McGoon's Cardiac Surgery: An Interprofessional Approach to Patient Care

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Preface

We believe that the best patient care results from collaborative practice between professionals directly responsible for that care. Fundamental to collaboration is an understanding of the contributions of each discipline. From that understanding a mutual respect can develop. The complexity of the care required by cardiac surgical patients makes collaborative practice all the more important. An initial step toward development of collaboration is an appreciation of knowledge unique to each discipline and recognition of that knowledge which is shared. This book represents a compilation of both types of knowledge, that unique to medicine and nursing, and that shared by both, as they relate to the patient undergoing cardiac surgery.

The first 17 chapters define in a comprehensive manner the background information a physician uses to determine the benefit of cardiac surgery to a particular patient and the care required once the decision to perform surgery is made. Although some of this information may not be directly applicable to nursing care, it is hoped that all of it will be of interest to nurses. In fact, it was the requests of nurses that led to the development of this collaborative effort. They appreciated that knowledge of patient selection, risks of surgery, desired outcomes, as well as potential complications was important to their practice. However, they pointed out that nursing care had not been defined in Dr. McGoon's book. Hence, the four chapters that closely examine nursing care were developed. We further recognized that both disciplines would benefit from scholarly discussion of cardiac anesthesia and drug therapy, and so these areas are explored in depth in two separate chapters.

The chapter on preoperative teaching is designed to be used, with institutional adaptation, as a teaching guide for the nurse. To facilitate this process the sections dealing directly with content to be taught are written in fairly simplistic language. Background information on the results of nursing research related to preoperative teaching, and specifically the findings related to cardiac surgical patients, is included. Patients who are highly anxious, withdrawn, or refuse information present a special challenge and guidelines for meeting their needs are included.

It is common for nurses to receive patients following cardiac surgery directly from the operating room or following a brief stay in the recovery room. Hence, a thorough understanding of cardiac anesthesia and intraoperative events is crucial to anticipation of postoperative care requirements. The chapter on cardiac anesthesia discusses preoperative considerations, the anesthetic process and intra-operative monitoring, effects of cardiopulmonary bypass and intra-operative respiratory function. It is written for the nurse with a basic understanding of critical care nursing. If the reader requires further background explanations, several critical care nursing texts are referenced in the chapter on nursing care in the intensive care unit.

In-depth knowledge of drug therapy is mandatory for all physicians and nurses who care for cardiac surgical patients. The chapter on drug therapy describes in detail the action of commonly used drugs, specific monitoring considerations and latest research.

The chapter dealing with nursing care in the intensive care unit assumes that the reader has a basic understanding of critical care nursing. Detailed explanations are provided when the content relates specifically to cardiac surgical patients, e.g., use of atrial electrograms in arrhythmia interpretation. Additionally, some fairly new and perhaps less widely known principles are discussed more comprehensively, even though they have application beyond the cardiac surgical patient. Research into patient positioning during pulmonary artery pressure recordings falls into this category. This chapter deals with nursing care requirements and monitoring for potential complications during the critical care period and is organized under broad categories of nursing diagnoses.

Once the patient leaves the intensive care unit, the focus of nursing care shifts to promotion of optimum independence and of patient and family participation in the recovery process. Consequently, the two chapters that deal with nursing care prior to discharge and with the long-term adaptive process incorporate Orem's conceptual model that focuses on self-care. Although readers may use other models in their practice, the authors have found Orem's work helpful in developing a broad approach to nursing care. As patients recover, they need to know what sensations are normal and what actions will promote return to optimum function. These two chapters direct the nurse in meeting these needs.

Knowledge of each other's contribution to patient care is the first step in physician-nurse collaboration. It is hoped that each will read what the other has written and that knowledge and mutual respect will promote the best possible patient management.

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Prologue: From Whence?

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In some ways, cardiac surgeons resemble salmon.

In the late summer of 1979, the expanded salmon census in Lake Superior stampeded the streams pouring into its northern shore, to the amazement even of the oldtimers. It was my first observation of this remarkable summer salmon run. They crowded up from the depths like football fans into the gates of a bowl game. One couldn't have crossed the stream's shallows without squashing them underfoot at every step. The most amazing thing was what happened at those periodic geologic walls where torrents of water plunged down from significant heights. Driven genetically by their procreative instincts, the salmon mustered every molecule of ATP and every ingenious trick contrived through eons of evolution to hurl themselves repeatedly up those vertical columns of crashing water, only to crash back with the water onto the rocks below. When the ATP was eventually gone, their bruised and bloated corpses floated down through the crevices between the eager upcoming ranks. Some stalwarts made miraculous progress up the smaller barriers to quieter pools beyond, but sooner or later the high upstream falls exceeded the capacity even of miracles. As far as I could tell, none of the fish recognized this nemesis—they kept hurling themselves 5 feet upward into 50 foot waterfalls until oblivion.

It wasn't clear to me then, nor even completely now, exactly what survival benefit this kamikaze-type activity bestows upon the salmon race. I describe the spectacle only because of its timely impact upon me and because the notion came that in some ways cardiac surgeons resemble salmon.

Our dilemma lies in the task of distinguishing a surmountable from an insurmountable barrier. Does there even exist in cardiac surgery a barrier that is insurmountable? We recall the wise anonymous proverb: "Whoever says something is impossible is apt to be interrupted by somebody already doing it." Furthermore, progress must surely be impeded by ill-founded timidity. Yet, one intuitively senses that up there eventually there must be a waterfall too high to conquer.

Probably because of its special mystique, the heart was the last of the organs approached by the surgeon.[1] Such sentiment was eloquently described by an innovative French surgeon of the 16th century, one who first discontinued boiling oil treatment of wounds and, in the battle of Denonvilliers in 1552, replaced the actual cautery with the ligature. "The heart," wrote Ambrose Pare, "is the chief mansion of the soul, the organ of vital faculty, the beginning of life, the fountain of vital spirits and so consequently the continual nourisher of vital heat, the first living and the last dying. . . ."[2]

Even after three more centuries had passed, surgical treatment of the heart still seemed impossible. In fact, it was essentially nonexistent. Even so, no less an authority than the

distinguished Stephen Paget wrote in the 1896 edition of his *Surgery of the Chest* the following statement: "Surgery of the heart has probably reached the limits set by nature to all surgery. No new method and no new discovery can overcome the natural difficulties that attend a wound of the heart. It is true that 'heart suture' has been vaguely proposed as a possible procedure and has been done on animals; but I cannot find that it has ever been attempted in practice."[3] How often since Paget's time have we come to that same conclusion: "Surgery of the heart has probably reached the limits set by nature to all surgery."

CARDIAC TRAUMA

But surgeons, like salmon, seem not to recognize an impossible barrier. Thus, in the same year as Paget's negativistic statement, Ludwig Rehn first successfully closed a stab wound of the heart in a 22-year-old male who had experienced a three-hour period of unconsciousness prior to operation.[4] He found a wound in the right ventricle with active hemorrhage. He placed a finger over the wound and controlled the hemorrhage with three silk sutures. The patient recovered, thus marking the beginning of cardiac surgery.

Similarly, the first cardiac surgery performed in the United States was also closure of a stab wound of the heart. On September 14, 1902, Dr. Luther Leonidas Hill of Montgomery, Alabama, was called to the home of Henry Myrick, a 13-year-old boy who had been stabbed five times in the chest.[5] The pulse was barely palpable and the heart sounds were heard with difficulty. The boy was dyspneic, restless, with cold extremities and had to be aroused to answer questions. Dr. Hill proceeded to perform an operation which was the first successful one of its kind in the United States. The operation was performed by the light of oil lamps on a kitchen table. His operative report reads: "The wound was about $^{3}/_{8}$ of an inch in length and from it came a stream of blood at every systole. I removed the boy from his bed to a table, at 1 AM, 8 hours after the stabbing, and proceeded to cleanse the field of the operation and placed the patient in as favorable a condition as my surroundings in the Negro cabin would allow. Commencing an incision about $^{5}/_{8}$ of an inch from the left border of the sternum I carried it along the third rib for 4 inches. A second incision was started at the same distance from the sternum and carried along the sixth rib for 4 inches. A vertical incision along the anterior axillary line was made, connecting them. The third, fourth and fifth ribs were cut through with the pleura. The musculo-osseus flap was raised with the cartilages of the ribs acting as the hinges. There was no blood in the pleural cavity but the pericardium was enormously distended. I enlarged the opening in the pericardium to a distance of $2^{1}/_{2}$ inches and evacuated about 10 ounces of blood. The pulse immediately improved and was commented upon by Dr. L. D. Robinson, who so successfully and skillfully administered the chloroform. I had my brother, Dr. R. S. Hill, to pass his hand into the pericardial sac and bring the heart upward and, at the same time, steady it sufficiently for me to pass a catgut suture through the center of the wound in the heart and control the hemorrhage. I cleansed the pericardial sac with a saline solution and closed the opening in it with 7 interrupted catgut sutures. The pleural cavity was also cleansed with a saline solution and drained with iodoform gauze. On September 17 he commenced to improve and his recovery has been uninterrupted."

It is remarkable how innovative and how bold surgeons of that time must have been. It seems from the operative report that Dr. Luther Leonidas Hill may not have understood the anatomy of the heart sufficiently to describe even which portion of the heart contained the stab wound. Shortly after this remarkable feat, Hill published his results and a Professor Sherman wrote at that time, "The road to the heart is only 2 or 4 centimeters in a direct line, but it has taken surgery nearly 2,400 years to travel it." Apparently, Professor Sherman was dating his 2,400 years back to the time of Hippocrates, whereas in fact he could have used a time interval of some 800,000 or a million years, which is the current estimate for the origin of our species. The management of heart wounds continued to be at the forefront of progress in surgery of the heart, until the experiences of World War II saw the full maturation of this surgical endeavor.

In pursuing the topic of surgical treatment of cardiac trauma, we have skipped past another basic contribution to which we owe much and which occurred at the turn of the century. Alexis Carrel made a landmark achievement while an investigator at the Rockefeller Institute in perfecting the technique of anastomosis of small blood vessels.[6] It is this technique which has made many of the feats of modern surgery possible today. In fact, Carrel was able to transplant organs in animals even at that time since he had developed the ability to anastomose vessels of 2 mm. or so in diameter. Fortunately, Carrel was awarded the Nobel Prize in 1912 for these major contributions.

VALVULAR HEART DISEASE

Those ten years surrounding the turn of the century could well be regarded as the time of conception of cardiac surgery. In 1898 Samways suggested that the tightly stenotic mitral valve might be opened surgically, and then in 1902 another distinguished English physician, Sir Lauder Brunton, wrote in Lancet: "Mitral stenosis is not only one of the most distressing forms of cardiac disease, but in its severe forms it resists all treatment by medicine. On looking at the contracted mitral orifice in a severe case of this disease, one is impressed by the hopelessness of ever finding a remedy which will enable the auricle to drive the blood in a sufficient stream through the small mitral orifice, and the wish unconsciously arises that one could divide the constriction as easily during life as one can after death."[7] In the postmortem laboratory, this physician obtained heart specimens and showed that one could successfully incise the margin in order to enlarge the orifice.

Additional years passed but in Paris in 1913 Doyen operated on a 20-year-old woman believed to have congenital pulmonary valvular stenosis.[8] A valvulotome was passed into the right ventricle and by this means Doyen attempted to cut the leaflets of the pulmonary valve. Unfortunately, the patient died several hours later and at autopsy it was tragically found that the lesion was not in the valve at all but was the result of infundibular stenosis, and therefore this precocious surgical approach met with failure. The next year, 1914, Tuffier[9] attempted to dilate a stenotic aortic valve simply by invaginating the aortic wall with finger pressure, a technique which, not surprisingly, provided little promise. Such forays against acquired valvular heart disease continued, next in Boston at the Peter Bent Brigham Hospital by Cutler and Levine,[10] again dealing with mitral stenosis. Levine recognized that the medical treatment of these mechanical cardiac disabilities was less than ideal when he said at that time, "No one who has seen any number of young adults suffering from mitral stenosis and has watched them go through several attacks of cardiac failure, only to die finally after a lingering illness, can help being impressed with the inadequacy of medical treatment." After several years of study, on May 20, 1923, Cutler operated for the first time on an 11-year-old girl with severe mitral stenosis. He inserted a valvulotome into the left ventricle and attempted to cut both cusps of the stenotic valve. The patient survived but her improvement was questionable and she later succumbed to her illness. Soon afterward, in 1925, in England, Henry Souttar developed a pioneering alternative to the cutting procedure of Cutler when he introduced a finger into the left atrial appendage and split this stenotic valve with finger pressure alone.[11] His operation was successful and for the first time a soundly established technique was developed.

Surprisingly, little came of this until the mid 1940s when Charles Bailey, working in Philadelphia, again approached the mitral valve, this time again using a valvulotome.[12] The renovation of mitral commissurotomy is a starkly bold story, because of the several initial failures encountered. Yet, the achievement of success on June 10, 1948, using Souttar's finger-fracture technique, is a distinctly significant milestone. Six days later, and working independently, Dwight Harken also successfully accomplished a commissurotomy on a 27-year-old adult male with severe mitral stenosis.[13]

Despite the remarkable safety and effectiveness of mitral commissurotomy as a method of treatment for rheumatic mitral stenosis, early attempts to dilate the stenotic aortic valve or to reduce the severity of mitral or aortic insufficiency while the heart was functioning were not

significantly rewarding. The solution to these problems awaited the development of extracorporeal circulation and open heart surgery. But before advancing to that era, it is well for us to look backward again to the first glimmerings of the treatment of congenital cardiac disease.

CONGENITAL HEART DISEASE

Ligation of the patent ductus was urged by Munro of Boston in 1907.[14] Unfortunately, no patients with this condition were referred to him (or perhaps it was fortunate, since the development of thoracic surgery was so primitive at that time). Thirty years later, in 1937, John Strieder[15] of Boston examined an 18-year-old girl with bacterial endocarditis associated with a patent ductus arteriosus. He made the bold decision that closure of the ductus might cure the endocarditis. He closed the ductus successfully but the patient died on the fourth postoperative day. In another hospital in Boston, Robert Gross proceeded in the following year to be the first to close successfully a patent ductus arteriosus.[16]

It is striking how often unexpected surgical problems and complications give rise, through serendipity, to new procedures. A classical example of this relates to an operation performed by Professor Clarence Crafoord of the Karolinska Institute in Stockholm.[17] In an operation for closure of a patent ductus, Professor Crafoord accidentally tore the ductus and severe hemorrhage ensued. It became necessary to cross clamp the aorta in order to control the hemorrhage. The operation ended successfully and from this he knew that cross clamping of the aorta would not inevitably result in paraplegia or renal insufficiency. Thus, on October 19, 1944 he performed the first successful resection of a coarctation with re-anastomosis of the aorta. Apparently, Gross, working independently in Boston, soon did the same operation and the procedure became firmly established.[18]

Although there is a tendency to classify patent ductus arteriosus and coarctation of the aorta along with congenital cardiac lesions, in truth they are vascular anomalies rather than anomalies of the heart itself. Thus it was not until that historic operation on November 30, 1944, at the Johns Hopkins Hospital in Baltimore that the door was finally opened to the surgical management of congenital cardiac anomalies.[19] It is a fascinating chapter in the history of cardiac surgery to review this remarkable event.

One can turn to no better souce than Dr. Blalock's recounting of that episode as made some 22 years later.[20] He stated, "In 1938, while on the faculty of the Vanderbilt Medical School, Dr. Sanford Leeds and I became interested in pulmonary hypertension. It occurred to us that it might be possible to produce it experimentally by anastomosing a systemic artery to a pulmonary artery. The left subclavian artery was anastomosed to the left pulmonary artery. Much to our disappointment, pressure determinations performed after varying intervals showed little alteration in the pulmonary arterial pressure.

"In 1942, after having moved to Baltimore, I presented the results of these studies to Dr. Edwards A. Park and his staff, and this led to the work on coarctation to which I have referred. At the time I reported the work on coarctation to the pediatric staff, Dr. Taussig asked if I could devise a method for increasing the blood flow to the lungs in patients with pulmonic stenosis. Vivien Thomas, my superb technician, and I performed many experiments with this end in view." He goes on then to explain that they first needed to cause cyanosis in animals and then to do their now famous operation to correct the cyanosis. Still, many doubts remained until these were eventually relieved by the success of the initial procedures. Here again is a classic example of how alert minds, in approaching one problem, find openings to the solution of another. To quote again from Dr. Blalock, "My point is that unsuccessful attempts to produce pulmonary hypertension led ultimately to a method for treating many unfortunate patients with congenital heart disease."

Following this initial step in the treatment of intracardiac anomalies, several other extracardiac palliative procedures were developed, such as the Potts anastomosis,[21] the Brock pulmonary valvotomy,[22] and the Blalock-Hanlon technique for creating an atrial septal defect.[23] Furthermore, techniques to allow a limited type of open cardiac surgery evolved in the early

1950s, including the use of hypothermia whereby atrial septal defect, pulmonary stenosis and even aortic stenosis could be rapidly corrected during 6 minutes or so of circulatory arrest. Gross developed the ingenious technique of sewing a well onto an incision in the right atrium and then working by touch through the pool of blood that accumulated in the well.[24]

OPEN HEART SURGERY

The foregoing developments bring us to the threshold of perhaps the most significant advance in cardiac surgery, namely, the successful application of the techniques of extracorporeal circulation. For many years previously, physiologists had worked on methods for oxygenating the blood artificially. It was a surgeon, however, who came to realize that the heart-lung machine must be developed as an essential tool in the surgical management of patients with heart disease. The idea came to John Gibbon while watching a patient die with massive pulmonary embolism in 1931. A few years later he began work on the project, both in Philadelphia and in Boston, and ultimately found that it was possible to take over completely the cardiorespiratory functions. Gibbon, working at Jefferson Medical College in Philadelphia, first successfully employed the heart-lung machine to close an atrial septal defect.[25] Having achieved success for his goal of developing a clinically applicable heart-lung machine, Gibbon returned to the laboratory for other pursuits.

In 1953 and 1954, C. W. Lillehei and his associates at the University of Minnesota were the first to perform many types of open heart operations by means of cross-circulation provided by a volunteer whose body was used as the pump oxygenator.[26] The systematic use of a heart-lung machine in an ongoing series of clinical operations was pioneered by John Kirklin at the Mayo Clinic beginning on March 22, 1955.[27, 28]

In the quarter of a century that has elapsed since those historic events surrounding the first efforts at open heart operations, each of the various diseases of the heart has come under the scrutiny of cardiac surgeons and the great majority, indeed almost all, of these cardiac lesions have been alleviated to some degree by surgical intervention. In the field of congenital heart surgery the simpler isolated lesions first responded to surgical care, and the more complex lesions were confronted and overcome with varying degrees of success.

CORONARY ARTERY DISEASE

The historic development of operations for coronary artery disease is particularly fascinating and additionally holds significant implication with respect to the current status of this form of surgical endeavor.[29] The surprising feature is the interest and activity of surgeons in coronary artery disease so long ago. The first known proposal for an operation aimed at coronary artery disease was made in 1899 by Francois-Franck.[30] He proposed sympathectomy as a surgical treatment for angina pectoris, the objective, of course, being relief of pain. The first actual clinical operation of this type was in 1916 in Bucharest by Jonnesco, who performed bilateral extirpation of the cervical sympathetic chain and removal of both first dorsal ganglia.[31] His operation was apparently successful and the patient had marked relief of chest pain. From that historic operation there ensued a great many operative variations, each of which had the common purpose of relieving the pain of angina pectoris by cardiac denervation. There was a proliferation of procedures over the next decade which led Cutler, the same surgeon who was involved in mitral valve surgery, to complain in 1927 of "the tangled mess of operative procedures" which made it difficult to evaluate the effect of any given procedure. It was noted that about 75 to 85 percent of patients experienced relief of angina by the denervation procedures at an operative mortality rate of about 10 to 20 percent.

The next phase of coronary artery surgery was pioneered by a persevering surgeon from Cleveland, Claude Beck. He attempted to increase or redistribute the myocardial blood supply. Beck had noticed during an operation that cutting a band of adhesions compressing the heart resulted in brisk bleeding from each end of the transected adhesion. He did thousands