

**CARDIOVASCULAR  
COLLAPSE  
IN THE  
OPERATING ROOM**

*Natof and Sadove*



**PITMAN MEDICAL**

# Cardiovascular Collapse in the Operating Room

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LONDON

PITMAN MEDICAL PUBLISHING CO., LTD.

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*Published in Great Britain by*  
PITMAN MEDICAL PUBLISHING CO., LIMITED  
39 PARKER STREET, LONDON, W.C.2

ASSOCIATED COMPANIES  
SIR ISAAC PITMAN & SONS, LTD.  
PITMAN HOUSE, PARKER STREET, KINGSWAY, LONDON, W.C.2  
THE PITMAN PRESS, BATH  
PITMAN HOUSE, BOUVERIE STREET, CARLTON, MELBOURNE  
22-25 BECKETTS BUILDING, PRESIDENT STREET, JOHANNESBURG  
PITMAN PUBLISHING CORPORATION  
2 WEST 45TH STREET, NEW YORK  
SIR ISAAC PITMAN & SONS (CANADA), LTD.  
(INCORPORATING THE COMMERCIAL TEXT BOOK COMPANY)  
PITMAN HOUSE, 381-383 CHURCH STREET, TORONTO

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PRINTED IN THE UNITED STATES OF AMERICA  
A — (A.N.5)

TO  
MIRIAM R. NATOF  
AND  
ETHEL S. SADOVE

# Foreword

In this monograph the authors have covered all phases of cardiovascular collapse or cardiac arrest in the operating room. In their first chapter they define the various terms referring to this condition and very appropriately call attention to the inadequacy of the term "cardiac arrest," because this complication may be produced by numerous causes and have different meaning to different people. They are correct in their insistence that the diagnosis should be accurate. In some patients severe pre-existing disease is the cause of the emergency condition, whereas on other occasions errors in anesthesia may be the cause. Still other factors, including inadequate preoperative preparation of the patient, or an excessive operative load on the weakened myocardium, may be the important etiologic mechanism. They emphasize the need for a meeting of various specialists to formulate definitions, to study the various causes of cardiac arrest and to establish accuracy in a classification of the various conditions and factors.

One of the most valuable sections in this monograph is the excellent discussion of the physiologic mechanisms which may give rise to cardiac collapse. The role of multiple factors such as hypoxia, hypercapnia, possible reflex mechanisms, and the toxic effects of agents utilized in the anesthetic is presented scientifically.

In Chapter 4 the cases of cardiac collapse occurring in the University of Illinois Research and Educational Hospitals over a 3-year period have been collected and studied in detail. A study of this relatively small number of cases allowed a detailed critical analysis of the various causes of this complication. After each protocol, the authors summarize the important factors leading to the arrest.

Treatment of a complication or a disease process can be carried out intelligently only when the causative factors are understood. Likewise, preventive measures are as important as definitive therapy; in fact, they are often much more important because resuscitative therapy is frequently ineffective. The authors have

correctly adopted a physiologic attitude in their plan for prevention of the complication. They emphasize that decrements such as anemia, hypoproteinemia, hypovolemia, etc., must be corrected if "cardiac arrest" is to be prevented. Failure to recognize cardiac or pulmonary disease may in itself be responsible for the complication. Unfortunately, even if recognized, cardiac or pulmonary disease cannot always be eliminated by preoperative therapy. Under such circumstances, the surgeon must co-operate and modify his plans, perhaps by staging the operation, but at least he must perform the operative procedure with the best technic at his command. The most skilled surgeon must be assigned the task of operating on patients when decrements cannot be eliminated by preoperative therapy. This is particularly true when the patient is aged.

In their discussion of diagnosis, the authors emphasize the obvious fact that the anesthesiologist must not for a moment allow his attention to be diverted from the patient's progress during the anesthesia and the operation because "cardiac arrest" may develop suddenly. An astute anesthesiologist may detect certain early pathologic manifestations which may lead to the disaster unless certain preventitive measures are adopted promptly. The surgeon and the anesthesiologist must co-operate completely during the operative procedure, the former informing the latter of changes in operative plans, and the latter informing the former of changes in the patient's condition.

In Chapter 7 the authors discuss the definitive therapy of "cardiac arrest" and the treatment of various pathologic manifestations which may signify the approach of this complication. The therapy of these conditions, including "cardiac arrest," is presented briefly, but in sufficient detail for all physicians to understand them. By adhering closely to the various steps outlined a successful outcome may be expected in many patients, particularly if the complication is detected immediately, or the pathologic manifestations treated early. Unfortunately on certain occasions, the pre-existing cardiac disease is so pronounced that restorations of heart action adequate to maintain life cannot be achieved.

All members of the medical profession participating in surgical procedures regardless of the functions they perform will find this volume of great value. Of equal importance, the internist or the general practitioner will find in this volume valuable lifesaving

information because cardiac arrest often develops in people not being operated on; in fact, newspaper accounts alone reveal the fact that cardiac arrest can occur in young people without evidence of organic disease. Therefore, every physician should be informed concerning the diagnosis and the treatment of this sudden threat to life. Only prompt action can save the patient; this must be initiated by the physician nearest the scene because time rarely permits the arrival of other physicians to carry out the crucial restorative measures.

The authors obviously have devoted an enormous amount of time and thought to the preparation of this book; they have accomplished their purpose exceptionally well. All physicians will profit from reading this volume.

WARREN H. COLE, M.D.

## Preface

*The search for Truth is in one way hard and in another easy.  
For it is evident that no one can master it fully nor miss it  
wholly.*—ARISTOTLE

No physician can divorce himself entirely from the problems of morbidity and mortality in the operating room. And no one physician can view the entire scope of this problem within the limitation of his own personal experiences. For this reason, we believe that the information in this book will be valuable not only to the surgeon and the anesthetist but also to the general practitioner, the internist, the pediatrician and other physicians who frequently must estimate operative risk and prepare the patient for surgery and anesthesia. We have attempted to review the broad problems of cardiovascular collapse in the operating room: predisposing and precipitating factors, pathophysiologic mechanisms, preventive measures, diagnosis and treatment.

During the preparation of this monograph we studied over 1,500 articles and published case reports; however, we have included in our bibliography only those references which contributed important material and fit within the organization and the scope of this book.

With regard to our analysis of published reviews, we recognize and carefully state within the text the limitations of our methodology. We encourage the reader to observe carefully the limitations which we have imposed upon the interpretation of our statistics. Far more important and significant than the percentile data is the ubiquitous pattern of *multiple factors* associated with cardiovascular collapse and *the relatively frequent occurrence of certain of these factors*. The relative incidence of cardiac and pulmonary disease, airway obstruction, or uncontrolled operative hemorrhage may vary from one hospital to another. However, an analysis of published reviews, corroborated by the personal experiences of many surgeons and anesthetists, has revealed that collapse, in most cases, is due *to the summation of multiple*

*pathophysiologic insults frequently superimposed upon serious preoperative disease.*

This basic doctrine has significant and practical value for the surgical team. The overwhelming majority of even "poor risk patients" will tolerate surgery and anesthesia when they are adequately prepared preoperatively and when they are subjected to careful and competent anesthesia and surgical intervention. The occurrence of cardiovascular collapse is enhanced by each additional stress which the surgical team imposes upon the patient, and the chances for a successful operative course are enhanced by each preventive measure instituted by the surgical team.

Failure to understand the mechanisms of collapse in the operating room frequently reflects a failure to recognize that cardiovascular collapse, in most cases, is the resultant of a *combination* of abnormal physiologic states due to prolonged hypoxia and hypercapnia, hypovolemia, excessive depth of anesthesia, careless movement and positioning of the patient, pre-existing cardiac and pulmonary disease, electrolyte disturbances, etc.

Unfortunately, many physicians regard "cardiac arrest" as a specific disease or syndrome. In our opinion, this attitude only serves to obscure our understanding of the mechanisms of collapse in the operating room. In Chapter 2 we present many of the current concepts of "cardiac arrest," and a comparison of these concepts reflects the present lack of uniform opinion and definition. We have not attempted to define "cardiac arrest" in this book because any definition of this term must include certain arbitrary limitations. We believe that an authoritative definition should be rendered by an official committee derived from the American Medical Association, the American College of Surgeons, the American Society of Anesthesiologists, and other interested medical societies.

We have selected the term, "Cardiovascular Collapse in the Operating Room," for our title. We believe that this term, although lengthy, has clear meaning for most physicians. The term indicates that there is a profound disturbance of the cardiovascular system producing cessation of adequate circulation to the vital organs. The term does not designate etiology because the collapse may result from a large variety of precipitating and predisposing factors. The patient's heart may be in complete standstill, manifest ventricular fibrillation, or beat so weakly that the patient's

life is immediately jeopardized. The term does not indicate whether the catastrophe was sudden or the result of prolonged and chronic failure. This term embraces not only patients who die in the operating room but also those patients who are resuscitated with subsequent recovery or death. The term states specifically that the episode has occurred in the operating room area and not on the ward, in the home, or on the street.

We have used the term "surgeon" to designate any physician who performs surgery, and the term "anesthetist" to include all persons who administer anesthesia to patients, regardless of training. We recognize that the skill, the training and the competence of both the surgeon and the anesthetist are extremely important factors influencing operating room morbidity and mortality. However, few authors have attempted to include this information in their published reviews; and of all the multiple factors associated with cardiovascular collapse in the operating room, the competence of the surgeon and the anesthetist remains one of the most difficult to evaluate statistically.

To Doctor Warren H. Cole we owe a special debt of gratitude for the Foreword, for his encouragement, inspiration, guidance and suggestions; for it was at his suggestion that we had the courage to go on in our work and prepare this monograph of our studies.

Because of the broad scope of our subject, we have welcomed the helpful suggestions of Doctors Warren H. Cole, Head of the Department of Surgery at the University of Illinois Research and Educational Hospitals; Danely P. Slaughter, Director of the Tumor Clinic at the University of Illinois Research and Educational Hospitals; John L. Keeley, Professor of Surgery at the Stritch School of Medicine; Ernest T. Morch, Director of the Department of Anesthesia at the University of Chicago; John Abajian, Jr., Chairman of the Department of Anesthesia at the University of Vermont; William R. Best, Assistant Professor of Medicine, University of Illinois Research and Educational Hospitals; Harry A. Bliss, Assistant Professor of Medicine, University of Illinois Research and Educational Hospitals, and Gwen Gleave, Clinical Instructor, Division of Anesthesiology at the University of Illinois Research and Educational Hospitals. We thank them for their criticism and many valuable comments. We also wish to commend Mrs. Mildred Evans who prepared our

manuscript and Miss Kathleen Mullens who prepared our illustrations. Also, we would like to express our grateful appreciation to the J. B. Lippincott Company and to Mr. J. Brooks Stewart, Medical Editor of that company, for the co-operation and the valuable assistance extended to us.

THE AUTHORS

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# 1

## The Validity of Morbidity and Mortality Data

### INTRODUCTION

### DEFINITION OF TERMS

#### DEATHS IN THE OPERATING ROOM

#### ANESTHESIA DEATHS

#### CARDIAC ARREST

### HISTORICAL ASPECTS OF CARDIAC RESUSCITATION

### UNIFORMITY OF DATA

### ACCURACY OF DATA

### SUMMARY

### INTRODUCTION

Over 100 years have passed since the introduction of clinical anesthesia. In 1848, less than 2 years after Morton demonstrated the efficacy of ether and some 2 months after Simpson introduced chloroform anesthesia, the literature recorded the first anesthesia death.<sup>1</sup> Since that time the character and scope of both clinical surgery and clinical anesthesia have changed; however, the problems of morbidity and mortality in the operating room remain omnipresent. The medical literature pertaining to this broad subject is profuse and in certain respects conflicting.

Morbidity and mortality in the operating room are recorded in the literature under one of three general categories: (1) deaths in the operating room or deaths on the operating room table; (2) anesthesia deaths and (3) cardiac arrest. Reports published in the literature prior to 1950, with few exceptions, classify their data under the category of either "deaths in the operating room" or "anesthesia deaths." The term "cardiac arrest" has gained increased usage in the literature during the past 6 years.

## 2 THE VALIDITY OF MORBIDITY AND MORTALITY DATA

It is the purpose of the authors in this review to subject these reports to objective, critical analysis. It is self-evident that the validity of any statistic inherently depends upon the validity of the methodology from which the statistic was derived. It is further self-evident that the validity of data pertaining to morbidity and mortality in the operating room depends not only upon the accuracy of reporting but also upon the uniformity of reporting. It became apparent during the course of this review that there were broad differences between the statistics of various authors regarding "operating room deaths," "anesthesia deaths" and "cardiac arrests." In many instances there is reason to suspect that the apparent statistical differences do not represent genuine variation, due to such variables as patient risk, extent and competence of surgery, and competence of anesthesia, etc., but rather represent variations in the methods of collection and classification of data.

When one sees the great variety of agents, and complicated apparatus being used, in many instances by incompetent anesthesiologists, and the recklessness with which the hazardous risk is approached today, the first thought is very much like the impression the country man gets when he is whirled through the streets of the crowded city in an auto. He wonders why more people are not hurt, when the facts are a great many more are hurt than he supposes. We are having an untold and alarming number of anesthesia deaths.

These forceful words were inscribed in the literature by E. M. Sanders in April, 1919.<sup>2</sup>

In 1927, A. G. Levy<sup>3</sup> provoked further attention:

We must conclude that little or nothing has been effected in the progress of years, whether through the medium of new knowledge or new methods, in the way of reducing the general liability to death under anaesthesia.

Ronald Jarman,<sup>4</sup> in 1939, stated:

One cannot help being impressed by the fact that since 1921 there has been a steady increase in the number of deaths under or associated with the administration of anaesthetics. The number of deaths has doubled itself in the last ten years alone.

In every decade since 1890, someone has recorded in the literature the "observation" that deaths associated with anesthesia have

increased in rather alarming and spectacular numbers. Without further scrutiny and evaluation, it would appear that the anesthetist has become inherently more inept and less skilled in each succeeding decade since the introduction of anesthesia. The fundamental problem, of course, does not lie in the evolution of anesthesia but rather in the collection and the interpretation of data. It is almost appalling to review the literature on this subject and discover the nearly uniform lack of scientific methodology regarding definition of terms, collection of data, and interpretation of data. Since morbidity and mortality data represent a relatively few patients in a relatively large surgical population, it is apparent that small breeches in methodology serve to compound this problem. Clarification, at least in part, may lie in the following information:

## DEFINITION OF TERMS

### DEATHS IN THE OPERATING ROOM

There can be no valid comparison of data without uniformly applied definitions of terminology. Data reported under the heading, "Deaths in the operating room," should include all patients who died prior to leaving the operating theater. *It does not include patients who are in extremis upon leaving the operating room or patients who manifested cardiovascular collapse with subsequent resuscitation.* Less than 25 years ago, the term "death on the operating room table" was grossly abused by the frequent practice of hastily removing the dying (or dead) patient to the corridor or ward where death (or pronouncement of death) ensued; and the mortality statistics were cheated. "One breath, only one, or the merest flicker of the pulse when outside the theater door and no more was said. The phrase 'death on the table' was taken absolutely literally."<sup>5</sup>

### ANESTHESIA DEATHS

The term "anesthesia deaths" has provoked considerable confusion. The *Journal of the American Medical Association*<sup>6</sup> presented this problem to an anesthesiologist who, in turn, submitted

#### 4 THE VALIDITY OF MORBIDITY AND MORTALITY DATA

it to a pathologist, a medical statistician, an attorney and a medical director.

The consensus was that to define the term may be easy but to penetrate behind the term, to cause of death and responsibility for it, is undoubtedly difficult. The anesthetic death may be defined as a death that takes place under anesthesia or that is caused by an anesthetic or other agent used by the anesthetist or anesthesiologist in the practice of his proper profession.

The basic problem remains: does an "anesthetic death" embrace any death which occurs during anesthesia, or does it imply that the conduct of anesthesia was responsible, in part or whole, for the death? If the latter concept is most applicable, then we must confront the problem of defining the criteria under which anesthesia has or has not contributed to death. In many cases the problem is well-defined. However, in other instances, the decision is ultimately based upon opinion and not upon objective criteria.

A young, healthy patient may come to the operating room for repair of an inguinal hernia and die due to the grossly mismanaged conduct of a spinal anesthetic. The etiology of cardiovascular collapse in this patient is indisputably the improper conduct of the spinal block. On the other hand, an elderly, malnourished, diabetic man with severe heart failure and bowel obstruction may die in the operating room during the course of a skillful and properly administered anesthetic. This patient succumbs to multiple pathophysiologic insults superimposed upon severe preoperative disease. These two patients represent the extreme ends of a continuum; at one end is the patient whose collapse falls unequivocally within the realm of the conduct of anesthesia, and at the other end is the patient whose collapse is basically related to causes other than the conduct of anesthesia. A large number of patients who collapse or die in the operating room lie between these two extremes, and the relative significance of each contributing factor can be evaluated only in a highly arbitrary and speculative fashion.

#### CARDIAC ARREST

The term "cardiac arrest" remains the enigma of modern medicine. In reviewing the medical literature, one finds that "cardiac