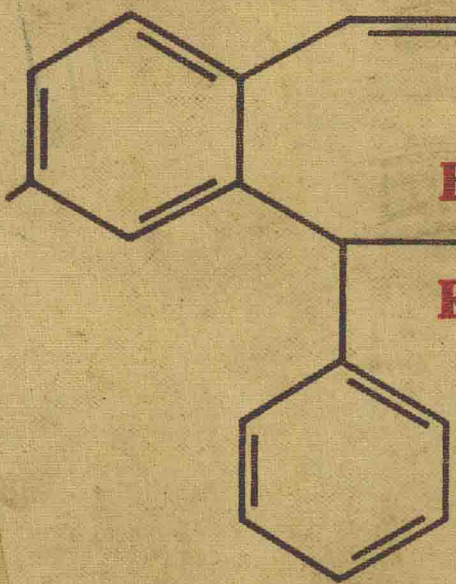
A Clinical Anesthesiology



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A Clinical Anesthesiology

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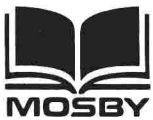
The C. V. Mosby Company

ST. LOUIS • TORONTO • PRINCETON 1985



A TRADITION OF PUBLISHING EXCELLENCE

Editor: Karen Berger
Assistant editor: Sandra L. Gilfillan
Editing supervisor: Peggy Fagen
Manuscript editor: Daphna Gregg
Book design: Jeanne Bush
Cover design: Tom Zigrang
Production: Mary Stueck, Teresa Breckwoldt

Printed in the United States of America

The C.V. Mosby Company
11830 Westline Industrial Drive, St. Louis, Missouri 63146

Library of Congress Cataloging in Publication Data

Brown, Burnell R.
Clinical anesthesiology.

Bibliography: p.
Includes index.
1. Anesthesiology. I. Blitt, Casey D.
II. Vaughan, Robert W. III. Title. [DNLM: 1. Anesthesia.
WO 200 B877c]
RD81.B67 1985 617'.96 84-14738
ISBN 0-8016-0858-9

TS/VH/VH 9 8 7 6 5 4 3 2 1 05/D/610

CLINICAL ANESTHESIOLOGY

TO OUR STUDENTS

Preface

This work is designed primarily to serve as a textbook for medical students serving a clinical clerkship in anesthesiology. We have amassed well over 50 years' combined experience teaching medical students the fundamentals involved in the discipline of anesthesiology. During numerous tutorials, we have developed a logical sequence for presenting, facilitating, and learning the theoretic and pragmatic aspects of the specialty. We have incorporated these teaching experiences into this text.

The chapter order parallels the thinking process of an anesthesiologist during the anesthesia sequence. Because clinical expertise is predicated on a basic science knowledge—physiology, pharmacology, anatomy, and biochemistry—the first chapters review information specific to anesthesia, such as the pharmacology of anesthetic drugs and adjuvants. Selection of anesthetics is discussed, based on the pathophysiology of the patient and the surgical requirements. Preparation, induction, maintenance, awakening or termination, recovery room problems, and postoperative care and complications follow in logical order. Special procedures and areas of subspecialty interest are discussed in subsequent chapters. The final chapter describes clinical case histories. The anesthesiologist's thought processes and alternatives are covered in these examples. The neophyte is urged to review these case histories carefully because they illustrate the need for flexibility in this specialty. Although strict dogmatism and inflexibility are frequently comfortable and nonthreatening, it must be realized early that anesthesiology has many acceptable alternatives in the majority of circumstances. We have attempted to present some of these options.

It is our hope that this book will be read and digested, not used as a shelf reference text in the classic German handbook style. Purposefully it has been kept compact so that the typical medical student can easily assimilate it during a 2- to 4-week anesthesiology clerkship.

We express our sincere appreciation to Joanne Barnes, Christan Pickering, and Shirley Glanzberg, secretaries of the Department of Anesthesiology, for typing the manuscript.

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chapter 1

Overview of Anesthesiology

Historical background
Anesthesiology defined

Contributions of anesthesiology to medicine

Why study anesthesiology?

Anesthesiologist's consultant role

Summary

This chapter introduces the history and breadth of anesthesiology and shows how the field integrates into care of the sick individual. The consultant role of the anesthesiologist is described, and the chapter concludes with a list of journals relevant to the field.

HISTORICAL BACKGROUND

Development of "painless surgery" is rather recent. Attempt at pain relief by the ancients was poor at best. During the classic ages, the Greeks and Romans employed extracts of the mandragora root as an analgesic and hypnotic. Its pharmacologically active agent, the alkaloid scopolamine, is more amnestic than analgesic, however. The opium poppy, *Papaver somniferum*, was used with limited success by the ancient Egyptians. The alcohol extract of this remarkable plant, tincture of laudanum, persisted in medical use until the beginning of the twentieth century. However, without adequate means for controlling ventilation, morphine and other opium derivatives cannot be given in doses sufficient to significantly reduce surgical pain because of the concomitant respiratory depression. Many civilizations used oral alcohol for surgery, but with no success. South American Indian tribes may have used coca leaves (cocaine) as a topically applied local anesthetic during their trephining procedures. However, brute force was the major means employed for performance of surgery until the mid-nineteenth century.

Modern anesthesia, unlike most specialties of medicine, is an American invention. In October 1846 W.T.G. Morton, a sophomore medical student in Boston who had learned dentistry as an apprentice, was the first to use diethyl ether vapors for surgery. New England dentist Horace Wells and Crawford Long, a Georgia general practitioner, claimed they had utilized inhalation anesthesia successfully some time before Morton. By December 1846 surgery was being performed in Europe with ether. Oliver Wendell Holmes suggested the term "anesthesia" (*an-*, without; *esthesis*, sensation) for the state produced by such potent drugs.

The development of anesthesiology, which was initially slow, has accelerated in the past four decades. A brief synopsis of the important events in the history of anesthesia follows:

1847 James Y. Simpson, Edinburg, used chloroform in clinical practice.
1848 Hannah Greener, age 15, was the first reported anesthetic death during chloroform anesthesia.
1855 John Snow, first full-time anesthesiologist, published the anesthesia medical text, *On Chloroform and Other Anaesthetics.*
1872 Joseph T. Clover, Britain, introduced nitrous oxide–ether sequence.
1884 Carl Köller introduced cocaine as a local anesthetic.
1894 E.A. Cockran and Harvey Cushing, United States, introduced anesthesia record keeping and use of the indirect sphygmomanometer to monitor patients under anesthesia.
1899 August Bier, Berlin, introduced spinal anesthesia.

1910 E.I. McKesson, United States, introduced the first nitrous oxide–oxygen anesthesia machine.
1915 Dennis Jackson introduced carbon dioxide absorption into anesthesiology.
1920 Arthur Guedel wrote a classic paper on signs and stages of ether anesthesia.
1928 Brian Sword introduced the circle absorption method for carbon dioxide elimination.
1933 Ralph Waters, Wisconsin, introduced cyclopropane.
1934 John Lundy, Mayo Clinic, introduced thiopental.
1942 Arthur Griffith, Canada, used d-tubocurarine to produce skeletal muscle relaxation during anesthesia.
1943 Sir Robert MacIntosh introduced the curved laryngoscope blade.
1956 Michael Johnstone used halothane clinically.
1962 Blood gas analysis became readily available.

Anesthesiology defined

The American Society of Anesthesiology has defined anesthesiology as the practice of medicine dealing with, but not limited to, the following*: (1) the management of procedures for rendering a patient insensible to pain and emotional stress during surgical, obstetrical, and certain medical procedures; (2) the support of life functions under the stress of anesthetic and surgical manipulations; (3) the clinical management of the patient unconscious from whatever cause; (4) the management of problems in pain relief; (5) the management of problems in cardiac and respiratory resuscitation; (6) the application of specific methods of inhalation therapy; and (7) the clinical management of various fluid, electrolyte, and metabolic disturbances.

CONTRIBUTIONS OF ANESTHESIOLOGY TO MEDICINE

The contributions to medicine as a whole made by the pioneer developers and later investigators in the field of anesthesiology are legion. Paramount has been the development of safer, more versatile anesthetic drugs. Deaths and severe morbidity from anesthesia have been real and, unfortunately, common. Introduction of nonflammable techniques of anesthesia led to institution of sophisticated electronic monitoring gear that allows the anesthesiologist to ascertain the patient's minute-to-minute physiologic status and to make appropriate responses. Surgical procedures impossible several years ago are now commonplace. The old adage of "this patient is too ill to undergo anesthesia and surgery" has been commutated to "this patient is too ill not to have the benefits of surgery" in many circumstances.

The field of neonatology was developed largely by anesthesiologists such as Dr. Virginia Apgar. Anesthesiologists spearheaded the development of general and special intensive care units and recovery rooms. Ventilator design as well as new forms of ventilatory control—e.g., positive end expired pressure (PEEP), intermittent manda-

*From the Directory of Members, Park Ridge, Ill., 1984, American Society of Anesthesiologists.

tory ventilation (IMV), continuous positive airway pressure (CPAP)—originated from the discipline. Invention of the carbon dioxide arterial gas electrode by anesthesiologist Dr. John Severinghaus made perioperative blood gas determinations possible. Many pharmacologic advances and concepts, in addition to pure anesthetic drugs, can also be attributed to anesthesiologists: clinical use of neuromuscular drugs and discovery of lidocaine as an antiarrhythmic agent are but a few of such additions to the totality of patient care.

WHY STUDY ANESTHESIOLOGY?

As one of the more newly recognized independent medical disciplines, anesthesiology might appear at first glance to be rather far removed from the mainstream of medical care (which involves initiating appropriate diagnosis and instituting therapy) and extremely narrow in intellectual mass. Anesthesiology, however, impinges on every facet of medicine with the possible exception of pathology. Today's student needs to know the basics of this advancing field, no matter what line of endeavor he or she eventually selects. The subject matter constituting the specialty has a very broad base.

Individuals choosing general surgery, a surgical specialty, or obstetrics and gynecology will be intimately involved with anesthesiology. For surgeons who practice in communities in which there are no trained M.D. anesthesiologists, this is especially critical. Most courts have upheld the ruling that in the absence of a physician anesthesiologist, the surgeon is ultimately responsible for conduct of anesthesia and for the actions of a nurse anesthetist. Internists and family practitioners need a modicum of knowledge of anesthesia, since many of their patients will eventually require surgical intervention. The internist frequently acts as an intermediary between the surgeon, the patient, and the anesthesiologist. An internist who is ignorant of the ramifications of anesthesia and of procedures used in caring for the patient in the operating room will be unable to offer advice beyond the stereotyped "avoid hypoxia and hypotension." Radiologists must understand anesthesiology, because many diagnostic radiologic procedures (e.g., computerized axial tomographic scans in uncooperative, inebriated, or young patients and various vascular studies) are now performed with the patient under general anesthesia. Anesthesia is customarily induced in patients before electroconvulsive therapy for treatment of severe depression. Thus anesthesiology impinges even on the domain of the psychiatrist.

ANESTHESIOLOGIST'S CONSULTANT ROLE

Many treatment and monitoring modalities used in the operating room can be transferred to outside areas. Well known is the practicality of using knowledge gained primarily from anesthesiology for management of the comatose patient and the patient with respiratory failure. For this reason intensive care units are frequently

headed by an anesthesiologist or have anesthesiologists as consultants. Although many medical students beginning an anesthesiology clerkship request teaching in respiratory support mechanisms, as seen primarily in intensive care units, they can best learn the basics of this subject through management of the unconscious anesthetized patient in the operating room.

The anesthesiologist serves as a consultant for patients scheduled for operative procedures. Not only does the anesthesiologist determine the safest and best anesthesia and decide on appropriate monitoring for the anesthesia and postoperative periods, but he or she is also responsible for blood and fluid management during the surgical procedure. In addition the anesthesiologist, in conjunction with the surgeon and advising internists or family practitioners, must treat medical problems that arise in the operating room or recovery room. These problems often require rapid evaluation and treatment. For example, diagnosis of congestive heart failure or hypoglycemia from insulin overdose can be far more difficult in the anesthetized patient than in the awake individual, because anesthetics mask many subtle diagnostic signs.

Temporally, anesthesia care can be divided into the following five discrete, yet interrelated, sequences collectively termed the anesthesia continuum:

1. **Preoperate evaluation and premedication.** Pathophysiology of the patient is matched to an appropriate, safe anesthetic program in the preoperative visit or consult. Medications are administered to allay anxiety and decrease autonomic functions as necessary.
2. **Anesthesia induction.** Appropriate steps are taken to assure adequate life support monitoring followed by administration of anesthetic drugs. This period lasts until the patient is judged ready for surgery.
3. **Anesthesia maintenance.** Appropriate anesthetic is continuously administered, and life function is appropriately monitored so the surgical procedure may be safely completed. Responses are made to alterations in the pathophysiology of the patient.
4. **Anesthesia termination.** This period extends from end of surgery until the patient is ready for transport to the recovery room or surgical intensive care unit. In certain situations the patient may intentionally be kept partially anesthetized or paralyzed and sedated for transport to a recovery area.
5. **Recovery period.** This is the interval between anesthesia termination and the time that the patient, having recovered adequately from anesthetic drugs and the immediate hazards of surgery, is judged to have adequate cardiopulmonary status so that constant attention is unnecessary.

Except in the intensive care unit and the pain clinic, the anesthesiologist rarely serves as the primary treating physician. Unlike the radiology or pathology consultant, however, the anesthesiologist is responsible for the maintenance of the second-to-second life functions of the patient. Long past is the time when the surgeon was the acknowledged director of every action in the operating room. Basically, the aim of the surgeon and the anesthesiologist is the same—to render the best possible medical care

to the patient. However, the mechanisms they use to achieve this goal differ. The surgeon's primary concern is the mechanical treatment of the patient's basic disease. The anesthesiologist, on the other hand, maintains life functions during the surgical procedure. The two physicians can interact and yet each be responsible for his or her own area of patient care.

The anesthesiologist should be a well-trained physician, not a mere technician. He or she must evaluate and integrate the patient's pathophysiology with the pharmacologic and physiologic effects of anesthesia and advise other members of the team of associated health risks. The anesthesiologist rarely unilaterally cancels surgery or withdraws from a particular case (such decisions should be team effort), but he or she does inform the other physicians associated with the patient's care of risks, possible complications, and therapeutic outcomes.

SUMMARY

The anesthesiologist is a medical consultant with responsibilities to the patient during some of the most critical areas of medical therapy. His or her primary duty is to support the vital functions of the patient during surgery and the critical, immediate postoperative period. In addition, the anesthesiologist maximizes patient comfort by using some of the most potent drugs known. Decision making must be rapid and accurate, based on sound knowledge of the basic sciences.

FURTHER READINGS

This text serves as a primer. The interested student who wishes to pursue the most up-to-date information in the field is advised to read or scan current issues of the following periodicals:

Anesthesiology (Lippincott). The official journal of the American Society of Anesthesiologists and an excellent quality scientific publication.

Anesthesia and Analgesia (Elsevier). Interesting, high-quality articles related to anesthesiology.

Survey of Anesthesiology (Williams and Wilkins). A compendium of abstracts from various journals, both anesthesia and nonanesthesia, of importance to the anesthesiologist, with at times pithy editorial comments.

British Journal of Anaesthesia (Macmillan). An excellent publication giving the reader insights into European views in the field.

chapter 2

Preoperative Evaluation

Overview of the preoperative interview

Criteria for selection of anesthesia

Risk factors for anesthesia and surgery
- Airway anatomy
- Pulmonary status
  - History
  - Physical examination of the chest
  - Pulmonary function tests
  - Arterial blood gases
  - Chest roentgenogram
  - Preoperative therapeutic interventions
  - Selection of anesthetic in the patient with pulmonary disease
- Cardiovascular status
  - Ischemic heart disease
  - Valvular heart disease
  - Electrocardiographic and angiographic information
  - Preoperative drug therapy assessment
  - Selection of anesthetic
  - Essential hypertension
    - Drug assessment and selection of anesthetic
- Renal status
  - Drug excretion and the kidney
  - Renal function tests
  - Effects of anesthesia and anesthetic drugs on the kidneys
  - Acute renal failure
  - Chronic renal failure
- Hepatic status
  - Laboratory examinations
  - Ascites
  - Renal failure secondary to hepatic disease
  - Cardiac problems in hepatic disease
  - Coagulopathies
  - Drug interactions
- Endocrine status
  - Diabetes
  - Pheochromocytoma
  - Parathyroid adenoma
  - Hyperthyroidism
  - Hypothyroidism
- Miscellaneous risk factors
  - Malignant hyperthermia
  - Inability to metabolize succinylcholine
  - Myasthenia gravis and Eaton-Lambert syndrome
  - Halothane hepatitis
  - Allergies
  - Hypokalemia
  - Obesity
  - Arthritis
  - Anemia

Summary

This chapter emphasizes the important predictive aspects of the preoperative evaluation and shows how they affect the selection of anesthetic and the eventual conduct of anesthesia. The opening discussion describes the anesthesiologist's review of the patient's chart, interview with the patient, history and physical examination, and preoperative note. Consideration of general risk factors is followed by a detailed discussion of specific risk factors arranged by organ system.

OVERVIEW OF THE PREOPERATIVE INTERVIEW

Many anesthesiologists consider the preoperative visit the most important part of the anesthesia continuum. On the basis of the physiologic, pharmacologic, and psychologic assessment at this time, the anesthesiologist formulates the anesthetic plan and makes preparations for possible complications and the postoperative course.

For typical elective surgery, the anesthesiologist ascertains the patient's name, anticipated surgical procedure, and age from the operating room schedule. If the patient has unusual pathophysiologic features, the surgeon may consult the anesthesiologist formally or informally. The patient's anticipated surgery and the anesthesiologist's previous clinical experiences provide the initial basis for the anesthetic selection process. For example, an anesthesiologist who has had considerable experience and salutory outcomes using caudal anesthesia for hemorrhoidectomies will initially think of this type of anesthetic for this procedure.

The anesthesiologist next reviews the patient's chart for the following salient features:

1. General physical condition
2. Pulmonary status and airway anatomy
3. Cardiovascular status
4. Renal status
5. Hepatic status
6. Endocrine status
7. Drug therapy and drug allergies
8. Laboratory values to corroborate history and physical findings

The next step is to interview and examine the patient. An adequate preoperative interview not only provides the anesthesiologist with information on which to base the care of the patient, but it also satisfies the patient intellectually and psychologically. Allaying patient apprehension during this period can be far more worthwhile than chemical premedication. After introducing himself or herself, the anesthesiologist proceeds to a history and physical examination that focuses on issues, systems, and functions that may affect anesthesia. The patient is questioned about anesthetics (e.g., previous experience, what kind, how long ago, problems, family history of anesthesia problems), general health, drugs (e.g., idiosyncratic responses, sensitivity to sedatives and hypnotics, medications regularly taken), and the cardiopulmonary, renal, hepat-

ic, and endocrine systems. Physical examination includes checking the patient's airway for features such as short neck, loose teeth, and bridgework; auscultation of the lung fields and heart; and determining potential venipuncture sites.

CRITERIA FOR SELECTION OF ANESTHESIA

After this assessment, the patient and anesthesiologist discuss selection of anesthetic. The decision to use general or regional anesthesia and the type of monitoring required depends on the following three factors, which are listed in order of importance:

1. ***Patient safety.*** The anesthetic administered must be that which the anesthesiologist is convinced will harm the patient the least.

2. ***Operative requirements.*** Allowance must be made for the peculiar situations of each surgical procedure. For example, during abdominal aneurysm surgery, extensive muscular relaxation is usually required. On the other hand, during resection of a parotid tumor the surgeon generally determines locations of branches of the facial nerve by electrical stimulation. Under these circumstances, use of a neuromuscular blocker, which obliterates the twitch response of facial muscles, would prevent the surgeon from identifying the nerves and would be against the best interests of the patient.

3. ***Patient request.*** This selection criterion is of primary importance in the decision of general versus regional anesthesia. Some patients are greatly upset by the thought of "staying awake" during surgery under regional anesthesia; others are terrified by the thought of losing consciousness and control under general anesthesia. If patient safety is in question, then the anesthesiologist must convince the patient to abide by his or her decision.

The neophyte to anesthesia wishes the comfortable dogmatism of being able to match an anesthetic technique with each surgical procedure. This is not possible. The single most important safety consideration in selection of an anesthetic is the facility of the anesthetist in managing the particular anesthetic chosen. In other words, the anesthetic selected depends on the skills the anesthesiologist has developed. For example, it is not prudent to use a technique that one employs infrequently for a high-risk, emergency surgery. Proven facility in numerous elective cases should precede use of any less familiar technique under less than optimal conditions. Consistent with that admonition remains the need for consultants in anesthesia to have a wide spectrum of options available for each patient. A consultant can elect general or regional anesthesia based on individual surgical and patient considerations. General anesthesia is defined as unconsciousness and freedom from pain; regional (or conduction) anesthesia refers to specific neural blockade (e.g., spinal, epidural, peripheral nerve block) designed to give freedom from pain without loss of consciousness. With the advent of secure airway control (endotracheal intubation), coupled with advances in understanding cardiopulmonary physiology and applied clinical pharmacology, critically ill