Post-operative Cardiac Care

M. V. BRAIMBRIDGE
M.A. M.B. F.R.C.S.
Senior Lecturer, St. Thomas's Hospital Medical School
Hon. Consultant, St. Thomas's Hospital, London
Late Senior Registrar, Hospital for Diseases of the Chest, London

AND

P. E. GHADIALI
M.B. B.S. F.R.C.S.
Senior Surgical Research Assistant
The Brompton Hospital, London

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Preface

As surgery of the heart has continued to achieve greater success with more complex cardiac lesions, so those involved in post-operative management have had to deal with patients who have been more sick before operation, who have undergone more elaborate surgical procedures and who are at risk from more post-operative complications. Successful post-operative management can only be a sequel of successful pre-operative diagnosis and operative technique, but patients are still lost because correctable complications have passed undiagnosed until their effects have become irreversible.

The justification for writing a book on the post-operative management of purely cardiac cases is the relative ignorance of the special problems that follow major cardiac surgery on the part of junior staff, who may otherwise be well versed in the care of general surgical patients. Basically this book is designed for resident surgical, anaesthetic and nursing staff, who are confronted with problems covering a wide field, and who need a practical manual about why complications occur, how they may be recognized and what exactly can be done to correct them.

Sections of each chapter are therefore devoted to the physiological and pathological background of the clinical problems, and the assessment and treatment of each are considered in detail. For the sake of clarity in such a practical manual for junior staff, references to the literature have been omitted from the text and collected at the end of each chapter.

Malfunction of the cardiovascular system necessarily involves all the other systems of the body and a working knowledge of specialties outside the cardiac field has proved to be essential and accounts for the space allotted to respiratory, renal and cerebral pathology.

One or both of us have been directly involved since 1957 in the detailed management of post-operative cardiac patients: at Stanford University Hospital (now the Presbyterian Medical Center, San Francisco) with Dr Frank Gerbode who initially stimulated our interest in this subject; at the Hammersmith Hospital with Mr W.P.Cleland

M.R.C.P F.R.C.S. and Professor H.H.Bentall F.R.C.S at the Brompton Hospital with Lord Brock, M.S. P.R.C.S., Mr O.S.Tubbs F.R.C.S., Mr W.P.Cleland M.R.C.P. F.R.C.P. and Mr M.Paneth F.R.C.S. at the London Chest Hospital with Sir Thomas Holmes Sellors D.M. ch.M. F.R.C.S. and Mr J.R.Belcher M.S. F.R.C.S., and at St Thomas's Hospital. This book is a synthesis of the experience gained during these years, which could not have been progressive without the considerable help and encouragement of these surgeons, and which we gratefully acknowledge.

M.V.B.
September 1965 P.G.

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Mr Brandon and the Photographic Department of St Thomas's Hospital, and Mr Vince and the Photographic Department of the Royal Marsden Hospital took the photographs and we would like to express our gratitude to them.

We would also like to thank Miss J.Dewe, medical artist, St Thomas's Hospital, who drew the diagrams, and Miss N.Banks and Miss M.Gover, who patiently typed and retyped the manuscript.

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CHAPTER 1

Introduction

In order to define the problems of post-operative cardiac care, it is necessary to consider what is meant in the present context by the terms cardiac patient, post-operative period and care.

A cardiac patient is loosely defined as one who has undergone surgery of the heart or great vessels in the thorax. Such patients differ from each other and from general surgical cases by virtue of the nature and severity of their lesions, the operative techniques used and the involvement of other systems.

The nature of the lesion from which the patient suffers affects the post-operative management profoundly. The patient with a simple persistent ductus arteriosus, atrial septal defect or mitral stenosis represents one end of the scale, allowing reasonably confident prediction of a smooth post-operative course, whereas patients who have undergone surgery for aortic or mitral incompetence, Fallot's tetralogy or pulmonary hypertensive left to right shunts lie at the other end of the scale and require intensive and skilled post-operative management to prevent unnecessary mortality. The severity of the individual lesion, with the concomitant damage of myocardium or pulmonary vasculature, will also affect post-operative management, which must be more stormy in the presence of cardiac failure or a raised pulmonary vascular resistance.

The operative technique used in correction of the cardiac lesion affects the post-operative course to some extent. The patient who has required no artificial means of maintenance of the circulation during operation will usually need less attention than one whose circulation has been interrupted for prolonged periods. The use of moderate (30°C) hypothermia with circulatory interruption for less than 10 minutes carries fewer inherent post-operative complications than profound hypothermia with circulatory arrest for an hour or the pump oxygenator with artificial circulation for two, three or four hours. The operative technique cannot be divorced from the nature of the lesion however, because the more complicated defect needs more time to correct it and hence more sophisticated methods.

The third characteristic of the cardiac patient is the facility with which other systems are affected by alterations in the cardiovascular

state. The function of the brain, lungs, kidneys, liver and other vital organs is dependent on an adequate nutrition, and will fail if the blood flow and pressure are compromised.

The post-operative period is the continuation and reflection of pre-operative and operative management, and may be defined as beginning when the last stitch is placed in the patient's skin. An interim period then follows as the endotracheal tube is removed, and the patient breathes on his own. He is transferred from the operating table to his bed, and handed over to ward nurses who escort him back to the recovery room or intensive care area and adjust his position, chest drainage and necessary measurements. This interim period may involve half to three-quarters of an hour and is a period when the tension and tedium of the operation are relaxed and the patient may receive somewhat cursory supervision by medically qualified staff. It can be a critical period for a patient who is re-establishing spontaneous respiration, and whose blood pressure, pulse rate and other parameters will not be accurately assessed until he is stabilized in the recovery room. In seriously ill patients, a compromise is to transfer the patient still anaesthetised.

The immediate post-operative period which concerns the greater part of this book is the next 48 hours, as it is during this time that the majority of acute complications occur, and during which skilful management can make the difference between success and failure. Complications may occur after 48 hours but they are usually less acute, amenable to medical management or simply those associated with any thoracotomy.

The third necessary definition is what constitutes care of a cardiac patient during the post-operative period. Care may conveniently be subdivided into basic nursing, accurate assessment of the cardiovascular state of the patient and the prevention and treatment of complications.

The modern scientific and physiological approach to surgery that has made the advances in treatment of cardiac abnormalities possible has also devalued basic nursing, which plays such a large part in maintaining the patient's mental and physical well-being. Simple measures for his comfort can be neglected because of the plethora of scientific commitments thrown on trained recovery room nurses which allows them no time to nurse in the accepted sense. Under basic nursing care can perhaps be included the proper preparation of the patient and his relatives for the ordeal ahead, and the avoidance of loud, brightly lit conferences at all hours around a conscious patient's bed.

The main theme of this book is that there is no substitute for continual and accurate assessment of the patient's condition during the

initial post-operative period. Deterioration can be insidious, rapid and become irreversible if not quickly corrected. There is no place for a laisser faire attitude in the management of cardiac patients if operative mortality is to be reduced to its minimum. The degree of intensity of assessment necessary is judged from the pre-operative and operative findings and manipulations, with a simple regime for straight-forward cases but a comprehensive scheme in the difficult case that will place in the hands of the medical staff enough data to enable them to tell at any given time which, if any, of the patient's systems is deteriorating and what is the urgency of treatment.

Prevention of complications is feasible if such a regime of assessment is followed, because deterioration is diagnosed early enough for simple measures of correction to be effective. Treatment of complications is also facilitated because they are discovered accurately and soon and specific therapy begun.

The book is designed as a practical manual for those immediately concerned in post-operative cardiac management—registrars, house officers and recovery room nurses—to aid them in the collection of data, interpretation of findings and management of complications. It has been divided into sections by systems, partly for ease of description and partly because it is a positive help to consider individual systems in turn when simultaneous deterioration of several systems confuses recognition of the primary complication.

Having defined the problem of post-operative cardiac care, and the object of writing this book, it would be wise to define what it is not. It is in no sense designed to supplement books on medical management of cardiac problems. Routine medical treatment and detailed dosages of drugs are omitted for the sake of brevity except where they form an essential part of the post-operative management. Exhaustive references to the literature have also been omitted from the text for ease of reading in such a practical manual and the relevant articles collected at the end of each chapter. The physiological background of each complication is considered in only enough detail to make the clinical presentation clear. Finally, familiarity with thoracotomy management is assumed and no space has been assigned to details of underwater seals, pleural complications and the like.

CHAPTER 2

Intensive Care Area

An intensive care area is an essential part of cardiac surgical management, allowing concentration of trained staff and specialized equipment which simplifies care of the seriously ill patient. The days when complicated post-operative manoeuvres had to be carried out behind screens in a general ward are fortunately over. A post-anaesthetic recovery room, while being adequate for general surgical patients, does not satisfy the requirements of cardiac surgical management because of the length of time that the patient needs to be under close observation.

1. STAFF

The nursing staff assigned to an intensive care area need to be experienced in the special problems of cardiac surgery. Eight-hour shifts allow the most continuity of personal attention for the individual patient and the most rest for the nurse. Each shift has to be under the care of a sister or trained charge nurse, as considerable scientific and diagnostic responsibility rests on the nursing staff. More junior nurses can then be rotated through the recovery room from the rest of the hospital for intensive training in post-operative management. Nursing in an intensive care area can be emotionally wearing, because there is inevitably a higher mortality than in the rest of the hospital, and the more senior nurses need adequate relief and holidays.

The responsible medically qualified staff also need training, because experience in general surgical post-operative management is little preparation for care of the bad risk cardiac case. This is true also of junior anaesthetic staff unused to cardiac surgery, who may not appreciate the dangers of anoxia in pulmonary hypertension, or the value of positive pressure respiration before respiratory derangement becomes obvious. A representative of both surgical and anaesthetic staff has to be constantly and quickly available for emergencies if the nurses are to receive adequate support.

2. DESIGN OF AREA

The design of an intensive care area will depend on the individual hospital, as it is usually an adaptation of existing accommodation, but there

are certain criteria that are universal. It should be near the operating theatre for rapid treatment of such complications as haemorrhage and tamponade. A single, large room accommodating several beds is preferable to a series of small cubicles, because one nurse can supervise several patients when necessary, and operative manoeuvres can be performed without limitation of space.

Ancillary space is required for storage, sterilization, preparation of sterile packs, simple pathological investigations, accommodation for relatives, kitchen and sluice. Storage space is needed for bulky equipment such as respirators, defibrillators and oscilloscopes, and cupboards are required for dangerous and others drugs, intravenous fluids, catheters, syringes and sterile packs. Sterilization facilities, such as ward autoclave, and a sink suitable for scrubbing up, are also necessary. Room is required to prepare sterile packs for dressings and emergency packs, thoracotomy and tracheostomy sets, gowns gloves and individual instruments. A small pathological laboratory is desirable for blood gas analysis equipment, urine testing, microhaematocrit and other simple pathological investigations. Time and staff are not then wasted in sending nurses with samples to pathological laboratories which may be at some distance from the recovery room. Relatives, always anxious and sometimes distraught, need comfortable accommodation nearby by day and by night where they can conveniently be seen by the medical staff and from which they can easily visit the patients.

The recovery room itself is painted a soft restful colour, as the morale of patients and nurses is affected by their surroundings, and walls and floor should permit washing and fumigation after a septic case. Good lighting includes general lights of adjustable intensity, moveable individual lights over each bed and a powerful shadowless light for emergency operations. Proper ventilation, heating and air-conditioning are desirable.

3. EQUIPMENT

Each bed stands in its own area which can be screened off from other patients, and which has available six electric plugs, intravenous fluid stands, and shelf space for oscilloscopes, fluid balance, temperature and blood pressure charts. Oxygen and suction are best piped to each bed but, failing this, moveable oxygen cylinders and high and low volume portable suckers can be used.

The design of the bed itself makes a difference to ease of nursing. The bed should be fairly narrow, and it should be possible to raise and lower the shoulders and feet of the patient independently and tip him from side to side. The head should be removeable for emergency in-

tubation and anaesthesia, and the wheels large enough for smooth and rapid transport to and from the operating theatre. Additional fitments are desirable for holding intravenous fluid bottles, chest drainage bottles and oxygen cylinders while in transit.

The emergency equipment needed in a recovery area can be conveniently grouped by the systems it is designed to assist. Respiratory failure requires an Ambu bag and face-piece or an anaesthetic bag permanently attached to a full oxygen cylinder which is used for no other purpose, so that ventilation can be quickly begun in an emergency by the nursing staff. Full anaesthetic equipment with laryngoscopes and sets of endotracheal tubes and connections also need to be available for emergency operations. Intermittent positive pressure respirators are necessary in sufficient numbers to allow for sterilization and servicing between cases, with full sets of tracheostomy tubes and appropriate connections for attachment to humidifiers and nebulizers when the respirator is not attached. A sterile tracheostomy set, disposable tracheal suction catheters, bronchoscopes, oxygen masks and tents are further basic items for respiratory management.

Cardiac arrest requires external and internal defibrillators—preferably D.C.—a board to place under the patient during external massage, external and internal pacemakers, a sterile thoracotomy set, an E.C.G. oscilloscope, syringes and long needles for intracardiac injection. Monitoring equipment of the cardiovascular system includes saline venous manometers, sphygmomanometers and possibly electronic monitors.

Renal failure requires urethral and peritoneal dialysis catheters and appropriate connections. Cerebral deterioration requires hypothermia equipment such as cooling blankets, ice bags and fans. Efficient gastric suction tubes and intermittent aspiration or continuous low pressure suction are used in the treatment of paralytic ileus.

4. DRUGS

The basic drugs required in a recovery ward include a full range of antibiotics, sedatives and anaesthetic drugs and their antidotes. Intravenous fluids commonly used are normal saline and dextrose 5 per cent, dextrose 5 per cent in $\frac{1}{3}$ and $\frac{1}{5}$ normal saline, 2·5 and 7·5 per cent sodium bicarbonate solutions, potassium chloride, mannitol 20 per cent in water and $\frac{1}{5}$ *N.* saline, fibrinogen, plasma, Dextraven and Rheomacrodex. Drip sets for adults and children (30 and 100 ml), Y sets for peritoneal dialysis, and 3-way taps allow variation of administration.

Cardiac arrest requires 10 ml ampoules of adrenaline 1 : 10,000, and calcium chloride 2 per cent and 10 ml syringes with long needles for intracardiac injection. Vasoconstrictive agents include Mephine, Ara-

mine and Levophed. Post-operative hypertension is treated with hypotensive drugs which include Arfonad and Trophenium. Heart block requires isoprenaline (0·1 mg ampoules, 5 and 10 mg linguettes and suppositories) and ephedrine. Cardiac failure and arrhythmias are treated with digoxin, lanatoside C, procaine amide, quinidine, aminophylline, mersalyl, chlorothiazide and hydrocortisone. Clotting problems require heparin, protamine, Dindevan, vitamin K_1, calcium gluconate 10 per cent, Trasylol, epsilon aminocaproic acid, and plastic bags containing A.C.D. solution for collection of fresh blood.

Respiratory failure may require respiratory stimulants, such as Vandid, Daptazole, Tensilon, and nikethamide, and depression of spontaneous respiration is performed with curare and Scoline. Prostigmine is also required as an antidote.

Renal failure may involve the use of peritoneal dialysate solutions, 20 per cent lactose, 50 per cent dextrose, fructose and ion exchange resins and anabolic steroids. Cerebral damage can be treated with urea, 50 per cent sucrose and dextrose and papaverine. Anticonvulsant drugs, such as phenobarbitone, Epanutin and others, are also necessary.

These drugs and fluids are many, and require substantial storage space, but they are often required at short notice and at night, which precludes keeping them in the dispensary.

5. IMMEDIATE MEASURES ON RETURN OF THE PATIENT TO THE INTENSIVE CARE AREA

On return of the patient to the recovery room, the most important immediate measures are re-establishment of pleural drainage and institution of monitors of the patient's general state.

The patient is placed in bed with the feet slightly raised and the shoulders at 30°. Raising the legs prevents postural hypotension and raising the shoulders allows blood to drain to the lower paravertebral gutters where the drains lie. Chest drains are connected to an underwater seal and a low volume suction pump set at 4 cms of water negative pressure. Vigorous 'milking' of the tubes removes clot formed during transfer from the theatre.

A clinical baseline is obtained of the patient's general state. The level of consciousness, reaction of the pupils, colour and temperature of the skin, jugular venous pressure, state of the peripheral pulses and filling of the foot veins, sphygmomanometer cuff arterial pressure, pulse rate, temperature and respiratory rate are noted. The levels of blood in transfusion and drainage bottles are marked so that post-operative blood balance can be accurately maintained on the balance chart.

The administration of oxygen is important as the patient begins to

breat e spontaneously. It is best given by mask, but an oxygen tent may be necessary in children. The oxygen is humidified with a nebulizer or a thermostatically controlled humidifier. The use of hyperbaric oxygen has not been fully explored after cardiac surgery but could play a part in cyanotic patients.

The problem of sedation after cardiac surgery is not a simple one. Proper sedation is important as pain and restlessness raise the pulse rate and cardiac work, but oversedation can depress respiratory function and reduce coronary arterial oxygenation. Small repeated doses of morphia and pethidine, initially intravenously and later intramuscularly, give the most accurate control of pain, but most simple cases can be managed with the routine intramuscular dosages alone.

If post-operative complications are anticipated, the patient will have been returned from the operating theatre with indwelling arterial, venous, oesophageal and urinary catheters. In addition to the general regime above, samples of arterial blood will be taken for oxygen saturation, P_{CO_2}, pH and bicarbonate estimation, and mixed venous blood for oxygen saturation, electrolyte and urea content, haemoglobin, packed cell volume, platelets, fibrinogen, fibrinolysins, and heparin neutralization tests if indicated. The urinary catheter is connected to a calibrated container and hourly production chartered. E.C.G. electrodes are attached and connected to an oscilloscope. The arterial pressure is recorded by sphygmomanometer cuff or directly from the arterial cannula, and the venous pressure by a saline or electronic manometer. The oesophageal tube is connected to constant suction or intermittently aspirated with a syringe. A rectal thermocouple allows regular recording of the patient's temperature without disturbing him. A chest radiograph is taken after a few hours, care being taken not to sit up a hypotensive patient suddenly.

Integration of the data assembled by these measurements is considered in the chapters which follow. Only by careful and accurate observation can complications be recognized early enough for effective and definite treatment to be given.

CHAPTER 3

Blood Balance

The single most important factor in management of the immediate post-operative period is maintenance of a normal blood volume. Too large a blood volume causes diastolic overloading of the ventricles, a raised systemic venous pressure and venous stasis. The left atrial pressure rises, reducing pulmonary compliance and eventually progressing to pulmonary oedema. Too small a blood volume results in vasoconstriction and inadequate tissue perfusion, metabolic acidosis and finally surgical shock.

PHYSIOLOGICAL EFFECTS OF HYPOVOLAEMIA

Untreated haemorrhage causes a low circulating blood volume, which reduces the cardiac output. Mechanisms are set in motion to counteract this state which are cardiovascular, nervous, endocrine and coagulatory, and include increased sympathetic nervous tone and increased secretion of adrenaline, noradrenaline, adrenal corticoids, and antidiuretic hormone from the posterior pituitary. The coagulation time of the blood is shortened, and fluid loss as urine, intestinal secretion or salivation is diminished. The low cardiac output diminishes the amount of oxygen available to the tissues and more is extracted from a unit volume, producing an increased arterio-venous difference and a fall in venous oxygen saturation.

The stages of increasing hypovolaemia have been described as depletion of venous reservoirs, failure to maintain the blood pressure and deterioration to death by vicious cycles.

The venous system accommodates 60–70 per cent of the blood volume. Sympathetic tone produces constriction of the veins and venules which can compensate for a 10 per cent loss of blood volume without alteration in cardiac output or blood pressure.

When the blood loss exceeds 10 per cent of the blood volume, sympathetic tone and secretion of noradrenaline cause arteriolar vasoconstriction of splanchnic, limb and skin vessels and maintain the blood pressure and blood flow to the brain and myocardium but not to the kidneys. The venous pressure and stroke volume fall slightly and the