



Perioperative Management in Cardiothoracic Surgery

Benson B. Roe, M.D.

PERIOPERATIVE MANAGEMENT IN CARDIOTHORACIC SURGERY

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To my residents in thoracic surgery

PREFACE

This text, written primarily for the qualified trainee in cardiothoracic surgery, is intended to provide a condensed and practical approach to the problems associated with management of the thoracic surgical patient. The material is presented as it relates to the specialty as a whole, rather than to individual diseases or operative procedures. No attempt has been made to annotate the enormous volume of current literature encompassing the subject matter of this book. The material conveys the essence of 36 years of personal experience, enhanced by familiarity with practices across the country; that experience spans the treacherous developmental years of cardiac surgery and the refinement phase of thoracic surgery. I hope this book will be readable and will provide perspective and consolidation.

My preceptors, Edward D. Churchill and Richard H. Sweet, pioneers in thoracic surgery, and J. Gordon Scannell, chief resident at Massachusetts General Hospital when I was a resident there, have my endless gratitude for inculcating in me the spirit of honest and critical evaluation and continuous attention to detail that I have attempted to impart to this work.

Each of the thoracic surgery residents at the University of California, to whom this book is dedicated, shared a segment of the experience on which it is based. I am indebted to every one of them for their individual contributions to the development of the subject matter and for their candor in constructive criticism of my methods. To my colleagues with special expertise in related fields who have contributed certain chapters go my profound thanks; without their help this text would have been incomplete.

I am grateful for the generous hospitality of the Cardiothoracic Institute of London, and particularly to Mr. Donald Ross, who provided the space and facilities that enabled me to complete this work. Viewpoints and criticisms of various chapters were generously offered by members of the Institute, including Dr. Endre Bonar and Dr. Richard Emanuel. Observations of the practices at the National Heart Hospital in London and at other hospitals in the United Kingdom, France, and Spain supplemented my principal experience at the University of California Hospitals in San Francisco.

The editorial and secretarial staffs who labored over the technical aspects of putting the pieces together, in particular, Beverly Hill, Elizabeth Winckler, Sheila Finnigan, Jan

PREFACE

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PERIOPERATIVE MANAGEMENT IN CARDIOTHORACIC SURGERY

Notice

The indications and dosages of all drugs in this book have been recommended in the medical literature and conform to the practices of the general medical community. The medications described do not necessarily have specific approval by the Food and Drug Administration for use in the diseases and dosages for which they are recommended. The package insert for each drug should be consulted for use and dosage as approved by the FDA. Because standards for usage change, it is advisable to keep abreast of revised recommendations, particularly those concerning new drugs.

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1. PREOPERATIVE SCREENING AND PREPARATION

A patient who is scheduled to undergo a thoracic operation, particularly cardiac surgery, requires more critical assessment and more meticulous preparation of his cardiopulmonary function than the patient whose operation will not directly impose an insult on the heart or lungs. In that sense, the risk or the "cost" of most thoracic procedures is disproportionately high and a greater responsibility rests with the surgeon who undertakes them. While abundant experience and modern techniques can now provide remarkably safe conduct even for those with severely impaired cardiopulmonary function, the imprudent or unnecessary foray into murky waters is to be deplored, particularly if functional improvement or prolongation of life from the operation is doubtful. Conversely, however, most cardiac operations and many thoracic procedures are likely to result in immediate symptomatic or physiologic benefit; hence, there tend to be high values on both sides of the cost-benefit ratio.

FUNCTIONAL CAPACITY TO TOLERATE OPERATION

The outcome of any operation performed with technical proficiency is largely determined by the patient's functional reserve and his ability to tolerate the operative insult, balanced against the anticipated functional benefits to be derived from a corrective procedure. In cardiothoracic disease these factors are usually complex and almost impossible to evaluate precisely; therefore, they must be estimated from experience [18]. The safest decisions in the marginal patient will result from the combined judgment of surgeon, anesthetist, cardiologist, and pulmonary physiologist, each of whom may interpret the available data differently or may suggest additional measurements to aid in the assessment. Forethought to the potential difficulties and their options for management will help avoid the chances of disaster.

FUNCTIONAL PATHOLOGY

Preoperative impairment of vital functions and the physiologic insult produced by the planned operative procedure together form the principal basis for postoperative morbidity and mortality. Some, but not all, aspects of impairment can be measured and projected. Unless there is clinically obvious reduction of functional capacity it is

1. PREOPERATIVE SCREENING AND PREPARATION

recommended that screening studies include only basic pulmonary function tests (see Pathological Anatomy), exercise tolerance, and cardiac output.

PATHOLOGICAL ANATOMY

When cardiac surgery is contemplated, the functional pathology and the operative plan must be established from the diagnostic studies. Evaluation and decision based on operative findings have proved to be treacherous. Surgical exposure is restricted and visualization in the collapsed, empty heart can easily mislead the operator about the presence or severity of functional pathology. Ventricular septal defects can be multiple and obscure; anomalous or fistulous pathways may be difficult to identify. Pathological anatomy of a valve often correlates poorly with functional performance; the effective orifice is not likely to be what is seen in the collapsed heart nor what can be forcibly created by a finger or instrument. External localization of critically obstructive lesions in coronary arteries is obscured by the diffuse character of the atherosclerotic process. Pulmonary lesions may be multiple and bilateral and sometimes are difficult to locate surgically when lying centrally in the pulmonary parenchyma. Mediastinal extension of pulmonary malignancy should not require thoracotomy to diagnose.

It is, therefore, axiomatic that safe and effective thoracic surgery cannot be performed without accurate, reliable, and unmistakable diagnostic studies. The surgeon subjects his patient to unjustifiable risk if he cannot be personally satisfied that the studies are of sufficient quality and validity to remove uncertainty about the appropriate procedure, or if he believes that reliable decisions can be made on the basis of operative findings. He must also be certain about the absence of associated pathology which could jeopardize the outcome or require simultaneous attention.

CONTROLLABLE FACTORS AFFECTING OPERATIVE MORBIDITY AND MORTALITY

CARDIAC DYSFUNCTION

IMPAIRED OUTPUT. Failure to deliver a normal or adequate circulatory flow may result in deficient vital organ perfusion or even lead to circulatory collapse when compounded by a slight volume deficit. If this low output state is temporary or remediable, patients can be provided with more effective organ perfusion during the immediate pre- and postoperative state either by mechanical circulatory assistance from intra-aortic balloon pumping (in the absence of significant aortic valve regurgitation) [8, 14], or by lowering resistance with afterload reducing drugs (in the absence of aortic valve obstruction) [2]. (See Chapter 6.)

ARRHYTHMIAS. Disturbances in the regularity or rate of cardiac contractions may be hazardous or functionally embarrassing. Appropriate drugs for prevention and manage-

ment of these arrhythmias are discussed in Chapter 7. Tachycardia (particularly in the presence of impaired ventricular filling) may significantly reduce cardiac output and should be treated with cardiac glycosides or propranolol before proceeding with operation. Bradycardia, if critical, should be managed with a temporary transvenous endocardial pacemaker before operation and by a surgically implanted pacemaker electrode in the postoperative period [13].

DRUG MANAGEMENT. Certain drugs may have an adverse or dangerous effect during operation and should be discontinued or neutralized preoperatively (see Chapter 7):

1. *Cardiac glycosides* should be withheld at least 24 hours preoperatively in patients for open-heart surgery because of the frequent occurrence of hypokalemia following extracorporeal circulation. The augmentation of cardiac irritability by the combination of digitalis and hypokalemia leads to a high incidence of ventricular fibrillation which may not respond to electrical depolarization [19].
2. *Propranolol* reduces myocardial contractility and hence may, at least in theory, critically compound any pre-existing or surgically induced myocardial deficiency. It should, therefore, preferably be discontinued 12 to 18 hours preoperatively. Experience has demonstrated, however, that those patients who required high doses of propranolol to control their crescendo angina while being prepared for operation seldom experience significant functional difficulty in coming off the pump or during the postoperative period [22].
3. *Anticoagulants* to control preoperative thromboembolism may cause troublesome surgical bleeding if not discontinued preoperatively (see Chapter 21). The relatively small risk of withdrawing Coumadin 2 or 3 days prior to operation is usually deemed to be inconsequential, but when an embolic threat is thought to be serious it is preferable to discontinue Coumadin for at least 4 days and maintain the patient on intravenous heparin (10,000 units IV) to the day of operation and reversing its effect with last minute protamine [12].
4. *Aspirin* and *dipyridamole* (*Persantine*), though not classified as anticoagulants, are frequently administered for their effect on diminishing platelet adhesiveness, either as a supplement to or as a substitute for Coumadin anticoagulation. Aspirin may also be taken regularly for arthritis or other painful inflammatory disease. Surgical experience has demonstrated frequent and severe incisional bleeding in patients who have had long-term aspirin intake, and therefore withdrawal of these drugs for 7 days or more before operation is strongly recommended [16]. (See Chapter 5.)
5. *Diuretics* in the management of congestive heart failure should preferably be reduced or discontinued early enough to assure that the patient is not hypovolemic during induction of anesthesia [20]. One of the contributors to the high mortality of early open-heart surgery was overzealous "preparation" resulting in unrecognized preoperative hypovolemia. If for any reason diuretics have not been discontinued it is important to have adequate volume augmentation on hand to deal either with the hypotension, which is likely to occur on induction of anesthesia, or with the disappearance of priming volume, which will occur on initiating cardiopulmonary bypass.

1. PREOPERATIVE SCREENING AND PREPARATION

PULMONARY DYSFUNCTION

VENTILATORY CAPACITY EVALUATION. Projecting a patient's functional capability to tolerate a major operative procedure without causing significant immediate postoperative respiratory embarrassment or ultimate respiratory disability may be difficult, particularly when the procedure will remove functioning lung or will burden the pulmonary circulation [7]. The following tests are useful in making this evaluation [11, 15, 17, 21, 23]:

1. Measurements of percent predicted vital capacity, maximum inspiratory force, maximum minute ventilation (MMV), and resistance and compliance provide a measurement of comparative function from which respiratory disability or embarrassment can be projected [10]. In addition, Boushy and associates found that the volume of air delivered in the first second of forced expiration ($FEV_{1.0}$) correlated with postoperative insufficiency when it measured below 2.0 [4]. Others have shown predictive value in the MMV. It should be emphasized, however, that these measurements are frequently invalidated by the patient's misleading performance; he may not have been adequately instructed about the test objective or he may simply lack the incentive to perform maximally, thus providing deceptively poor values.
2. Exercise tolerance, as judged from the crude test of walking up a hospital stairway, proves to be at least as reliable as the measurements of ventilatory volume. I have done pulmonary resections without serious consequence on patients with less than 30 percent of predicted ventilatory values but who easily climbed one or two flights of stairs.
3. Blood gas determinations will demonstrate respiratory acidosis, CO_2 retention, or hypoxia. Arterial blood CO_2 tensions above 55 mm Hg and O_2 tensions below 60 mm Hg are predictive of severe respiratory insufficiency postoperatively.
4. Ventilation-perfusion scan will reveal areas of deficient aeration or impaired circulation. If these areas coincide with the segments of lung to be resected the projected disability will be reduced; whereas if postoperative function must be maintained by impaired lung the outcome could be disastrous [5].
5. Pulmonary artery pressure will reveal pulmonary hypertension. A mean pressure of greater than 36 mm Hg after ligation of one pulmonary artery has been reported as a predictor of inability to tolerate pneumonectomy [7]. Unilateral temporary pulmonary artery occlusion with a balloon catheter is a useful preoperative test, not only to determine the probable postoperative pressure but also to ascertain the capability of the remaining lung to oxygenate the total cardiac output.

DEFICIENCY IMPROVEMENT. Training in respiratory dynamics and coughing will result in an increased ventilatory capacity for most patients. Tussic agents which promote bronchorrhea are helpful in clearing viscous or tenacious bronchial secretions. Bronchial dilators relieve the element of obstruction caused by spasm. Various commercially available gadgets provide the patient with training and incentive to improve ventilatory velocity. Ventilatory volumes frequently can double their percentage of the predicted value

in a week or 10 days of vigorous therapy, transforming the patient's status from inoperable to operable. Personal attention to detail and encouragement of patient incentive are key elements in the success of such a program.

EFFECTS OF SMOKING. Heavy cigarette smokers have a combination of impaired bronchial ciliary activity, abnormal secretions, and varying degrees of emphysema and chronic bronchitis. The risk of respiratory complications is significantly higher in these patients than in the nonsmoker. If patients can be persuaded to stop smoking a month or more prior to operation, it is very likely that their postoperative problems will be diminished, although short term abstinence is of doubtful value.

RENAL DYSFUNCTION

Renal insufficiency can be protected from exacerbation during operation by meticulous maintenance of total body perfusion. It is doubtful, however, that pharmacologically induced diuresis preoperatively or intraoperatively will prevent the progression of renal damage except under certain circumstances involving tubular obstruction. In fact, diuretics have been reported to compound ischemic renal damage [20]. (See Chapter 13.)

NEUROLOGIC DYSFUNCTION

Neurologic deficits that result from impaired circulation to the brain or spinal cord can similarly be protected from exacerbation by maintenance of satisfactory perfusion pressures. Patients with history (transient ischemic attacks) or physical findings (carotid bruit) suggestive of impaired circulation to the central nervous system should have appropriate angiographic evaluation and neurologic consultation to consider the desirability of corrective vascular procedures prior to or simultaneously with the planned thoracic operation [9]. Alternatively protective measures (hypothermia or shunts) during operation may be desirable if perfusion of the central nervous system is likely to be jeopardized by the planned operation.

HEMATOLOGIC DISORDER

Disorders of the blood which may result in troublesome or fatal postoperative bleeding or which could trigger intravascular coagulation (cold agglutinins) are worthy of careful consideration [6, 7]. It is notable, however, that routine exhaustive screening for coagulation defects has seldom, if ever, yielded information which correlates closely with clinical experience, other than thrombocytopenia and prolonged prothrombin time. Neither prospective nor retrospective studies have identified the conditions which lead to postoperative bleeding. The one factor that does correlate better than any clinical test is a history of repeated abnormal bleeding. While such a discovery should certainly be heeded, there is no evidence that it justifies cancelling the procedure and no preventive measures have been clearly established to reduce operative bleeding in this circumstance.

1. PREOPERATIVE SCREENING AND PREPARATION

NUTRITIONAL DEFECT

Nutritional or vitamin deficiency, or both, can cause multiple complications such as prolonged bleeding, impaired healing, and infection from a depressed immune response [1]. A negative nitrogen balance results from the anorexia associated with chronically impaired cardiac output (cardiac cachexia) and with advanced malignancy. While the underlying disease process frequently makes nutritional rehabilitation impossible, the trend can be reversed with considerable benefit by nasogastric intubation and instillation of appropriate feeding formula or by intravenous hyperalimentation [3]. The relative benefit of these measures versus prompt surgical correction of the causative factor is a difficult clinical judgment which must be individualized. The busy and impatient surgeon, however, is less likely to recognize the potential value of correcting malnutrition than he is to concentrate on the benefit of surgical intervention.

PSYCHOLOGIC DISORDER

The attitude of a patient – his confidence, his will to live, his determination to get back to normal activity – plays an important role in his recovery and deserves the serious attention of the surgeon. Careful and complete explanation of the surgical plan and its alternatives is not only helpful in establishing confidence but also is a medico-legal responsibility. Demonstration of facilities, monitors, and apparatus which the patient will encounter helps to assuage fear and to promote cooperation. Explanation of possible complications, reassurance about incisional integrity, expression of understanding about pain and its treatment are all important in dealing with possible postoperative psychoses or hostilities (see Chapters 15 and 17).

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