ATLAS OF SURGICAL OPERATIONS

Second Edition

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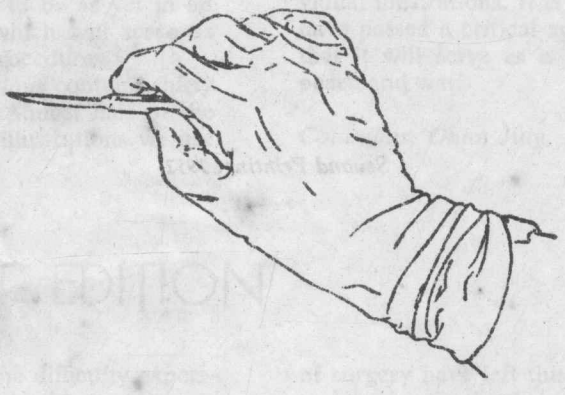
SECOND EDITION



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PREFACE TO THE SECOND EDITION

Since the first edition of the *Atlas of Surgical Operations* was published ten years ago, many significant advances have been made in the field of surgery. New and better methods are being practiced in anesthesia and in preoperative and postoperative care, which have extended the scope of surgery and contributed to its safety. Whole blood is now readily available for the control of shock; sepsis is better managed by chemotherapy and the antibiotics; and there have been many improvements in therapeutic methods. In spite of these advances, however, there is no substitute for meticulous surgical technic and rigid attention to the most minute details of technical procedure.

As a result of many comments and suggestions from young members of the surgical profession, we have devoted the book mainly to the methods for performing the more common operations. More attention has been given to detail than is found in the first edition, for the benefit of students and those whose experience and activities may be limited to a community away from medical centers. In addition to these standard procedures which we feel every young surgeon should be competent to perform, we have included certain operations which the general surgeon may be required to execute, in an emergency, although they are not usually regarded as being within the domain of general surgery. Vagotomy has been included because of the frequency with which it is done, although this procedure should be considered to be as yet in an experimental stage. Many textbooks are available which will serve as reference for the more advanced and complicated procedures.

The revised edition of the *Atlas of Surgical Operations* contains thirty new procedures in addition to the original number. Almost half of the plates have been revised and redrawn. For the fine illustrations we are indebted to Miss Mildred Codding, without whose talents and co-operation the purpose of the book would have been defeated. Despite the handicap of dividing her time between two places a thousand miles apart, she did not waver in her determination to make each sketch accurate and clear.

It is our hope that the methods illustrated may provide sufficient background and information to assist the surgeon, regardless of the technic he may use. Almost every procedure has been modified by many surgeons, and we would be the first to acknowledge that there are many satisfactory ways of performing a given operation, which may be at variance with the method herein presented.

Almost fifty people have co-operated in the preparation, revision, and proofreading of this book. Although not individually named, we are very grateful to these many colleagues of the visiting and resident staffs of the Peter Bent Brigham Hospital in Boston and the University Hospitals in Columbus, Ohio.

The satisfaction of seeing the revision completed was tragically denied the "Chief." Doctor Cutler's interest in the young surgeon was manifest to all throughout the years, and especially during the recent war. Despite his progressive illness, he maintained an active interest in the over-all plan for the revision, as well as in the details of the individual illustrations. It is sincerely hoped that the completed effort would have passed a critical appraisal of this master surgeon and teacher, and that it will serve as a useful guide for those he championed in both peace and war.

Columbus, Ohio, July, 1949. R. M. Z.

PREFACE TO THE FIRST EDITION

This *Atlas of Surgical Operations* is the result of the difficulty experienced in answering the countless questions of interns, resident surgeons, students, and assistants over a period of twenty years of teaching as to where they might learn about the intimate technical steps of surgical procedures. It has long been apparent that no single volume could contain both adequate descriptions of all surgical diseases as well as a complete recital of the steps in the operations which such diseases require. As a result, the admirable textbooks which the medical students of today use most frequently are those describing diseases for which surgery may seem advisable. The more extended attempts to write surgical textbooks for the practicing surgeon, compressing both diagnosis and therapy into a single volume, have necessarily resulted in incomplete descriptions which fail to give the information desired.

Four hundred years ago when Peter Lowe wrote his single small volume entitled *A Discourse of the Whole Art of Chyrurgerie,* it was possible to contain in a single volume everything then known regarding the diagnosis and the treatment of surgical disorders. One hundred years later the two-volume book of Daniel Turner entitled *The Art of Surgery* was also competent for the task of that day. But by the beginning of the nineteenth century when John Bell published his four-volume book entitled *The Principles of Surgery,* it was apparent that a single treatise could not describe adequately the technical forms of surgical operations as well as the conditions which might necessitate these procedures. Keen's *Surgery,* published in eight volumes one hundred years later, was the last attempt of a single individual to publish an encyclopedic textbook of surgery. This great compilation adequately represented the handicraft and art of surgery of that day and contained a complete description of the diseases for which the surgeon might give treatment. It was actually the beginning of the systems of surgery which are now being published and which represent the collaboration of many authors.

Shortly after the beginning of this century the fields for surgical endeavor were extended to every part of the human body. Each addition to our knowledge of physiology and biochemistry gave a further impetus to the methods of treating disorders by surgical procedures, so that it became impossible for any single individual to be experienced in more than a limited field. This finally culminated in the publication of multiple-volumed systems of surgery in which experts in special fields wrote single chapters. Such systems are invaluable for reference and are a necessary part of medical libraries. Yet the extraordinary rapidity with which new discoveries in the biologic field received immediate trial through surgical methods has, even in a brief decade, made such great systems incomplete. For the student in medical school such great systems are too advanced and extensive. To fill this important want, textbooks of surgery in single volumes have appeared in which there are excellent descriptions of surgical diseases and in which the form of therapy is carefully suggested. Such volumes, however, do not contain the intimate technical steps of surgical procedures, and their teaching value would be impaired if they did. Writers of these textbooks of surgery have left this to the current periodical and surgical literature and to special books on surgical technic. Such a policy, which is so beneficial to the medical student, has made it difficult for the young surgeon to find adequate statements of even simple surgical procedures. This book had its inception in the desire to alleviate this need and to bring forward to the unfledged surgeon in a single small volume the simpler and standardized procedures of modern surgical practice.

The model for this book is the illustrated manual, *Précis Iconographique de Médecine Opératoire et d'Anatomie Chirurgicale,* published in Paris in 1853 by Cl. Bernard and Ch. Huette. We have utilized this book as a model because of the ideal simplicity of arrangement of material and plates, consisting of illustrations of the operative steps on one page and on the opposite page a short text more fully enumerating the technical steps.

This *Atlas* contains most of the common surgical procedures which are standardized and about whose technical performance there exists no essential difference of opinion. Wherever several procedures are generally recognized as useful and desirable, we have, as a rule selected the one which we think has best stood the test of time, in the belief that it is better for the young surgeon to perform one procedure well than several procedures improperly. Should the *Atlas* fulfill our hopes, other procedures will doubtless appear in subsequent editions.

The format of the book is simple. We wished the drawings to tell the story and wished to include no more text than would conveniently fit opposite the plates. This left us in the dilemma that in our great concern over the importance of technical details the preoperative and postoperative care of the patient and the choice of the anesthetic might not be adequately emphasized. Since these matters underlie the success of every surgical performance, we have felt it necessary to introduce the plates with short chapters on the above matters, leaving to the readers the understanding that whatever appears in the introductory chapters may apply to the details of each procedure as it is depicted and described.

No attempt has been made to give references. Modern surgical procedures are largely composite undertakings, and it is impossible to give a chief credit for the final form of our common operations to any individual. This is a book about surgical craft. Its aim is to teach people how to do things, and it has no intention of describing the historical background upon which the present procedures were erected.

We are very grateful to many members of our recent house staff, whose criticisms and suggestions have been frequently followed in order that this *Atlas* may prove as useful to young surgeons as we can make it. And finally, and therefore most important, come our acknowledgments to the artist. This is a small book, and a chief part of its value lies in the illustrations, which are from the pen of Miss Mildred Codding. She has survived the innumerable corrections over a long period of time with an almost saintly disposition.

Boston, March 27, 1939. E. C. C.

TABLE OF CONTENTS

CHAPTER 1 · SURGICAL TECHNIC

Asepsis, hemostasis, and gentleness to tissues are the bases of the surgeon's art. Nevertheless, the last two decades have shown a shift in emphasis from the attainment of technical skill to the search for new procedures. Undoubtedly, this attitude was the result of the extraordinary increase in the application of surgical methods to new fields. Such a point of view led to an unremitting search for new procedures when results were unsatisfactory, whereas faulty technic rather than the procedure itself was the cause of failure. Now that all regions of the body have been explored, it is appropriate to stress the important relationship between the art of surgery and success in surgical therapy. The growing recognition of this relationship should re-emphasize the value of precise technic.

The technic described in this book emanates from the school of surgery inspired by William Stewart Halsted. This school, properly characterized as a "school for safety in surgery," arose before surgeons in general recognized the great advantage of anesthesia. Prior to Halsted's teaching, speed in operating was not only justified as necessary for the safety of the patient but was extolled as a mark of ability. Despite the fact that anesthesia afforded an opportunity for the development of a precise surgical technic which would insure a minimum of injury to the patient, spectacular surgeons continued to emphasize speedy procedures which disregarded the patient's welfare. Halsted first demonstrated that, with careful hemostasis and gentleness to tissues, an operative procedure lasting as long as four or five hours left the patient in better condition than if a similar procedure were performed in 30 minutes with the loss of blood and with the injury to tissues attendant on speed. The protection of each cell with the exquisite care typical of Halsted is a difficult lesson for the young surgeon to learn. The preoperative preparation of the skin, the draping of the patient, the selection of instruments, and even the choice of suture material are not so essential as the manner in which details are executed. Gentleness is essential in the performance of any surgical procedure.

The young surgeon has difficulty in acquiring this point of view, because he is usually taught anatomy, histology, and pathology on tough, dead, chemically fixed tissues by teachers lacking surgical experience. Hence, the student regards tissues as inanimate material which may be handled without concern. He must learn that living cells may be injured by unnecessary handling or dehydration, and that they require the surgeon's punctilious care. The young surgeon is often impressed by the speed of the operator who is interested more in accomplishing a day's work than in teaching the art of surgery. Under such conditions there is little time for consideration of technic, discussion of wound healing, or criticism of end results. Wound complications become a distinct problem associated with the operative procedure. If the wound heals, that is enough. A little redness and swelling in and about wounds is taken as a natural course and not as a criticism of what took place in the operating room three to five days previously. Should a wound disrupt, it is a calamity; but how often is the catgut blamed, or the condition of the patient, and how seldom does the surgeon inquire into just what did go wrong when the operation took place? Detailed consideration of a common surgical procedure, appendectomy, will serve to illustrate the care necessary to ensure successful results. The patient, an otherwise healthy youth, is anesthetized and wheeled into the operating room. The operating table must be placed where there is maximum illumination and adjusted to present the abdomen and right groin. The patient must be placed so that the site for the operation is thrust gently forward; often a small sandbag under the loin accomplishes this readily. The light must now be focused with due regard for the position of the surgeon and his assistants as well as for the type and depth of the wound. These details must be planned and directed before the skin is disinfected.

The preoperative preparation of the skin is chiefly concerned with mechanical cleaning. Preliminary scrubbing, with soap and water, and shaving should be done before the patient is brought to the operating room. A stiff lather should be developed, and the skin should be held taut to present an even, smooth surface as the hair is removed with a sharp razor. Multiple superficial abrasions and incomplete removal of the hair often result if the skin is not properly shaved.

It is a useless gesture to scrub the skin the night before operation and send the patient to the operating room with the site of incision covered with a sterile towel. However, some surgeons prefer, in elective operations on the joints, hands, and feet, to carry out a preliminary 24-hour preparation. In these cases the skin may be thoroughly scrubbed with soap and water, following which continuous alcohol dressings are applied, or a wet dressing of tincture of Zephiran, 1:1,000, or 1 per cent aqueous iodine solution applied for 30 minutes is satisfactory. A lipolytic agent such as ether may be applied for removal of the skin fats. Lime paste applied as a thin cream and gently rubbed for four minutes is a very useful method for cleansing the contaminating greasy skin of the hands or about traumatic wounds. A disinfectant acceptable to the surgeon is next applied. The first assistant completes the mechanical cleansing of the operative site by scrubbing the skin with 12 sponges, each alternate pair moistened with 1:1,000 aqueous solution of Zephiran or with 40 per cent isopropyl alcohol solution. The contemplated site of incision is scrubbed first; the remainder of the field is cleansed with concentric strokes until all the exposed area has been covered. Now the surgeon marks the extent of the incision by scratching the skin and lightly cross-hatching it several times to aid in the proper reapproximation of the skin edges. The folded edges of sterile towels are clipped to the skin, leaving 1 to 2 cm. of skin exposed at either side of the scratch, so that the relatively unsterile surface of the operative field is excluded from the vicinity of the incision. These towels also serve to limit contact of extruding viscera with irritating disinfectants, thereby preventing an insult to delicate tissues.

Heavy suture materials, regardless of what type, are not desirable. Fine silk, cotton, or catgut should be used routinely. We prefer fine silk as the most suitable material for sutures and ligatures because it engenders a minimum of tissue reaction, even in potentially infected wounds, and prevents secondary hemorrhage when securely knotted. If a surgeon's knot is laid down and tightened, the ligature will not slip when the tension on the silk is released. A square knot then can be laid down to secure the ligature, which is cut close to the knot. The knots are set by applying tension on the ligature between a finger held beyond the knot in such a plane that the finger, the knot, and the hand are in a straight line. However, it takes long practice to set the first knot and run down the setting, or final, knot without holding the threads taut. This detail of technic is of great importance, for it is impossible to ligate under tension when handling delicate tissue or when working in the depths of a wound. It is important when tying vessels caught in a hemostat that the side of the jaws of the hemostat away from the vessel be presented so that as little tissue as possible be included in the tie. Moreover, the hemostat should be released just as the first knot is tightened, the tie sliding down on tissue not already devitalized by the clamp. One-handed knots and rapidly thrown knots are unreliable. Each knot is of vital importance in the success of an operation which threatens the life of the patient.

The subcutaneous tissues must be protected from further injury before the muscles are incised. Gauze pads, moistened periodically with warm, sterile, isotonic saline and placed along each edge of the wound, serve to prevent desiccation and trauma of the relatively avascular fatty tissue.

As the wound is deepened, exposure is obtained by retraction. If the procedure is to be prolonged, the use of a self-retaining retractor is advantageous, since it ensures constant exposure without fatigue of assistants. Moreover, the constant shifting of a retractor held by an assistant not only perturbs the surgeon but stimulates the sensory nerves unless the anesthesia is deep. Whenever a self-retaining retractor is adjusted, the amount of compression of the tissues must be judged carefully because excessive compression may cause necrosis. Difficulty in obtaining adequate exposure is not always a matter of retraction. Unsatisfactory anesthesia, faulty position of the patient, improper illumination, and failure to use instruments instead of hands are factors to be considered when visibility is poor.

Handling of tissues with fingers cannot be as facile, gentle, or safe as handling with properly designed, delicate instruments. Instruments can be sterilized, while rubber gloves offer the danger that a needle prick may pass unnoticed and contamination may occur. Moreover, the use of instruments keeps hands out of the wound, thus allowing a full view of the field and affording perspective, which is an aid to safety.

After gentle retraction of the skin and subcutaneous tissue to avoid stripping, the fascia is incised in line with its own fibers; jagged edges must be avoided to permit accurate reapproximation. The underlying muscle fibers of the internal oblique and transversalis may be separated longitudinally with the handle of the knife. Blood vessels are divided between hemostats and ligated. Because of the friability of muscle, immediate transfixion and ligation are desirable. After hemostasis is satisfac-

tory, the muscle is protected from trauma and contamination by moist gauze sponges. Retractors may now be placed to bring the peritoneum into view.

The peritoneum is seized with toothed forceps by the operator and is lifted. The assistant grasps the peritoneum near the apex of the tent, while the surgeon releases his hold. This maneuver is repeated until the surgeon is certain that only peritoneum free of intra-abdominal tissue is included in the bite of the forceps. A small incision is made between the forceps with a scalpel. This opening is enlarged with scissors by inserting the lower tip of the scissors beneath the peritoneum for 1 cm. and by tenting the peritoneum over the blade before cutting it. If the omentum does not fall away from the peritoneum, the corner of a moist gauze sponge may be placed over it as a guard for the scissors. The incision should be made only as long as that in the muscle, since peritoneum stretches easily with retraction, and closure is greatly facilitated if the entire peritoneal opening is easily visualized. The surgeon soon learns that the likelihood of hernia is diminished when perfect approximation of the peritoneum is possible. As the incision is lengthened, the edges of the peritoneum are attached by curved hemostats to several threads of the moist gauze previously used to protect the muscles. Retractors may now be placed to give the optimum view of the abdominal contents. If the appendix or cecum is not immediately apparent, the wound may be shifted about with the retractors until these structures are located.

Although it is customary to wall off the intestines from the cecal region by several moist sponges, we are convinced that the less material introduced into the peritoneal cavity the better. Even moist gauze injures the delicate superficial cells, which thereafter present a point of possible adhesion to another area as well as less of a barrier to bacteria. The appendix is then delivered into the wound, and its blood supply is investigated, the strategic attack in surgery always being directed toward control of the blood supply. The blood vessels lying in the mesentery are more elastic than their supporting tissue and tend to retract; therefore, in ligating such vessels it is best to transfix the mesentery with a curved needle, avoiding injury to the vessels. The vessel may be safely divided between securely tied ligatures, and the danger of its slipping out of a hemostat while being ligated is eliminated. The appendix is removed by the technic depicted in a later chapter, and the cecum is replaced in the abdominal cavity. Closure begins with a final inspection to detect hemorrhage from the relaxed mesentery of the appendix. In reapproximating the peritoneum a continuous catgut suture or interrupted silk sutures are used to evert the edges of the peritoneum. Successive bites of these sutures should include both the peritoneum and the transversalis fascia, thus ensuring the reapproximation of a large area of peritoneum reinforced by the strong layer of transversalis fascia.

With the peritoneum closed, the muscles fall together naturally, unless they were widely separated. Several loosely tied sutures may be placed to reapproximate, but not strangle, gaping muscles. The fascia overlaying the muscles, must, however, be carefully reapproximated with interrupted sutures.

Coaptation of the subcutaneous tissues is essential for a satisfactory cosmetic result. Well-approximated subcutaneous tissues permit the early removal of skin sutures and thus prevent the formation of a wide scar. Subcutaneous sutures are placed with a curved needle, taking large bites so that the wound is mounded upward and the skin edges are almost reapproximated. These sutures must be located so that both longitudinal and cross-sectional reapproximation is accurate. Overlapping or gaping of the skin at the ends of the wound may be avoided readily by care in suturing the subcutaneous layer.

The skin edges are brought together by interrupted sutures. If the subcutaneous tissues have been sutured properly, the skin sutures may be removed on the second or third postoperative day, resulting in a fine white line as the ultimate scar.

Finally, there must be proper dressing and support for the wound. If the wound is closed *per primam* and the procedure has been "clean," the wound should be sealed off, since for at least 48 hours it may be contaminated from without. It is our custom to place silver foil directly on the skin. This adheres well if the surface of the skin is first moistened with alcohol. Silver has bactericidal qualities and, in addition to sealing off the wound, inhibits bacterial growth from organisms present in the deeper layers of the skin. If the wound has been contaminated, but no drains have been used, we have found it wiser not to use skin sutures, although the subcutaneous tissues should be carefully approximated. Such a wound is best dressed with a pad wrung out in warm saline solution. Under such circumstances the by-products of infection escape easily, the moist dressing does not inhibit cell growth, and suppuration will not occur so frequently as when the skin is closed and the products of inflammation are locked within the subcutaneous tissue. When drains are utilized, moist saline dressings and a minimal closure of the skin are desirable for the same reasons. Chemotherapy and antibiotics have made it possible to effect primary closure in many more wounds.

The time and method of removal of skin sutures are important. In the ideal wound closure the approximation of the subcutaneous tissue should be so accurate that the skin sutures can be tied without tension and merely serve to hold the lips of the wound in apposition.

Lack of tension on the skin sutures and their early removal, often in 48 hours, eliminate ugly crosshatching and are especially desirable with wounds on exposed parts such as the face and neck. Also, in other parts of the body the same rule holds, and if the approximation has been satisfactory, all skin sutures should be out by the fifth to the seventh postoperative day. When tension sutures are used, the length of time the sutures remain depends entirely on the cause for their use; when the patients are elderly or cachectic or suffer from chronic cough, such sutures may be necessary for as long as 10 to 12 days.

The method of removal of sutures is important and is designed to avoid contamination of a clean wound with skin bacteria. At the time of removal the surgeon grasps the loose end of the thread, lifts the knot away from the skin by pulling out a little of the suture from beneath the epidermis, cuts the suture at a point which was beneath the skin, and pulls the suture free. Thus, no part of a suture which was on the outside of the skin will be drawn into the subcutaneous tissues, to cause an infection in the wound.

This example of the characteristics of a technic which permits the tissues to heal with the greatest rapidity and strength and which conserves all the normal cells demonstrates that the craftsmanship of a surgeon is of major importance to the safety of the patient. It emphasizes the fact that technical surgery is an art, which is properly expressed only when the surgeon is aware of its inherent dangers. The same principles underlie the simplest as well as the most serious and extensive operative procedure. The young surgeon who learns the basic precepts of asepsis, hemostasis, adequate exposure, and gentleness to tissues has mastered his most difficult lessons. Moreover, once the surgeon has acquired this attitude, his progress will continue, for he will be led to a histologic study of wounds where the real lessons of wound healing are strikingly visualized. It will also lead him to a constant search for better instruments until the surgeon emerges finally as an artist, not an artisan.

The surgeon who is unaccustomed to this form of surgery will be annoyed by the constant emphasis on gentleness and the time-consuming technic of innumerable interrupted sutures. However, if the surgeon is entirely honest, and if he wishes to close all his clean wounds *per primam,* thus contributing to the comfort and safety of his patient, he must utilize all the principles which have been outlined. He must use fine suture material—so fine that it breaks when such strain is put on it as will cut through living tissue. He must tie each vessel securely so that the critically important vessel will always be controlled. He must constantly avoid desiccation and all other forms of injury to tissues. He must practice asepsis. All this is largely a matter of conscience. To those who risk the life of others daily, it is a chief concern.

CHAPTER II · ANESTHESIA

The realm of surgery has become so broad that specialization in separate fields is commonly accepted as a proper limitation for good work. Anesthesia, at long last, has become a special field for endeavor, both as an art and as a science. This has resulted from the addition of new drugs and methods and from fundamental advances in physiology and pharmacology applicable to the anesthetized patient. New drugs have become available for inhalation, intravenous, spinal, and regional anesthesia. As an adjunct to anesthesia, drugs have been developed which produce muscular relaxation in the lightly anesthetized patient. Spinal and caudal anesthesia have been improved by the development of the continuous technic, and by more accurate methods of controlling the ascent of the drug. Anesthetic procedures for open chest surgery include the maintenance of an adequate airway and the prevention of mediastinal shift; the operative field remains quiet, and harmful alterations of circulatory and respiratory function are minimized. The importance of hypoxia and hypotension has been recognized, and means have become available for preventing or treating these undesirable alterations of physiology. A simple consideration of these developments in anesthesia makes it clear that the busy practicing surgeon cannot himself have expert knowledge of them all.

Since the number of trained physician anesthetists is very small, the greater share of surgery for many years to come will be performed by surgeons with colleagues or nurses as anesthetists. Thus, the surgeon will continue to carry full responsibility for the anesthesia, and he is driven logically to a sustained interest in further developments in this vitally important field. In practice we find that most surgeons confine their choice of anesthesia to a few drugs and methods with which they are personally familiar. This attitude may in some instances deprive an occasional patient of the most valuable anesthetic. The theoretical advantage of a new drug or technic, however, is largely offset by lack of familiarity with its details; in most cases the anesthetist should use a drug and method with which he is experienced and skilled. Only when the surgeon feels accountable will he acquaint himself with the indications and contraindications for the use of any given anesthetic. He will then make himself familiar with the injurious effects of anesthetic agents. He will evidence discretion in his choice of anesthesia for special fields, such as pulmonary, renal, and neurologic surgery. If his practice includes infants and children, the screaming of his little patients as they are put to sleep may encourage him to use a basal anesthetic in suitable cases. Thus, psychologic terror in the young will be removed, and the operating room will be a quiet place where important and serious tasks may be performed with equanimity. Moreover, when the surgeon has the entire responsibility for the anesthesia, he will observe more accurately its effects. He will learn to check the condition of the patient by observing the rate of pulsation in the blood vessels, the color of the blood, and the blood pressure as measured by the force and amount of bleeding from vessels. Such observations will be found to agree with the anesthesia chart and the opinion of the anesthetist.

Thus, it appears that in the long run it is beneficial to both the patient and the science of anesthesia for the surgeon to maintain a strong sense of responsibility for the anesthesia. It is this point of view which has caused us to present in this practical volume the following short outline of modern anesthetic principles. This outline makes no pretense of covering fully the physiologic, pharmacologic, and technical details of anesthesiology, but it offers to the surgeon some basic information of importance.

GENERAL CONSIDERATIONS. The prevention of anoxia is the most important function of the anesthetist. Severe anoxia may cause sudden disaster; anoxia of moderate degree may result in slower but equally disastrous consequences. Death or damage to vital organs may occur. Cyanosis is not a reliable index of adequate oxygenation. Anoxia may be caused by the administration of anesthetic gas mixtures containing less than 20 per cent oxygen; this should never be permitted. The most common cause of anoxia during operation is failure to maintain a clear airway, resulting in respiratory obstruction. The airway may be partially or completely occluded by the tongue, by foreign bodies, by secretions and vomitus, and by laryngeal spasm. Technical competence of the anesthetist is important in avoiding respiratory obstruction. When partial or complete respiratory obstruction is present, the effort of breathing is particularly harmful to the patient with pre-existing heart disease. In every operating room a person who is capable of performing direct laryngoscopy and of intubating the trachea should be present. The use of an endotracheal tube is the best, although not a complete, guarantee of a clear airway.

During the course of general anesthesia, suction should be employed to clear the respiratory passages of secretions. This should be done before the volume of secretions becomes great enough to interfere with the airway. Suction should also be employed at the conclusion of the operation and after the patient has been returned to bed. Every effort should be made to prevent aspiration of secretions or vomitus during and after surgery. The patient should be closely watched until the cough and swallowing reflexes return. The trachea and bronchi may be cleared whenever necessary by suction through an endotracheal tube, although bronchoscopic aspiration may occasionally be required. Careful cleansing of the tracheobronchial tree may do much to reduce the incidence of postoperative pulmonary complications.

Fluid therapy during the operative procedure is a joint responsibility of the surgeon and the anesthetist. Except in unusual circumstances, anemia, hemorrhage, and shock should be treated by blood transfusion preoperatively. During operation, transfusions should be given to equal or exceed slightly the blood loss. Plasma may be used in an emergency if whole blood is not available, but the possibility of transmitting infectious hepatitis makes it necessary to exercise caution in its administration. Intravenous infusions of normal saline should be limited in volume; dextrose in distilled water is the preferred preparation for intravenous administration during operation.

The position of the patient is an important factor both during and after operation. The operating table should be so placed that the benefit of natural lighting is made available to the surgeon whenever possible. The patient should be placed in a position which allows gravity to aid in obtaining optimal exposure. The most effective position for any procedure is the one which causes the viscera to gravitate away from the operative field. Proper position on the table allows adequate anatomic exposure without traumatic retraction and without the use of massive abdominal packs. With good muscular relaxation and unobstructed respiration, however, the use of exaggerated positions and prolonged elevation of rests becomes unnecessary. The surgeon should bear in mind the fact that extreme positions result in embarrassed respiration and harmful circulatory responses. When the surgical procedure is concluded, the patient should gradually be returned to the horizontal supine position; sufficient time should be allowed for the circulatory system to become stabilized. When an extreme position has been used, the patient should be returned to the normal position in several stages, with a rest period between each one. Abrupt changes in position or rough handling as the patient is returned to bed may result in unexpected circulatory collapse. After he is returned to bed, the patient should be closely watched until the circulation is stabilized.

In the surgery of infancy and childhood there are two general principles which concern all procedures: (1) hypnotics, such as morphine, must be used in small doses suited to the age of the patient; (2) a general anesthetic rendering the patient unconscious is almost essential. But exceptions occur: pyloromyotomy in infants may be satisfactorily accomplished under local anesthesia. Ether is usually safe, and rapid induction of anesthesia may be accomplished by the use of Vinethene. Avertin, because it removes the terror of an operating-room experience in the young, has proved a chief blessing in this field, but it is contraindicated when renal or hepatic damage is present. Avertin should be used as a basal anesthetic only, and should be supplemented by inhalation or local anesthesia. Pentothal Sodium by rectum may also be used for basal anesthesia, in a dose of 20 mg. per pound of body weight. Endotracheal intubation should not be routinely practiced on small children, because of the small caliber of their respiratory passages and because of the danger of producing laryngeal and tracheal edema.

In the aged patient we have a different picture. The amount of preoperative sedation should be carefully individualized for aged and malnourished persons; they usually require small doses. Local or regional anesthesia is frequently more desirable than general anesthesia. This is true partly because reason and education have submerged the natural fear, and partly because, in the aged, degenerative changes in the major systems are likely to be present, and therefore any general anesthetic may provoke greater changes than can be anticipated.

In surgery for the diabetic person, careful attention must be paid to the acid-base balance and glucose metabolism. Local, regional, and spinal

anesthesia produce minimal changes. If unconsciousness is desired, ethylene, cyclopropane, or nitrous oxide and oxygen with Pentothal may be used.

Small doses of Pentothal Sodium, given intravenously, provide a rapid and pleasant means of producing unconsciousness. This method may be used for induction of general anesthesia in most patients. It eliminates almost entirely the excitement stage often seen during ether induction.

Pentothal Sodium should be used as an anesthetic only for short minor surgical procedures. Nitrous oxide and oxygen in 50 per cent concentration should be administered when Pentothal anesthesia is used. This reduces the amount of Pentothal necessary, gives a smoother anesthetic, and provides an increased amount of oxygen for the patient.

Curare or a similar-acting drug should be used for those operations requiring muscular relaxation. It permits maintenance of the patient in a lighter plane of anesthesia and provides adequate muscular relaxation for the surgical procedure.

For local anesthesia it is desirable to use the most dilute solutions which can accomplish the task. In most instances 0.5 per cent procaine may be substituted for the 1 per cent solution. A 2 per cent solution of procaine should be used only for nerve blocks. The maximum safe dose of procaine is 1 Gm.; this corresponds to 50 cc. of 2 per cent, 100 cc. of 1 per cent, or 200 cc. of 0.5 per cent solution. The use of small amounts and dilute solutions will reduce the number and severity of reactions to local anesthetics. The addition of epinephrine to the procaine solution will prolong the duration of anesthesia, and reduce the incidence of toxic reactions. Regardless of the volume of anesthetic solution to be used, the total amount of epinephrine added should not exceed 0.5 cc. of 1:1,000 solution. If the anesthetic is to be injected into the digits, epinephrine should not be added because of the possibility of producing gangrene. Epinephrine is also contraindicated if the patient has hypertension, arteriosclerosis, or coronary or myocardial disease. If local infiltration is performed with an anesthetic containing epinephrine, vasoconstriction is produced in the operative field. After the operative procedure has been completed and the effect of the drug has worn off, bleeding may occur in the wound because of failure to ligate the previously constricted vessels.

CHOICE OF ANESTHESIA. The first consideration is the proposed operation—its site, magnitude, and duration, the amount of blood loss and shock to be expected, and the position of the patient on the operating table. The patient should then be studied in order to ascertain his ability to tolerate the surgical procedure and the anesthetic. Factors of importance are the age, weight, and general condition of the patient; the presence of acute infection, toxemia, chronic debility, dehydration, and malnutrition; alterations in physiology caused by the surgical condition, such as blood loss, shock, deranged acid-base balance, hypoxia, and low vital capacity; medical conditions either independent of or associated with the surgical lesion, such as heart disease, thyrotoxicosis, diabetes, anemia, arthritis, hypertension, nephritis, syphilis, tuberculosis, and hepatic diseases.

The previous experience of the patient and his prejudices regarding anesthesia should be considered. Some patients dread losing consciousness, fearing that they will never awaken; others wish for oblivion. Some patients, or their friends, have had unfortunate experiences with spinal anesthesia and are violently opposed to it. An occasional individual may be sensitive to local anesthetics or may have had a prolonged bout of vomiting following ether anesthesia. Whenever possible, the preference of the patient regarding the choice of anesthesia should be followed. If his method of choice is contraindicated, the reason should be carefully explained to the patient, and the procedure of preference should be outlined in such a way as to remove his fears.

Most patients prefer to be unconscious. One cannot dissociate mind and body, and to insist upon local or spinal anesthesia in a highly neurotic and apprehensive individual is to court trouble and perhaps disaster. If local or spinal anesthesia is to be used, psychic disturbance will be diminished and the anesthetic made more effective if it is preceded by adequate premedication. Local infiltration anesthesia is unwise in the presence of infection or a malignant tumor. The needle carrying the anesthetic may injure the tissues and thereby encourage the spread of infection. In the case of malignant tumor similar dissemination may occur; or the procedure, which should have been a radical operation, may be restricted to a bungling and dangerous biopsy. In infants and children, if a general anesthetic is safe, its use prevents much psychic trauma.

Combinations of drugs, formerly considered unwise, are now regarded as a safer method of producing anesthesia than complete reliance upon one drug for a given procedure. For example, morphine and scopolamine may be used for premedication. The patient may be rendered unconscious by administration of Pentothal Sodium, intravenously, light anesthesia then being maintained by cyclopropane and oxygen with a small amount of ether. Muscular relaxation may be obtained in this patient by administration of curare, intravenously, and after the peritoneum is closed the depth of anesthesia is reduced by changing to nitrous oxide and oxygen.

PRELIMINARY MEDICATION. The administration of preoperative medication is an essential part of the anesthetic procedure. The choice of premedication depends on the anesthetic to be used, and the dosage should vary with the age and the general psychic condition of the patient. Premedication should remove apprehension, reduce the metabolic rate, and raise the threshold to pain, and upon arriving in the operating suite the patient should be unconcerned and rested. Preanesthetic medication should begin with a sedative on the night before operation, so that the patient does not spend the night tossing about and worrying. If a general anesthetic is to be administered, morphine and atropine or scopolamine should be given subcutaneously one hour before the patient is brought to the operating suite. These drugs should be administered in a ratio of 25:1, an average dose in a healthy adult being morphine 0.010 Gm. (gr. 1/6) and atropine 0.0004 Gm. (gr. 1/150). The atropine or scopolamine serves a threefold purpose: it counteracts the respiratory depression caused by morphine; it reduces the buccal and bronchial secretions; and it reduces the vagal effect upon the heart. If local or regional anesthesia is to be used, a barbiturate should be included in the premedication, because it reduces the incidence and severity of reactions to local anesthetic drugs. If intravenous anesthesia is to be used, atropine should be administered to reduce secretions and to lessen the danger of laryngospasm.

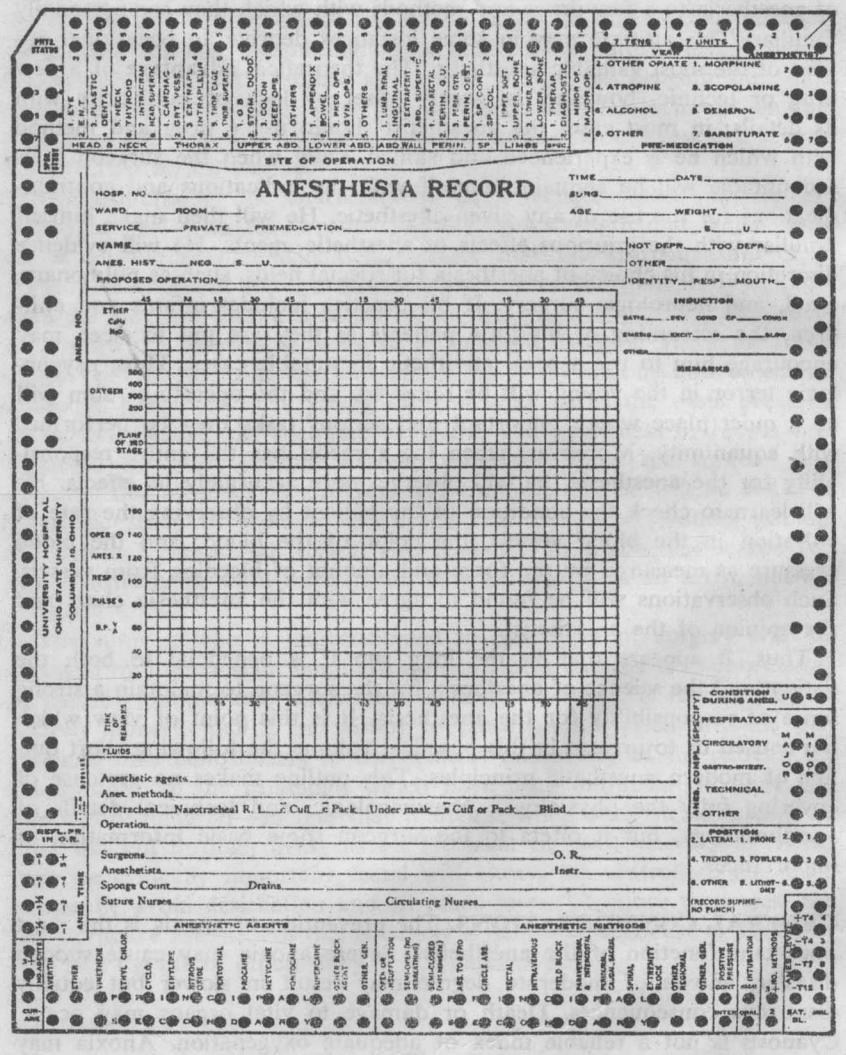


Figure 1

THE USE OF ANESTHESIA CHARTS. The use of an anesthesia chart is essential to every surgical procedure, no matter how simple the operation may be. The blood pressure and the pulse and respiratory rates should be recorded on this chart at definite time intervals. The anesthetic drugs and their doses and the methods used should be noted. The amount of blood loss, the type and quantity of fluids administered, and notes regarding the patient's condition should also be recorded. The chart should be started before the anesthesia is administered and should be continued after the operation, with the observations taken at longer in-

tervals until the patient is conscious. Nothing contributes so greatly to a full appreciation of the condition of the patient at any given time as the data on this chart. A glance at it will immediately show whether the condition of the patient is satisfactory; and the changes noted will predict what is to happen. Thus, catastrophe may be avoided.

In order to emphasize this point we are including reproductions of the front and back of widely used charts **(Figures 1 and 2).** The front page is written in duplicate, one sheet being placed on the patient's chart and the remainder of the record, on cardboard, being retained by the anesthetist for pre- and postoperative study of the patient. The punched holes along the sides facilitate statistical study of the anesthetic procedures.

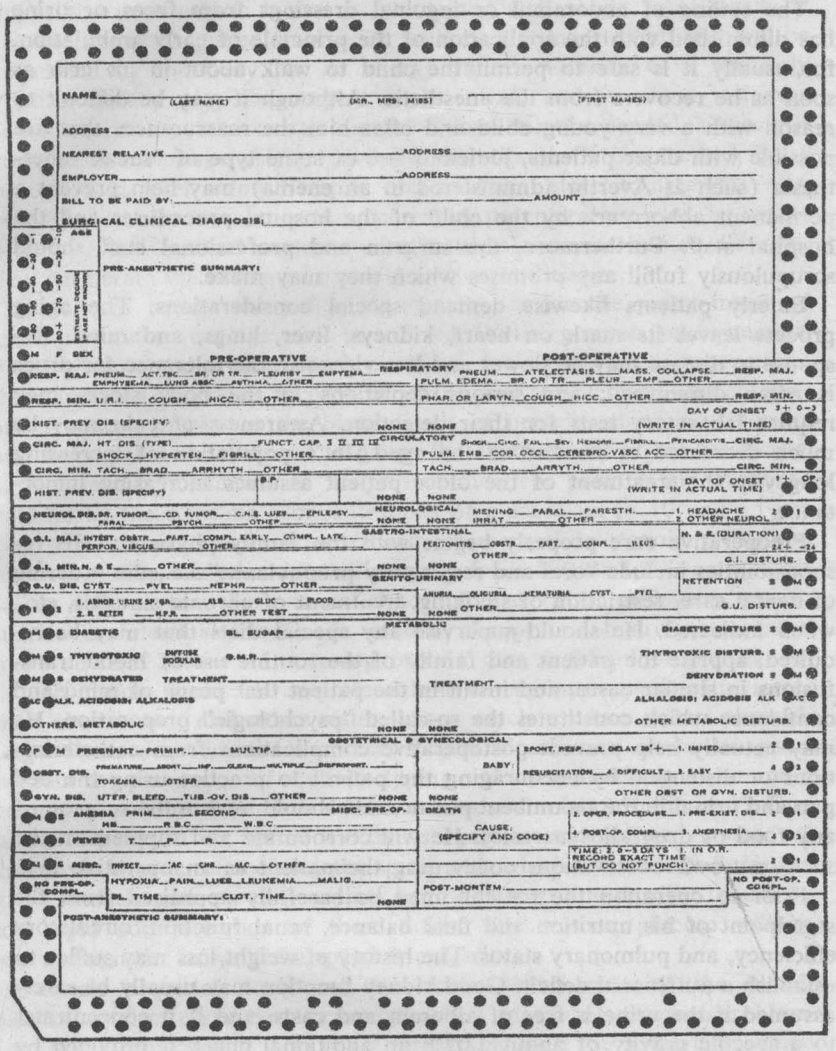


Figure 2

The patient is visited on the day before operation, and the record is prepared at that time by the anesthetist. The preoperative summary is filled out, information being obtained from the patient and his chart. At this time the patient is questioned about previous anesthetic experiences and drug sensitivities. The procedure to be followed is explained to him, he is reassured, and preoperative medication is ordered. The record contains the correct title of the procedure, which will assist the record room staff in those institutions where a proper listing is kept of surgical operations as well as of diagnosis. The notation of drains may save worry in the postoperative period when memory often plays one false.

ANESTHETICS RECOMMENDED IN SPECIAL FIELDS

I. Neurologic surgery
  A. Intracranial procedures
    1. For co-operative patients, local infiltration
    2. When unconsciousness is desirable, endotracheal anesthesia should be used for most patients because of possible difficulties with respiration. When cautery is to be used, Avertin or Pentothal Sodium combined with nitrous oxide and oxygen provide a nonexplosive, noninflammable anesthetic
    3. For children, Avertin supplemented by nitrous oxide and oxygen, or by ether
  B. Spinal procedures
    1. In the prone position endotracheal anesthesia assures a patent airway. Cyclopropane or ether and oxygen provide satisfactory anesthesia
    2. Local infiltration
  C. Operations on the peripheral nervous system
    1. No special indications or contraindications other than suiting the anesthesia to the disease and the condition of the patient
    2. Novocaine infiltration is undesirable in a nerve upon which a procedure is to be done, because of the distortion created by the edema

II. Thyroid surgery
  A. Good-risk patients, whether thyrotoxic or not
    1. Avertin supplemented by ether or cyclopropane is useful, especially for thyrotoxic patients
    2. The dose of Avertin should be greater with elevation of the basal metabolic rate—80 to 90 mg. per kilogram of body weight are satisfactory
  B. Poor-risk patients, i.e., serious thyrocardiacs, retrosternal goiter
    1. Novocaine 1 per cent infiltration is the anesthetic of choice
  C. Special-risk patients
    1. If tracheal compression exists, or if the trachea is deviated, an endotracheal tube should be passed beyond the area of pathology. This will prevent the occurrence of respiratory obstruction during the surgical procedure

III. Thoracic surgery
  A. Chest wall
    1. Breast. No special indication or contraindication. (Deep anesthesia with relaxation is unnecessary)
    2. Empyema
      a. Local infiltration
      b. If general anesthesia is desired, a high concentration of oxygen should be provided
    3. Collapse procedures for tuberculosis
      a. Cyclopropane and oxygen. Endotracheal intubation should be performed, so that secretions may be easily and promptly removed from the trachea and bronchi by means of a suction catheter passed through the tube
      b. Intercostal nerve block and local infiltration. These may be supplemented by Pentothal Sodium and nitrous oxide and oxygen
  B. Pulmonary surgery. Cyclopropane or ether and oxygen, using an apparatus which provides for positive pressure and controlled respiration
  C. Cardiac or pericardial surgery. Cyclopropane or ether and oxygen, using an apparatus which provides for positive pressure and controlled respiration. Procaine should be administered in a 0.1 per cent solution as an intravenous drip during the cardiac manipulations, and small amounts of 1 per cent procaine should be dropped upon the heart from time to time to minimize or prevent the occurrence of arrhythmias

IV. Abdominal surgery
  A. Upper abdominal
    1. Cyclopropane or ether and oxygen, supplemented by curare to provide relaxation. If an endotracheal tube is used, more satisfactory working conditions for the surgeon will be obtained
    2. Spinal or continuous spinal anesthesia. Nausea will be reduced and the patient's comfort increased if small amounts of Pentothal Sodium are administered from time to time
  B. Lower abdominal. General or spinal anesthesia
  C. Poor-risk patients
    1. Local infiltration with splanchnic nerve block
    2. If general anesthesia is desired, ethylene is the anesthetic of choice

V. Gynecologic surgery
  A. Abdominal procedures. General or spinal anesthesia
  B. Perineal procedures. Low spinal or general anesthesia

VI. Surgery of the extremities
  A. If general anesthesia is desired, Pentothal and nitrous oxide and oxygen, or cyclopropane and oxygen
  B. Brachial plexus block for surgery of the upper extremity
  C. Spinal anesthesia for surgery of the lower extremity
  D. Local infiltration
  E. Refrigeration for poor-risk patients

VII. Genito-urinary surgery
  A. Spinal or caudal anesthesia for bladder, prostate, urethral, and penile surgery
  B. Spinal anesthesia for kidney surgery
  C. Cyclopropane, or Pentothal and nitrous oxide and oxygen for those cases where unconsciousness is desired

CHAPTER III · PREOPERATIVE AND POSTOPERATIVE CARE

A little more than a century ago the advent of painless operations ushered in a new era of surgical practice. Before the days of anesthesia only great physical suffering or the certain knowledge of inevitable death would enable the patient to steel himself for the horrible ordeal of an operation. The knowledge that he could be rendered insensible during a surgical procedure by means of an anesthetic was of tremendous psychologic benefit to the patient, and it became a far easier task to persuade a stricken individual to undergo necessary surgery at a much earlier phase of his illness.

A few decades later, when the seeds planted by Lister and Pasteur had blossomed into a sound understanding of asepsis, the curse of inevitable infection was eliminated, and the day of "elective" surgery was born. Since that time constantly improving technics in both anesthesia and the control of sepsis have made it possible to execute safely ever bolder and more extensive surgical procedures.

For centuries the chief training of the surgeon was in anatomy, almost to the exclusion of other aspects of his art. With the increasing scope of surgery the unremitting efforts of the leaders of the profession to cut down the number of deaths and complications to the barest minimum led inevitably to the realization that a sound understanding of physiology was of equal importance to thorough grounding in anatomic relationships. This in turn created intense interest in the preoperative and postoperative care of the patient and in scientific methods to restore him to a normal physiologic state and maintain him in physiologic equilibrium.

The modern surgeon, therefore, is concerned not only with the proper technical conduct of an operative procedure but also with the general problem of the patient as a whole. He must try to bring the patient to operation in physiologic balance—the food reserves in their normal state, the intestines working normally, the respiratory tract free from infection, the circulation at its optimum efficiency, and the nervous system as undisturbed and peaceful as in daily life. The fact that this often appears to be an unattainable ideal must not deter the surgeon from striving constantly for its realization.

Only 40 years ago it was customary to deny the patient food and water for a day or more before the surgical ordeal, and to purge him deliberately. This was based on the assumption that postoperative vomiting and distention were less likely to occur when the intestines were empty. The potential dangers of dehydration and starvation were not understood; nor were tests available for the determination of the levels of the normal constituents of the blood serum. Measures of circulatory efficiency, blood volume, and accurate fluid and electrolytic balance had not been established. The surgeon of today is much better equipped for assaying the physiologic status of the patient, and he devotes himself to correcting the abnormalities which he detects.

On the other hand, there is little doubt that sins of commission may be just as unfortunate as the sins of omission. It is often noted that a healthy patient who suddenly becomes the victim of an accident, and who requires immediate operation without preparation, frequently suffers a minimum of postoperative discomfort. It is likewise well recognized that a long period of hospitalization before surgery, particularly if it involves rest in bed, may be undesirable. The fact that a patient with a simple hernia can tolerate with impunity a preoperative regimen involving a change in diet, enemas, and rest in bed does not justify the unnecessary use of such preparation.

The surgeon should remember that the body spontaneously endeavors to repair the physical vicissitudes by which man is beset, and he should attempt to assist the natural physiologic processes; contrariwise, he should not arbitrarily attempt therapy without reference to the fundamental physiologic reactions of the body.

PREOPERATIVE CARE. Although every patient must be individualized, certain groups of patients will have characteristics in common. The extremes of life are an example. Infants and children are characterized by the rapidity of their reactions; they are more likely to show explosive response to infections; they are more easily and quickly thrown out of equilibrium with restriction of food or water intake; they are more susceptible to contagious diseases that may be contracted during a long hospitalization. Conversely, the healing processes are swifter, and there is a quicker restoration to normal health. A greater proportion of the body weight is made up of fluids in infants and very young children than in the adult. They require, therefore, proportionately more fluid. The dehydrated infant will require 3 to 4 oz. of fluid per pound of body weight per day. Two thirds of the required amount may be given as normal saline and may be administered subcutaneously; one third may be given as 5 per cent glucose in distilled water by the intravenous route. If the plasma protein level is low, or anemia is marked, or oral feedings must be postponed for longer than a few days, plasma or whole blood transfusions may be given in the ratio of 10 cc. per pound of body weight per day.

The soiling of abdominal or inguinal dressings from feces or urine has diminished with the application of the principle of early ambulation, for usually it is safe to permit the child to walk about in his crib as soon as he recovers from the anesthetic. Although it may be difficult to reason with a very young child and offer him the reassurances that are possible with older patients, judicious use of some type of "sneak" anesthesia (such as Avertin administered in an enema) may help prevent a permanent abhorrence by the child of the hospital procedures and the hospital staff. Furthermore, the surgeon and professional staff should scrupulously fulfill any promises which they may make.

Elderly patients likewise demand special considerations. The aging process leaves its mark on heart, kidneys, liver, lungs, and mind. Response to disease may be slower and less vigorous; the tolerance for drugs is often diminished; and serious depletions in the body stores may require laboratory tests for their detection. Awareness of pain may be much decreased or masked in the aged. In a population of increasing longevity the treatment of the older patient assumes increasing importance.

Preoperative care properly begins with the family physician. His responsibilities include "oral and respiratory prophylaxis," i.e., the ordering of dental care, restriction of smoking, treatment of chronic sinusitis, etc., when indicated. He should supervise any special diets that may be required, apprise the patient and family of the routine use of blood transfusions in similar cases, and instill in the patient that peace of mind and confidence which constitutes the so-called "psychologic" preparation. He may actually help prevent postoperative complications from catheterizations or distention by encouraging the patient to practice using the bed pan and urinal in the recumbent posture. He should inform the surgeon of any food or drug idiosyncrasies. He will corroborate and supplement the surgeon's own observations concerning the patient as an operative risk.

Prior to operation the patient must be carefully appraised from the standpoint of his nutrition and fluid balance, renal function, circulatory efficiency, and pulmonary status. The history of weight loss may suffice to establish a nutritional deficit. Good kidney function may usually be safely assumed if the urine is free of albumin and casts, and if it concentrates to a specific gravity of about 1.020; an additional check is provided by the level of the blood urea nitrogen and nonprotein nitrogen. The vital capacity furnishes a rough-and-ready check of both cardiac and pulmonary function, since a rather marked decrease will accompany any pronounced loss of efficiency of either. In addition a preoperative X ray of the chest is usually advisable in patients requiring major surgery. Malnourished patients or those facing formidable procedures should have a plasma protein determination, in addition to the routine blood and urine studies carried out on every patient. Any departure from the norm disclosed by the history, physical examination, or the various procedures enumerated above may call for further investigation and will suggest the type of preoperative preparation required. The surgeon should not hesitate to seek the assistance of the internist in the evaluation of the poor-risk patient and in the regulation of constitutional disorders such as diabetes, chronic nephritis, or congestive heart failure. The anesthesiologist should also be given the opportunity to interview patients with serious constitutional disease, as well as those needing extensive surgery; the choice of anesthesia in such patients is an exacting problem, and an ill-considered decision may have fatal consequences.

Chronic malnutrition is to be assumed in every patient who has lost weight, who has long-standing sepsis, or who is the victim of a deep-seated malignancy. It is an almost invariable accompaniment of gastrointestinal carcinoma. One must remember that dehydration or hemoconcentration may mask an anemia or hypoproteinemia; a determination of the blood volume may assist in exposure of the true situation. Furthermore, an occasional patient will accumulate edema fluid—especially ascites—at such a rate that there will be no change in total body weight, although the patient is actually starving.

Malnutrition results in depletion of liver glycogen, exhaustion of tissue protein, and ultimately in clinical vitamin deficiencies. Its successful correction requires painstaking attention to many details and may tax to the utmost the resources of the surgeon. Alimentary feedings are always preferable to parenteral feedings. In some patients who cannot eat, the appropriate high-protein, high-calorie, high-vitamin diet may be given by gastric gavage, or a gastrostomy or high jejunostomy may be done for feeding purposes. Although about ½ Gm. protein per pound of body weight is the average daily requirement of the healthy adult, frequently it is necessary to double this figure to achieve a positive nitrogen balance and protect the tissues from the strain of a surgical procedure and a long anesthesia. The administered protein may not be assimilated as such unless the total caloric intake is maintained well above basal levels. If calories are not supplied from other sources, the ingested protein will be consumed by the body for its energy values. Vitamin C is the only vitamin usually requiring urgent replacement, and in some instances (severe burns are one example) massive doses may be needed. Vitamin-B complex is advantageously given daily, and vitamin K is indicated if the prothrombin level is low. Despite oral feedings, blood transfusions may be needed to correct anemia. Supplementary parenteral proteins, by means of any of the standard protein hydrolysates, plasma, or human albumin, may accelerate the return of a positive nitrogen balance.

If for any reason the patient cannot be fed via the gastro-intestinal tract, parenteral feedings must be utilized. Water, glucose, salt, vitamins, blood plasma, and protein hydrolysates are the elements which constitute these feedings. Accurate records of intake and output are indispensable, and frequent checks on the blood levels of protein, albumin, chloride, and hemoglobin are essential to gauge the effectiveness of the treatment. It is exceedingly difficult to administer sufficient protein and sufficient calories by these means. Concentrations of glucose up to 10 and 15 per cent will deliver extra calories. One must be careful to avoid giving too much salt. The average adult will require from 500 to 1,000 cc. normal saline daily unless there is an abnormal loss of chlorides by gastric suction or intestinal fistulae. In general, the protein hydrolysates are a more efficient means of restoring protein than is blood or plasma, although plasma is considered preferable in severe burns, peritonitis, intestinal obstruction, and other states where much exudate is lost through large diseased or injured surfaces. Whole blood must never be given without the precaution of accurate typing and cross-matching. A common error is to give too little. It is desirable to raise the hemoglobin to 12 Gm. or more per 100 cc. before elective surgery is undertaken. A word of caution is in order concerning the speed with which intravenous fluids are given: elderly patients and cardiacs can be thrown into cardiac failure by too rapid administration of these fluids; furthermore, glucose will be lost through the urine if the speed is excessive.

Patients requiring treatment for acute disturbances of the blood, plasma, or electrolytic equilibrium present a somewhat different problem. Immediate replacement is in order, preferably with the substances which are being lost. Thus, in shock from hemorrhage, replacement should be made with blood. In severe burns, plasma and blood are in order. In vomiting, diarrhea, and dehydration, water and electrolytes will often suffice. If acidosis is present, sixth molar sodium lactate may be useful. Evidences of restoration toward normal blood volume and electrolytic balance are to be found in an increase in the urine output, return of the hematocrit toward normal, correction of acidosis, and the appearance of chlorides in the urine.

Chemotherapeutic and antibiotic agents have proved their usefulness in the preparation of the patient whose condition is complicated by infection or who faces an operation where infection is an unavoidable risk. Thus, a day or two of intensive therapy may be desirable before operations upon the lung, and four or five days of treatment with certain oral preparations diminish the bacterial flora of the feces and render resections of the large bowel more safe. The beneficial action of these agents must not give the surgeon a false sense of security, for in no sense are they substitutes for good surgical technic and the practice of sound surgical principles.

The forehanded surgeon will assure himself of a more than adequate supply of properly cross-matched blood at the time of operation. Each surgeon should familiarize himself with the estimated blood loss of the average patient during extensive procedures, so that he can estimate the probable amount required for any replacement in any given operation. In major procedures, such as abdominoperineal resection, between 1,000 and 1,500 cc. blood are required to replace the loss.

Finally, the surgeon should forewarn the nursing staff of the expected condition of the patient after operation. This will assist them in having necessary oxygen, aspirating apparatus, syphonage devices, etc., at the patient's bedside upon his return from the operating room.

POSTOPERATIVE CARE. Postoperative care begins in the operating room with the completion of the operative procedure. The objective, like that of preoperative care, is to maintain the patient in a normal state. Ideally, complications are anticipated and prevented. This requires a thorough understanding of those complications which may follow surgical procedures in general and those most likely to follow specific diseases or procedures.

In the operating room the surgeon is well advised to consider the possible benefit to the patient of the injection of a local anesthetic agent in oil into the lower intercostal nerves. This simple procedure is especially advantageous after operations in the upper abdomen; the resulting analgesia of the wound allows more efficient coughing and exercise and reduces the amount of narcosis usually required.

The unconscious patient or the patient still helpless from a spinal anesthesia requires special consideration. He must be carefully lifted from table to bed without unnecessary buckling of the spine or dragging of flaccid limbs. The optimum position in bed will vary with the individual case. Patients who have had operations about the nose or mouth should be in bed face down; in some instances, even better protection against aspiration of mucus, blood, or vomitus is provided by elevating the foot of the bed. Major shifts in position after long operations are to be avoided until the patient has regained consciousness; experience has shown that such changes are badly tolerated. After the recovery of consciousness most patients who have had abdominal operations will be more comfortable with the head slightly elevated and the thighs and knees slightly flexed. Patients who have had a spinal anesthesia are ordinarily kept flat in bed for four to six hours to minimize postanesthetic headache.

Postoperative pain is controlled by the judicious use of narcotics. It is a serious error to administer too much morphine. This will lower both the rate and amplitude of the respiratory excursions, and thus encourage pulmonary atelectasis. The very young, the elderly, the debilitated, and those with liver disease or myxedema, require proportionately less narcosis. It is better to start with a small dose and repeat it in a short time if necessary than to snow the patient under with an overdose.

As long as the patient requires parenteral fluids, accurate recording of the intake and output is essential for scientific regulation of water and electrolytes. Immediately after surgery the blood volume of the patient should be returned to normal by additional transfusions if necessary. Then, the daily amount and type of fluid to be given depends upon the condition of the patient before operation, the drainage (i.e., loss through colostomy or biliary fistula), and the loss by vaporization through skin and lungs. The amount excreted by vaporization varies with the temperature and ranges between 1,500 cc. and 2,000 cc. daily. In the average healthy adult the urinary output should lie between 1,000 and 1,500 cc. daily.

It is a common error to administer too much salt in the form of normal saline in the immediate postoperative period. From 6 to 10 Gm. sodium chloride satisfy the daily requirement, unless there is unusual loss from vomiting or drainage. This is provided by 1,000 cc. or less of physiologic saline. The remainder of the parenteral intake should be glucose and distilled water, or protein hydrolysates, as the nutritional requirements of the patient dictate. One hundred grams of amino acids as hydrolyzed protein (5 per cent) and 5 per cent glucose in distilled water may be given. If it is desired to increase the calories, the hydrolysates (5 per cent) combined with 300 Gm. glucose (15 per cent) may be used in 2,000 cc. distilled water. Additional glucose in water or saline may be used to increase the urinary output or the total caloric intake.

The surgeon should interest himself in the details of the patient's diet. Prolonged starvation is to be avoided. On the first day the diet may need to be restricted to toast and clear liquids such as tea. Fruit juices may increase abdominal distention and are best omitted until the third postoperative day. In a convalescence proceeding normally, a 2,500-calorie diet with 100 Gm. protein may be started on the second postoperative day.

Constant gastro-intestinal suction will ordinarily be employed after operations upon the esophagus, resections of the gastro-intestinal tract, and in the presence of peritonitis, ileus, or intestinal obstruction. For peritonitis, intestinal obstruction, or large bowel resections, a long tube of the Miller-Abbott type is preferred. The tube is usually kept in place for two to five days and removed as normal bowel function returns; this will be evidenced by resumption of peristalsis and the passage of flatus. It must be remembered that the fluid removed by suction will affect the fluid and electrolytic balance, and must be considered in the daily calculations for fluid requirements.

No set rule can be laid down for the particular time at which a patient is to be permitted out of bed. The tendency at present is to have the patient ambulatory at the earliest possible moment, and most patients

may be allowed out of bed on the first day after operation. A longer period of rest may be essential in patients who have recently been in shock, who suffer from severe infection, cardiac insufficiency, cachexia, severe anemia, or thrombophlebitis. The principle of early ambulation has unquestionably speeded up the recovery period, accelerated the desire and tolerance for food, and probably decreased the incidence or severity of respiratory complications.

The surgeon should distinguish between *ambulation* and sitting in a chair; the latter may actually favor deep venous thrombosis. Every surgeon should establish a method of assisting patients out of bed and teach these principles to those responsible for the bedside care. On the evening of operation the patient is encouraged to sit on the edge of the bed, kick his legs, and cough. He is urged to change his position in bed frequently and move his legs and feet. The following day he is turned on his side (wound site down) with the hips and knees flexed. This brings the knees to the edge of the bed, and an assistant then helps him to raise himself sideways to a sitting position as his feet and lower legs fall over the side of the bed. He then swings his legs, and moves his feet, stands erect, and breathes deeply and coughs several times. Following this he takes 8 or 10 steps and sits in a chair for 10 minutes. He returns to bed by a reversal of the foregoing steps. Once he has been up, he is encouraged at first to get up twice daily, and later on, to be up and walking as much as his condition permits.

It is helpful to determine the vital capacity and to measure the circumference of the calves daily. Sharp changes in the vital capacity may give a clue to impending complications of a pulmonary nature or in proximity to the chest wall or diaphragm. Increase in calf circumference may be due to the edema of an otherwise unsuspected deep venous thrombosis. The measurement of the calves should go hand in hand with daily palpation of the calves and adductor canals for tenderness.

With the occurrence of a deep venous thrombosis, corrective therapy may be instituted at once, and disabling or fatal pulmonary embolism may be avoided. Anticoagulant therapy and/or interruption of the involved veins are practiced by surgeons of repute in the treatment of deep venous thrombosis of the legs. Thrombosis is always to be considered as a potential complication; it appears to be commoner in elderly and obese individuals, in infective states, and in malignant disease. Early ambulation has not eradicated this dreaded complication.

It is also desirable to weigh patients frequently—daily if there is a problem in nutrition or fluid balance, and twice weekly otherwise. This will portray the general trend and may stimulate more efficient feeding or a search for hidden edema in the case of too rapid gain.

Disruption of abdominal wounds is fortunately infrequent. It is more common in patients who have had extensive surgery for carcinoma or obstructive jaundice. Contributing factors may be vitamin-C deficiency, hyproproteinemia, vomiting, abdominal distention, or wound infection. The disruption is rarely recognized before the seventh day, and is exceedingly rare after the seventeenth and eighteenth days. A sudden discharge from the wound of a large amount of pinkish serum is practically pathognomonic of dehiscence. Investigation may disclose a protruding loop of bowel or merely lack of healing of the walls of the wound. The proper treatment consists of replacing viscera under sterile conditions in the operating room, and closure of the wound by through-and-through interrupted sutures of fine or heavy silk (as described in Plate XXVI).

The surgeon must assume the responsibility for all untoward events occurring in the postoperative period. This attitude is necessary for progress. Too often surgeons are content to explain a complication on the basis of extraneous influences. Although the surgeon may feel blameless in the occurrence of a cerebral thrombosis or a coronary occlusion, it is inescapable that the complication did not arise until the operation was performed. Only as the surgeon recognizes that the sequelae of surgery, good and bad, are the direct results of preoperative preparation, the performance of the operative procedure, or postoperative care will he improve his care of the patient and prevent the avoidable complications.

PLATE I · TONSILLECTOMY AND ADENOIDECTOMY

INDICATIONS. Tonsillectomy with adenoidectomy is indicated when there is a history of (1) repeated attacks of tonsillitis; (2) repeated attacks of cervical adenitis; (3) tuberculosis of the cervical lymph nodes; or (4) an attack of peritonsillar abscess. Other indications are (5) simple hypertrophy of the tonsils and adenoids to such a degree that there is interference with any of the following functions: swallowing, speech, nasal respiration, or hearing (conduction deafness in children); (6) in chronic carriers of virulent diphtheria bacilli; and (7) in any instance demanding the removal of all foci of infection when there is evidence of chronic local disease manifested by palpable cervical lymph nodes, occluded tonsillar crypts, injection of the mucous membrane covering the tonsils and anterior pillars, and repeatedly positive throat cultures for pathogenic organisms.

Adenoidectomy alone is done chiefly in infants and children under the age of three. Indications are (1) repeated attacks of otitis media; (2) interference with breathing through the nose; or (3) repeated attacks of sinusitis.

Operations on the tonsils and adenoids are not performed (1) in the presence of any acute infection; (2) in the acute phase of rheumatic fever, chorea, nephritis, arthritis, or during the incubation period following exposure to an infectious disease when the patient is known to have no immunity to it; (3) in the blood dyscrasias or any condition likely to be associated with excessive bleeding; (4) when poliomyelitis is epidemic.

PREOPERATIVE PREPARATION. Infection about the mouth or teeth should be cleared up before operation. The condition of the teeth should be noted carefully and recorded. When doubt exists as to the presence of active infection in the tonsils and adenoids, the administration of antibiotics and chemotherapy may be started 48 hours before operation.

ANESTHESIA. Local anesthesia may be employed for tonsillectomy, using Novocaine with Adrenalin. The Novocaine is injected into the three different points on either anterior pillar indicated by "x" in **Figure 5.** For children, and for adults when the adenoids are also to be removed, general anesthesia is preferred. Induction with intravenous Pentothal Sodium is satisfactory for adults, and Vinethene or Avertin is suitable for children. Open-drop ether is used to attain the second plane of surgical anesthesia. Ether vapor is then blown into the patient's mouth by means of an insufflation device connected to the mouth gag or to a small, metal mouthpiece **(Figures 2, 4, and 5).** For adults endotracheal anesthesia is preferred, since it provides a clear airway and permits the throat to be packed so that aspiration of blood is avoided.

POSITION. When general anesthesia is used, the operating table should be tilted so that the lower extremities are elevated about 1 ft. above the head. The patient's head rests on a small rubber ring, or "doughnut," to give stability **(Figure 1).**

OPERATIVE PREPARATION. Asepsis is not possible in throat operations; however, care is taken to prevent the introduction of pathogenic organisms. The skin of the face about the mouth is cleaned with a nonirritating antiseptic solution. The eyes should be protected by covering them with an oblong of moistened cotton batting. A towel is placed over the head and face to the vermilion border of the upper lip, and another towel is placed over the chest to the vermilion border of the lower lip.

EXPOSURE AND INCISION. The mouth gag is inserted carefully and deliberately in order to prevent injury to the lips, teeth, and tongue. The gag is then opened slightly so that the position may be determined, and the patient's respirations are observed. At the beginning of the operation, the tongue blade of the mouth gag is placed in the mid-line of the tongue. The handle of the mouth gag is held by the anesthetist with the hand under the drapes **(Figure 2).** Later, after first closing the gag, the blade may be shifted to one side or the other to give better visibility. When the drapes have been applied and the procedure is about to begin, the gag is opened as far as the easy compressibility of the tongue will allow, and then closed about 1 to 2 cm. to prevent undue stretching of the tissues. Great care is taken to avoid hyperextension or suspension of the head by means of the mouth gag, since this may result in avulsion of the front teeth, dislocation of the lower jaw, trauma to the cervical vertebrae, or damage to the soft palate or pillars.

Some operators prefer to remove the adenoids first. The surgeon palpates the adenoid mass and, with the finger, separates any adhesions which may exist between the lateral edges of the mass and the Eustachian bullae. A curet which will pass between the bullae is placed over the mass, with the dull edge against the most superior portion of the nasal septum **(Figure 3).** Firm, deliberate pressure is applied downward and then toward the patient's spine to remove the mass. Suction is applied immediately, as bleeding is usually profuse. The nasopharynx is again palpated, and any remnants of lymphoid tissue are removed by further curettage. After removing blood clots with suction, the nasopharynx is packed firmly with a sponge to which a string is attached **(Figure 4).** This packing is not removed until the tonsillectomy has been accomplished, by which time hemostasis is usually complete.

The tonsil is grasped with a tenaculum and rotated laterally to expose the posterior pillar; it is then pulled toward the mid-line to expose the plica semilunaris **(Figure 6).** With a retractor held by the assistant, gentle tension is applied to the anterior pillar; this aids in the exposure. An incision is made through the mucous membrane from the edge of the posterior pillar around the upper pole and down the edge of the anterior pillar to the edge of the tongue **(Figure 7).** If the plica semilunaris does not contain lymphoid tissue, it need not be included in the incision.

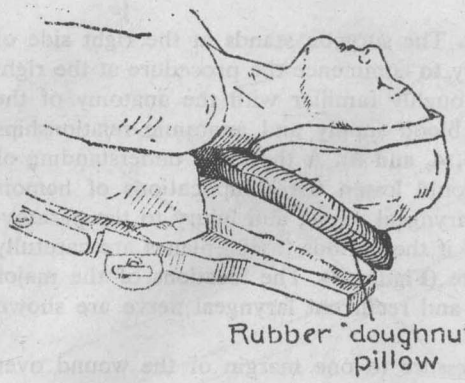
DETAILS OF PROCEDURE. The upper pole is dissected free by grasping the areolar tissue at its attachment to the tonsil, with angled scissors slightly opened, and by pushing the tip of the scissors smartly toward the fossa **(Figure 8).** The tenaculum is then readjusted to take in part of the newly exposed surface of the tonsil, and the position of the retractor is altered to improve visibility **(Figure 9).** The dissection is continued until the main body of the tonsil is freed and the attachment of the tonsillopharyngeus muscle, at the juncture of the lower pole with the intratonsillar lymphoid tissue, is encountered. The mucous membrane of the posterior pillar is then dissected away from the tonsil to as near the edge of the tongue as possible. **(Figure 9).** Keeping close to the capsule of the tonsil, the muscular attachments are then severed by sharp and blunt dissection until the edge of the tongue is reached **(Figure 10).** A snare is fitted over the dissected tonsil, flush with the edge of the tongue, and then slowly tightened to separate it from the final attachments **(Figure 11).** The fossa is then sponged and inspected for bleeding vessels **(Figure 12).** If bleeding is not controlled by a sponge held tightly over the bleeding point, the vessel is grasped with a tonsil hemostat, and an 000 plain catgut suture, on a small, round needle is passed through the tissue behind the clamp and then in front of the clamp and tied **(Figures 13, A; B; and C).** Should bleeding prove troublesome at any time during the course of the procedure, before removal of the tonsil, the fossa may be packed with a sponge and the tonsil held tightly against it for several minutes. If this does not control the bleeding, the vessel may be grasped with a clamp and sutured after removal of the tonsil. At the conclusion of the procedure the fossae are inspected, and the nose is carefully suctioned with a catheter to remove blood clots. The string sponge in the nasopharynx is removed along with the drapes and mouth gag. The lips of the patient are covered with cold cream or petrolatum.

POSTOPERATIVE CARE. To prevent aspiration of blood and mucus, the patient is placed in bed in a prone position with the face turned to one side. A sandbag or pillow is placed under the shoulder toward which the face is turned, to allow uninhibited respiratory excursion. To prevent dehydration, fluids should be given on the first postoperative day and continued until the throat is comfortable. An ice collar will often decrease the discomfort. Bleeding within the first 24 hours may require general anesthesia and suturing of the bleeding vessel, if packing and other local measures are not promptly successful. Chemotherapy and antibiotics are given in the presence of infection. The patient is maintained on a soft diet until a regular diet can be tolerated. Aspergum or some similar preparation may alleviate discomfort.

PLATE I

TONSILLECTOMY AND ADENOIDECTOMY

1



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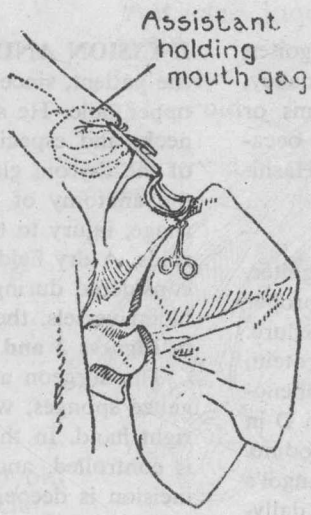

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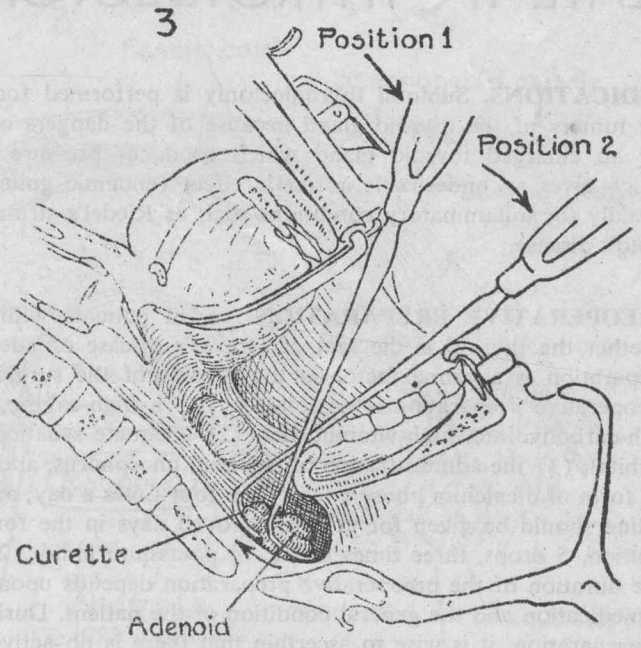

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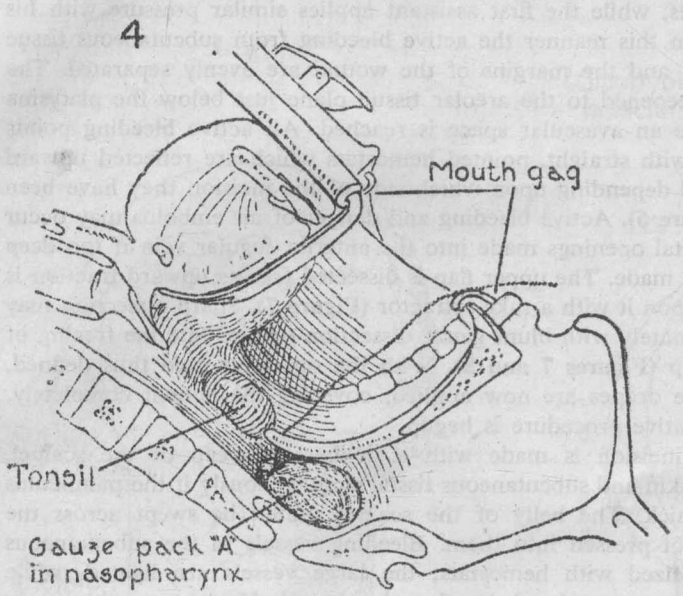

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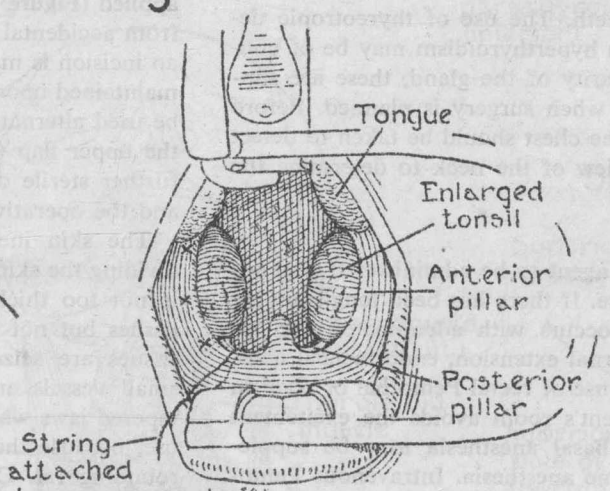

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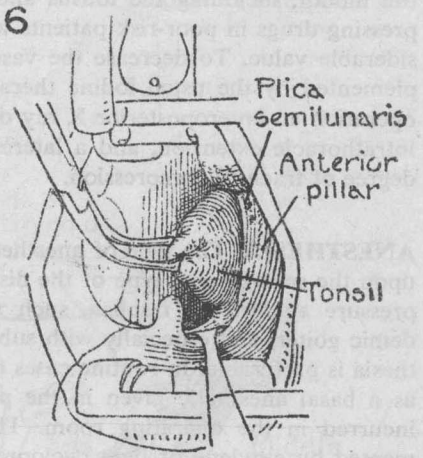

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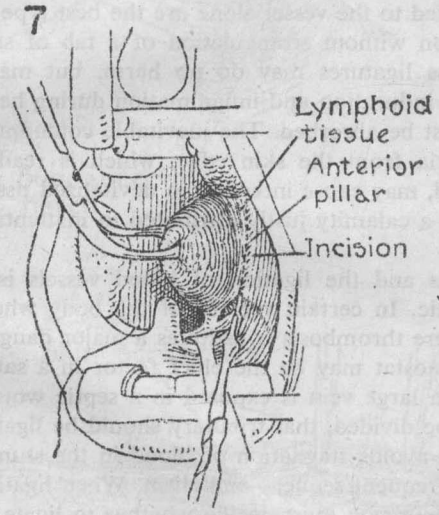

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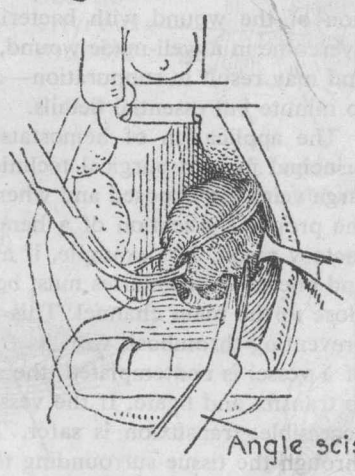

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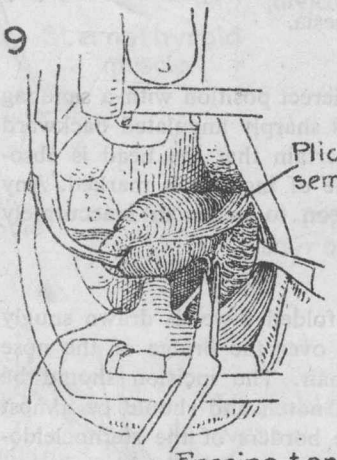

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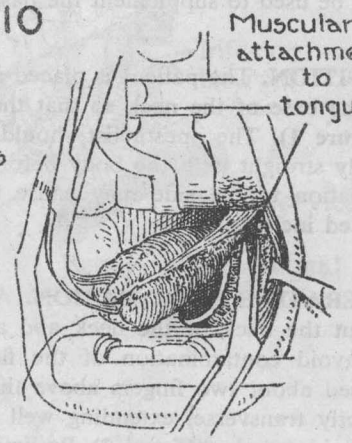

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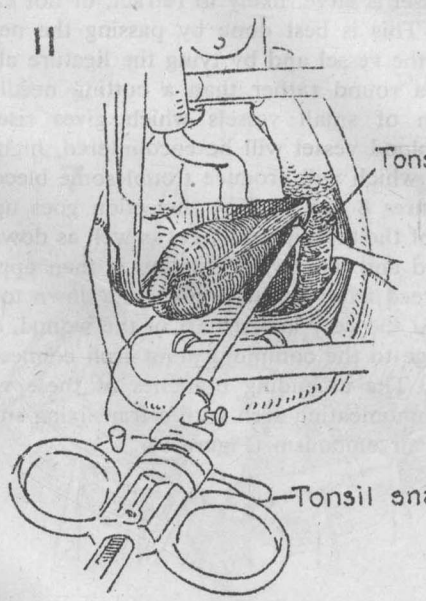

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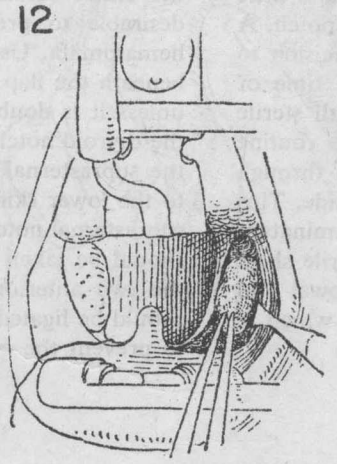

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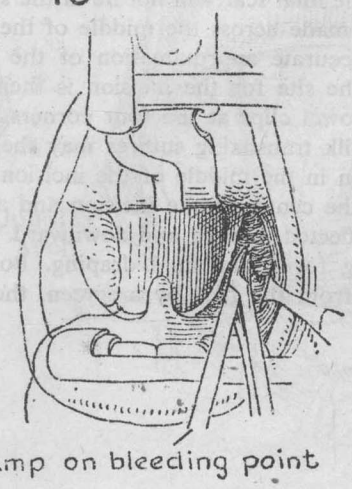

Figure of 8 suture

PLATE II · THYROIDECTOMY, SUBTOTAL

INDICATIONS. Subtotal thyroidectomy is performed for toxic goiter, for tumors of the thyroid gland because of the dangers of malignancy, for an enlarged thyroid gland which produces pressure symptoms or which gives an undesirable cosmetic effect (endemic goiter), and occasionally for inflammatory conditions such as Riedel's struma and Hashimoto's disease.

PREOPERATIVE PREPARATION. In all patients with toxic goiter, whether the thyroid is the seat of Graves's disease or adenoma, proper preparation is a prime factor in the success of the surgical procedure. Preoperative preparation is as follows: (1) a high-calorie, high-protein, high-carbohydrate, high-vitamin diet; (2) adequate sedation with phenobarbital; (3) the administration of calcium, phosphorus, and vitamin D in the form of dicalcium phosphate, 1 Gm. four times a day; and (4) iodine. Iodine should be given for at least 8 to 10 days in the form of Lugol's solution, 5 drops, three times a day, or potassium iodide, 225 mg. daily. The duration of the preoperative preparation depends upon the response to medication and the general condition of the patient. During the period of preparation, it is wise to ascertain that there is no active infection of the mouth, including the tonsils and teeth. The use of thyreotropic depressing drugs in poor-risk patients with hyperthyroidism may be of considerable value. To decrease the vascularity of the gland, these are supplemented by the usual iodine therapy when surgery is planned. Before operation an anteroposterior X ray of the chest should be taken to detect intrathoracic extension, and a lateral view of the neck to determine the degree of tracheal compression.

ANESTHESIA. The type of anesthetic agent to be administered depends upon the severity and type of the disease. If there has been long-standing pressure against the trachea, such as occurs with adenomatous or endemic goiter, and especially with substernal extension, endotracheal anesthesia is preferable. In routine cases the use of rectal Pentothal or Avertin as a basal anesthetic given in the patient's room avoids the excitement incurred in the operating room. The basal anesthesia may be supplemented by ethylene or light cyclopropane anesthesia. Intravenous Pentothal in small doses, plus nitrous oxide and oxygen in equal amounts, may also be used to supplement the basal anesthesia.

POSITION. The patient is placed in a semierect position with a sandbag at the base of the neck so that the head is sharply angulated backward **(Figure 1).** The anesthetist should make certain that the head is absolutely straight with the body before the line of incision is marked. Any deviation to the side may cause the surgeon to make an inaccurately placed incision.

OPERATIVE PREPARATION. A moist, folded towel is drawn snugly about the back of the neck and anchored over the bridge of the nose to avoid contamination of the field by hair. The incision should be placed about two fingers above the sternal notch and should be almost exactly transverse, extending well onto the borders of the sternocleidomastoid muscles **(Figure 2).** Preliminary to scratching the incision, it may be accurately outlined by compressing a heavy silk thread against the skin. In the presence of large goiters the incision should be made a little higher in order that the final scar will not lie in the suprasternal notch. A crosshatch should be made across the middle of the outlined incision to provide a guide to accurate approximation of the skin at the time of closure **(Figure 2).** The site for the incision is then draped with sterile towels secured with towel clips at the four corners, similar to a routine abdominal draping. Silk transfixing sutures may then be placed through the towel into the skin in the middle of the incision on either side. This secures the towel at the center of the incision and avoids contamination when the flaps are reflected upward and downward. A large sterile sheet with an oval opening forms the final draping. Both upper towel and sheet are held away from the face by a screen, the height of which is easily adjusted.

INCISION AND EXPOSURE. The surgeon stands at the right side of the patient, since it is customary to commence the procedure at the right upper pole. He should be thoroughly familiar with the anatomy of the neck, and especially with the blood supply and anatomic relationships of the thyroid gland **(Figures 3, 4, and 5).** A thorough understanding of the anatomy of this region should lessen the complications of hemorrhage, injury to the recurrent laryngeal nerve, and injury to the parathyroids. A dry field is maintained if the various fascial planes are carefully considered during the procedure **(Figure 3).** The locations of the major blood vessels, the parathyroid, and recurrent laryngeal nerve are shown in **Figures 3 and 5.**

The surgeon applies firm pressure to one margin of the wound over gauze sponges, while the first assistant applies similar pressure with his right hand. In this manner the active bleeding from subcutaneous tissue is controlled, and the margins of the wound are evenly separated. The incision is deepened to the areolar tissue plane just below the platysma muscle where an avascular space is reached. All active bleeding points are grasped with straight, pointed hemostats which are reflected upward or downward depending upon which side of the incision they have been applied **(Figure 6).** Active bleeding and danger of air embolus may occur from accidental openings made into the anterior jugular vein if too deep an incision is made. The upper flap is dissected free as upward traction is maintained upon it with a rake retractor **(Figure 7).** Sharp dissection may be used alternately with blunt gauze dissection to facilitate the freeing of the upper flap **(Figures 7 and 8).** With the operative field thus defined, further sterile drapes are now applied, covering the patient completely, and the operative procedure is begun.

The skin incision is made with a deliberate sweep of the scalpel, dividing the skin and subcutaneous tissue simultaneously if the panniculus is not too thick. The belly of the scalpel should be swept across the tissues but not pressed into them. Bleeding vessels in the subcutaneous tissues are seized with hemostats; the large vessels are ligated, while small vessels are merely clamped and released. Hemostats with finely tapered jaws which can be applied to the vessel alone are the best type to use, because they permit ligation without strangulation of a tab of surrounding fat. One or two mass ligatures may do no harm, but many strangulated bits of tissue cause induration and inflammation during healing since the avascular tabs must be absorbed. The inevitable contamination of the wound with bacteria from the skin edge, which is readily overcome in a well-made wound, may cause infection in devitalized tissue and may result in suppuration—a calamity justly attributed to inattention to minute but essential details.

The application of hemostats and the ligation of blood vessels is a principal part of surgical technic. In certain regions of the body where large veins are exposed and where thrombosis constitutes a major danger, the proper application of a hemostat may be the chief factor in a satisfactory result. For example, if a large vein is exposed in a septic wound and one of its tributaries must be divided, that tributary should be ligated close to the main channel. This avoids stagnation of blood in the stump, preventing thrombosis with its frequent sequel—embolism. When ligation of a vessel is contemplated, the surgeon must decide whether to ligate or to transfix and ligate. If the vessel is large, likely to retract, or not easily accessible, transfixion is safer. This is best done by passing the needle through the tissue surrounding the vessel and by tying the ligature about the entire vessel. The use of a round rather than a cutting needle is desirable to prevent laceration of small vessels which gives rise to hematomata. Usually, a small blood vessel will be encountered, high up beneath the flap on either side, which will produce troublesome bleeding unless it is doubly ligated **(Figures 8 and 9).** The dissection goes up to the thyroid notch, exposing all of the thyroid cartilage, as well as down to the suprasternal notch. Outward and downward traction is then applied to the lower skin flap as it is freed from the adjacent tissue down to the suprasternal notch **(Figure 9).** At the very lowest part of the wound, care should be taken to avoid damage to the communicating arch connecting the two anterior jugular veins. The ascending branches of these veins should be ligated below the communicating arch with a transfixing suture to prevent the complication of air embolism **(Figure 9).**