ANESTHESIA IN CASES OF POOR SURGICAL RISK

Some Suggestions for Decreasing the Risk

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WHEN a patient who is classified as presenting a poor surgical risk comes to operation today, he stands a better chance of withstanding the effects of both the anesthesia and the operation than he did a few decades ago. Advances in many fields of medicine have helped to decrease the risk of operation and anesthesia in these cases. For instance, the use of insulin for diabetes, together with other methods of treatment, has reduced greatly the incidence of complications which accompanied surgical procedures on such patients. The preoperative management of patients who have thyrotoxicosis has reduced the morbidity and mortality rate accompanying thyroidectomy. Improved operative procedures have decreased the risk in certain fields, such as the present method of transurethral prostatic resection for prostatic hypertrophy.

Advances in the field of anesthesia and its related specialties have been of prime importance in the successful preoperative, operative, and postoperative management in cases of poor surgical risk. These advances are classified broadly as follows: (1) the evolution of less toxic anesthetic agents; (2) improved methods of administration of anesthetic agents; (3) the use of a combination of agents and methods, thereby decreasing the toxicity resulting from the use of a single agent, for instance, the so-called balanced anesthesia as previously described by one of us (Lundy, 25); (4) improved methods of administration of oxygen and other inhalants; (5) supportive measures during the operative and postoperative period and (6) special measures, such as the use of tracheobronchial aspiration after operation. Finally, the skill and versatility of the anesthetist must be considered as important contributing factors to the welfare of the patient for whom the risk of operation is great. The patient's life often depends more on the way a certain anesthetic agent is administered than on the effects of the anesthetic agent itself.

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Various methods have been employed in grading the degree of risk which each patient presents.

Saklad (36), as a member of a committee of the American Society of Anesthetists, Inc. studied problems of classification of anesthetic data and suggested that the term "operative risk" be supplanted by the term "physical state." The reason for this suggested change was for the purpose of limiting many variable factors, such as the type of operative procedure, ability of the surgeon and anesthetist, and the type of anesthetic agent the patient will receive. On the basis of "physical state," 4 classes were made, with two additional classes for emergencies. In brief, the first 4 classes are as follows:

In class 1 are included cases in which organic pathological change is absent or the pathological process is localized and does not cause any systemic disturbance or abnormality; for example, any type of operation for fractures without shock or loss of blood or uncomplicated hernias.

In class 2 are included those cases in which a moderate but definite systemic disturbance, caused either by the condition that is to be treated by surgical intervention or which is caused by other existing pathological processes is present; for example, mild diabetes, mild acidosis, moderate anemia, or mild thyrotoxicosis.

In class 3 are included those cases in which severe systemic disturbance from any cause or causes is present. It is not possible to state an absolute measure of severity, as this is a matter of clinical judgment. For example, these conditions include complicated or severe diabetes, combinations of cardiac disease and respiratory disease, pulmonary tuberculosis associated with tachycardia or dyspnea, and severe accidental trauma associated with shock.

In class 4 are included those cases in which extreme systemic disorders already have become a threat to life regardless of type of treatment. For example, these disorders include cardiac decompensation, a combination of cardiovascular-renal disease with marked renal impairment and of an operation on a patient already in poor condition to arrest hemorrhage after much loss of blood.

One of us (Lundy) suggested a brief classification of operative risk as follows: grade 1, patients in such good physical condition that they will probably tolerate any anesthetic agent well; grade 2, cases of so-called average risk, in which the risk of the operation is greater than the risk of the anesthesia; grade 3, patients for whom the anesthetic agent must be selected with care, since, owing to pathological conditions, the risk of the anesthesia is as great or greater than the risk of the operation; and grade 4, patients who are in such serious physical condition that the use of any anesthetic agent is dangerous. For such patients, local infiltration may be used to control the pain but only half the concentration and half the usual amount of solution should be employed.

The risk of operation in a certain case can be evaluated intelligently only after all findings from physical and laboratory examinations are available. In certain cases, the effects of pathological lesions are so well marked that the risk is obviously poor. In others, there may be a number of obscure and less marked pathological changes which do not become apparent until the results of a complete examination have been obtained.

All anesthetic agents may be toxic to human tissue, but certain organs and tissues may suffer more acutely than others. The liver and kidneys usually are affected owing to their functions of detoxication and excretion (32). Certain anesthetic agents produce specific damage to certain organs, such as damage to the tissue of the liver by chloroform. When pre-existing damage to such an organ by some pathological process is present, the toxic effect of the anesthetic agent becomes more marked and results in greater inhibition of function. Therefore, in choosing the anesthetic agent for a patient who presents a poor surgical risk, the main factor to consider is to what extent the agent or agents will affect physiological processes already impaired. It is difficult and impractical to attempt to lay down general rules as to the choice of anesthetic agent for these patients, as each presents an individual anesthetic problem (13). The method of choice is one which will produce the least deleterious effects in the light of the existing pathological processes and which, at the same time, will be adequate for the anticipated operation. By the choice of the proper anesthetic agent, skillfully administered and preceded by careful preoperative preparation of the patient and accompanied by suitable supportive measures, it is possible to improve the status of his risk from one of doubtful outcome to one which offers him more than a reasonable chance of satisfactory convalescence and recovery (1, 37).

GENERAL FACTORS CONTRIBUTING TO THE PATIENT'S RISK

A few basic facts which can be ascertained from the physical and laboratory examinations usually will be all that are required in order to form a fair approximation of the risk of anesthesia and operation in a particular case. Important among these are the estimation of hemoglobin, the level of blood pressure, findings on urinalysis, degree of cardiac and renal sufficiency, and the general appearance of the patient in regard to nutrition, debility, and loss of weight. Although a more detailed examination may uncover further evidence of physiological abnormalities, such information may not be essential to the choice of the safest anesthetic agent. If these salient features are weighed and estimated carefully, it is not essential that facilities for a thorough laboratory examination be available. Some of the more ordinary factors to consider follow.

Age. Anesthesia and operation are not tolerated as well by patients at the extremes of life. The respiratory system of infants and young children is depressed easily by anesthetic agents. Debility and cardiovascular-renal disease may be complicating factors in the cases of aged persons. Miller observed that the mortality rate of surgical patients more than 50 years of age was eight times as great as that for patients less than 50. The need for supportive treatment should be anticipated for aged patients (15). Elderly patients fare better after operation if they are gotten up out of bed at the earliest possible time.

Habits. The mode of life of a patient has a bearing on the risk. Those who use tobacco excessively and have accompanying bronchitis are prone to respiratory complications after anesthesia and operation. Chronic alcoholics usually fare poorly under anesthesia and seem more susceptible to complications during the postoperative period. The same applies to drug addicts, since there are often accompanying nutritional and nervous disturbances.

Nervous system. Patients who are "high strung" usually are more difficult to anesthetize than those of more stolid type. Those who come to the operating room worried, frightened, and with the mental attitude that death is imminent or that they cannot survive the operation do not present a good risk and often have a stormy convalescence. Adequate preliminary medication and assurance are important therapeutic measures in these cases.

Toxic states. Toxemia, whether attributable to systemic or malignant disease, infections, or other causes, increases the gravity of the risk in direct proportion to the degree of toxemia present.

Debility. Patients who are frail, debilitated, underweight, and poorly nourished lack the reserve of robust patients to withstand the toxicity of anesthesia and the shock associated with the operation. The risk of operation on markedly debilitated patients is always high. The vital functions of these patients are depressed by even small doses of anesthetic agents and great caution must be observed to prevent overdosage. Prolonged vomiting is serious, since it leads to nutritional disturbances, decrease of glycogen in the liver, and to the more serious conditions of acidosis and ketosis. The other extreme, also serious, is alkalosis, which can be produced, among other conditions, by intestinal obstruction.

Obesity. Obese patients need not necessarily present a poor surgical risk, but by and large a patient who is grossly overweight does not have as good a chance of withstanding anesthesia and operation as one whose weight is nearer a normal figure. In the cases of obese patients, the operative manipulations often are more difficult and fatty infiltration of the cardiac muscle may be present, thereby lowering cardiac reserve and more or less inhibiting respiratory exchange.

HEPATIC FUNCTION

The liver and the state of its function have an important bearing on the anesthesia and its effect on the patient (31). One of the principal functions of the liver is its power of detoxification, including detoxification of certain anesthetic agents (3). In addition, the functions of the liver are inhibited and liver tissue is damaged by the action of certain anesthetic agents in the body. Bourne stated that with the exception of cyclopropane, all anesthetic agents may cause some impairment of hepatic function. The normally functioning liver, however, handles the strain imposed on it by anesthesia and operation well, provided its store of glycogen is adequate and anoxia is prevented. If its function has been impaired by toxemia and if nutritional disturbances have depleted its supply of glycogen, it then not only performs its normal functions poorly, but its vulnerability to further damage from the anesthetic agent is increased. The malfunctioning liver invariably has a low content of glycogen which always increases the risk from the anesthesia and operation. The most toxic anesthetic agent to hepatic tissue is chloroform, manifested by toxic changes in the lobules of the liver, degeneration and necrosis, leading to inhibition of function of varying degrees. For this reason, chloroform anesthesia has been largely abandoned. Divinyl ether anesthesia also may damage the liver, particularly if the state of anesthesia is prolonged, but not to the extent or with the frequency of that produced by chloroform. Ether anesthesia impairs the function of a normal liver slightly, causing diminution of its content of glycogen, hyperglycemia, and decrease in hepatic secretion, but normal function is soon resumed during the postoperative period. Cyclopropane has little, if any, deleterious effect on hepatic function, and the same is thought to be true in the case of the very short acting barbiturates.

The best means of protecting an impaired liver are diet high in carbohydrates in order to increase the content of glycogen of the liver before operation and the maintenance of adequate oxygenation during the anesthesia and after operation. In cases of obstructive jaundice, in which the prothrombin time is increased and postoperative hemorrhage is feared, treatment with vitamin K before operation is indicated (38). Allen and Livingstone stated that the early postoperative fall in prothrombin in cases of jaundice and biliary fistula seems to be caused primarily by the inadequate administration of vitamin K before the operation, rather than from anesthesia, operative trauma, or hemorrhage. Blood transfusions are also of value. Adequate oxygenation during anesthesia is of the utmost importance in protecting the liver against the toxic effects of anesthetic agents.

RENAL FUNCTION

Although the kidneys are affected directly by certain anesthetic agents, their function also is impaired indirectly as a result of the effect of the anesthesia and operation. Chloroform may produce direct damage to the renal epithelium. Ether anesthesia causes a marked decrease in urinary output, ending in almost complete suppression after an hour or more of anesthesia. Normal function is resumed in the first 24 hours after operation. Cyclopropane anesthesia also suppresses urinary output during anesthesia: this is followed by a compensatory increase in excretion after operation. Tribromethanol anesthesia also causes urinary suppression and Veal, Phillips, and Brooks have shown in rabbits that when even mild degrees of nephritis are present, the margin of safety with this type of anesthesia is small (41). If, at the time of operation renal damage has occurred, anesthetic agents which are toxic to renal tissue and tend to inhibit renal function will produce more drastic disturbances in these organs than if they were normal. Thus, renal insufficiency markedly increases the gravity of the patient's risk.

Indirect effects of the anesthesia and operation also have an important bearing on renal function. These effects, according to Beecher, depend on several things. A marked fall in blood pressure during operation can diminish and arrest urinary secretion. Asphyxia may cause constriction of the renal vessels, leading to diminished blood flow through the kidneys and decreased formation of urine. Owing to the resultant local anoxia, the glomerular epithelium is damaged and permits the passage of albumin, proteins, and blood. Loss of fluids and blood during the course of the operation also contributes to postoperative anuria. In cases of advanced nephritis the risk of operation is not good, and nephritis often is accompanied by arteriosclerosis, hypertension, and cardiac insufficiency, which further increase the gravity of the risk (33). In such cases, careful tests for renal function should be performed and the level of blood urea and nonprotein nitrogen should be evaluated. In the preparation of such patients for operation, the values for blood urea, creatinine, and nonprotein nitrogen should be reduced as far as possible by forcing fluids and intravenous therapy before operation. If these values stabilize readily to values not grossly abnormal, the patient may stand operation and anesthesia satisfactorily.

CARDIOVASCULAR SYSTEM

Cardiac insufficiency, if advanced and uncompensated, forms one of the gravest complications the anesthetist has to face. However, it is agreed among cardiologists that patients who have many types of cardiovascular conditions, provided that compensation is adequate and cardiac reserve is satisfactory, stand anesthesia and operation remarkably well (17). Patients who give the most concern are those who have advanced myocardial degeneration accompanied by circulatory insufficiency and marked dyspnea. Although a careful cardiovascular examination should be routine before any operation, a fair estimate of the patient's cardiac reserve may be obtained from information the patient can supply. If he does not have dyspnea or precordial pain, either with or without moderate exertion, and if he is able to carry on the usual activities of daily life, it is probable that his heart will stand the strain of anesthesia and operation. The risk increases in proportion to the extent with which his activities are limited by the cardiac condition. Hypertension itself does not increase the risk markedly, provided cardiac reserve is satisfactory. From a review of the literature, Woodbridge stated, "it is generally agreed that coronary occlusion, angina pectoris, congestive failure, and syphilitic aortitis carry high operative mortality; and that valvular heart disease and auricular fibrillation if uncomplicated by failure, and paroxysmal auricular flutter, fibrillation, or tachycardia do not add appreciably to the anesthetic or surgical risk."

RESPIRATORY SYSTEM

Disease of the lungs or of the respiratory passages obviously has an intimate bearing on the course of anesthesia, the complications that may arise and the degree of risk for the patient during and after operation. The effect is dependent on the site, nature, and extent of the lesion, to what extent the lesion will interfere with the supply of oxygen and its transportation to the body tissues and the elimination of carbon dioxide. There is also the added risk of the production of other pulmonary complications after operation as a result of the anesthesia and operation or the extension of those which existed before operation. Any pathological condition which lowers vital capacity to a marked degree increases the patient's risk. Moersch stated that the closer the vital capacity approximated tidal air, the graver was the risk. Examples of lesions which affect vital capacity are emphysema, abscess of the lung, tuberculosis, pneumonia, pleurisy with effusion, asthma, defects of the thorax, and also certain cardiac conditions, particularly mitral stenosis.

A reduction in vital capacity always calls for particular care in the maintenance of adequate ventilation during anesthesia. The most important factor for accomplishing this is a free airway. When there is any question of difficulty in maintaining an adequate supply of oxygen, an intratracheal tube should be inserted after induction of anesthesia. Kloty pointed out that obstruction of the upper or lower portions of the respiratory tract which prevents the free passage of air to the blood and tissues is always serious; he also emphasized the great importance of terminal blockage of large numbers of air sacs, which reduces vital capacity and interferes with adequate exchange of oxygen and carbon dioxide, as well as that of anesthetic gases. One of the greatest hazards of deficiency of oxygen, as demonstrated by Courville (6, 12), is its damaging effect on the central nervous system, particularly on the cerebral cortex. A few minutes of severe anoxemia may produce permanent damage. Waters (44) stressed the necessity of maintaining the integrity of the patient's mechanism for transportation of oxygen, of maintaining a free airway and maintaining adequate tidal exchange, by mechanical means if necessary. For the relief of pain, he further stressed caution in the use of drugs which may

aggravate respiratory depression and predispose to postoperative pulmonary complications (43). Asthma usually does not produce an untoward surgical risk. After both ether and intravenous pentothal sodium anesthesia, periods of relief from the asthmatic attacks have been observed.

Anemia frequently accompanies pathological lesions of the respiratory system and is present often when the patient is debilitated and when the risk of operation and anesthesia is great. This condition, owing to the lowered oxygen carrying capacity of the blood, interferes with adequate transportation of oxygen to the tissues. When concentration of hemoglobin is less than 8 to 10 grams per 100 cubic centimeters of whole blood, it is wise to give a blood transfusion before operation.

When indicated, the value of suction aspiration of the tracheobronchial tree during the immediate postoperative period is assuming major importance in relation to the control and prevention of postoperative pulmonary complications, such as atelectasis, massive collapse of the lung and bronchopneumonia (18, 30). According to Hinshaw, defective pulmonary drainage appears to be the primary cause of many cases of pneumonia after operation. If permitted to exist for long, depression of respiration during anesthesia and the formation of viscid mucus may plug a bronchus and lead to lobular, lobar, or massive collapse of the lung. The use of suction bronchoscopy is one of the greatest advances in helping to lower the incidence of postoperative pulmonary complications after anesthesia.

The administration of oxygen, whether by tent, nasal catheter, or special masks, such as the B.L.B. (Boothby, Lovelace and Bulbulian) oxygen mask, has become of routine importance in the postoperative management of surgical patients (8, 42). The administration of 100 per cent oxygen after operation has been useful in the relief of gaseous distention. Helium with mixtures of oxygen may be respired with less effort than oxygen or oxygen and air. Treatment with oxygen and helium has been beneficial after operation for patients who have asthma and mechanical obstruction to respiration as a result of infections, tumors, foreign bodies, or laryngeal edema.

DIABETES

Generally speaking, modern methods of diabetic therapy and anesthesia have lifted the diabetic patient out of the group of patients who present a poor risk. Unless these patients have other pathological conditions which in themselves would lead to abnormal hazards from surgical procedures and anesthesia, their outlook is generally favorable. Other conditions frequently do exist in cases of diabetes, among which are tendencies to coronary thrombosis and cerebrovascular accidents. Many clinicians are of the opinion that the diabetic patient under satisfactory control can even withstand the disturbance of such agents as ether without untoward reactions. This seems to be true, but with the anesthetic agents available we are of the opinion that we are justified in using those which interfere least with carbohydrate metabolism. Ether not only elevates the level of blood sugar but tends to produce acidosis as a result of postoperative vomiting and restriction of food. Nitrous oxide, ethylene, and cyclopropane are suitable since they only slightly affect carbohydrate metabolism. Anoxemia may result in acidosis and thus, cyclopropane is preferable to nitrous oxide or ethylene, unless these agents will produce adequate anesthesia without deficiency of oxygen. Neff and Stiles found that Bourne's buffer phosphate solution reduced the incidence of postanesthetic nausea and vomiting with cyclopropane anesthesia. Spinal and regional anesthesia also are satisfactory for diabetic patients. Pentothal sodium intravenously administered and used alone or in combination with local or regional anesthesia also is advocated. If it is necessary to operate on a patient who has uncontrolled diabetes, every effort should be made to control the diabetes before the operation is performed unless the operation is urgent. When stabilization has occurred, any of the suggested methods of anesthesia which are adequate for the operation may be employed and if ether is necessary, it may be used in minimal amounts.

AGENTS AND METHODS

It would be impractical to attempt to establish criteria for the types of patients who present poor surgical risks, but brief mention may be made of the potentialities of certain anesthetic agents. A discussion of chloroform and ethyl chloride is purposely omitted because of their toxicity. Divinyl ether and tribromethanol have a place in anesthesia, but the former is somewhat toxic to the liver, particularly for prolonged administration, and the latter produces toxic effect on both the liver and kidneys and is considered safe only when used as a basal anesthetic agent.

Nitrous oxide. On the basis of its low toxicity, nitrous oxide and oxygen is safe, but the toxic effect of the anoxemia which may accompany the anesthesia definitely is deleterious. If the nature of the operation will permit adequate oxygenation, the method is commendable in cases in which

risk is poor. Local or regional anesthesia used with nitrous oxide and oxygen permits larger interventions and is relatively safe for these patients.

Ethylene. Like nitrous oxide, the toxicity of ethylene is low and better oxygenation may be obtained than with nitrous oxide. Its uses parallel those of nitrous oxide.

Ether. Valuable as ether is in anesthetic practice, its use should be avoided as much as possible in cases of poor surgical risk, owing to its irritating action on the respiratory tract which predisposes to postoperative pulmonary complications, and the vomiting, acidosis, and hepatic dysfunction it causes.

Cyclopropane. The value of cyclopropane in many types of cases of poor surgical risk is incontestable on the basis of its low toxic effect on the liver and kidneys, its anesthetic potency with high concentrations of oxygen and absence of irritation to the respiratory system (45). Its use is particularly indicated in thoracic surgery (35).

Cyclopropane has certain disadvantages, however. It is a very potent gas and in high concentrations is thought to be toxic to cardiac muscle. Cardiac arrhythmias have been observed during the course of cyclopropane anesthesia, but ventricular fibrillation and complete heart block are among the few that are of grave significance. If local or regional anesthesia is to be used with cyclopropane, epinephrine is withheld from the local anesthetic solution since it increases the tendency to ventricular fibrillation (4, 10). Guedel suggested the combination of cyclopropane anesthesia with subarachnoid, peridural, or local block to increase abdominal relaxation in certain cases. Another hazard of cyclopropane anesthesia which cannot be overlooked is its explosiveness in anesthetic concentrations. It should never be used in the presence of cautery or other electrical apparatus. Steps are now being taken to decrease the hazard of electrostatic sparks, among which is intercoupling of the anesthetist, gas machine, patient, and operating table (20). When cyclopropane is used with all proper precautions, its advantages in certain cases of unfavorable risk far outweigh its hazards.

Intratracheal anesthesia. Respiratory obstruction and resultant anoxemia should never be allowed to persist when such difficulties may be promptly controlled by passage of an intratracheal tube. In cases of graver risk or in those in which complications are anticipated, its routine use may be advisable. The effortless breathing that results, the ease and control of anesthetic administration and oxygenation, and the facility of aspirating mucus through the tube, all favor better control. The intratracheal tube has another important use in addition to its use in anesthesia, that is, its value in resuscitation. Prompt resuscitative measures during operations in the presence of poor risk are required frequently. The effectiveness of treatment with oxygen and artificial respiration depends on the patency of the airway. The intratracheal tube assures a patent airway. Reid and Brace drew attention to the danger of altered cardiac and respiratory function and circulatory derangement as a result of irritation of the respiratory tract, particularly when anesthesia is light. This occurs as a result of reflex action in the autonomic nervous system by introduction of intratracheal tubes or other mechanical airways.

Local and regional anesthesia. Since procaine is the least toxic of local anesthetic agents, its use is preferred in the cases in which the risk of operation is great. Infiltration and block anesthesia, either alone or supplemented, continues to be one of the safest methods for such patients (26). In cases in which cardiac disease or hypertension is present, epinephrine is contraindicated in the anesthetic solution. Hypersensitivity to local anesthetic agents in certain cases must be borne in mind, as well as the inadvertent injection of the solution into a blood vessel.

A few regional methods may be mentioned. Cervical block, skillfully performed, produces adequate and safe anesthesia for most operations about the neck. For operative procedures on the upper portion of the abdomen, abdominal wall block, bilateral intercostal nerve block of the seventh to eleventh intercostal nerves, inclusive, and splanchnic block are valuable procedures. Splanchnic block, supplemented by one of the gases, in addition to either abdominal or intercostal block often is used for operations on the upper portion of the abdomen in cases in which the condition of the patient is unfavorable. Peridural block also may be used with relative safety. For operations on the anus, lower portion of the rectum, perineum, and prostate gland, sacral block carries a relatively wide margin of safety. Individual nerve block and simple infiltration frequently are adequate procedures for small interventions.

Spinal anesthesia. Spinal anesthesia, although preferred in certain cases of poor operative risk often is contraindicated in others. Here again, procaine is the agent of choice, but if the risk of operation for the patient is fair the use of metycaine may be considered because of the longer duration of effect.

Regardless of other factors, spinal anesthesia is contraindicated when the value for hemoglobin is less than 50 per cent (Dare), or persistent hypotension, disease of the central nervous system, or marked debility exists. Spinal anesthesia is the preferred method for many acute abdominal conditions and for operations in the presence of intestinal obstruction. Spinal anesthesia is safer for operations on the lower portion of the abdomen than on the upper. In considering spinal anesthesia for a patient of doubtful risk, it must be remembered that varying degrees of circulatory and respiratory deficiency are produced through paralysis of the sympathetic and intercostal nerves. These conditions increase in severity with the height of the spinal anesthesia, and this circulatory and respiratory deficiency leads to deficiency of oxygen and varying degrees of anoxemia, the dangers of which have been pointed out.

The method of continuous spinal anesthesia as advocated by Lemmon (22, 23) has certain advantages for prolonged operations in which spinal anesthesia appears to be the method of choice. Its use may be advantageous for spinal anesthesia for certain patients whose condition is unfavorable and for whom it is not desirable to give a dose of the spinal anesthetic agent sufficient for the whole operation. By using the continuous method, a minimal dose is administered and if the patient is reacting favorably to the effects of the spinal anesthetic, subsequent doses may be added as required. In this way it may be possible to prevent circulatory and respiratory insufficiency, which often occurs after a single large dose of a spinal anesthetic agent has been given.

Intravenous anesthesia. Pentothal sodium is the anesthetic agent of choice in intravenous anesthesia. Evipal soluble (sodium salt of n-methyl-C-C-cyclo-hexamyl-methyl barbituric acid) although less potent, also is short acting and satisfactory. In cases in which intensive treatment with sulfanilamide has been given up to the time of operation, evipal soluble is preferred since it does not contain sulfur. Adriani (2) demonstrated that evidences of increased toxicity occur when pentothal sodium is administered to animals that have been receiving sulfanilamide. Lorhan and his associates concluded from their experiments that no cumulative toxic action on the liver or kidneys occurred from the administration of sulfanilamide and evipal soluble. It is generally felt that the concurrent use of these agents should be with caution, if at all.

Ordinary anesthetic doses of pentothal sodium have relatively little effect on the liver and kidneys, but when the drug is administered too rapidly or in too large doses respiratory function is depressed acutely. A 2.5 per cent concentration is preferred. The normal heart and the heart in which reserve is within normal limits tolerate the effects of pentothal sodium well. Advanced myocardial degeneration associated with dyspnea is a definite contraindication to its use. Most patients, even when debilitated and intoxicated, tolerate the effects of intravenous anesthesia satisfactorily, provided anoxemia is prevented. The risk to the patient is increased when, in order to produce satisfactory relaxation for certain operations, marked respiratory depression and anoxemia are allowed to persist.

The recent trend of opinion is pointing more and more to the increased usefulness and safety of intravenous anesthesia combined with various other methods.

Comment. If it is possible to generalize concerning anesthesia in cases of grave surgical risk, it may be said that combinations of regional anesthesia and cyclopropane and oxygen anesthesia, or regional anesthesia, intravenous anesthesia and nitrous oxide and oxygen anesthesia possess the widest margin of safety. The latter combination obviates the hazard of explosion or fire. Abdominal wall and intercostal block, when supplemented by intravenous anesthesia and the continuous administration of oxygen or 50 per cent nitrous oxide and 50 per cent oxygen by inhalation, is one of the safest methods for anesthetizing patients of doubtful risk. Light pentothal sodium anesthesia forms a satisfactory supplement to spinal anesthesia when indicated and aids in the control of nausea and mental trauma. Small doses, slowly administered, are indicated, since the circulatory and respiratory functions already are depressed by the spinal anesthesia.

RISK AND THE OPERATIVE PROCEDURE

Certain operations carry with them more than the usual degree of risk. Anticipation of the added risk of such procedures to that already existing is necessary from the standpoint of intelligent supportive therapy during the operation. Intracranial interventions usually are serious. It is important that the method of anesthesia does not elevate intracranial pressure. Open drop ether administered by means of an intratracheal tube is satisfactory for many intracranial operations, since an obstructed airway tends to elevate intracranial pressure.

Operations on the thyroid gland do not carry the risk they did in the past, owing to the preoperative management of the patient. Crile (14) stated that the only two absolute contraindica-

tions to operation on the thyroid gland are persistent delirium and persistent vomiting. Local infiltration in addition to gas and oxygen anesthesia usually is satisfactory. In cases in which the gland is exceptionally large or is substernal, tracheal collapse because of prolonged pressure on the trachea is a serious potential complication. In such cases, intratracheal anesthesia is the safest method, or at least, facilities for prompt intratracheal intubation should be available. Patients who do not respond favorably to preoperative medical treatment present more serious risks than those whose basal metabolic rate and pulse rate do drop satisfactorily after medical treatment. When the basal metabolic rate and pulse rate continue to remain above normal levels despite treatment, many surgeons prefer to perform thyroidectomy in two stages.

Most intrathoracic operations, such as lobectomy, pneumonectomy, and open drainage for emphysema, carry unusual risk. All open operations on the thorax require delicate anesthetic control, owing to disturbances of respiratory function. Cyclopropane administered by means of an intratracheal tube permits better anesthetic control than any other method. This method often is chosen for operations on the diaphragm, such as in repair of diaphragmatic hernia. Slight amounts of ether sometimes may be added to increase the degree of relaxation and exposure.

Operations on the stomach, duodenum, gall bladder, liver, and spleen may present serious anesthetic problems.

Either low spinal anesthesia or intravenous anesthesia with pentothal sodium as the anesthetic agent has been the preferred method for transurethral prostatic resection or for other manipulations on the urethra or bladder (39). Many of these patients are in poor condition because of their advanced age, debility, and the prolonged retention of urine which has resulted in retention of nitrogenous waste products and uremia.

SUPPORTIVE MEASURES

Modern methods of preoperative and postoperative treatment and advances in the field of surgical shock and supportive therapy have changed the condition of many patients from that which constituted a poor surgical risk to one for which the risk was fair or even good. Modern methods of intravenous therapy, such as administration of sodium chloride, dextrose, and so forth, have been important. Coller and Maddock mentioned the importance of the kidneys in maintaining water balance. They stated that for seriously ill patients, particularly those who have a septic condition, severe disease of the biliary tract or some renal impairment from any cause, an intake of water that provides at least 1,500 cubic centimeters of urine daily is often desirable. Intravenous therapy is important in maintaining water and electrolyte balance, when, because of vomiting, fluids cannot be taken by mouth. Drew and associates stated that in the presence of shock, treatment, to be rational, must overcome the severe arteriolar and venular spasm, the capillary paralysis and dilatation and the great loss of circulating blood volume. Hypertonic solution of sodium chloride is used successfully in relieving these effects. The use and value of chemotherapy, particularly with the sulfonamide compounds, for infective conditions, is well known.

High in the scale of importance is the treatment of shock during and after surgical operations (40). Shock occurs during operation as a result of several factors, for instance, the anesthesia, operative manipulation and trauma, dehydration, hemorrhage, fear, exhaustion, and anoxemia. Shock, as Moon has pointed out, may become a vicious cycle, associated with low blood pressure, low volume of circulating blood, and hemoconcentration. This circulatory deficiency is associated intimately with oxygen want in the tissues and with atony of the capillaries. Shock, if allowed to persist without treatment, tends to become irreversible. Varying degrees of shock occur during any operative procedure, depending on the preoperative condition of the patient, the anesthetic, and the type and duration of the operation. It is obvious that debilitated, anemic, toxemic, and functionally abnormal patients will succumb to shock both more easily and to a more profound degree than will more normal patients. Therefore, the anticipation of the need of treatment for shock is particularly important in a case in which the risk of operation is poor.

If shock is to be treated effectively, it must be treated promptly. Better still, if it is known that the patient is in poor condition, the shock should be treated before it actually occurs. This is accomplished by various measures, depending on the urgency. A fall in blood pressure during the operation need not be serious if it is not persistent and if it is not associated with marked loss of fluid or blood. Vasopressor agents, such as ephedrine or neosynephrin hydrochloride, may be injected intramuscularly or intravenously in order to elevate the blood pressure. If the fall in blood pressure occurs in the presence of marked loss of fluid (profuse sweating) or is obviously attributable to hemorrhage, vasopressor agents give only transient relief and a false sense of security.

A pale, cold, clammy patient is in a state of shock and needs fluids, blood, or both. In the management of patients for whom the risk of operation is great it is safest to start an infusion of physiological saline solution or a 5 per cent solution of dextrose in physiological saline solution at the beginning of the operation. In this way it is possible to combat dehydration and shock during the operation by compensating for loss of fluid and maintaining the volume of circulating fluid and the electrolyte balance of the tissues. In addition, if shock appears suddenly or if any emergency, such as profuse hemorrhage, occurs, there is no delay in the administration of fluids or blood. Loss of minutes in the institution of treatment for shock may cost the patient his life, particularly if he is in poor condition. Transfusion of blood is the best means of combating shock. The amount necessary will depend on the preoperative level of hemoglobin, the amount of blood lost during the operation, and the response of the blood pressure, pulse rate, blood volume, color, and skin. Refrigerated blood from universal donors has simplified prompt treatment. If blood is not readily available, administration of fluids may be followed by administration of a 6 per cent solution of acacia until blood can be obtained. The use of plasma, which can be stored in the desiccated state and redissolved before use, provides all the elements of whole blood for treating shock, with the exception of erythrocytes. By its use, shock may be controlled for several hours, even after marked hemorrhage has occurred.

SUMMARY

Anesthesia in relation to pathological conditions which go to make up the so called poor risk has been discussed, and suggestions made as to choice of anesthetic agents and methods.

Stress has been laid on the value of certain types of treatment and supportive measures which help to favor the operative and postoperative outlook and lessen the degree of risk.

REFERENCES

1. Adams, R. C., and Lundy, J. S. Surg. Clin. N. America, 1940, 20: 915–929.
2. Adriani, J. J. Lab. & Cin. Med., 1939, 24: 1066.
3. Idem. Anesthesiology, 1940, 1: 312–322.
4. Allen, C. R., Stutzman, J. W., and Meek, W. J. Anesthesiology, 1940, 1: 158–166.
5. Allen, J. G., and Livingstone, Huberta. Anesthesiology, 1940, 1: 89–93.
6. Batten, C. T., and Courville, C. B. Anesthesiology, 1940, 1: 261–273.
7. Beecher, H. K. The Physiology of Anesthesia. 388 pages. New York: Oxford University Press, 1938.
8. Boothby, W. M., Mayo, C. W., and Lovelace, W. R., II. Surg. Clin. N. America, 1940, 20: 1107–1168.
9. Bourne, Wesley. Am. J. Surg., 1936, 34: 486–495.
10. Burstein, C. L., Marangoni, B. A., DeGraff, A. C. and Rovenstine, E. A. Anesthesiology, 1940, 1: 167–186.
11. Coller, F. A., and Maddock, W. G. Surg., Gynec. & Obst., 1940, 70: 340–354.
12. Courville, C. B. Untoward Effects of Nitrous Oxide Anesthesia, etc. Mountain View, Calif.: Pacific Press Pub. Ass., 1939.
13. Crile, George. Surg. Clin. N. America, 1936, 16: 1037–1040.
14. Crile, George, Jr. Surg. Clin. N. America, 1936, 16: 1051–1059.
15. Crile, George, and Crile, George, Jr. Surg. Clin. N. America, 1936, 16: 1091–1097.
16. Drew, C. R., Scudder, John, and Papps, Jean. Surg., Gynec. & Obst., 1940, 70: 859–867.
17. Dry, T. J. Surg. Clin. N. America, 1940, 20: 1169.
18. Eversole, U. H. Anesthesiology, 1940, 1: 72–81.
19. Guedel, A. E. Anesthesiology, 1940, 1: 13–25.
20. Horton, J. W. Anesthesiology, 1941, 2: 121–137.
21. Kloty, Oskar. Anes. & Anal., 1933, 12: 122–125.
22. Lemmon, W. T. Ann. Surg., 1940, 111: 141–144.
23. Lemmon, W. T., and Paschal, G. W., Jr. Pennsylvania M. J., 1941, 44: 975–981.
24. Lorhan, P. H., Guernsey, Gretchen, and Harless, Morris. Anesthesiology, 1941, 2: 326–332.
25. Lundy, J. S. J. Tenn. M. Ass., 1932, 25: 496–498.
26. Lundy, J. S., and Tovell, R. M. Proc. Staff Meet. Mayo Clin., 1934, 9: 523–527.
27. Miller, A. H. Am. J. Surg., 1919, 33: 112–114.
28. Moersch, H. J. Anes. & Anal., 1928, 7: 262–264.
29. Moon, V. H. Arch. Path., 1937, 24: 794–813.
30. Mousel, L. H. Proc. Staff Meet. Mayo Clin., 1940, 15: 261–264.
31. Mousel, L. H., and Lundy, J. S. Anesthesiology, 1940, 1: 40–55.
32. Neff, W. B., and Stiles, J. A. Canadian M. Ass. J., 1936, 35: 56–61.
33. Odel, H. M. Collected Papers of the Mayo Clinic and the Mayo Foundation. 1940, 32: 419–424.
34. Reid, L. C., and Brace, D. E. Surg., Gynec. & Obst., 1940, 70: 157–162.
35. Rovenstine, E. A. Anes. & Anal., 1935, 14: 270–275.
36. Saklad, Meyer. Anesthesiology, 1941, 2: 172–178.
37. Ibid. 1941, 2: 281–284.
38. Snell, A. M. J. Iowa State M. Soc., 1941, 31: 1–7.
39. Tovell, R. M., and Thompson, G. J. J. Urol., 1936, 36: 81–87.
40. Tuohy, E. B., and Lundy, J. S. Surg. Clin. N. America, 1940, 20: 1093–1106.
41. Veal, J. R., Phillips, J. R., and Brooks, Clyde. J. Pharmacol. & Exper. Therap., 1931, 43: 637–644.
42. Warnock, E. H., and Tovell, R. M. Anesthesiology, 1940, 2: 187–204.
43. Waters, R. M. Anesthesiology, 1940, 2: 136–144.
44. Idem. J. Am. M. Ass., 1940, 115: 1687–1690.
45. Waters, R. M., and Schmidt, E. R. J. Am. M. Ass., 1934, 103: 975–983.
46. Woodbridge, P. D. Am. J. Surg., 1936, 34: 410–418.