BASHORE

Invasive Cardiology

Principles and Techniques

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edited by

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PREFACE

We are in an era of unprecedented expansion of cardiac catheterization facilities. Cardiac catheterization involves a true team effort, with physicians and nonphysicians working closely together to obtain accurate and useful information for eventual patient management decisions. By addressing the needs of both physicians and nonphysicians in the cardiac catheterization laboratory, this book is meant to broaden the understanding of both groups. The physician will gain new insights into methodology and equipment, while the nurse and technologist will be given a broader view of analysis and interpretation. This interchange will be mutually beneficial.

Invasive Cardiology: Principles and Techniques presents the latest methodology in a "cookbook" fashion and includes chapters directly related to laboratory organization and patient flow. Other chapters review the basics of normal cardiac physiology and of abnormal cardiac disease states, with emphasis on interpretation. Specifics related to the efficient operation of both hemodynamic and radiographic equipment are outlined, and electrophysiology and interventional procedures are similarly described.

The list of contributors to this text includes a cross section of health professionals. The information herein is equally applicable to the training of resident physicians, nurse specialists, and technicians. Much space is devoted to helpful photographs and line drawings, but the reference list is intentionally limited to basic articles and reviews. It is anticipated that this textbook can be used to form the basis for a program of training personnel with widely divergent backgrounds in the proper performance of all invasive cardiovascular procedures.

Thomas M. Bashore, M.D.

To the diligent and compassionate staff of the Cardiac Catheterization Laboratory at Duke University Medical Center

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CHAPTER 1

Introduction and Historical Perspective

Thomas M. Bashore, MD

The striking increase in the number of cardiac catheterizations being performed in the United States has resulted in a need for a reference source for the personnel who staff and operate cardiac catheterization laboratories and clinics. This book is meant to respond to that need. Rather than focus on detailed pathophysiologic mechanisms, this text is intended to provide a foundation for the understanding of the basic principles involved in performance of the various catheterization procedures in a practical manner. Although the text undoubtedly reflects bias toward the methodologic procedures as performed at Duke Medical Center, it is hoped that its content will be applicable to the performance of catheterization procedures at any institution.

This manual has been prepared specifically with the help of the many nurses and technicians in the Cardiac Catheterization Laboratory at Duke Medical Center. The text and figures are meant to provide guidelines for the performance of cardiac catheterization in an efficient and safe manner. Line drawings and schematics are used whenever possible to explain major concepts. The theoretical basis of the pathologic disease states studied are emphasized only to the degree that is necessary for the understanding of the results of these studies. This text is an outgrowth of a yearly training session that the personnel in the laboratory attend. These individuals provided both the inspiration and the perspiration needed to bring this manual together.

Historical Perspective

Modern cardiac catheterization and angiography are rooted in three major medical discoveries: the development of radiographic and appropriate imaging equipment; the development of readily usable catheters and a safe means of cannulating the vascular system; and the discovery of a safe radiographic contrast medium. A brief review of these events may be of interest to the reader.

William Roentgen's discovery of the x-ray principle in 1895 quickly led to its application in humans. The first angiogram (of a human hand) was reported in 1896 by Haschek, and the beating heart was observed on fluoroscopy by Williams in 1896. It wasn't until the development of the 16-mm cinefilm camera by Stuart and colleagues in 1937 and the development of the modern film-roll changer in 1953 that cineangiography was able to develop. Most recently, digital angiography has started to be used in many of the laboratories around the country, and the future will undoubtedly see the routine use of the computerized storage of radiographic information in a digital format. It is equally likely that there will be a gradual shift from a cinefilm-based medium to a more computer-based digital-imaging format.

The first human catheterization procedure has been credited to Dr. Werner Forssmann in 1929. Over the protestations of his colleagues, Dr. Forssmann tricked an assistant, Nurse Gerda, into allowing him into the surgical suite, where she was able to provide access to the venipuncture instruments. He then inserted a urethral catheter into his own arm and walked to the basement of the hospital, where an radiograph was taken to demonstrate that the catheter was indeed in his heart.

By 1939, Klein and colleagues reported 11 human patients in whom cardiac output was measured using catheter techniques. Following this, the activity in catheterization suites during the 1940s dramatically increased, especially at the Bellevue Hospital in New York under the influence of Drs. Cournand and Richards. In 1956, Forssmann, Cournand, and Richards received the Nobel Prize in medicine for these efforts. Many advances occurred during the 1940s and 1950s. Left-heart catheterization provided the most formidable challenge. The left heart was first approached via left atrial puncture during bronchoscopy, by a posterior transthoracic puncture approach, by a suprasternal method, by a left subcostal technique, and via transseptal (transatrial septal) puncture. A practical method was finally devised by Seldinger in 1953 wherein a percutaneous needle was used to puncture the femoral artery, and the catheter exchanged over a guidewire. A modification of this method is in use today.

Cannulation of the coronary arteries, however, required the development of specialized catheter techniques. Radner, in 1945, is generally credited with being the first to visualize coronaries with radiographic contrast media. Sones and colleagues at the Cleveland Clinic described a practical method of selectively cannulating the coronary arteries in 1959. The Sones method utilized cutdown of the brachial artery for catheter insertion. Ricketts and Abrams, in 1962, suggested that a preformed catheter might be used from the femoral arterial approach. These catheters were subsequently modified by Judkins and Amplatz in 1967. Other modifications, such as those by Schoonmaker and King in 1974, are still in use. The Judkins approach is the most popular in the United States today.

In 1970, balloon-tip catheters were introduced that could be inserted

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without fluoroscopy by Swan et al. These catheters were then coupled to a thermal sensor so that thermodilution cardiac outputs could be measured along with pressures. Catheter designs changed only modestly in the 70s, until the advent of the interventional era. There is now a resurgence in catheter design and innovation.

The final step in the modern development of cardiac catheterization procedures required the development of a safe radiographic contrast agent. In 1931, Forssmann injected a bolus of Uroselectin into his right atrium and experienced only mild dizziness. Attempts at defining vascular structures using radiographic contrast have included the use of a variety of materials from the bizarre to the ridiculous, including buckshot, air, bismuth and oil, and potassium iodide. In the 1950s, a tri-iodinated benzoic acid contrast medium was developed that substantially reduced contrast reactions, diatrizoate. The 1980s has seen the introduction of nonionic and low-ionic media that have been shown to have even fewer side effects than the ionic diatrizoate compounds that have become standard.

The Future

The future of cardiac catheterization laboratories appears bright. Not only has catheter size been reduced and safety improved, but the innovative new designs in catheter function will allow for improvement in the current techniques of myocardial biopsy, angioplasty, and valvuloplasty. These innovations in catheter function provide hope that there may be an expanding role for laser technology to "vaporize coronary plaques," atherectomy devices to remove obstructing lesions, and stents to hold the vessels open.

We are probably only seeing the beginning of a marked improvement in our ability to utilize catheter techniques in the study and treatment of cardiac diseases. New catheters are also being developed for intraluminal angioscopy, two-dimensional echocardiography, and the measurement of flow velocity via either thermodilution, impedance, electromagnetic, or Doppler velocity methods. Intracardiac sensors are being placed on catheters to monitor metabolic changes, pO_2, or pH. We clearly are in an era in which the safety of catheterization has been well established, and we will see a marked evolution in techniques over the next two decades. The cardiac catheterization laboratory promises to be a dynamic setting for the study of patients with cardiac disease.

SELECTED REFERENCES

Amplatz K, Formanek G, Stanger P, et al. Mechanics of selective coronary artery catheterization via femoral approach. Radiology 1967; 89: 1040.

Brannon ES, Weens HS, Warren JV. Atrial septal defect: Study of hemodynamics by the technique of right heart catheterization. Am J Med Sci 1948; 210:480.

Brock R, Milstein BB, Ross DN. Percutaneous left ventricular puncture in the assessment of aortic stenosis. Thorax 1956; 11:163.

Cope C. Technique for transseptal catheterization of the left atrium: Preliminary report. J Thoracic Surg 1957; 37:482.

Cournand A. Cardiac catheterization: Development of the technique, its contribution to experimental medicine, and its initial application in man. Acta Med Scand [Suppl] 1978; S79:7.

Dexter L, Haynes FW, Burwell CS, et al. Studies of congenital heart disease: II. The pressure and content of blood in the right auricle, right ventricle and pulmonary artery in control patients, with observations on the oxygen saturation and source of pulmonary capillary blood. J Clin Invest 1947; 26:554.

Forssmann W. Experiments on myself: Memoirs of a surgeon in Germany. New York: Saint Martin's Press, 1974: 84.

Gorlin R, Gorlin G. Hydraulic formula for calculation of area of stenotic mitral valve, other cardiac valves and central circulatory shunts. Am Heart J 1951; 41:1.

Gruentzig A, Sennìg A, Siegenthaler WE. Nonoperative dilatation of coronary artery stenosis: Percutaneous transluminal coronary angioplasty. N Engl J Med 1979; 301:61–68.

Haschek E, Lindenthol O. Ein Beitrag zur proktischen Verwerthung der photographie noch Röntgen. Wien Klin Wochenschr 1896; 9:63.

Judkins MP. Selective coronary arteriography: I. A percutaneous transfemoral technic. Radiology 1967; 89:815.

Klein O. Zur Bestimmung des Zerkulatorischen Minutens Volumen nach dem Fickschen Prinzip. Munch Med Wochenschr 1930; 77:1311.

Mason JW. Techniques for right and left ventricular endomyocardial biopsy. Am J Cardiol 1978; 41:8874.

McKay RG. Balloon valvuloplasty for treating pulmonic, mitral and aortic valve stenosis. Am J Cardiol 1988; 61:102G.

Miller SW. History of angiocardiography. In: Miller SW, ed. Cardiac angiography. Boston: Little, Brown & Co., 1984:3.

Radner S. Attempt at roentgenologic visualization of coronary blood vessels in man. Acta Radiol 1945; 26:497.

Rashkind WJ. Transcatheter treatment of congenital heart disease. Circulation 1983; 67:711.

Ricketts HJ, Abrams HL. Percutaneous selective coronary cinearteriography. JAMA 1982; 181:140.

Rigler LG, Watson JC. A combination film changer for rapid or conventional radiography. Radiology 1953; 61:77.

Seldinger S. Catheter replacement of the needle in percutaneous arteriography: A new technique. Acta Radiol 1958; 39:368.

Schoonmaker FW, King SB III. Coronary arteriography by the single catheter percutaneous femoral technique. Circulation 1974; 50:731.

Simpson JB. Future interventional techniques. In: Califf RM, Mark DB, Wagner GS, eds. Acute coronary care in the thrombolytic era. Chicago: Year Book Medical Publishers, 1988: 392.

Sigwart V, Piel J, Mirkovitch J, et al. Intravascular shunts to prevent occlusion and restenosis after transluminal angiography. N Engl J Med 1987; 316:701.

Spears JR, Spokojny AM, Marais J. Coronary angioscopy during cardiac catheterization. J Am Coll Cardiol 1985; 6:93.

Stewart WH, Hoffman WJ, Ghiselin FH. Cinefluorography. Am J Roentgen 1970; 38:465.

Swan HJC, Ganz W, Forrester JS, et al. Catheterization of the heart in man with use of a flow-detected balloon-tipped catheter. N Engl J Med 1970; 283:447.

CHAPTER 2

The Cardiac Catheterization Suite

Mary Jane McCracken, RN, and Mary Jo Chapman, RN

Among the most important components of an efficient and smooth-running catheterization laboratory (or cath lab) are laboratory design, patient flow, and a well-trained and integrated staff. Other factors that enhance the operation of a cath lab are sufficient and well-placed technical components, technical backup, and an administrative network that will guarantee that the mission of the unit can be carried out with a minimum of stress to the patient and a maximum utilization of the expertise of the personnel. If these parameters can be met, the cath lab will be successful and its environment will be a pleasant and rewarding place in which to work. Efficient organization and personnel integration also make a clinical cath lab an excellent teaching vehicle for the training of medical, technical, and administrative staff.

Laboratory Design

At the center of activity and the focal point of information flow in the laboratory is a large, centrally located board that outlines the daily and hourly operation of the lab (Fig. 2–1). After the last patient has arrived in the cath lab suite and is prepared for catheterization, this board is prepared for the next day's caseload. As much information about the patient as possible is included on this scheduling board, including the patient's name, diagnosis, attending physician's name, cathing physicians' names (and that of the cardiovascular fellow assigned, if applicable), the patient's hospital room number, and hospital control number. Any deviation from the routine left-heart diagnostic procedure (e.g., left groin, right heart, transplant candidate, valvuloplasty, and so on) should also be written next

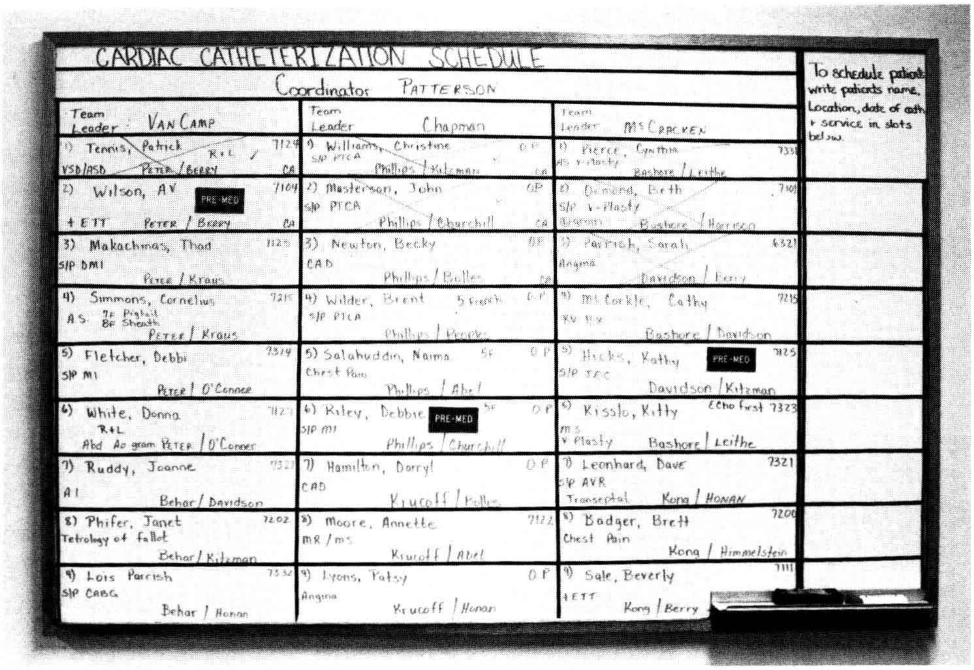

Figure 2–1. Representative scheduling board.

to the patient's name to alert the staff. This board should provide an up-to-the-minute status report on every patient as he comes through the lab. A cath-lab designate should control the board, updating it at every step in the patient's progress through the lab. Appropriate check marks or magnetic tags provide confirmation that the patient has been premedicated, has been sent for, has arrived in the lab, and has been discharged from the lab.

The cath-lab procedure itself is performed in a room with a functional area of at least approximately 750 square feet (minimum length is 25 feet and width 15 feet) (Fig. 2–2). Ancillary equipment (catheter racks, cabinets, shelf space, linen, sink, counter space, crash cart, and so on) is located around the perimeter of the room to allow for ease of movement around the angiographic table.

Control rooms that protect the technician from radiation exposure are now commonly in use in most institutions. Separate clear-glass shields may be used in the room to protect employees who must remain in the lab itself. Computer flooring in the control room is a valuable adjunct, as it raises the technician above the level of the procedure-room floor. The computer flooring allows for ready access to the myriad of cables and ducts that connect the control room to other areas of the cath lab. The control technician is in hard-wired headset communication with the physician at all times and monitors the patient's status during the procedure. He should be positioned so he has ready access to the x-ray console, the hemodynamic monitor, and the playback tape. The primary monitor-

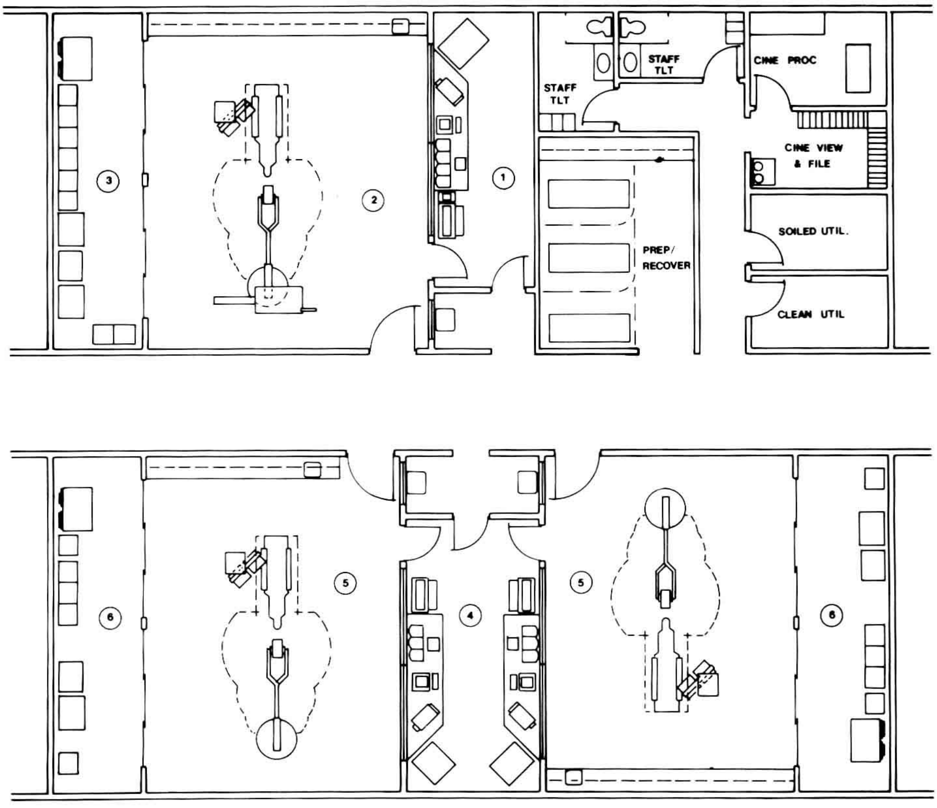

Figure 2–2. Representative floor plan for a traditional cardiac catheterization suite with single-plane x-ray equipment. A separate control room is shown in the top panel, and a shared control room is shown in the bottom panel. The need for a scrub area at the entrance to the control room is questionable nowadays; likewise, the reduction in the size of x-ray equipment makes large equipment rooms less necessary.

ing functions include keeping the procedure protocol, pressure recording, ECG monitoring, videotape playback, digital imaging control (if available), and x-ray control functions. The minimum area for a control room should be approximately 80 to 100 square feet.

From the standpoint of radiation safety, there are major advantages to having the control room isolated from the main cath lab and its x-ray equipment. A large leaded-glass window should be used to keep visual contact with the proceedings in the catheterization procedure room. In general, the physician should be on the opposite side of the table from the control room so that eye contact with the technician is possible. (This setup may not be feasible in some situations.)

The electronic switching cabinetry, generator, tetrodes, and so forth are best kept in a separate equipment room when possible, although recent advances have made these items less susceptible to heat and have somewhat reduced the need for separate cooling from the procedure room. Digital angiographic equipment also is best kept in an environmentally controlled room. All of these items produce considerable heat (Table 2–1).

The laboratory should also have adequate storage space for catheters, contrast media, film-processing supplies, manuals, and other extra equipment. The amount of storage is obviously dependent upon the volume in the cath lab. It is almost impossible to have "too much" storage space.

Whenever possible, film developing is best located within the catheterization area. This area should include space for viewing and splicing films and a darkroom for film development. Included in the darkroom is the film processor, an area for loading and unloading film, the chemistry for the processor, water feeds and drainage, and a silver recovery unit (these items are discussed in Chapter 4). A separate area for film storage should be close by with easy access. Some form of record to log the checkout of films should be provided to assist in what is one of the biggest headaches—the tracking of cinefilm location. In our own laboratory, a computer-generated name tag is used, and color-coded labels (changed each month) help prevent the misplacement of film in the wrong month's rack. Keeping track of cinefilm in a busy department remains a challenge for everyone.

Each laboratory should have a cinefilm viewing room. Both back-projection and screen-projection cinefilm viewers are available. This room frequently can double as a conference or teaching room or can be used for final dictation or entry of the report. In our institution, the reports are entered directly into a

TABLE 2–1
"Generic" Outline of Commonly Used X-ray Equipment, Their Weights, and the Amount of Heat Generated.

Item	Weight	Heat Generated (BTU/hr)
Control Room		
Bi-plane control desk	216 lb	850
Digital imaging viewing equipment	313 lb	5455
Physiologic monitoring equipment	1200 lb	3700
Data management system	500 lb	4200
Biplane Cath Lab		
AP gantry and x-ray	2646 lb	6169
X-ray table	700 lb	375
Quad monitor suspension	330 lb	1700
Lateral gantry and x-ray	1213 lb	480
Equipment Room		
Tetrode tank	1188 lb	3910
Transformer	1716 lb	1020
Rack cabinet(s)	300-816 lb	300-3060
Digital imaging interface rack cabinet	419 lb	3414
Digital imaging control cabinet	1544 lb	15365

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