recent “firsts”: Duskin MA. Gift for the heart. *BaylorHealth*, March 2002.

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casts of the coronary arteries. Their landmark study has stood the test of time. In 1929, Arthur M. Master described a 2-step protocol for testing patients with coronary disease, and in 1941 he modified his protocol to include a 3-lead electrocardiogram before and after an exercise challenge (2).

Canadian physician Dr. Maude Abbott completed her atlas of congenital heart disease in 1907 (3). When she met William Osler in Baltimore in 1898, he told her about the heart specimens that he had collected while at McGill. Osler saw the teaching possibilities of such a museum, calling the collection "pictures of life and death together." Abbott later wrote, "And thus he gently dropped a seed that dominated all my future work." Returning to Montreal, she gave herself entirely to studying congenital heart disease. Advances in cardiac surgery and pediatric cardiology would have been impossible without her contributions (3).

In 1876, Claude Bernard was the first to catheterize the heart in animals (4). He used a catheter made of lead to facilitate getting the correct curvature. Inspired by the knowledge that catheterization could be safely done in animals, Werner Forssmann passed a catheter from his left antecubital fossa to the right ventricle, walked down to the basement of the clinic, and had an x-ray made to prove that the catheter was in his heart. He did the procedure on himself because his chief had forbidden him to do it on a patient. He lost his job over it but soon continued elsewhere. He decided to inject contrast material into his own heart to "improve cardiac diagnosis." He had done it successfully in dogs. Fearing an allergic reaction to the foreign substance, he tested the iodine solution on his buccal mucosa for hours. He again placed the catheter in his heart and then injected contrast material while x-rays were being taken. Unfortunately, the filming was not quick enough to show the contrast material, but he suffered no ill effects. He was allowed 4 minutes to present his findings before the prestigious Surgical Congress of 1931. There were snickers of ridicule and derision.

Having read Forssmann's paper, O. Klein in Prague published a definitive paper within 6 months on the determination of cardiac output according to the Fick principle (4). Klein performed cardiac catheterization on 18 men to obtain mixed venous blood and calculated cardiac output. He described the procedure as simple and without incident. At Bellevue Hospital in New York, Andre Cournand and Dickinson Richards had begun cooperative studies in 1932 examining the heart, lungs, and central circulation. They first attempted to pass a catheter in a human in 1940 but failed when the catheter hung up in the axilla. Homer Smith, the renal physiologist, was planning to measure cardiac output in hypertensive patients. They did this for him and went on with extensive studies of cardiac and pulmonary blood flow using the Fick technique. Cournand, Dickinson, and Forssmann were awarded the Nobel Prize for cardiac catheterization in 1956 (4).

In the late 1930s, Lewis Dexter, a research fellow with Nobel Prize laureate Bernardo Houssay in Buenos Aires, was catheterizing the renal veins to measure renin content. Occasionally, he would have a bad day and get hung up in the right atrium or sometimes, even worse, the right ventricle. He recalled once passing the catheter out into the lung field. With horror, he assumed he had perforated the heart. However, the patient had no symptoms or changes in vital signs. He measured a pressure with a waveform similar to that of the pulmonary artery pattern in dogs.

He always believed he was the first to catheterize the pulmonary artery, but he failed to grasp the importance of obtaining mixed venous blood samples, which could be obtained from the pulmonary artery only after thorough mixing in the right ventricle. Cournand rightfully deserved recognition for this concept. It was the groups of Cournand in New York, Dexter at Harvard, and Bing at Hopkins who defined the procedures for the diagnosis of congenital heart disease by means of cardiac catheterization. The abundance of patients presenting for surgical repair provided a wealth of material for study. Dexter discovered the pulmonary wedge pressure, which allowed estimation of left atrial pressure for the first time.

The history of defibrillation began when the Consolidated Edison Company of New York sought advice from the Rockefeller Institute about accidental electrocutions (1). A commission was headed by Professor Howell to study the effects of electricity in the body. Professor Carl J. Wiggers joined the research effort. In 1899, Prevost and Botelli had reported that strong currents did not always produce cardiac arrest but could even correct it when present. Both Howell and Wiggers doubted this, but they assigned Hooker, Kouwenhoven, and Langworthy to explore the possibility of electrical countershock for the treatment of ventricular fibrillation. Their preliminary report of its success was made in 1932, followed by a more detailed report 1 year later.

By 1936, Wiggers was convinced that proper oxygenation of the heart was essential for successful defibrillation and used open chest compression of the ventricles to achieve it (1). Claude Beck, also in Cleveland, and his associate, Mautz, worked on ways to improve the success rate. They found that applying procaine or metycaine directly to the ventricles and using multiple shocks could improve the results. Beck defibrillated a human heart in 1938 and another in 1939, but both patients died of brain damage. His first successful defibrillation with recovery was in 1947, and he began to spread the gospel of "hearts too good to die." He even advocated that the chest be opened on patients who had fatal myocardial infarctions outside the hospital! As interns in 1954, we all carried pocket knives in hopes of saving someone, but we never succeeded. By the late 1950s, most hospitals—like Baylor—had "Dr. Heart" teams that would rush madly through the corridors, dragging a defibrillator from the emergency department to the bedside of patients throughout the hospital.

Pacemaker development began in the 1950s. In 1957, Weirich, Gott, and Lillehei reported the use of myocardial electrodes to pace hearts with iatrogenic atrioventricular block after closure of a ventricular septal defect (1). Transistors became available in 1956, and in 1957 the first experiments on implantation of electrodes were begun in Stockholm. In 1958, the first unit was implanted in a patient with complete atrioventricular block due to myocarditis. The energy source was a battery that was recharged once a month by a radiofrequency generator. The first pacemakers had a fixed rate of 72 with no programming to avoid the vulnerable zone on the T wave where ventricular fibrillation might occur. Thus, over time it was learned that pacemaker discharges produced almost a 25% death rate! Deaths were avoided in 1964 by demand pacemakers with R-wave inhibition, and R-wave triggering began in 1966 (1). Atrioventricular pacing was introduced in 1969 by Berkovits. With progress in electronics, the circuits changed from discrete to hybrid to integrated circuits,

and finally to microprocessors. Programmability progressed from simple invasive changes of rate and voltage to external noninvasive radiofrequency adjustments of all pacing parameters (1). The units have become progressively smaller.

Other diagnostic techniques for patients with heart disease were based on ultrasound technology, which had been used in World War I for detecting submarines under water (5). The first attempted medical use of ultrasound was in 1942 when Dussik used it to measure phasic volume changes of the heart. In 1954, Edler and Hertz first used ultrasound in Sweden for examination of the living human heart. The first echocardiograms in the USA were done by Wild, Reid, and Claude Joyner at the University of Pennsylvania and were reported at the American Heart Association's annual meeting in 1962. With his famous textbook in 1972—the first on the topic—Harvey Feigenbaum in Indianapolis influenced a whole generation of cardiologists and their fellows in training. For 15 years, echocardiograms were used primarily for valvular and pericardial disease using the M-mode equipment that provided an “ice-pick” view of the heart with images recorded on Polaroid film. Segmental wall motion due to coronary disease and myocardial infarction was first reported in 1971. Bom, a Dutch engineer, described the first practical real-time multiscan ultrasonogram in 1971 and published his experience with 150 patients in 1973 (5).

In 1842, Christian Johann Doppler called attention to the fact that “the color of luminous bodies, just like the pitch of a sounding body, changes with motion of the body to and from the observer” (5). The principle was first used in cardiology by Satomura in 1956 to time the opening and closure of cardiac valves. Pulsed-wave Doppler was developed by Baker at the University of Washington and allowed flow velocity measurements for specific chambers and valves. In 1976, Holen and Hatle simultaneously published methods for estimating mitral valve orifice size. The first commercially available color Doppler machine and the first book on color Doppler both came from Japan (5).

As cardiology became a science and a separate branch of medicine in the 1930s and physiologic findings were moved from the laboratory bench to the catheterization laboratory and ultimately to the intensive care unit (ICU) and the patient's bedside, so advances were made in the field of cardiovascular surgery.

The field of surgery for congenital heart disease was born in 1938 when Robert E. Gross, chief resident in surgery at the Children's Hospital in Boston, successfully ligated the patent ductus arteriosus of a 7-year-old girl (3). He seized the opportunity to operate while his chief was on vacation! The first reported repair of coarctation of the aorta was by Clarence Craaford in Stockholm, although Gross always believed he had actually done it first. Helen Taussig had dissected hundreds of cardiac specimens with congenital malformations and was a close friend and disciple of Abbott. She became convinced that additional pulmonary blood flow would help babies with cyanotic congenital heart disease. In the early 1940s she traveled to Boston to propose to Gross that if he could ligate a systemic artery-to-pulmonary artery shunt, why couldn't he create one? He was not interested, so she returned to Baltimore and to Alfred Blalock, who had performed shunt operations in dogs by anastomosing the subclavian artery to the pulmonary artery while at Vanderbilt in 1939 to produce pulmonary hypertension. Thus, Blalock and Taussig teamed up,

and the Johns Hopkins Hospital became the leading center in the world for the “blue baby” operation (3).

Charles A. Lindbergh, the first solo pilot to fly nonstop across the Atlantic Ocean, became interested in developing a mechanical pump to sustain the heart during surgery because his wife's oldest sister developed rheumatic heart disease and needed an operation in 1929 (6). The operation was ruled out because the heart could not be stopped long enough for the surgeons to work. Lindbergh was discouraged in this effort by Alexis Carrel of the Rockefeller Institute, who made him aware of the great difficulties in oxygenating blood in such a system and preventing it from clotting. Heparin had been discovered in 1915 but was not available in purified form until 1937. In that same year, it was observed that protamine was a heparin antagonist, thus permitting a time-limited application of heparin that was ideal for cardiopulmonary bypass. Many experiments during the late 1940s and early 1950s performed by Gibbon, Craaford, Bjork, Dennis, and others culminated in the successful use of cardiopulmonary bypass by John Kirklin at the Mayo Clinic on March 27, 1955—1 year after C. Walton Lillehei's successful use of the cross-circulation technique in Minneapolis (6). The era of open heart surgery was launched.

Heart transplantation became a reality through the pioneering work of Alexis Carrel (1873–1944) (7). He mastered the technique of suturing blood vessels as a young physician in Lyon, France, and received the Nobel Prize in 1912. He transplanted many vessels and organs, including skin, and mentioned heart transplantation as early as 1912. While at the Rockefeller Institute, he investigated methods of keeping organs or tissues alive by circulating blood through them, and his work laid the cornerstone for all vascular, cardiac, and transplantation surgery. The first human heart transplant using a primate heart was in 1964 by James Hardy in Mississippi. Utilizing the techniques meticulously worked out by Shumway and colleagues at Stanford, Christiaan Barnard performed the first human heart allograft operation in Cape Town, South Africa, in December 1967. The patient lived only 18 days, but the publicity was worldwide. Two weeks later Shumway began his transplant program at Stanford, and it remains the only uninterrupted transplant program in existence from then until now. Carrel had already demonstrated that the problem in cardiac transplantation was not surgical technique but graft rejection. Cyclosporine was discovered accidentally at the Sandoz laboratory in Switzerland in 1970. Synthesized to be an antifungal agent, it failed to excite, but its immunosuppressive qualities were discovered by Borel in 1972. Its clinical use in transplant patients was introduced at Stanford in December 1980 (7).

CARDIOLOGY AT BAYLOR UNIVERSITY HOSPITAL AND BAYLOR UNIVERSITY MEDICAL CENTER, 1936–1970

The cardiology department probably originated with Dr. Henry Winans, Sr., who was chief of internal medicine from 1947 to 1955. As early as 1938, he is reported to have had a dog laboratory where experiments were conducted. In the late 1940s, Dr. Warner T. Duckett visited Dr. William Blalock at the Johns Hopkins Hospital in Baltimore and brought the technique of the “blue baby,” or Blalock, operation and ligation of patent ductus arteriosus back to Dallas. Dr. Duckett probably first ligated a patent ductus at Baylor in 1949. During the early 1950s, he began doing

Figure 1. Dr. James M. Blain, the first director of the cardiopulmonary laboratory.

closed mitral commissurotomies at Baylor. Most of the Blalock operations he did were done at Children's Hospital, but he occasionally had right-sided heart catheterizations done at Baylor with Dr. Carlton B. Chapman and his cardiology fellows, who came over from Southwestern Medical School. Dr. Duckett also began doing coarctation operations at Children's Hospital.

By 1955, it was decided that Baylor should have its own cardiac catheterization laboratory. Dr. Paul J. Thomas headed the search

committee, and he and Boone Powell, Sr., the chief executive officer of Baylor University Hospital, recruited Dr. James M. Blain to be the first director of the cardiopulmonary laboratory (*Figure 1*). Dr. Blain had trained at the University of Alabama with Dr. Richard Bing. He and another fellow in cardiology—a French Algerian named Herbert Schafer—had been doing most of the catheterization work at the University of Alabama. Dr. Blain persuaded Dr. Schafer to come to Baylor with him as his fellow. Thus, Dr. Schafer became the first Baylor cardiology fellow in 1955. The second fellow, Dr. Antonio C. Quiroz, came to Baylor in mid October 1957. He had graduated from the University of St. Thomas in Manila and had been referred by his chief of cardiology, Dr. Alimurung, who had been trained by Dr. Paul Dudley White in Boston. With all of his earthly belongings in one suitcase, Dr. Quiroz was directed up the stairway of the Veal building to the catheterization laboratory, which would introduce him to the procedures that would revolutionize cardiology. For that year he lived in a hotel near the Baylor campus. His description of the early laboratory is most interesting:

James Marshall Blain, founder and director of the cardiac laboratory, was an up-and-coming young man who lisped and stuttered when he was excited, which was often. He had graduated from Southwestern Medical School in Dallas, interned at St. Louis City Hospital, and trained in cardiology at the University of Alabama in Birmingham, where Tinsley Harrison was chairman and Richard Bing was doing cardiac catheterizations. He had put together the personnel for the cardiac lab, beginning with a Van Slyke technician (to measure the oxygen content of the blood samples), a part-time scrub nurse, a secretary who also doubled as the pulmonary function technician, and a cardiology fellow named Herbert Schafer. An old fluoroscopy table, a new Electronics for Medicine recorder (otherwise known as the Scheiner machine), a couple of Van Slykes, a Tissot, a couple of Douglas bags for oxygen collection, a Scholander apparatus, a Collins spirometer, a Sanborn Twin-Beam phonocardiogram, an earpiece oximeter, a few Courmand and Goodale-Lubin catheters, and pressure strain gauges were all very exciting to the young physician.

Early attempts to do open heart surgery were prepared meticulously in the experimental surgery laboratory by Drs. LeRoy Kleinsasser and Paul Ellis, who worked tirelessly with nurse-technician Rhoda Whitcomb. One of the early survivors of open heart surgery for atrial septal defect had a difficult postoperative course with chest pain, pleural effusions, and dyspnea. Everyone thought the patient had congestive heart failure except for Dr. Blain, who recognized that she had the postcommissurotomy syndrome. The case was presented at grand rounds. Among the houseofficers that year were

Carlos Piacentini, Gerardo Martinez, and Enrique Hinojosa, all of whom subsequently went on to become cardiology fellows at Baylor (Quiroz AC, personal communication).

Space was available on the second floor of the Veal building in what had been a maternity ward and delivery room. The area included offices for the physician, the fellows, and the secretaries; a small workroom for pulmonary function studies; another room for the catheterization laboratory; a waiting room; and a darkroom for film processing. A Westinghouse standard x-ray unit was purchased. The recorder was called a "Scheiner" after Martin B. Scheiner who had developed the equipment that later became Electronics for Medicine and has now merged with Honeywell, Inc. This machine had 6 channels and was actually the third such machine produced. The first one had gone to Dr. André Cournand in New York, and the second machine had gone to Dr. Richard Bing at the University of Alabama. A Sanborn twin-beam phonocardiography machine also was used.

The photographic recorder would record a heart sound channel with an electrocardiogram channel for timing. The paper had to be processed in a darkroom and then washed, dried, cut into strips, coated with glycerin, dried on waxed Plexiglas, and mounted on cardboard. The tracings were elegant but very time consuming and labor intensive. Scholander equipment was purchased so that the oxygen content of expired air could be measured in order to do Fick cardiac output determinations. In those days cardiac catheterization was applicable to <1% of cardiac patients—those who had congenital heart disease and those with the most severe valve problems. Right-sided heart catheterizations were set up in the laboratory and gradually increased to about 3 cases per month. These procedures were done mostly for congenital heart disease with suspected shunts and for mitral valve disorders.

Electrocardiography was a major effort, and repair of the machinery was a problem because no repairmen or electronics experts were available. The physicians themselves had to do much of the maintenance on the electrocardiogram machines. The electrocardiogram technicians were among the most highly sought after employees in the hospital, which became a source of conflict: physicians tried to hire the technicians to work in their own offices, and the chief of medicine was infuriated by the loss of his technicians.

Electrocardiography was actually a function of the hospital in a separate department and was associated with electroencephalography and the basal metabolic rate determination (the only thyroid test then available), which had to be done on a patient who was asleep. The result was that the laboratory was kept dark early in the morning and everyone went around whispering. Only later in the day could physicians come in to read electrocardiograms. Thus, the electrocardiography department and the cardiopulmonary laboratory were each separate, and each reported directly to the hospital administration. They were not a part of the Department of Internal Medicine. A great many phonocardiograms were done in those years, and they turned out to be very educational for the staff as well as for the referring physicians. It became fashionable for almost every murmur, rub, or gallop to be sent for phonocardiography so that it could be measured and documented.

The first open heart operation in Dallas occurred on August 30, 1957, when Dr. LeRoy Kleinsasser and Dr. Paul R. Ellis, who

Figure 2. Dr. LeRoy Kleinsasser and Dr. Paul Ellis teamed to perform the first open heart surgery at Baylor. They are shown with a pump oxygenator during a cardiovascular research procedure in the early 1950s.

later did his surgical residency in Houston under Dr. Michael DeBakey, operated on a 14-year-old girl (*Figure 2*). They used hypothermia and successfully repaired her valvular pulmonic stenosis. In April 1958, the same team of surgeons first used the heart-lung machine for repair of a ventricular septal defect. Dr. Maurice Adam performed the first pacemaker implantation in the Southwest on July 28, 1960.

In those early days, the cardiologists and cardiology fellows accompanied the patients to the operating room and monitored the heart during these long procedures. Reams of electrocardiogram paper covered the floor, and afterwards all the arrhythmias were interpreted with a typed report that was many pages long. The cardiologist was intimately involved in making determinations by pressure measurement and waveforms during valve operations and congenital heart operations. Dr. Blain had 5 different fellows in cardiology during these years, usually 2 at a time. The consultation service was gradually increased, and most patients were referrals from the internal medicine department.

In 1962, Dr. Blain left his position at Baylor to go into private practice. I was proud to be recruited to be the new chief of the cardiopulmonary department (*Figure 3*). I had trained with Dr. Lewis Dexter at the Peter Bent Brigham Hospital and Harvard Medical School in Boston. In addition to the director, there was a secretary, a nurse-technician who had recently graduated from nursing school, and an aide who served as technician and darkroom operator.

The internal medicine staff considered left-sided heart catheterization to be far too dangerous to be used. Right-sided heart catheterizations were permitted only in extreme situations when it was fairly clear that significant congenital heart disease or mitral stenosis was present. Apparently, some bad experiences had occurred when patients were sent to distant medical centers for these studies. The internal medicine staff wanted catheterization to be restricted and under tight scrutiny; they preferred that a few people develop the skill and expertise they expected. My challenge, in turn, was to demonstrate that these diagnostic techniques were highly useful and could be done safely.

Figure 3. Dr. John W. Hyland, director of the cardiology department from 1962 to 1994. Photo: Gittings.

When I began, catheterization was considered a “service function.” I was not allowed to charge for catheterization or for consultations on those patients—which was not as unreasonable as it sounds since the hospital got no revenue either. By the late 1960s, Medicare allowed fees for catheterization.

Transeptal left-sided heart catheterization by the Brockenbaugh technique was soon begun and was the major form of left-sided heart catheterization done for several months. Equipment

was purchased to do dye curves utilizing indocyanine green dye and a withdrawal pump. The first dye curve required 12 attempts to complete one successful cardiac output. No one on the team had ever seen or engaged in that type of activity before. Fellows of that era remember having to wear red goggles for 45 minutes before doing any fluoroscopy so they would be visually accommodated to the dark and be able to see the catheter in the patient under the fluoroscope. Because the lights had to be turned off and on frequently during the procedure, a technician would stand behind the physician and bring the red goggles down prior to turning on the lights so that the accommodation would not be lost. One of the worst breaks in technique would occur if someone accidentally turned on the lights before the goggles were in place. One of the problems for new trainees was to learn to palpate arteries and veins and do cutdowns with red goggles on.

Most of the work was done on the patients with congenital and valvular heart disease, so it soon became clear that angiography also was vitally needed. On these occasions, the entire catheterization team—all dressed in caps, gowns, and masks with their arms wrapped in protective towels—would march in a caravan to the elevators and then down to the radiology department, where Schonander cut films could be made. This was a very slow and lengthy process. The defibrillator and several other pieces of equipment, including the dye curve machine and the recorder, all had to be moved to radiology with as many as 6 or 8 people in the procession. There was no fluoroscope in the radiology department that could be used in the same room where the films were made. For this reason, the catheter had to be positioned upstairs in the catheterization laboratory and left in place while we moved the patient and all the equipment down to radiology. It was necessary to leave the catheter in a rather stable location, such as the superior vena cava, the ascending aorta, or sometimes the pulmonary artery. Inevitably, sometimes the catheter would slip out of the position desired before the films could be obtained. It is no wonder that soon the catheterization laboratory was moved to the back end of the radiology department. A better x-ray unit was installed and enabled the fluoroscopy unit and the Schonander film-changing unit to be in the same room and utilize the same table. This was a major accomplishment because films could be more readily made.

Many pulmonary angiograms were done. Before this time, pulmonary angiography had been done by means of a peripheral

venous injection. We began placing the catheter in the pulmonary trunk to do more selective pulmonary angiography. The demand for this procedure increased.

Since we were also the pulmonary laboratory, we performed and interpreted spirometers for the thoracic surgeons. This was an important service function of the laboratory because these were often done the night before a patient was to have a pneumonectomy or lobectomy. I had been doing arterial blood gas studies on dogs in our research work at Harvard, so I had purchased a machine for doing this. At that time the only blood gas studies here were being done on venous blood. This caused an impasse with the pathology department, but the matter was settled by having us do the arterial studies and having them continue doing the venous studies. I had to do the arterial punctures to obtain the samples because no one else was trained to do it. This became a great chore that I was happy to give to the pulmonary technicians when the pulmonary laboratory was split off. Later, technicians were trained to puncture the radial arteries to obtain samples for blood gas studies. In 1963, Dr. George Schools, who had recently gone into the practice of pulmonary disease, was persuaded to spend half his time running the pulmonary activities. He continued until 1965, when Dr. Charles Jarrett joined the staff as the first full-time director of the pulmonary laboratory, which we had spun off, and he thus became the third full-time member of the internal medicine department.

In December 1963, under pressure from the thoracic surgeons, Dr. A. D. Sears, Mr. David Hitt, and I traveled to Cleveland, Ohio, to visit Dr. F. Mason Sones (in the midst of a 3' snowstorm) to see coronary angiography performed and to decide whether we should begin doing it ourselves. Our reaction was favorable, and many months were spent trying to duplicate the film results in Dallas. It gradually became clear that our equipment did not have the power to do good coronary angiography. It was possible for us to see the angiograms on the fluoroscope, but we could not obtain films for many months. We continued to perform the test on patients with aortic valve disease primarily because of the bad prognosis of coronary disease when associated with aortic stenosis. Many months were spent working with the Picker X-ray Company engineers and equipment people and gerrymandering the equipment trying to improve film quality.

In 1964, the first direct-current cardioverter was obtained and a great many cardioversions were done, both for elective arrhythmias and for emergencies. The units available before that time were made with alternating current and could be used only for cardiac arrest. This demand was large, and most of the cardioversions that were done electively were done in the catheterization laboratory at the end of day, after the catheterization procedures had been finished and when the anesthesiologists were through with their major cases in the operating rooms so they could anesthetize our patients. Cardioversion quickly gained favor, and a large series was done. At about the same time, propranolol (Inderal) was obtained on an experimental protocol for use in patients with idiopathic hypertrophic subaortic stenosis. It quickly became apparent that propranolol was useful also for cardiac arrhythmias, hypertension, and hyperthyroidism. A large number of patients were referred to be treated with propranolol for these conditions.

By 1963, it had become clear that retrograde brachial catheterization had many advantages for left-sided heart cath-

eterization, including the ability to do coronary angiograms, so this procedure was begun. In the early years, the cardiologist would do the cutdown but not the arterial repair that was necessary afterwards. We would wait until one of the vascular or cardiac surgeons was available to do the repair. This process became so cumbersome that Dr. Paul Ellis was kind enough to teach the cardiologists to do a proper vascular repair using DeBakey clamps and fine-suturing technique. As a result, procedures

were completed far more quickly, and the laboratory increased the number of studies performed. Left-sided heart catheterization by the retrograde brachial cutdown approach quickly became the standard on all patients, with the vein being used for the right-sided heart catheterization and the artery used for left-sided heart catheterization in the same incision. Percutaneous work on the femoral arteries and veins was abandoned.

While all of the thoracic surgeons had a natural interest in our activities, Dr. Paul Ellis was special. While a surgery resident at Baylor, he had worked with Dr. LeRoy Kleinsasser in the animal laboratory and had assisted in our first operation using hypothermia. After his cardiac surgery training with Dr. DeBakey in Houston, he returned to Dallas and was interested in all that we did. It was he, more than any other, who pushed for us to learn coronary angiography. It was he who always assisted us in learning how to do proper arterial vascular repairs. He taught us the correct surgical technique and insisted that we *always* work until we got a good pulse—something seldom done by cardiologists in those years! If we failed, he was doggedly relentless in coming to our aid to make sure the repairs were correct. His enthusiasm was infectious. Much of what we did could not have been possible without him. He performed the first 2 successful venous bypass operations on coronary patients in Dallas at St. Paul Hospital in February 1968. They both did well, but Paul's untimely death in the Braniff plane crash over Corsicana 2 months later prevented him from knowing how well they had done. Paul's death was an irretrievable loss for all of us and our patients.

Dr. James L. Matson was the key person in the development of the laboratory (Figure 4). I first met him when he came to Baylor as an intern in 1962. He rotated on my service, and we became fast friends with many interests in common—not the least of which was sports, especially the Dallas Cowboys! After completing his medicine residency at Baylor from 1963 to 1965, Dr. Matson became my fellow in cardiology from 1965 to 1967 and became the second full-time physician in cardiology in 1967. From 1968 to 1970, he had to leave for service in the navy during the Vietnam War. When he returned, he found our pace much increased because of the advent of bypass surgery. He was a diligent, hard-working associate who carried a very heavy workload in the catheterization laboratory for many years. He was strong in teaching and patient care and was especially good with the families of patients. He supported our administrative activities in ways too numerous to mention. He was loyal and absolutely

Figure 4. Dr. James L. Matson.

essential in all that we did. His was a mature, calming, humorous effect that was appreciated by all.

Dr. Rolando M. Solis became the third full-time cardiologist in the laboratory. He was a medicine resident here from 1966 to 1968 and was our cardiology fellow from 1968 to 1970. Because of his immigrant visa, he was about to be sent back to the Philippines, but we successfully intervened through a congressional bill supported by both senators from Texas, and he finally won citizenship in 1971. It was apparent to all that he had a quick mind and exceptional manual dexterity. He continues to be very active in cardiac catheterization and pacemaker work and has many of our "firsts" to his credit, including the first balloon angioplasty and the first permanent pacemaker implantation by a cardiologist. He started the pacemaker clinic and the angioplasty program. He returned to Manila in 1986 to campaign for the presidency of Corazon Aquino, the wife of his patient Benigno Aquino, a political prisoner of the Marcos regime who was allowed to come to the USA when he developed a serious heart condition. Aquino chose Dr. Solis as his physician. In 1987, Dr. Solis went back to the Philippines and began an angioplasty program there at the request of President Corazon Aquino (Figure 5).

By the mid 1960s, the surgeons were primarily doing internal mammary artery implants, first on the anterior wall and later on the posterior wall, for coronary artery disease. The demands on the angiographer for this were simply to decide whether the disease was anterior or posterior or both. In the late 1960s, coronary artery bypass surgery was developed by Dr. Rene Favaloro in Cleveland, and on June 1, 1968, Dr. Ben F. Mitchel performed Baylor's first coronary artery bypass employing a vein graft to the right coronary artery. The patient had been in the coronary care unit (CCU) for over a month with repeated episodes of ventricular tachycardia and cardiac arrest. It had not been possible to get him out of the unit, so in a desperate move he was studied by means of angiography, much to the horror of the cardiologist. However, the study went smoothly, as did the subsequent surgery. The patient made a good recovery, and repeat coronary angiography some 4 months later demonstrated the beauty of the bypass graft. The patient lived for many years thereafter. Only a few more coronary bypass procedures were done in 1968, but by 1969 the floodgates had opened and procedures were done frequently. The wisdom of performing bypass surgery was not at all clear. The surgeons were very much in favor of doing it, and the majority of internists were horrified at the prospect. There were many conflicting reports, some touting the virtues of the procedure and others castigating those who performed such acts.

It was clear that the volume was becoming overwhelming. There were times when patients had to wait 6 weeks for coronary angiography. Each week 1 or 2 patients would be erased from the schedule, because they either died or had a heart attack and had to postpone the procedure. The pressure on those involved was enormous. For these reasons, those years were marked by frantic efforts to increase the number of physicians, fellows, technicians, and nurses involved in all phases of coronary care. A second catheterization laboratory was opened in the radiology department adjacent to the first laboratory, and this greatly expanded the number of cases that could be studied. By 1972, plans had been made to upgrade the catheterization lab equipment to the finest image-intensifying systems of the day. The cost of the new

Figure 5. Philippine President Corazon Aquino visiting Baylor in 1990. Dr. Rolando Solis, Benigno Aquino's cardiologist, is speaking; Gordon Caswell, President Aquino, and Larry Meagher are in the background.

x-ray equipment was \$200,000—an enormous sum at the time. The equipment arrived, but the renovation of the rooms was not complete. The crated x-ray units were put in the warehouse unopened.

In November of that year, a new prototype was demonstrated at the American Heart Association meeting in Anaheim, California. This unit was more powerful than any previous model and enabled the patient to lie flat while the surrounding tube rotated and filmed at the various angles necessary. I went to see Boone Powell, Sr., and made the plea that we return the \$200,000 equipment for the new catheterization laboratory in exchange for the newest in technology. For a "mere" \$40,000 more, we could have the newest system for coronary angiography. When I finished, there was a considerable silence (it was just the two of us), and he looked up and said "Okay." He then put his initials on the largest purchase we had ever made, and there wasn't even a requisition. Just as I was about to go out the door, without ever looking up or cracking a smile, he said, "Hyland, don't go to any more medical meetings!" I smiled because, of course, I knew he didn't mean that.

Baylor was able to get the fourth installation in the world of this most advanced coronary angiography system. The original unit was at the Cleveland Clinic. This step placed Baylor many years ahead of others and gave us the preeminent filming capabilities available at the time.

In the early 1960s, medicine residents usually rotated in the department for 3 months at a time. They saw each patient for about an hour in the patient's room, during which time they completed the history and physical examination. The patient was then brought to the cardiac laboratory for a vectorcardiogram. In the meantime, the resident would present the case to the staff member, and the two would discuss the history and physical and go over the electrocardiograms and the cardiac series, which consisted of the 4 standard views of the chest with barium in the esophagus. They would then talk with and examine the patient and perform phonocardiography, which enabled the resident to hear all of the heart sounds and see them recorded. Most of the patients had congenital heart disease and valvular problems, so the cases were somewhat involved. The numbers were small; the pace, leisurely. Every Monday morning, catheter conference was

Figure 6. The Wadley Tower waiting room in the H. L. and Ruth Ray Hunt Heart Center when it was opened in 1976.

held, and each case that had been studied the week before was presented. Once again, the residents and fellows would present all aspects of the case, including the history, physical findings, electrocardiograms, vectorcardiograms, cardiac series, and then the catheterization results. This lengthy process took all morning. It probably represented the pinnacle of cardiac teaching for this kind of work, but soon the flood of coronary patients increased the workload so greatly that the leisure of doing consultations in this manner was no longer possible.

CARDIOLOGY AT BAYLOR UNIVERSITY MEDICAL CENTER, 1970–2003

After opening of the CCU in 1967 and the advent of coronary bypass surgery in 1968, it was apparent to all that cardiology was in a rapid development phase. The need for additional physicians was great, and the need for a means of supporting the cardiology fellows was keenly felt. Professional practice associations had recently become legal in Texas, so David Hitt of Baylor's administration suggested that we combine the cardiac laboratory, the electrocardiogram department, and the CCU into one department to be called the Division of Cardiology with myself as director and Drs. James Matson and Rolando Solis as associates. He suggested that we have the fellows read the electrocardiograms, which would generate enough income for their salaries. He insisted that I be the majority stockholder, and he would hold me responsible for running the department, hiring the cardiologists and fellows as needed, and paying them salaries from this pool. This system for funding fellows began in 1971.

It was clear that the cardiac laboratory on the second floor of the Veal building and the 2 catheterization laboratories in

Figure 7. Bob Lobdell explaining catheterization procedures to visitors upon the opening of the Hunt Heart Center laboratory.

the radiology department were not adequate for future growth. There was no room for expansion in either place. Long-range planning sessions clearly outlined the massive increase in growth that was needed in cardiology to meet the needs of patients, to fulfill the needs of the Department of Internal Medicine, and to provide adequate support for the cardiac surgeons. By 1974, the Barnett and Wadley Towers and the Plaza area were being built. The administration decided to give the cardiology department the first 3 floors of Wadley Tower. This was an enormous step in our growth. The total space was well over 20,000 square feet. In 1974, detailed planning of the space began.

The department moved to Wadley Tower in 1976. The new facility was named in honor of its major donor and her late husband, H. L. and Ruth Ray Hunt. A large waiting room was finished with fine furniture, beautiful carpets, and fine paintings selected by Mrs. H. L. Hunt personally (Figure 6). The first floor contained examining rooms, treadmill exercise rooms, echocardiology rooms, Holter monitoring rooms, fellow offices, and physician offices. There was a small conference room and space for a typing pool. The second floor contained the catheterization laboratories, which at first consisted of 2 laboratories but later was expanded to 3 (Figure 7). A large medical record library and rooms for film storage (Figure 8), dictation, and analysis of the catheterization films and pressure tracings were also on this floor. On the third floor were physician offices, secretarial spaces, the new computer department, and the extensive cardiac rehabilitation section. The electrocardiogram department remained in the Y wing of the Truett building adjacent to the intermediate CCU, which had opened on the second floor of Jonsson Hospital in 1971. The CCU was on the second floor of Hoblitzelle Hospital. Thus, the Heart Center and its responsibilities continued to be rather widely dispersed.

During the 1970s, rapid strides were made in echocardiography. It progressed from a little-understood and bizarre idiosyncrasy to a basic part of every cardiac examination. The technology improved greatly from the original single-plane "ice-pick view" of the heart to 2-dimensional angiography, which greatly enhanced the images and the information obtained. Echocardiography

Figure 8. Film storage required a significant amount of space.

quickly replaced phonocardiography and vectorcardiography, which were both useful techniques but were phased out because of this new, more valuable type of study.

By 1978, management of the Heart Center had become increasingly difficult, with activities dispersed over so many areas. I decided it would be best to create subdivisions to report to me, each with its own physician and supervisor. Dr. Charles Gottlich was appointed director of the noninvasive laboratory. Dr. Walter Berman and Dr. James Shelton were placed in charge of the newly created cardiac rehabilitation and nuclear cardiology departments. A few years later, the pacemaker department was placed in the hands of Dr. Rolando Solis, and Dr. Michael S. Donsky was placed in charge of the catheterization laboratories. Dr. Ed Bond was in charge of the computer department, and I remained in charge of the electrocardiogram department, the CCU, and the intermediate CCU, or telemetry floor (*Figure 9*). Nursing supervision of the entire cardiology department had been under Rhoda Whitcomb until 1976, when the divisions were set up and Robert Lobdell became supervisor of the catheterization laboratory. In 1979, James Hirsch succeeded him, followed by Nancy Vish from 1989 until the present.

At the American Heart Association meeting in November 1978, I heard Dr. Andreas Grunzig's presentation of the first 6 cases of coronary angioplasty. Within 2 weeks, I had arranged for Dr. Rolando Solis to travel to Switzerland and spend 2 weeks with Dr. Grunzig to learn the technique. It took several months for a catheter to be obtained since they were made by hand in Dr. Grunzig's laboratory and were distributed only to people who had trained with him. The original angioplasty catheters were stiff and large and were not as flexible or as maneuverable as they later became. Only patients with large anterior descending arteries were candidates in the beginning. After getting permission from our institutional review board on a research protocol, Dr. Solis did the first angioplasty on an anterior descending artery in August 1980. From that moment on, the number of angioplasty procedures has increased steadily, and the Heart Center and cardiology in general would never be the same. Whereas the demands of coronary bypass surgery had greatly increased the need for cardiac catheterization facilities, angioplasty increased the need even more because the procedures were lengthy and tied up the catheterization rooms for prolonged periods of time. The learning curve for angioplasty was significant, and attempts were made to

Figure 9. Physician directors for various segments of the cardiology department beginning in the late 1970s. Top row: Dr. Charles Gottlich, noninvasive laboratory; Dr. Walter Berman, cardiac rehabilitation; Dr. James Shelton, nuclear cardiology. Bottom row: Dr. Rolando Solis, pacemaker department; Dr. Michael S. Donsky, catheterization laboratories; Dr. Ed Bond, computer department.

funnel all cases to one person so that he could rapidly obtain the necessary expertise to do the best work. Dr. Solis quickly excelled in this and became very busy. Catheter modifications (greater flexibility, smaller size, and better balloons) and other equipment gradually made it possible to approach all 3 coronary arteries and deal with lesions in much smaller distal vessels. The first balloon angioplasty attempts on vein bypass grafts proved difficult because the vessel would stretch but not stay enlarged permanently. With the advent of stents, angioplasty of vein grafts became reliable and developed into a major activity of the laboratory, eventually accounting for about half of all of the angioplasties. At Baylor, the first stents were placed in diseased vein bypass grafts in the late 1980s. The Food and Drug Administration approved use of stents in coronary arteries in 1994 (8).

In the early 1980s, thrombolytic agents became available, but the original streptokinase had to be infused via catheters placed in the coronary arteries close to the clot. For this reason, there was round-the-clock coverage for emergency angioplasty and thrombolytic procedures for patients with acute heart attacks. Dr. Charles Gottlich was in charge of the thrombolytic infusions in these patients and stayed quite busy with this activity for several years. Although Dr. Solis and Dr. Michael Donsky handled most of the angioplasty procedures, the demand was so great that most catheterizing cardiologists had to begin doing angioplasties also.

In the early 1980s, when the decision was made to build the Roberts Hospital, it seemed desirable to have 3 things close together: the emergency department, the cardiac catheterization laboratory, and the CCU. At the time, emergency catheterization was required for infusion of streptokinase during the acute phase of heart attacks. Plans for Roberts Hospital placed the emergency department in the basement and the Heart Center on the third floor along with the catheterization laboratories. The CCU was across the hall, with the electrocardiogram department in between.

Figure 10. Drs. John Schumacher and Kevin Wheelan, current cochiefs of the Division of Cardiology.

The Heart Center was moved to the Roberts building in January 1986. By that time, however, it had been learned that coronary angiography was no longer required for the effective infusion of streptokinase in heart attack patients; a peripheral venous infusion would work almost as well. Thus, catheterization could be delayed for a day or two. This change greatly altered the need for having the facilities arranged as close together as they were.

The catheterization laboratory, which had been 1 room in the old Veal building, 2 rooms in the radiology department, and 3 rooms on the second floor of Wadley Tower, was moved to the third floor of the Roberts building. Now there are 7 catheterization laboratories: 5 are devoted to angiography and angioplasty and 2 are for electrophysiology and pacemaker work.

After funds had been raised and the laboratory planned, the first atrioventricular nodal ablation was performed in July 1986 by Dr. Kevin Wheelan. By June 1987, he had inserted the first transthoracic defibrillator, which originally had to be implanted with a chest incision but gradually developed into a catheter implantation technique. By January 1990, the first radiofrequency ablation was done. Laser-assisted lead extraction was first accomplished in January 1997.

FELLOWSHIP PROGRAM

From the very beginning, fellows have been a key element of the department's activities. Dr. Blain had 5 fellows. His first one—Herbert Schafer—came with him from the University of Alabama and even arrived shortly before he did in 1955. I had no fellow for the first year that I was here. In my second year, Dr. Dexter had a break in his fellowship training program in Boston and asked me to train a first-year fellow here who would then go up there for his second year. This was Ali Shahriari who was my first fellow here in 1963–1964. Harold Brooks also had his first year here in 1966–1967 and then went to Boston for his second year. James Matson was a fellow from 1965 to 1967, and Dr. Solis was a fellow from 1968 to 1970. The program has had 107 fellows; 40 of them are practicing in North Texas and 15 elsewhere in Texas. Eleven practice in 8 foreign countries (*Table 2*).

Why have fellows? In the early days, we were always short-handed, and those who knew how to do our work were few and far between. Clearly, it was a means of obtaining manpower to aid us at a time of critical shortage. Trainees are also a liability. They require much more time and much more explanation and conferring time, and they slow the teacher down. Boone Powell, Sr.,

always insisted that a teaching program led to the best patient care. Can you imagine doing anything to cut corners, save time, or be expedient with all those beady eyes and idealistic medical students, interns, residents, and fellows always asking why? Their presence made us all more deliberate, contemplative, and pedantic. In the process, we took the time to be better physicians.

ELECTROCARDIOGRAM DEPARTMENT

The date when electrocardiograms were first done at Baylor Hospital is unknown, but it undoubtedly was our first cardiology test that is still being used. In 1935, 443 tracings were made. For the 10 years through 1945, an average of 586 tracings were made each year for a monthly average of 49. In the year 2000, the average number of tracings per month was 6500.

In the earliest days, patients were brought to the electrocardiogram laboratory by stretcher and were usually accompanied by their nurse. Mrs. Evelyn Rich was supervisor in 1954 and continued until 1972. By 1954, some electrocardiograms were still being recorded using the old string galvanometer and photographic recorder, which required processing the paper, drying it, coating it with glycerin, and mounting the cut strips on cardboard. Single-channel direct-writing machines came in the early 1950s and were a great improvement, but they still required a technician to cut and staple all of the individual strips on cardboard mounters. This required 20 minutes for each tracing! On rounds in the evening, the physicians had to go down to the electrocardiogram department and search through stacks of records to find the one they needed. In the early 1970s, direct-writing, 3-channel machines became available and greatly speeded the process. I had each tracing done in duplicate so that one was placed immediately on the chart and the other copy went to the electrocardiogram department for the official interpretation.

Until 1980, all electrocardiograms were indexed manually on 3" × 5" cards and arranged alphabetically. In 1980, 160,000 patient charts were transferred to the Heart Center computer. In 1980, the AM surgery panel was started with a group of readers interpreting the tracings early in the morning so the results would be on the charts in time for surgery. In 1997, the MUSE system for reading electrocardiograms on the computer went online at the BUMC campus and in 1998, the electrocardiogram department was downsized; 15 technicians were integrated into other areas of the hospital. Respiratory technicians and nurses began doing the electrocardiograms. The MUSE system was gradually expanded to all of the Baylor facilities. Now, when the physician types in the interpretation of the tracing, it is immediately available throughout the Baylor system.

Originally the electrocardiogram department reported directly to the administration, and Dr. James Blain was in charge from 1955 to 1962. Dr. Ralph Tompsett took charge of the department from 1962 to 1971, at which time the department was incorporated into the cardiology department under me. When I retired in 1994, cochiefs of cardiology, Drs. Kevin Wheelan and John Schumacher (*Figure 10*), continued the management.

CORONARY CARE UNIT

By the mid 1960s, it was apparent that CCUs could save lives and improve the care of patients. The wing of the hospital between the Hoblitzelle and Jonsson buildings was shelled in,

Table 2. Cardiology fellows trained at Baylor University Medical Center

Fellowship period	Last name	First name	Location of practice	Fellowship period	Last name	First name	Location of practice
1955–1956	Schafer	Herbert	France	1982–1984	Muntha	Syam†	Las Vegas, Nev
1955–1956	Quiroz	Antonio	New Orleans, La	1983–1984	Elhard	Bonnie	Dallas, Tex
1956–1957	Nizet	Pierre	Belgium	1983–1985	Henderson	David	Daytona Beach, Fla
1958–1959	Piacentini	Carlos M.*	Dallas, Tex	1983–1985	Pacini	Donald R.	Grand Junction, Colo
1958–1961	Hinojosa	Enrique	Mexico	1983–1985	Weingarden	Gary I.	Richardson, Tex
1959–1961	Martinez	Gerardo	Mexico	1984–1985	Floyd	Bonnie Elhard	Dallas, Tex
1963–1964	Shahriari	Ali	St. Louis, Mo	1984–1986	Bret	John Robert	Garland, Tex
1965–1966	Hughes	David	Arlington, Tex	1984–1986	Johnston	Stephen B.	Dallas, Tex
1965–1967	Matson	James L.	Dallas, Tex	1985–1987	Delphia	Robert E.	Columbia, SC
1966–1967	Brooks	Harold L.	Tulsa, Okla	1985–1987	Hauser	Jack	Hamden, Conn
1967–1969	Khalaf	Jawdat D.	Egypt	1985–1987	Mitchell	Michael R.	Garland, Tex
1968–1970	Solis	Rolando M.	Dallas, Tex	1985–1987	Raftery	John	Traverse City, Mich
1969–1970	Enriques	Christino C.	Fort Lauderdale, Fla	1986–1988	Miller	Andrew H.	Arlington, Tex
1969–1970	Hasija	Kenny	Southbridge, Mass	1987–1989	Nussbaumer	Samuel A.	N. Richland Hills, Tex
1970–1971	Khaksar	Parviz	Iran	1987–1989	Overbeck	John Douglas	Irving, Tex
1971–1972	Akhtar	Nassim	Fort Worth, Tex	1987–1989	Zellmer	Terry	Baton Rouge, La
1971–1972	Padmanabhan	Vellore T.	New York, NY	1988–1990	Burns	Russell F.	Amarillo, Tex
1972–1973	Mouradian	Arto S.	Tampa, Fla	1988–1990	East	Cara A.	Dallas, Tex
1972–1974	Pollo	Walter H.	Houston, Tex	1988–1990	Slusky	Harvey E.	Webster, Tex
1972–1974	Rao	Niranjan	Maspeth, NY	1989–1992	Ferry	Michael T.	Arlington, Tex
1973–1974	Khan	Suhrab A.†	Pakistan	1989–1992	Malone	Christine T.	Dallas, Tex
1973–1974	Mouradian	Arto S.	Tampa, Fla	1990–1993	Crumpler	Charles	Longview, Tex
1973–1974	Perez	Gloria L.	Houston, Tex	1990–1993	Hecht	Phillip J.	Grapevine, Tex
1974–1975	Antonatos	Peter G.	Greece	1990–1993	Routh	Keith	Garland, Tex
1974–1975	Gerka	Carlos	South America	1991–1992	Mallick	Saleem	Paris, Tex
1974–1975	Wuebker	Marguerite	Dallas, Tex	1991–1994	Schilling	Steven	Irving, Tex
1975–1976	McCleskey	Ralph M.	Abilene, Tex	1991–1994	Stephenson	Scott K.	Dallas, Tex
1975–1976	Sabharwal	Subhash	Dearborn, Mich	1991–1995	Talbert	Timothy	Chattanooga, Tenn
1975–1976	Singh	Parvinder	Los Angeles, Calif	1992–1995	Jones	Billy Don	Brownwood, Tex
1975–1977	Ewer	Michael S.	Houston, Tex	1992–1995	Sherman	Jon	Fullerton, Calif
1975–1977	Tocatjian	Alain Z.	Sherman, Tex	1992–1996	Vallabhan	Ravi	Dallas, Tex
1975–1977	Waheed	Abdul	Elmira, NY	1993–1996	Boylan	Chris	Tyler, Tex
1976–1977	Jackson	Thomas	Florida	1993–1997	Khan	Muhammad	McKinney, Tex
1976–1978	Gan	Luisa	Mesquite, Tex	1994–1997	Pelosi	Frank	Ann Arbor, Mich
1976–1978	Revana	Madaiah	Humble, Tex	1994–1997	Waller	Tom	Plano, Tex
1977–1978	Browne	Patrick J. G.	Sun City, Ariz	1995–1998	Isaac	Michael	Sherman, Tex
1977–1978	Chaffin	Lowell R.	Amarillo, Tex	1995–1998	High	Shyla Thomas	Dallas, Tex
1977–1979	Caskey	David M.	Shreveport, La	1996–1999	Marshall	Winston	Dallas, Tex
1977–1979	Richardson	James A.	Arlington, Tex	1996–1999	Stocker	Eric	San Antonio, Tex
1978–1979	Brown	Douglas K.	Enid, Okla	1997–1998	Akhtar	Salman	Houston, Tex
1978–1979	Huang	Milch T. C.	Rochester, NY	1997–2000	Shah	Tushar	Dallas, Tex
1978–1980	Drake	Glen B.	Temple, Tex	1997–2001	Johnson	Ken	Dallas, Tex
1978–1980	Vicario	Jose H.	Argentina	1998–2001	Summers	John	
1979–1981	Dorion	Clint T.	Knoxville, Tenn	1998–2002	Schussler	Jeff	
1979–1981	Eliz	Julian S.	Paris, Tex	1999–2000	Smith	Bobby	Oklahoma City, Okla
1979–1981	Pai	Arvind	Houston, Tex	1999–2002	Jain	Vikas	
1980–1981	Manviwala	Minhas S.	Houston, Tex	1999–2002	Lander	Stuart	
1980–1981	Saranathan	Kas	Houston, Tex	2000–2003	Jones	Hamp	
1980–1982	Agrawal	Kanti L.	Garland, Tex	2000–2003	Phillips	Sabrina	
1981–1983	Grodin	Jerrold M.	Dallas, Tex	2001–2004	Donsky	Alan	
1981–1983	Lundeen	Thomas E.	Waco, Tex	2001–2004	Gerber	Terry	
1981–1983	Mikhael	George	Dallas, Tex	2003–2005	Moore	Tim	
1981–1983	Schumacher	John R.	Dallas, Tex	2003–2005	Theleman	Kevin	
1982–1984	Masters	Robert	Laguna Hills, Calif				

*Name changed to Charles Preston in 1963.

†Deceased.

Figure 11. Mr. and Mrs. I. A. Victor in the cardiac rehabilitation unit, 1977.

and the decision was made to put the CCU on the second floor, the general ICU and dialysis unit on the third and fourth floors, respectively, and the postoperative open heart and thoracic surgery unit on the fifth floor.

The training of nurses became a major activity. I gave a daily electrocardiogram lecture with a quiz to about 30 nurses. In this effort, I survived only by using Dr. Barney Marriott's textbook on electrocardiography (eventually all 8 editions) and his Tampa Tracings, which were a series of slide presentations on many cardiology topics, including arrhythmias. During the past 40 years, untold numbers of nurses, medical students, housestaff, cardiology fellows, and emergency room physicians have benefited from the use of over 1000 of these slides, which are still in use. Marriott's impact on our institution has been substantial.

The classes for the nurses lasted for about 6 weeks, and other specialized training was given. At the end of this time, the most accomplished nurses were selected to be CCU nurses. About 6 were chosen. The first supervisor was Eva Childers.

Four beds were opened at the east end of the second floor. The design of the unit was critical. Every effort was made to have the patients feel that they were not in a hospital. The equipment at the headboard was concealed as well as possible. Each room had a clock, a television, and an outside window. The nurses could view the patients through a small window, but the patient had the feel of being in a private room. A considerable argument erupted over whether or not to carpet the rooms. I insisted on carpeting throughout the unit to cut down on noise. Mr. Powell felt that it would be too hard to push food service carts and other equipment across carpeted floors, so the compromise was made to have the rooms themselves carpeted but not the hallways.

The first patients were admitted with considerable fear and trepidation. At that point, no interns or residents were available to serve in the unit, so the nurses had to provide the care without immediate physician support. Many of the senior nurses felt that nurses were not qualified or able to do cardiopulmonary resuscitation and cardioversion. They finally gave way with the passage of time and the demonstration that the nurses could do all of these things well. As the unit gradually expanded and more beds were added, it became possible to have nearly full-

time housestaff coverage with interns and residents. Eventually, the CCU expanded to occupy the entire second floor between Jonsson and Hoblitzelle.

As the demand became greater, it was decided to have an intermediate or step-down unit, which came to be called the telemetry unit. This was on the second floor of the Jonsson building, where most patients went after they left the CCU. The unit began with 4 beds and eventually expanded to occupy the entire floor.

Because of the rapid expansion and the turnover in nursing ranks, it was difficult to provide training in all aspects on a continuing basis. Nurses were being trained not only in electrocardiograms, but also in defibrillation, cardiopulmonary resuscitation, and managing the intraaortic balloon pumps and respirators. Nurses also began removing sheaths after angioplasty. The fundamental achievement was the recognition that nurses had to train themselves. As the senior nurses learned new skills, they then taught their juniors. The medical staff continued to give occasional lectures, but the great burden of training new nurses fell to the nurses themselves. This was the best possible solution.

By about 1990, it became apparent that there was a need to have a postangioplasty suite close to the catheterization laboratories, where special nurses could watch the patients and remove angioplasty sheaths. It was felt that this area should be close to the catheterization laboratory and the CCU, so the electrocardiogram department was moved out and replaced by the new postangioplasty unit, which consisted of about 12 beds right across from the catheterization laboratory. The first supervisor of CCU was Eva Childers in 1967, followed by Carolyn Keever, Barbara Montgomery, Shirley Shofner, Helen Collins, and currently Nancy Vish. Nancy Vish also supervises the cardiac catheterization laboratory.

NONINVASIVE LABORATORY

Dr. Charles Harris started echocardiography at Baylor in 1972, using the single-dimensional equipment that had been contributed by Mr. and Mrs. I. A. Victor (*Figure 11*). The usefulness of the procedure grew steadily. After Dr. Harris left in 1975, Dr. Charles Gottlich joined the staff in 1976. Eventually 2-dimensional echocardiography was added as the technology improved. In the late 1980s, color Doppler was added. Dr. Melissa Carry joined the staff in 1989 and began doing stress echocardiography. This technique became greatly favored by the cardiologists because the answer could be obtained in about an hour if the patient could exercise adequately. With the rapid turnover of patients in and out of the hospital, it was necessary to quickly determine the need for surgery or intervention, and this provided the most useful and easily available information. Dr. Gottlich began doing transesophageal echocardiography, probably in 1989, and this greatly expanded the role of the echocardiographer and made it necessary for him or her to be present in the operating room for many types of valve surgery. The use of dobutamine for stress proved very useful for patients who could not exercise to an adequate heart rate, and this greatly expanded the use of stress echocardiography.

PACEMAKER DEPARTMENT

Temporary pacemakers were first used at Baylor by Dr. Blain when he arrived in 1955. The first permanent transthoracic pacemaker was inserted by Dr. Maurice Adam in 1960. The patient

had complete heart block and many episodes of cardiac arrest. It was necessary to open the chest and bring the leads out through the chest wall to a large battery that was carried in a wheelbarrow. The patient lived this way for a number of months until a newer unit became available and was small enough to be permanently implanted under the skin of the abdomen. She lived another 25 years after that and became the longest-living survivor of a pacemaker implantation. The first permanent transvenous cardiac pacemaker was inserted by Dr. Judson McNamara in 1967 when he was a thoracic surgery fellow with Dr. Harold Urschel. He had learned the technique the previous year when he was a fellow in Boston. The patient was considered too sick to survive thoracotomy and had to have something less invasive. The procedure was successful.

Dr. Rolando Solis performed the first implant of a pacemaker by a cardiologist in September 1977. By 1978, pacemaker implantation by cardiologists and surgeons became much more frequent; multiprogrammable pacemakers were introduced in 1979, further increasing the complexity of programming and evaluating pacemakers. The cardiologists had developed great skill in catheter manipulation under the fluoroscope—something awkward for the surgeons. Cardiologists had been inserting temporary pacemaker catheters for years, so inserting a pacemaker was not a great leap. However, a surgical incision had to be made in the chest wall to implant the battery pack, and this involved much more surgery than cardiologists had done before. The thoracic surgeons did not resent this intrusion on their turf because they were so overwhelmed by the flood of coronary bypass patients that they had no time to worry about the occasional pacemaker case. Thus, the entire cardiac pacemaking effort passed from the surgeons to the cardiologists.

Ed Bond, PhD, was the director of Baylor's newly created computer department, and his first assignment (after organizing the patient filing system for Heart Center records) involved the pacemaker clinic, which was growing rapidly. By the early 1980s, there were 41 different kinds of pacemakers, and if one considered the variety of leads and batteries that could be put together, the number of combinations was overwhelming. Only a computer could keep track of it all. Dr. Bond worked out a unique computer program, which was one of the first of its kind (perhaps the first) in the USA. Physicians from around the country visited our center to learn about it. The program made the management of the patients much easier and more accurate. Later, telephone transmission of data became available and further added to the usefulness of the computerized system.

Rhoda R. Whitcomb, RN, completed her postgraduate course at Baylor in operating room technique and management and began working for Dr. LeRoy Kleinsasser in the dog laboratory, which was in a corrugated metal building that had been loaned to them by Dr. Joseph Hill of the hematology and blood bank department. They were using hypothermia to create septal defects in dogs. After healing had occurred, they were repairing the defects with an experimental heart/lung machine provided by the Dallas Heart Association. Because of her training as a scrub nurse and her interest in open heart procedures, Ms. Whitcomb rapidly excelled in the pacemaker field. She measured thresholds on the patients in the operating room and became an expert in all aspects of pacemakers and their evaluation. Thus, she became involved when

Figure 12. Rhoda Whitcomb, RN, supervisor of the catheterization laboratory from 1955 to 1962 and 1964 to 1977. Photo: Olan Mills.

Dr. Maurice Adam began his work with surgically implanted permanent pacemakers after he arrived in 1959. Together, she, Dr. Adam, and Dr. Blain did a large series of successful pacemaker implantations in elderly patients with complete heart block, and each of them had a thoracotomy with the leads sutured to the myocardium. All of the patients lived—an incredible accomplishment! The pacemaker clinic began in 1977 and did over 700 evaluations the first year.

In 1962, Ms. Whitcomb left Baylor to work for Dr. Blain as his office nurse but came back

to Baylor in 1964 and quickly became involved in all phases of the cardiology department's activity. She insisted on the highest standards of sterile technique, as only a scrub nurse could! She ran all of the equipment in the catheterization laboratory, including the large 8-channel recorder, the withdrawal pump, the oximetry devices, and the x-ray equipment itself. She learned to process 35-mm film and to develop the phonographic recordings. She was the first to scan Holter monitors and spent long hours in the darkened room analyzing arrhythmias. Her expertise was in such great demand that she spent long hours in the laboratory, only to return early the next day. She became the first supervisor of the department and trained countless others in all phases of our activities. By the time she left Baylor in 1977, she was truly an expert in all phases of the Heart Center's activity. She was probably the most dedicated, hard-working member that the department has ever had (*Figure 12*). Before leaving, Ms. Whitcomb trained her successor, Winnie Stankey, RN, who had trained at the Mayo Clinic before coming to Baylor as supervisor of the postoperative open heart ICU. With her vast medical experience, she quickly became deeply involved in the pacemaker department as head of that division and continued in that activity until her retirement in 1996.

Starting with over 1000 active pacemaker patients in 1982, the pacemaker clinic began adding real-time data on all new implants and revisions and by 1997 had more than 5500 patients enrolled. The data included telephone evaluations, which grew from 138 patients in 1978 to more than 3000 in 1988. In 1986, Dr. Kevin Wheelan became director of the pacemaker division. In 1987, he and Dr. Peter Alivizatos performed the first implanted cardiac defibrillator. In 1988, he and Dr. Allan Cook did the first surgical ablation of an accessory pathway.

By 1988, Kathy Blake, RN, who had been a pacemaker nurse at Baylor for 5 years, was hired by Texas Cardiology Consultants to provide outpatient pacemaker follow-up services for that group. In 1992, Marcia Seaton, RN, who had also been a pacemaker nurse for 5 years, was hired by HeartPlace to do the pacemaker follow-up for their group. Thus, the follow-up of pacemaker implantation patients moved from the Heart Center to the physicians' private offices.

COMPUTER DEPARTMENT

By 1976, it was clear that the burgeoning growth of the department and the increase in the number of patients and the data accumulated on them made computerization essential. Accordingly, Edward Bond was recruited from the training program of Dr. Homer Warner at the University of Utah in Salt Lake City. Dr. Bond earned his PhD in computer science and also had extensive training in cardiac physiology; thus, he was uniquely trained to bridge the gap between cardiologists and computers. He joined the staff as director of the computer department in September 1976 and conceived the idea of "minicomputers" to do the work of the many cardiology divisions with a central "mother" computer networked to them to collect, store, and analyze the data as needed. This was 3 years before the introduction of the personal computer. The first central computer was on the third floor of Wadley Tower housed in a large, air-conditioned room with limited access. It became known as our Los Alamos Project. A minicomputer was set up to do the treadmill stress tests on the first floor. The first project was to establish a central filing system, with primary information having to be entered on more than 35,000 patients. Stress test data and file management systems were then added such that every patient chart had to be checked out and the computer knew who had it—a great advance for keeping track of patient records in a rapidly growing department.

By 1978, Dr. Bond began implementation of computerized hemodynamic systems that enabled the catheterization laboratory to do cardiac outputs from dye-dilution curves, to record pressures, and to calculate resistance, work, and valve areas. He captured the procedure record of all the details during the case and monitored the patients. In 1979–1980, the Holter monitor scanning systems were created for analyzing the data and writing the reports. By 1981, all Heart Center scheduling was done by computer; each cardiology secretary could see the schedule on her desktop and schedule tests. The pacemaker management system allowed the recording of the input parameters of the pacemaker units at the time of implantation, with further addition of data from both telephone and office evaluations. Battery life could be estimated, and patients could be recalled for a battery change before the battery completely failed. By 1983, the system had won wide professional acclaim as one of the very first pacemaker management systems in the world, and it had many unique features. In 1983, ventricular volume analysis began for the catheterization laboratory with wall motion studies and ejection fractions immediately available in the lab during the procedure. By 1986, Kenny Teoh joined the department as systems analyst, and he continues to enlarge the scope and expertise of the department.

In 1989–1990, all cardiac rehabilitation data were entered into the system, including all scheduling (patient evaluations, classes, and stress tests) and physiologic data. The system even scheduled the next visit for the patient and sent the required progress reports to Medicare. Coronary angiography and cardiac catheterization report writing was begun between 1986 and 1988. Later, scheduling for the new electrophysiology department was started, and eventually the new Apollo System was installed and the module for electrophysiologic studies and reports was rewritten to our specific requirements. At a later time, the pacemaker reporting system and the intracardiac defibrillator modules were also rewritten for the Apollo System. By 1993, echocardiography

reports and signal-averaged electrocardiogram data and reports were added.

The original Data General Nova 3 central processing unit had only a fraction of the processing power available on the early personal computers and a thousand times less the power of today's desktop computers. What it lacked in processing power, it made up for with a lean and mean operating system that was capable of supporting multiple users and managing multiple tasks simultaneously. The source code was available so it could be customized to meet the unique requirements at hand and was trimmed down to the bare essentials. Our system was a client/server implementation some 5 years before this technology was introduced to the personal computer world in the mid 1980s.

The first central patient database system (Data General Eclipse) was enclosed in a cabinet the size of 2 refrigerators. The single hard drive for the system was the size of a washing machine, weighed over 600 lb, and stored data on removable 90 MB spindles. The cost of the disk drive alone was over \$10,000. In contrast, common hard drives today are the size of a paperback novel, hold 400 times more data, and cost under \$200.

New technology has dramatically increased storage capacity, processing speed, and graphical interface resolution for the user, but the new features and capabilities have added tremendous processing and storage overhead, slowing down some basic functions. The newer systems are developed as general-purpose systems to satisfy the needs of many rather than to perform specific tasks with speed and efficiency.

CARDIAC REHABILITATION

Shortly after he was recruited to join the staff in 1976, Dr. Walter I. Berman was charged with setting up cardiac rehabilitation. The concept was so new that no one knew what would be required. Dr. Berman traveled extensively and combined the best elements from the few units then in operation around the country. With strong support from Mr. and Mrs. I. A. Victor and Mr. Boone Powell, the unit quickly gained popularity with patients and their families. For the first time, the hospital was perceived as wanting to keep patients healthy rather than simply treating them when they were ill. This positive idea ushered in a new era in our perception of cardiac care. While the exercise on bicycles and treadmills was the window dressing that received most of the notice, the fundamental benefit probably was psychological. The patients were frightened, did not understand their conditions, did not know their medications, and were unsure how much activity they were allowed. The spouses attended classes with the patients and learned about risk factor modification, medications, stress management, and what to do or not to do following a heart attack. Thus, while exercise plays an important role, education and psychological support are probably even more important.

With the move of the Heart Center to the Roberts building in 1986, the cardiac rehabilitation unit occupied the east end of the third floor on the north side. This crowded space was somewhat less desirable than what they had had before, but it did tie the patients more closely to other activities in the Heart Center. However, when the opportunity arose, the rehabilitation unit moved to the third floor of the Baylor Tom Landry Center, where it had beautiful space and for the first time had extensive facilities to meet its growing needs. The patient acceptance of this

new location was high, and the popularity was great. Although this location was away from the Heart Center and allowed less contact with the rest of the Heart Center staff, it placed patients in a pleasant environment where rehabilitation, exercise, and sports activities were ongoing. Parking and in-and-out access also were much easier.

Dr. Berman's achievement was unique. He carefully created a patient care facility that was academic but also caring and free of commercialism. His name became synonymous with cardiac rehabilitation in this region. It was fitting that Baylor dedicated the unit to him, naming it the Walter I. Berman Center for Cardiovascular Prevention and Rehabilitation in May 1999, shortly before his untimely death.

NUCLEAR CARDIOLOGY

In the mid 1970s, Dr. A. D. "Ziggy" Sears came to me to discuss the fact that the new technique of nuclear cardiac imaging appeared to be of interest and something that the hospital should offer. The problem was how to accomplish it. The radiologists had the nuclear license and expertise to perform and interpret the images, but they were uncomfortable at the prospect of doing stress testing on sick cardiac patients who might develop angina, arrhythmias, or cardiac arrest. We worked out the first joint venture of its kind between 2 hospital departments. The cardiologists were in charge of the patient, did the stress test and its interpretation, and handled any emergencies. The radiologists were in charge of injecting the isotopes, performing the imaging, and interpreting the images.

Dr. James H. Shelton was placed in charge of the cardiology side, with Dr. Herbert Steinbach in charge of the nuclear portion. Many radiologists rotated through the unit daily with Dr. Shelton, along with the cardiology fellows and the radiology residents.

Initially, most studies were done by the first-pass technique with the patient sitting up, peddling a bicycle, and hugging the camera with his arms around it. This procedure required exercising to an adequate heart rate for good stress, limiting the number of patients who could be tested. Today, about half of the patients are tested with pharmacologic stress to avoid this problem.

With the move of the Heart Center to the Roberts building in 1986, the nuclear laboratory was placed on the third floor between the noninvasive laboratory and the computer department. To the first-pass technique were added the multiple gated acquisition scan, shunt studies, and thallium perfusion images used in the evaluation of coronary artery disease. At present, the dual-isotope technique using thallium with sestamibi or technetium Tc99m tetrofosmin is most popular for the study of coronary disease.

Dr. Sears was one of the most important people in our development and perhaps the one closest to my heart. I had not had any angiography experience during my training, and I was acutely aware of my shortcomings. I knew of the beautiful angiograms being done at the Karolinska Institute in Stockholm and by radiologists who had trained there, but they were few and far between. Dr. Sears made it possible to develop those techniques at Baylor. He was always interested in and made time for our embryonal projects. In the early days of angiography, the syringe used to inject contrast dye under high pressure was metal; you could not see any bubbles that might be there. For this reason, Dr. Sears was the only one I trusted to fill the syringe. Only after glass and plastic

syringes were available did I trust others to fill them. He or Dr. Arndt reviewed every arterial or venous injection that we made and wrote a separate report for it. As the avalanche hit us and we became so busy with coronary angiography, they found it onerous trying to keep up, and they themselves proposed that they stop doing separate radiology interpretations and reports since we were duplicating their efforts. We, in turn, were resolved to continue seeking their counsel at any time that we were unsure.

The radiologists not only gave of their time, they gave their space. Crowded as they always were, they made room for our first and second catheterization laboratories in the back end of the radiology department on the first floor of the Truett Hospital. With all of our frenzied activity, I am sure they were happy to support our move to new quarters in the first 3 floors of Wadley Tower!

It was radiologist Dr. Herbert Steinbach who came to me and suggested we learn to do echocardiography. Until then, all sonography was done by the radiologists, but he felt that "too much cardiology was involved" and that a cardiologist should do it. Much of what we did in cardiology would not have been possible without the complete cooperation that we received from the radiology department.

CARDIAC TRANSPLANTATION

In the late 1960s, cardiac surgeons at Baylor were eager to get involved in transplantation. I argued against such an irrational advance into this new area, however, because the problem of rejection had not yet been solved. By the early 1980s, the problem of rejection had been addressed and transplantation was feasible. Led by Dr. Ben F. Mitchel and supported by most of the members of the thoracic surgery and cardiology departments, plans were made to begin cardiac transplantation. Dr. Mitchel hired Dr. Peter Alivizatos, who joined the staff in April 1984. Soon thereafter, Dr. Harold Urschel hired Dr. Ivan Crosby and together they performed Baylor's first heart transplantation on March 6, 1986; the patient lived for 17 years afterward. Three heart transplants were done that year, 12 in 1987, and 20 in 1988. The number of transplantations gradually increased, and the program was successful but was hindered by the limited availability of donor organs. The cases done were usually limited to about 20 per year. The 1-year survival rate was in line with national averages and continually improved.

After a few years, Dr. Crosby left Baylor and Dr. Alivizatos was appointed director of cardiac transplantation. He did the first combined heart and kidney transplant in 1988 (the fifth in the world). In July 1990, he did our first single-lung transplant on Gene Gaillard, who continues to do well. Dr. Alivizatos was the first to perform single-lung transplantation in this part of the world, and he did our first double-lung transplant in September 1993. The first heart and single-lung transplant patient is still alive after 10 years. Baylor's lung transplantation program was the first in Dallas. Patients for cardiac or lung transplantation were selected with great care, and the transplant selection committee was very active under my direction from 1985 until 1996.

Before the end of his cardiology fellowship at Baylor, Dr. Andrew Miller received special training in medical cardiac transplantation, and when he joined the staff in 1988, he became our first medical cardiac transplantation specialist. By 1998, Dr. Alivizatos had decided to return to Greece, and the Baylor

program was merged with the program at Southwestern Medical School, with Dr. Steves Ring in charge as the transplant surgeon; he has continued to oversee the continued growth and expansion of the program.

ELECTROPHYSIOLOGY LABORATORY

By the mid 1980s, it was clear that electrophysiologic testing would soon become an important part of cardiology. At that time there were only 2 such laboratories in Texas—one in Houston and one at Southwestern Medical School in Dallas. Dr. Kevin R. Wheelan finished his training at the medical school in July 1986 and began electrophysiology testing here. In July 1987, he implanted the first open chest defibrillator to be used in North Texas, with the surgical assistance of Dr. Peter Alivizatos. That year, atrioventricular nodal ablations were started using direct current. In 1988–1989, Dr. Wheelan began doing the first transvenous cardiac defibrillator procedures in the state. Dr. Jay O. Franklin joined the staff in January 1988 after completing his electrophysiology training with Dr. Mel Scheinman in San Francisco. He brought with him an antitachycardia pacing catheter and first used it for recurrent ventricular tachycardia. He first used intravenous amiodarone at BUMC in 1988 and implanted our first atrial defibrillator. He has also been active in the biventricular pacing study. In January 1990, Dr. Peter Wells joined the staff and did Baylor's first ablation procedure using radiofrequency as the energy source. Transvenous extraction of pacemaker leads was started in 1995; use of a new laser cutting catheter made it possible to avoid an open chest operation. The demand for this procedure gradually became large. By 1999, the department became one of the first centers in the USA to be involved in a study employing biventricular pacing for the treatment of intractable congestive heart failure.

Ablation and mapping procedures gradually evolved from Wolf-Parkinson-White syndrome and atrioventricular nodal re-entrant tachycardia treatment to the ablation of atrial flutter and, in selected patients, treatment of atrial fibrillation. We became the second center in the USA to have the Ensite 3-dimensional computerized mapping system, which had been developed at the Mayo Clinic. This provided much more rapid and accurate mapping of both auricles and ventricles. New catheter designs have also been an ongoing involvement.

PHYSICIAN RELATIONS

In 1962, when the members of the search committee—Drs. Ralph Tompsett, Paul Thomas, Richard Hunter, Billy Oliver, Howard Coggeshall, and others—interviewed me, they explained that the new director of the cardiology laboratory was to be a *consultant*, not a practitioner. He was to see the difficult cases in consultation when requested, but he was not to build a busy clinical office cardiology practice. This meant that he was to see the small percentage of cardiology patients who had congenital or valvular disease that internists felt insecure about treating, but the great majority of cardiac problems were to be handled by the internists. After all, up to this point, internists had traditionally handled all cardiology. It was only the development of cardiac catheterization and surgery that left them ill at ease. I concurred with this attitude and was quite comfortable with it since it was the way my mentor, Dr. Dexter, had always practiced.

In those days, once you got beyond congenital and valvular heart disease, there wasn't much challenge because the remaining 97% of cardiology cases consisted of coronary disease, hypertension, and an occasional arrhythmia. For me, these patients did not represent much challenge since we had few treatment options. There were only 3 cardiac drugs—digitalis, quinidine, and procainamide.

The committee also noted frequently that they did not want any "DeBakeyism." Visiting from Boston, I did not understand the term, but they explained the concept of "building the tallest hospital and sending all the world's patients to us to be cured." They did not want an empire builder who would cut the internist out of the role of caring for the cardiac patient.

When the CCU opened with 4 beds in 1967, internists feared that only cardiologists would be allowed to admit patients to the fancy, ultraequipped unit that some dubbed "the Hyland Hilton." At that time, the internists treated and admitted *all* of the patients with myocardial infarction. So as not to disrupt the existing practice pattern, I worded the original CCU admission rules such that only internists could admit to the unit, but they must seek consultation with a cardiologist within 24 hours. Gradually, by the early 1980s, with the advent of the use of more complex pacemakers, coronary angioplasty, intraaortic balloon pumps, and transplantation, the CCU admissions were almost all done by cardiologists.

The first staff privileges crisis developed in 1976. Dr. Charles Harris had joined our group fresh from his fellowship at St. Paul Hospital in Dallas. He was an excellent physician, but he had never become involved in the new field of echocardiography. Our group provided the equipment, salary, and patients that allowed him to advance through the usual learning curve rapidly. He was also doing catheterizations and built a good practice and was recognized by the staff as the only one doing echocardiography work. After 3 years, he decided to go into private cardiology practice at Baylor and wished to continue doing echocardiograms and catheterization work just as before. The chief of medicine and the administration were appalled at this prospect, which would set the precedent that anyone new coming to the staff could have the same privileges, as could anyone who decided to leave the full-time cardiology group. In fairness, every member of the department should be accorded the same privilege. Baylor had spent sizable sums of money to build our then-new facility on the first 3 floors of Wadley Tower. Now, there was the possibility of losing the physicians and the revenue that made the department what it was.

The cardiology department had never officially been closed. It just started as a one-man operation and grew. When I first arrived, I invited Dr. George Carman to do catheterizations if he wished. He had had extensive training with Dr. Hans Hecht at the University of Utah and was well qualified and experienced. He declined but did become active with me in setting up vectorcardiography. He continued to read these for about 10 years and was the only one of the staff to do so other than our own group. I also offered my predecessor, Dr. James Blain, catheter privileges, but he also declined. I did send him almost all of my temporary and permanent pacemaker patients for several years because of his interest and special ability in those areas. Thus, both of these

“outside” physicians were very much involved with the work of the department, even taking night call when I was out of town.

By the early 1970s, bypass surgery was burgeoning and more and more trainees were coming out; our department was turning out 2 to 4 graduates each year. Many traveling applicants came in, slapped 2"-thick stacks of credentials on my desk, and requested laboratory privileges. We had neither the need nor the room for them.

When Dr. John Fordtran became chief of medicine in 1979, he was faced with strong support for opening up the cardiology department among members of the medical advisory committee who had favored Dr. Harris' appeal for privileges and who felt that even those who had trained here all the way through internal medicine and cardiology could not get on the staff. There was also the growing feeling that the full-time cardiology staff and their fellows were not as available to see patients or respond to night call or emergency department calls as they might have been.

With a new administrator and new chief of medicine, the argument of fairness became foremost; the decision to open the department was made. But how? They did not wish to flood the system with new people. Remember, by this time Baylor was an enviable cardiology center, and many would have liked to join. In 1983, it was finally decided to admit John Schumacher, who had completed all of his internal medicine and cardiology training at Baylor, and Robert Rosenthal, who had trained at Parkland, as separate, independent practitioners with the idea that they were not to form a group to compete with the full-time staff. It was hoped that they would bring new patients into the Baylor system rather than dilute work that was already here. Dr. Jerrold Grodin had begun a successful cardiology practice in East Dallas but was persuaded to return to Baylor in 1986. The physicians at first had a loose arrangement for on-call coverage, but in 1986 when Dr. Stephen Johnston finished his fellowship with us, he joined them, and the group became formalized as Texas Cardiology Consultants.

Competition between groups gradually became intense as each added more members in an attempt to grow their practices, perform outreach functions in outlying areas, and supply the wide geographic area thought to be necessary in order to service contract obligations. Both groups were more assiduous in answering night and emergency room pages and in meeting teaching assignments. In this way there was benefit. Like an “arms race,” each group added members in greater and greater numbers. This had the beneficial effect of adding patient volume and revenue for the hospital but led to management and quality assurance problems never before imagined and has almost certainly led to an oversupply of cardiologists. The internists soon lost their role in caring for patients with myocardial infarction, arrhythmias, and even congestive heart failure. Our internists lost further ground with the advent of full-time physicians in the emergency department and later the formation of an in-house intensive care group. The internist's role in the treatment of heart disease has become almost completely confined to the office—a complete reversal of the situation that had once existed.

Dr. William C. Roberts joined Baylor in 1993 after 32 years as chief of the pathology branch of the National Heart, Lung, and Blood Institute of the National Institutes of Health. As one of the world's foremost cardiac pathologists and longtime editor of *The American Journal of Cardiology*, he brings great prestige to our institution. His emphasis on teaching and research has been stimulating, and his crusade to lower cholesterol has had a beneficial impact on the physicians, and hence the patients, of North Texas.

CONCLUSION

The growth in cardiology has been staggering. From the first procedures done in 1955, the number of catheterizations has grown to 1600 in 1981 and is >7000 in 2003. Pacemaker implantations have increased from about 300 in 1986 to almost 700 in 2003. Electrophysiologic testing has grown from 22 in 1986 to over 1000 in 2003. The number of intracardiac defibrillators has increased from 8 in 1987 to 321 and is expected to increase even more rapidly in the future.

The latest step in our progress was the opening of the Baylor Jack and Jane Hamilton Heart and Vascular Hospital in April 2002. With 6 stories and about 30,000 square feet on each floor, it has 50 hospital beds for patients undergoing heart and vascular procedures that require a hospital stay of <72 hours. It is connected to Baylor across Hall Street by a wide walkway that opens directly into the Heart Center and catheterization laboratories on the third floor of Roberts Hospital. The 900-car garage with covered walkways to the Heart Hospital and to Hall Street provides convenient access for patients and their families. The education and research center on the first floor houses a 100-person auditorium fully equipped with the most sophisticated audiovisual equipment.

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