

RESUSCITATION AND ANESTHESIA *

LIEUTENANT COLONEL HENRY K. BEECHER †

Army of the United States

RESUSCITATION

FROM the time the enemy's missile strikes until the surgeon begins to repair the damage it has caused, every effort is directed toward a single aim, that of presenting to the surgeon a patient who will be as favorable an operative risk as possible. Several principles that are basic in this have emerged from or been tested in the present conflict. They will be described, along with their practical application.

SOME BASIC PRINCIPLES AND THEIR APPLICATION

1. *Speed in Forward Evacuation and Preparation for Surgery is Urgent.*—Reduction in the time from wounding to surgery means the saving of extremities, the minimizing of deformity, the shortening of convalescence, and the saving of lives. Every effort is bent toward reduction in evacuation time. To this end it is not necessary that all critically injured men be removed from the ambulance at every post along the evacuation route. It is often apparent that they should be taken at once to the hospital where essential surgical procedures can be carried out. Possibly there are some cases among those with extremity wounds that would profit by being held in a forward installation for an hour or two, but to teach which ones would so profit, not only is almost impossible, but if imperfectly applied, might be disastrous in many cases. I have never seen, at least never recognized, a patient whose life was lost because of too hasty evacuation. There have been instances in which death has occurred because of too slow evacuation, often unavoidable.

2. *The most Efficient Resuscitation is Preventive.*—Economy of materials, of time and of lives will be effected by preventing the serious deterioration of the patient's condition. Once down, much more of materials and effort is required to restore good condition than would have been needed to prevent the decline.

3. *Resuscitation should be Graded.*—The importance of rapidly restoring a good blood color and the systolic blood pressure to an arbitrary level of about 80 mm. of mercury needs no discussion. Once

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† Consultant in Anesthesia and Resuscitation, Mediterranean Theater of Operations.

these things have been accomplished the rate of infusion of blood or blood substitutes depends on several factors. For example:

a. If blood for transfusion or operation will not be available for a matter of hours, infusion of plasma should be rapid enough only to maintain the aforementioned state. More rapid administration of plasma will elevate the blood pressure to the level where bleeding will be renewed or increased, with further and perhaps disastrous loss of irreplaceable (for the time being) hemoglobin.

b. If a patient must await surgery for a considerable period, even though blood may be available, there is no need to transfuse more rapidly than necessary to achieve these conditions, with one addition: when blood is available it is desirable to administer it until the skin loses the chill of shock and becomes warm. As long as the systolic blood pressure is not below a level of about 80 mm. of mercury, the mucous membranes of good color, the skin warm and the pulse of good quality, there is no need to administer further blood until surgery is available. To administer blood beyond the quantity necessary to achieve the condition mentioned, before surgery is available, inevitably means that more blood must be used than is otherwise the case. Blood or plasma will leak into traumatized regions, be needlessly wasted, and the hazard of an unnecessary number of transfusions incurred. Even though time may show this hazard to be limited to the occasional administration of incompatible blood, it is a definite one. Moreover, reasonable economy of blood means that it will be abundantly available when its need is urgent (systolic blood pressure below 80 mm., pulse of poor quality, cold, pallid patient).

c. When surgery is available, further transfusion of blood is advisable so that a rising (or normal) blood pressure is achieved at the time the anesthesia is started.

4. *Complete Restoration to Normal of Blood Volume or Blood Pressure is not a Necessary Preliminary to Successful Surgery in Previously Healthy Young Men.*—Unquestionably, the consequence of the wound, and of shock, produces organic damage that cannot be overcome in a matter of an hour or so. Recovery from the damage produced by low blood pressure and by tissue anoxia probably requires many days. Practically, it is necessary to initiate the surgical procedure long before the consequences of shock can be fully overcome. Operation is undertaken as soon as experience has shown that the patient will tolerate it, indicated chiefly by a *rising blood pressure* (80 mm. or above), a *falling pulse rate*, a *warm skin* and *good color* of the mucous membranes. Delay in surgery beyond the accomplishment of these things requires the constant support of the patient by blood or blood substitutes and, in the end, the use of needlessly large total quantities of these agents. Delay means that infection will have progressed and is shown to be closely allied to a rising death rate.

5. *Surgery is an Inseparable Part of Resuscitation.*—Resuscitation

as usually thought of—fluid therapy, oxygen administration, and so forth, can and should continue during operation. These forms are only supportive. Surgery alone checks the consequences of the wound.

PROCEDURES

Resuscitation includes all methods of management of the wounded man that make him first transportable to and then prepared to meet the stress of essential surgery.

1. *In the field, the Battalion Aid Station, the Collecting Company, and the Clearing Station* local conditions must always determine the measures that can be employed. In general, these are of the simplest order and have the single object of making the casualty transportable.

a. *Continuing hemorrhage* must be controlled by pressure bandaging if possible and only as a last resort by the application of a tourniquet. A circular bandage on an extremity may act as an improperly applied tourniquet, with disastrous consequences to life or limb. The use of blood and blood substitutes is discussed above.

b. *Pain Relief and Sedation.*—Morphine is used for the treatment of severe pain. The dosage cannot be standardized, but the ideal is to employ the smallest effective dose. Large doses cause nausea, vomiting and sweating, with undesirable fluid loss and, worst of all, depression of the respiratory center, with anoxia and increase in the signs of shock. Only occasionally is the half grain (30 mg.) dose of morphine necessary or reasonable. If given, it should not be repeated for at least four hours.

Disappointing results from the smaller doses are often attributable to poor absorption. (In cold weather or in the wounded with low blood pressure the peripheral circulation may be so sluggish as to retard the absorption of any drug administered subcutaneously or intramuscularly.) When relief of pain is urgent the intravenous route is the choice. Morphine grain $\frac{1}{2}$ (10 mg.) or grain $\frac{1}{4}$ (15 mg.), never more, diluted to 1.0 cc. with sterile water and injected over a minute can be depended on to reduce pain at once. Severe pain is the only important indication for the use of morphine. The restlessness of hemorrhage, excitement, fear, and hysteria is treated with small doses of barbiturate (sodium amytal grain 1, 60 mg., intravenously). Severe pain in the badly wounded is much less common than is generally believed; for some of these men, a cigarette is more appropriate than morphine.

c. *Splinting.*—Adequate immobilization of the wounded part, particularly when skeletal injury is suspected, not only prevents further local damage, but prevents shock. It is important not only to unlace, but to slit shoes left on when Thomas leg splints are applied.

d. *Special Injuries.*—Closure of sucking chest wounds, clearance of the airway in maxillofacial injuries with maintenance of the face-down

position during transport, and similar remedial measures for other injuries with special indications must always be kept in mind.

e. Food should not be given to a patient on his way to an operation.

2. In the *Field* or *Evacuation Hospital* the continuous service of one man in charge of resuscitation is desirable. He establishes local policy and sees to it that it is carried out by his assistants. He and the surgeons are in constant collaboration in deciding the extent of therapy and priority of operation. General care in the preoperative ward includes:

a. Removal of all clothing at once on admission.

b. Head-down position (foot of litter elevated about 12 inches) for all patients when the systolic blood pressure is falling or is below 80 mm. Exceptions are pulmonary edema, or if the position causes obvious difficulty, such as respiratory distress and cyanosis.

c. Complete physical examination and any immediately needed care of wounds are given.

d. Aspiration of Gastric Contents.—The only sure way to empty the stomach is to induce vomiting. This may be accomplished during placement of the gastric tube. Use the largest tube that will slip down easily. Washing of the stomach is usually not necessary and is contraindicated if the stomach or esophagus may have been penetrated by a missile.

e. The body heat of a wounded man is to be conserved by means of blankets. Gentle warming may be desirable *after* blood therapy is actually in progress.

f. Oxygen therapy is instituted when cyanosis is present, when the pulse rate is unduly high, or when the wound itself may cripple cardio-respiratory function.

g. The vasoconstrictors and the so-called "stimulants" are of little use in treating the wounded. They are contraindicated in large dosage.

h. The administration of any fluid or food by mouth is generally contraindicated once the hospital has been reached where definitive surgical procedures will be carried out. (Aspiration of vomitus is one of the most serious and common accidents to be encountered. This may be precipitated by anesthesia. Oftentimes fluid will be expressed from the stomach during intra-abdominal operations. This fluid flows into the pharynx and is quietly aspirated by the deeply anesthetized patient without outward sign, until hours later.)

i. Glucose and saline solutions are useful only in the treatment of dehydration.

j. When a patient is admitted in critical condition, a unit of plasma is administered at once and a blood sample taken for grouping and crossmatching. Occasionally, when the need for blood is very great, the first transfusion (low titer O blood) is administered without prior grouping and crossmatching. Rarely, it may be necessary to force blood in under pressure, but this is a dangerous practice and if judged

essential is to be carried out only by medical officers. Except in dire emergencies *both* grouping and crossmatching will be carried out in all cases. The principles describing the use of blood and blood substitutes have been given above. In the hospital where initial surgery is to be carried out, one unit of plasma to about three blood transfusions has been found desirable in preparing for and carrying badly wounded patients through operation.

k. It should rarely take more than three hours (and often it should be much less) to prepare even a badly wounded man in shock for surgery. Longer delay may indicate improper organization for the care of the patient.

ANESTHESIA

Resuscitation and anesthesia are parts of the single problem: to make surgery possible and as safe as it can be. Experience in these fields in the Mediterranean Theater has been considered elsewhere (1) and need not be described in detail here. In this section the views that have determined the choice of anesthesia for most of our patients will be considered.

PREANESTHETIC MEDICATION

The seriously wounded need very little premedication and morphine should be avoided in most cases, except when severe pain may interfere with induction. Atropine is useful to decrease the flow of mucus under ether and to minimize vagal reflexes; it is given in doses of grain $\frac{1}{100}$ (0.6 mg.), and occasionally repeated after one hour. Atropine for the latter purpose is useful in thoracic operations, in operations on the abdomen, particularly the upper abdomen, in surgical procedures on the neck when inflammation is present in the region of the carotids, or when barbiturate (pentothal) anesthesia is employed, and to counteract the occasional laryngeal spasm that occurs under this agent. (In this case the use of an additional dose will help. It is injected intravenously as soon as the spasm becomes troublesome.)

When local anesthesia is to be employed, if pain and considerable discomfort are to be anticipated, morphine may be used. In addition, pentobarbital sodium grains $1\frac{1}{2}$ to grains 3 (90 to 180 mg.) by mouth is often desirable about forty-five minutes before operation. Generally, during heavy military action, all preanesthetic medication is given intravenously, five or ten minutes before operation.

CHOICE OF AGENTS

Except for topical anesthesia of mucous membranes, three agents fulfill all of the important requirements of military surgery: ether, sodium pentothal and procaine hydrochloride.

Ether has clearly emerged as the agent of choice for the seriously wounded, for the man in bad condition, and for long operations. It is tolerated extraordinarily well by the critically impaired patient.

Facilities for the administration of ether with oxygen in a closed system with carbon dioxide absorption are important for the best general anesthesia. These conditions are essential for consistent success in open thoracic operations.

Overdosage in the hands of the inexperienced is less likely to prove serious than is the case with the other general anesthetic agents, for with ether the intake (respiration) stops before the circulatory system is seriously damaged. Recovery from overdosage is usually no more complicated than the prompt artificial respiration needed to eliminate the agent. These and other considerations make this the safest general anesthetic agent for use by those with little experience.

Sodium Pentothal.—Acceptable practice in the employment of this agent includes the use of 2.5 per cent solution, routine administration of oxygen with it, frequent observation and recording of pulse rate and blood pressure levels, traditional with other agents, but too often neglected with sodium pentothal.

While it is true that the total quantity of the agent needed in a given case can be considerably reduced by the use of morphine, this may be at the cost of unexpectedly prolonged postoperative depression, and postoperative nausea and vomiting. A better method of reducing the total quantity of sodium pentothal used is to supplement the agent with 50 per cent nitrous oxide and 50 per cent oxygen.

Sodium pentothal is useful for thirty to forty-five minutes, or less, of anesthesia in the lightly wounded. It is useful when employment of a noninflammable agent is imperative. It is hardly ever acceptable for use in the seriously wounded, in the patient in poor general condition, or in the man in shock. In terms of general principles, then, whenever the respiratory (oxygen intake, carbon dioxide removal) or circulatory systems (oxygen distribution, carbon dioxide removal) are actually handicapped, or if they may be during the course of the operation, this agent should be avoided.

Specific examples: Pentothal anesthesia should be avoided when the respiration is depressed, when surgery involves the airway, when the face down position must be used, when there is inflammation in the region of the carotids (hyperactive carotid reflexes),⁴ when the blood volume is low from considerable loss of whole blood or plasma (burns), and when gas gangrene is present (heart impaired by toxins). When an operation turns out to be unexpectedly long it is usually better to shift to ether after forty-five minutes or earlier if the patient tolerates pentothal poorly. Although pentothal may be useful for induction of anesthesia to be followed by ether in men in good condition, the routine use of pentothal preliminary to ether anesthesia in those in poor condition is not wise.

Local Procaine.—The multiplicity of wounds in a given seriously wounded man often limits the usefulness of local or regional block anesthesia for surgery in forward areas; however, intercostal and para-

vertebral blocks to control chest wall pain and sympathetic blocks for improving the blood supply to an extremity are often of value. Peritoneal block under direct vision is useful to improve relaxation of the abdominal wall under light general anesthesia. Many other blocks have occasional usefulness.

Spinal anesthesia has few indications in surgery in forward areas. The strongest argument against it is the poor tolerance of the freshly wounded for this technic, shown by a tendency of the blood pressure level to fall. The difficulty of preserving sterility of equipment in the field is another reason for limiting the technic in the forward areas. Spinal anesthesia is widely and properly used in base hospitals.

MISCELLANEOUS NOTES

Intratracheal intubation under general anesthesia is especially desirable for intracranial, maxillofacial, thoracic (pleural involvement) and abdominal surgical procedures and in other cases when the position of the patient makes it difficult to maintain a good airway, and finally when the operation promises to exceed an hour or so.

Postoperative Bronchoscopy.—While preparation of badly wounded patients for surgery should include check on the availability of a bronchoscope, the routine use of this even in open thoracic cases is undesirable for the following reasons: The airway should, if necessary, be kept clean by means of frequent aspiration of the trachea through a catheter. Use of the bronchoscope at the end of operation involves one of three things, all undesirable. If the bronchoscope is to be introduced at this time, either the anesthesia must be maintained at a deep level for an undesirably long time; it must be deepened with possible harm at the end of a trying operation when the condition of the patient may be poor, or topical anesthesia must be used. In this case, if the patient vomits on recovery from the general anesthesia, he is almost certain to aspirate vomitus through his locally anesthetized airway.

REFERENCE

1. Beecher, H. K.: (a) The Preparation of Battle Casualties for Surgery, *Ann. Surg.* **121**: 769-792 (June) 1945; (b) Anesthesia for Men Wounded in Battle, *Ann. Surg.* **122**: 807-819 (Nov.) 1945.

NEW SECTION ON ANESTHESIOLOGY

Recently a Section on Anesthesiology in the Ohio State Medical Association has been established. The officers of the section are Dr. A. A. Brindley, Toledo, Ohio, President, and Dr. R. J. Whitacre, Cleveland, Ohio, Secretary.