PART III

General Considerations of Wound Management

CHAPTER XII

Sorting of Casualties

GENERAL CONSIDERATIONS

Sorting, or triage, implies the evaluation and classification of casualties for purposes of treatment and evacuation. It is based on the principle of accomplishing the greatest good for the greatest number of wounded and injured men in the special circumstances of warfare at a particular time. The decisions which must be made concern the need for resuscitation, the need for emergency surgery, and the futility of surgery when the intrinsic lethality of certain wounds is clearly overwhelming. Sorting also involves the establishment of priorities for treatment and evacuation.

Military medical activities differ from those in the civil sector in that they must adapt to the special circumstances of a tactical combat situation. Combat hospitals must be not only mobile but also capable of receiving and treating large numbers of casualties that arrive simultaneously, the so-called mass casualty situation. The facility should be designed and staffed with these contingencies in mind. The medical officers, nurses, and support personnel must be well trained in the medical tactics necessary to cope with the ever-present possibility of receiving an overwhelming number of casualties presenting within a short period of time. During such situations, conventional standards of medical care cannot be delivered to all casualties. Some of the very seriously wounded will not receive the same degree of care they would have received had they presented as a single admission. Others may receive no immediate care except to insure that they are made as comfortable as possible under the circumstances.

In all mass casualty situations, there are logical categories into which all casualties can be classified. Some will have sustained critical injuries, but will have a high potential for survival with prompt treatment. These should have a high priority for treatment, while others, with mortal wounds, are not salvageable no

matter what degree of medical care resources are expended upon them. Certain others do not require immediate lifesaving procedures and will tolerate reasonable delays while the more critical are being cared for. The group with minor injuries will survive with directed self care or no care at all.

TRIAGE

In order to cope effectively and efficiently with large numbers of battle casualties that present almost simultaneously, the principles of triage, or the sorting and assignment of treatment priorities to various categories of wounded, must be understood, universally accepted, and routinely practiced throughout all echelons of collection, evacuation, and definitive treatment. This practice enables us to effectively provide the greatest amount of care to the largest number of soldiers, which in turn will salvage the greatest number of lives and limbs. The ultimate goal of combat medicine is the return of the greatest possible number of soldiers to combat and the preservation of life and limb in those who cannot be returned.

The casualty with multiple life-threatening wounds and a poor prognosis, who requires many surgeons and the expenditure of hours of operating room resources, may divert care from those with less serious, but more rapidly treatable, injuries and a better prospect for recovery. Not uncommonly, the most gravely injured are the first to be evacuated from the collection points. They will also be the first to arrive at the definitive care facility. The receiving surgeon (triage officer) must guard against overcommitting his resources to those first arrivals prior to establishing a perspective of the total number and types of casualties still to be received.

It is easier to assign priorities of care to individual casualties if the medical officer has a feel for the usual anatomical distribution of war wounds. Survivors present with a reasonably consistent pattern of wound distribution. Fortunately, the largest proportion of injuries affect less critical areas, such as the upper and lower extremities.

TABLE 8.—*Anatomical distribution of battle wounds*
Percent

Location	WWII	RVN
Multiple	**11%**	20%
Head/Neck/Face	**12**	**14**
Chest	**8**	**7**
Abdomen	**4**	**5**
Upper Extremities	**26**	**18**
Lower Extremities	**39**	**36**
	100%	**100%**

One can predict from the Table 8 that the majority of wounded is not likely to require urgent resuscitation or immediate surgical intervention. At the other extreme are those with maxillofacial or head wounds with airway destruction, those with wounds of the chest (ventilation compromise and hemorrhage), and those with abdominal wounds (uncontrollable hemorrhage), all of which require much more urgent intervention. Sometimes the time lag between wounding and hospital presentation is of such duration that those who temporarily survived the initial impact of their injury are no longer salvageable, further narrowing the group which requires urgent attention upon arrival. With experience, the forward surgeon comes to recognize this recurring pattern and the relatively consistent distribution of wound types and locations in groups of battle casualties. A small number of casualties will require urgent resuscitation and prompt operative intervention, whereas the majority of the wounded will tolerate varying degrees of delay prior to operation. Application of the following criteria makes the receipt, triage, and treatment of large numbers of simultaneously arriving casualties more manageable, while at the same time minimizing the confusion and calamity that otherwise could prevail. Again, it should be emphasized that every effort should be made to insure that the existing resources are expended upon the maximum number of salvageable soldiers. Simple lifesaving procedures which can be rapidly performed should be given the highest priority. Life takes precedence over limb, and functional repair over cosmetic concern.

PRIORITIES OF TREATMENT

Sorting is the process of prioritization or rank ordering wounded individuals on the basis of their individual needs for surgical intervention. The likely outcome of the individual casualty must be factored into the decision process prior to the commitment of limited medical resources. Casualties are generally sorted into five categories or priorities, These priority groupings are discussed in decreasing order of surgical urgency.

URGENT. This group requires urgent intervention if death is to be prevented. This category includes those with asphyxia, respiratory obstruction from mechanical causes, sucking chest wounds, tension pneumothorax, maxillofacial wounds with asphyxia or where asphyxia is likely to develop, exsanguinating internal hemorrhage unresponsive to vigorous volume replacement, most cardiac injuries, and CNS wounds with deteriorating neurological status.

Therapeutic interventions range from tracheal intubation, placement of chest tubes, and rapid volume replacement to urgent laparotomy, thoracotomy, or craniotomy. Shock caused by major internal hemorrhage will, in these circumstances, require urgent operative intervention to control exsanguinating hemorrhage.

If the initial resuscitative interventions are successful and some degree of stability is achieved, the urgent casualty may occasionally revert to a lower priority. The hopelessly wounded and those with many life-threatening wounds, who require extraordinary efforts should not be included in this category.

IMMEDIATE. Casualties in this category present with severe, life-threatening wounds that require procedures of moderately short duration. Casualties within this group have a high likelihood of survival. They tend to remain temporarily stable while undergoing replacement therapy and methodical evaluation. The key word is temporarily. Examples of the immediate category are: unstable chest and abdominal wounds, inaccessible vascular wounds with limb ischemia, incomplete amputations, open fractures of long bones, white phosphorous burns, and second- or third-degree burns of 15-40% or more of the total body surface.

DELAYED. Casualties in the delayed category can tolerate delay prior to operative intervention without unduly compromising the likelihood of a successful outcome. When medical resources are overwhelmed, individuals in this category are held until the urgent and immediate cases are cared for. Examples include stable abdominal wounds with probable visceral injury, but without significant hemorrhage. These cases may go unoperated for eight or ten hours, after which there is a direct relationship between the time lapse and the advent of complications. Other examples include soft tissue wounds requiring debridement, maxillofacial wounds without airway compromise, vascular injuries with adequate collateral circulation, genitourinary tract disruption, fractures requiring operative manipulation, debridement and external fixation, and most eye and CNS injuries.

MINIMAL OR AMBULATORY. This category is comprised of casualties with wounds that are so superficial that they require no more than cleansing, minimal debridement under local anesthesia, tetanus toxoid, and first-aid-type dressings. They must be rapidly directed away from the triage area to uncongested areas where first aid and non-specialty medical personnel are available. Examples include burns of less than 15% total body surface area, with the exception of those involving the face, hands, or genitalia. Other examples include upper extremity fractures, sprains, abrasions, early phases of symptomatic but unquantified radiation exposure, suspicion of blast injury (perforated tympanic membranes), and behavioral disorders or other obvious psychiatric disturbances.

EXPECTANT. Casualties in the expectant category have wounds that are so extensive that even if they were the sole casualty and had the benefit of optimal medical resource application, their survival still would be very unlikely. During a mass casualty situation, this sort of casualty would require an unjustifiable expenditure of limited resources, resources that are more wisely applied to several other more salvageable individuals. To categorize a soldier to this category requires a resolve that comes only with prior experience in futile surgery that ties up operating rooms and personnel while other more salvageable casualties wait, deteriorate, or even die. The expectant casualties should be separated from the view of other casualties; however, they should not be abandoned. Above all, one attempts to make them comfortable by whatever means necessary and provides attendance by a minimal but competent staff. Examples: unresponsive patients with penetrating head wounds, high spinal cord injuries, mutilating explosive wounds involving multiple anatomical sites and organs, second- and third-degree burns in excess of 60% total body surface area, convulsions and vomiting within twenty-four hours of radiation exposure, profound shock with multiple injuries, and agonal respiration.

Exposure to radiation or biologic, and chemical agents when presenting in conjunction with conventional injuries will alter the above categorization. The degree to which such agents compound the prognosis is somewhat variable and difficult to specifically apply to a mass casualty situation. A safe practice is to classify the exposed casualty at the lowest priority in his category. It has been stated that those in the immediate category with radiation exposure estimated to be 400 rads be moved to the delayed group, and those with greater than 400 rads be placed in the expectant category. Those with convulsions or vomiting in the first 24-hours are not likely to survive even in the absence of other injuries. Mass casualty situations are highly probable when troops have been exposed to radiation or chemical or biological agents. There must be areas set aside within the hospital to safely isolate these types of patients, and special procedures must be established to safeguard the attending medical personnel.

PAST EXPERIENCE

In World War II, the lines of combat were relatively discrete and fixed, allowing the echelons of medical support to be structured and upgraded in a logical manner. The most seriously wounded casualty received care as close to the front as possible; those less seriously wounded and more transportable were moved to the more fixed installations in the rear. Battalion aid stations were generally situated about 500 yards behind the front. Triage was performed here and medical evacuation for further rearward evacuation was located here. The main thrust was to render the casualty transportable after all vital systems were evaluated. Airways were cleared, adequate ventilation assured, and accessible hemorrhages controlled. Dressings and splints were applied as necessary, fluid replacement initiated, and pain medication administered. Those with the most critical injuries were considered the first priority and were evacuated about one mile to the collecting station, where further lifesaving treatment was administered. Further to the rear (five-miles) at the division clearing station, casualties were once again triaged, and those with the highest priority injuries (urgent and immediate) were taken to the adjacent field hospital for immediate surgery. The remainder, who could better tolerate delay and further transport, continued on to general or evacuation hospitalization deeper within the rear area. The bulk of the extensive lifesaving procedures was provided at the forward hospital, where the wounded were operated upon, held until stable, and then transferred to the rear echelon hospitals.

By contrast, the Vietnam conflict consisted of sporadic small unit engagements which were widely dispersed geographically and seldom lasted more than six hours. Major battles, such as those fought at Hue and in the A Shau Valley, were measured in days, fought with mobile units, and accounted for the greatest number of mass casualty situations. Major medical support was not mobile and remained fixed within relatively secure centrally-located military compounds. Although labeled as semimobile, hospitals were generally Quonset-type structures, bolted to concrete slabs and provided with permanent electrical and plumbing connections. The inflatable "MUST" hospitals, while capable of mobility, required unacceptable levels of fuel for power generation and also became relatively fixed. Since the forward hospitals could not go forward to the casualty in those campaigns, the air ambulances went forward and brought the casualties to the hospitals. Fortunately, air superiority was never in doubt.

FACILITY DESIGN

To facilitate efficiency and optimize triage, evaluation, and definitive care under mass casualty conditions, certain features should be incorporated into the combat hospital's physical plant. The design should promote smooth casualty flow through all areas of the facility. At no time should the normal progression of care or casualty flow be allowed to have a reverse direction. A casualty should not be carried off to X-ray and then returned from whence he came. Traffic should not enter and exit through the same portal. Flow against the grain must be held to an absolute minimum.

These principles should apply regardless of the nature of the construction whether it be Quonset, tentage, or modification of already existing permanent structures. Figure 21 illustrates this concept.

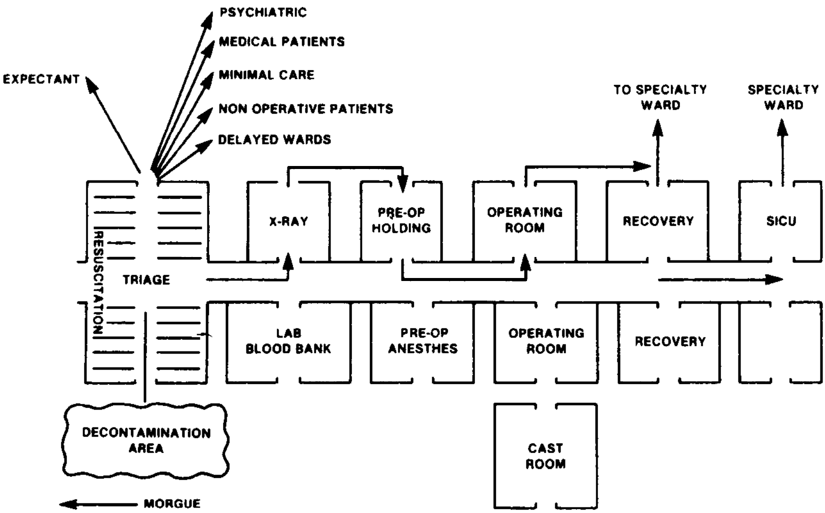

FIGURE 21 — Proposed Scheme for Mass Casualty Flow

HELIPORT. Ideally, the helipad should be close enough to the hospital's receiving area to preclude the need for intermediate motorized surface transport.

DECONTAMINATION AREAS. A decontamination area should be set up under shelter, and provided with temperature-controllable water and drainage away from the hospital. If prevailing winds exists, this area should be downwind from the hospital. A separate area nearby is required for the collection and disposal of contaminated uniforms, equipment, weapons, and personal items.

TRIAGE AREA. Adequate space in this area is of the utmost importance Overcrowding contributes to confusion and unacceptable noise levels, and detracts from careful casualty evaluation. Each patient station must be accessible from all sides. Multiple stations consisting of litters placed on sawhorse frames should be in place and ready. Shelving'or cabinets should be installed along the walls to supply the required consumable supplies: IV fluids, administration sets, venipuncture sets, tetanus toxoid, antibiotics, dressings, evaluation forms, identification tags, etc There should be an ample supply of IV poles or an overhead cable or rail from which to suspend IV solutions and blood.

Each casualty should pass into the decontamination and triage areas one at a time. It is a mistake to have two or more helicopters discharging casualties simultaneously, although this is sometimes unavoidable when tactical aircraft assist in the evacuation. This leads to confusion and competition among litter bearers for doorways and stations, and a critical casualty may pass by the triage officer unnoticed.

Those deemed urgent and requiring resuscitation should be taken to that specific area equipped for their evaluation and management. Type O-negative or O-positive low-titer blood should be available, as well as airway management equipment, suction, and closed thoracotomy setups.

Each litter station is attended by one medical officer, usually a surgeon, and one nurse. Here the casualty undergoes evaluation, fluid administration, tetanus toxoid injection, and assignment of an appropriate priority of care by the triage officer. When appropriate, the immediates will pass through X-ray and into the preoperative area, where they are further triaged and assigned to operating teams. This cycle is repeated until all casualties have been operated. When the number of patients exceeds the bed space, convalescing patients are triaged for further evacuation to make beds available.

To ease congestion and confusion, ambulatory casualties should be evaluated in a separate area designated for minimal care. If the triage area needs to be cleared for new arrivals, wards should be made available to receive the spillover. The delayed casualties are often held in designated wards until the preoperative area is clear of the more seriously injured. One must remember that triage is a dynamic process. The initially-assigned priority may change as the individual's condition changes or with the receipt of additional casualties.

Above all, the dead must not be introduced into the triage area. Not uncommonly, a casualty will expire enroute, and, not infrequently, a unit commander will demand that his dead be evacuated in air ambulances along with the wounded. In either case, the litter bearers must halt outside and request guidance or pronouncement from the triage or some other medical officer.

OPERATING ROOMS. The surgical suites are most often configured with operating tables in a single large room. The arrangement functions very effkiently, in spite of an increased noise level.

PERSONNEL. After the intial notification of the anticipated large influx of casualties, a timely alert is passed along the chain of responsibility, and the triage officer insures that all stations and services are prepared. Personnel should be well drilled in their responsibilities and remain at their stations unless otherwise directed.

The triage area will rapidly develop into the site of greatest activity, usually attended with some degree of initial hyperexcitability and confusion among the staff. Access to this area should be restricted to the assigned medical officers, nurses, corpsmen, litter bearers, and those administrative personnel required to assist with patient identification, custody of personal belongings, and registration. Overcrowding with nonessential personnel is common and can become an impediment to efficient progress. Once the litter bearers discharge their patient, they should revert to the pool for further assignment. The tendency is to stand around in an observer status. All hospital personnel, no matter how well intentioned, should stay clear of the active areas unless their presence is requested.

TRIAGE OFFICER: The triage officer, usually the Chief of Surgery, must be the most experienced of the surgeons, and must exercise absolute authority in all decisions involving the sorting and assignment of casualty priorities. He must continually monitor each patient's status while simultaneously managing and committing his resources. He will direct the activities of the evaluating teams in the triage room and the preoperative holding area, and the eventual movement and priority of patients proceeding into the operating room. He will designate the number of operating teams necessary and will mobilize pools of medical officers and other personnel as necessary to assist in the total effort. He must continually reassess the hospital's ability to sustain momentum while simultaneously providing routine care to patients already hospitalized. When his resources are all committed, he must request the diversion of additional workload to some other medical treatment facility.

As the exercise proceeds, the triage officer must continually evaluate and reevaluate the status of his resources, fatigue level of his personnel, bed availability, and the surgical backlog. Not infrequently, a patient in the delayed category will deteriorate and require more immediate attention. Once those in the initial immediate category have been operated and stabilized, others from the delayed category are funneled into the surgical treatment channels on a prioritized basis.

THE FINAL PHASE. As the casualties finally clear the operating room suites, the pace will slow for the surgeons. The recovery room and intensive care units will become crowded, nursing shifts will have to be extended, and fatigue will rapidly become a hospital-wide factor. Numerous authors state that after the first 24 hours of a mass casualty ordeal, the activities of the personnel must be decreased by one half to allow for rest for the participants, and a new rotation must be established to sustain a modified but continuous effort.

Once the press is over, personnel must be encouraged to rest rather than to socialize. Rest must be enforced since the entire scenario may recur at any time.

COMMANDING OFFICER'S RESPONSIBILITY. The medical facility commanding officer must be kept informed of the tactical situation, the likelihood of extended combat in his area, the security of his hospital, and the possible need to divert patients to other medical facilities. He must know the status of his resources and must support or modify the activities of the triage process depending on the reserves within his hospital, the threat from without, and the capacity of his personnel. He must have knowledge and control of all the support activities involved in the effort, including such services as feeding those unable to adhere to the standard schedule; resupply of urgently needed items, such as blood, plaster, or medications; and the status of his staff. His wisdom may be required when wounded prisoners are introduced into the triage situation, not an uncommon situation in Vietnam. During such episodes when his unit is under maximal stress, his role should be one of total involvement and his primary concern should be to provide an environment in which his surgeons, nurses, and support personnel can function at the maximal level of productivity.

CHAPTER XIII

Aeromedical Evacuation

INTRODUCTION

As the intensity of combat operations varies, so varies the flow of wounded and the strain placed upon all echelons of medical care. At the same time, the ever-present requirement of maintaining available bedspace for additional incoming casualties creates the constant requirement for evacuation of those occupying the system's forward beds. The provision of optimal, individualized surgical care, in concert with the efficient utilization of resources, necessitates close coordination between the direct care providers at all levels and those responsible for the administration 'and operation of the full spectrum of medical evacuation.

Aeromedical evacuation is a modern, complex transportation system designed to move casualties rapidly. Appropriate utilization of this system markedly reduces the time lapse from initial wounding to definitive care That such rapid movement of patients results in overall decreases in morbidity and mortality has been demonstrated repeatedly in recent conflicts. This holds true regardless of the category of patients considered.

At the point of initial wounding, where medical capability is limited to first-aid measures, dedicated rotary-wing air ambulances are utilized to provide rapid transfer of the casualty to an area providing first-line resuscitation capability. Triage is accomplished at each echelon of medical care Patients are evaluated at aeromedical evacuation battlefield collecting points and categorized as to their relative needs and general stability. From these collection points, and with an awareness of each casualty's individual clinical needs and personal stability, further retrograde movements are programmed. Patients may be removed from the evacuation chain at any medical facility along the evacuation route when it is the professional opinion of the evaluating surgeon that patient safety will be compromised by continued transfer.

AIRCRAFT

Helicopters are versatile, maneuverable aircraft normally utilized to evacuate injured patients short distances rapidly. The flying time of currently deployed helicopter ambulances is about three hours with a range of 250-300 miles. Utilization of these aircraft results in the casualty reaching well-equipped medical facilities in a matter of minutes. Casualties with grave injuries that would have been fatal without the utilization of rapid air transportation reach operating rooms. The foregoing was repetitively demonstrated in Vietnam where, due to the relatively short distances involved, the battalion aid station was for the most part overflown, with direct evacuation from the battlefield to definitive care facilities having surgical capabilities.

The effects of this rapid field aeromedical evacuation system were twofold. On the one hand, many casualties, who in previous conflicts would have died of their wounds while awaiting or undergoing surface medical evacuation, reached definitive care facilities and were salvaged. Without taking anything away from the superb performance of corpsmen, nurses, and surgeons, this very substantial salvage of human life was in large measure directly attributable to the gallant, selfless professionalism of the “can do” air ambulance flight crews.

On the other hand, rapid field aeromedical evacuation of fresh battle casualties attributed at least in part to the slightly increased hospital mortality experience in Vietnam. For example, in World War II, with no field aeromedical capability, 4.5% of those wounded in action (WIA) and subsequently hospitalized died of their wounds. In the Korean conflict, with its limited utilization of field aeromedical evacuation but better medical-technical capabilities, the hospital mortality of this same group of casualties declined to 25%. However, in Vietnam, with its even further advanced medical-technical capabilities but almost universal application of rapid field aeromedical evacuation, hospital mortality of WIAs increased to 35%. This increased WIA hospital mortality rate is thought to be due, at least in part, to early hospital presentation of a small but significant number of casualties with mortal wounds. These represent casualties that would never have arrived alive at medical treatment facilities in previous conflicts.

With the availability of helicopter evacuation from the battlefield, the decision to fly casualties directly to hospitals depends on five variables: the clinical status of the casualty, the flying time, the weather conditions, the casualty generation rate or load, and the tactical situation. Where casualty generation is heavy and helicopter resources are limited, casualties can be transported by air or by land from the battlefield to nearby clearing stations. After triage and initial resuscitation, they will be moved to more definitive facilities in order of their clinical priority. Even when the hospital is relatively close to the battlefield, the division clearing station can serve as a buffer when casualty loads temporarily overwhelm a hospital's capability. It must be constantly borne in mind that the availability of rapid transportation by air does not alter, in any way, the necessity for correct application of surgical principles. Experience has shown that field aeromedical evacuation functions most efficiently and reliably when these assets are dedicated to their medical mission and are under direct medical command and control.

INTRA- AND INTERTHEATER MEDICAL EVACUATION

Intratheater medical evacuation moves patients from one hospital to another within the theater of operations. This includes evacuation between combat zone hospitals, between communication zone (COMMZ) hospitals, or from combat zone hospitals to COMMZ hospitals. Out-country, or intertheater medical evacuation moves patients from hospitals located within the theater of operations to designated casualty-receiving Medical Treatment Facilities (MTFS) located in the Continental United States (CONUS) or in host nations outside the theater. This complex evacuation system consists of two interrelated processes: patient regulation and patient movement. Whereas the medical officer is always responsible for any decision that impacts on the clinical welfare and stability of his patient, the patient administrator and the medical regulating officer (MRO) provide invaluable assistance by communicating up and down the echelons of the combat health care delivery system to facilitate the provision of safe, timely, and efficient movement of casualties. MROs at each echelon function as the gatekeepers and facilitators who achieve an even distribution of cases, assist in minimizing surgical backlogs, maintain an adequate number of available beds for current and anticipated needs, route patients requiring specialized treatment to the proper facilities, and coordinate the smooth, safe retrograde movement of casualties. This system is designed to ensure both the efficient and safe transfer of patients, often over great distances, in such manner that the welfare of the patient is second only to the success of the tactical mission. To achieve these objectives, MROs must maintain current information on the tactical situation, the availability of all types of transportation, the location and capacity of facilities with special capabilities, the current bed status of treatment facilities, surgical backlogs, the number and location of patients by diagnostic category, the location of airfields and seaports, and, most important of all, the individual patient's suitability to withstand evacuation.

Fixed-wing aircraft of the nonmedical variety are utilized to transport personnel and supplies into the theater of operations. After off loading, these same aircraft can be quickly converted and internally reconfigured to accommodate both litter and ambulatory patients. With the exception of aircraft specifically designed to transport patients, most aeromedical evacuation is performed in reconfigured standard military transport aircraft. These aircraft and their medical teams are selected carefully in consideration of the patient's needs. jet-powered aircraft are capable of rapid patient movement in smooth air at high altitude in pressurized comfort. These movements can be accomplished for short or long distances as required. Overnight rest stops can be provided along the way, depending upon the patient's clinical status and the distances involved.

SPECIAL CONSIDERATIONS

Individual patients, each with his own peculiar problems, will require special considerations. Scheduling the evacuation, managing the patient in transit, arranging special attendants and equipment, programing rest stops, and determining appropriate destination hospitals are all vital considerations in the safe, rapid movement of the battle casualties.

Although the exigency of a given situation may require a patient to be evacuated earlier and for longer distances than ordinarily would be deemed advisable, the rule should be to await adequate clinical stability prior to subjecting the patient to what could turn out to be an arduous, clinically risky, prolonged trip.

1. Tracheostomy care: Tubes should be of proper size. When mechanical respirators are to be used, cuffed tracheostomy tubes

are usually required. Because of the low humidity of the aircraft cabin atmosphere, the use of a humidification device is recommended to avoid the production of dry mucous plugs and to assure proper tracheal care during flight. Humidity levels in the pressurized cabin are around 5-20 %. At these levels, insensible losses and drying of the tracheobronchial tree, especially in those with tracheostomy, are considerably increased. The ultrasonic nebulizer is the most efficient apparatus at this time. A heat aerosol nebulizer is probably the second-best apparatus.

Mucous plugs and encrustations must be removed promptly to avoid respiratory distress and obstruction. The use of tracheostomy tubes that do not have cleaning cannulae should be avoided. Rubber and plastic tracheostomy tubes normally do not have cleaning inner tubes or cannulae. The periodic instillation of 2 ml. of sterile isotonic saline solution into the tracheostomy with prompt aspiration enhances the cleansing of the airway.

In emergency situations during transit, endotracheal intubation is usually safer and quicker than tracheostomy and is well tolerated by the patient. Prompt use of such tubes usually eliminates the need for tracheostomy. A T-tube, if available, should be attached to the endotracheal tube or tracheostomy tube during evacuation to provide humidity and reduce the likelihood of mucous plugg ing and encrustation. The balloon of a cuffed tube should be inflated with air, not water.

2. Cranial tongs: Special attention should be paid to the proper seating of the tongs. Traction must be maintained by a closed system, preferably with a spring device such as the Collins' spring. In the absence of a spring device, traction may be maintained by heavy rubber tubing tied to the litter frame. To prevent sudden jerking of the tongs, free hanging weights must not be left attached during flight.

3. Skin traction: Stockinette glued to the skin can be utilized to maintain traction during evacuation. Traction is maintained by rubber tubing interposed between the stockinette and a plaster-incorporated wire loop. The surgeon who orders the evacuation of the patient is responsible for removing weights and substituting a self-contained traction device before aeromedical transfer.

4. Chest tubes: Ideally, patients should not be evacuated by air with chest tubes in place, nor should they be evacuated within 72 hours after removal of the tube. Absence of pneumothorax must be demonstrated by a chest roentgenogram just before movement.

On the other hand, when necessary, chest tubes may be left in position during evacuation but should be equipped with functioning valves, such as the Heimlich valve. Pressurization of the aircraft to ground level is desirable if such patients must be moved. Thoracic patients that require assisted ventilation should not be placed in air evacuation channels.

5. Nasogastric tubes: All patients requiring nasogastric suction at ground level should have similar protection during flight. The combination of one's basic medical problems coupled with air swallowing due to anxiety or pain, and the reduced barometric pressure at high altitudes results in hollow viscera gas expansion that can cause complications. Failure to decompress the stomach can result in pain from distention of hollow viscera, dehiscence, and, most significantly, vomiting and aspiration with serious pulmonary complications. Increased abdominal pressure under a restricting body cast can also result in vomiting and aspiration.

6. Plaster casts: When evacuating patients with circular plaster casts, all such casts should be appropriately bivalved before movement. This allows for swelling of soft tissue, permits rapid emergency access to secondary hemorrhage, and may facilitate escape through emergency hatches in the event of an emergency. It is helpful to evacuation chain personnel when casts are labeled. Such inscriptions should include the date and type of injury, the date of surgery and cast application, and a simple sketch of the bone injury,

7. Stryker frame: Such frames may be used for transfers by air. Patients should be turned during travel as ordered by the referring surgeon.

8. Catheter care: Indwelling catheters in use before transfer should be left in place during transfer. Instructions for specific care enroute both at the staging area and aloft should be provided to the medical evacuation teams. Every attempt should be made to maintain urinary output above 1,500 ml per day.

9. Hypothermia blankets: Patients requiring hypothermia blankets before evacuation should have this therapy continue enroute. Equipment is normally available aboard the aircraft to continue such treatment. Convulsions, high fever, and respiratory distress can be expected to develop if this principle is not followed.

10. Circulating blood volume and oxygenation: The hematocrit is not a reliable indicator of the adequacy of circulating blood volume The casualty is most likely to be hypovolemic or hyper-

volemic during the first 3-4 days post injury. Homeostatic mechanisms have usually restored the circulating volume to normal after this period. Oxygenation problems at ground level will be increased at higher altitudes. Patients having hematocrits of 30% or below should not be transferred under any but the most urgent situation. If transfer must be accomplished, proper supplies for transfusions should accompany the patient with orders for the use of blood enroute. Measurement of pO_2 should be used as a criterion of air evacuability in the seriously ill patient. Levels below 60 mm Hg are considered a contraindication to movement. It has been demonstrated that wounded patients can have dangerously low arterial pO_2 at sea level without any clinical indication of hypoxia. One U.S. Air Force casualty study revealed that none of the casualties with an arterial pO_2 of 35-40 mm Hg and normal pH was cyanotic, although some were mildly tachyneic. At this level of pO_2, arterial saturation was approximately 70%; however, many of-these patients did not have enough reduced hemoglobin (5 gm/100 ml) to become cyanotic. This sort of situation at sea level is particularly dangerous in flight. At altitudes of 35,000 feet, the cabin is pressurized down to about 8,000 feet equivalent, or 564 mm Hg. At this pressure, alveolar air pO_2 is about 69 mm Hg, or 33% less than sea level. An arterial pO_2 that was 50 at sea level is dangerously low at 8,000 feet.

11. Cerebrospinal leak: A wound draining cerebrospinal fluid at ground level will drain slightly faster at higher altitudes. These wounds are not a contraindication for transfer.

12. Abdominal surgery patients: Experience shows that premature evacuation of casualties shortly after abdominal surgery carries a high morbidity. Patients with wounds and injuries of the abdomen are best retained at the facility in which they have undergone their initial surgical care until complications have been controlled, bowel functions have returned, and the wound is healing. These requirements are seldom met in fewer than seven days.

13. Vascular injuries: Patients with vascular injuries require special attention and immobilization. Casts should be bivalved to provide emergency access to the area. When circumstances permit, primary repair or graft cases should not be transferred for 14 or more days after repair, unless the wound has been closed and is healing without evidence of infection. Patients should have the repair date and type of repair inscribed on the cast or dressing.

14. Burns: Burn patients may be transferred at any time during their care; however, as in all severely wounded patients, transfer is unwise until the blood volume has been restored and the patient's condition is stable. The best time for this category of patient to travel is 4-7 days postburn, when diuresis has begun and the complications of fever and infection have not yet presented. Bums greater than 40%, or lesser burns associated with severe injuries, ordinarily should have a surgeon in attendance. Preparation for transfer should include:

a. Airway assurance by whatever means necessary.

b. Functioning intravenous pathway

c. Adequate urinary output.

d. Fresh burn dressings.

e. Immobilization of associated injuries as indicated.

f. Functioningnasogastric tube if any gastrointestinal dysfunction exists.

g. Complete medical records, particularly accurate fluid balance sheets.

15. Maxillofacial Injuries: During transportation, these patients should be placed in a semiprone position on the litter. If there are upper respiratory difficulties, or if they are likely to develop during transportation, tracheostomy should be performed before evacuation. If tracheostomy or endotracheal intubation is not performed, the patient with a maxillofacial injury must be evacuated with an attendant especially instructed in the possibilities of respiratory obstruction and in techniques for dealing with it.

Patients with major maxillofacial wounds require special preparation before evacuation to the intermediate or reconstructive care facility If possible, infections should be under control, no significant fever should be present, and the patient's general condition should be sufficiently stable to withstand the evacuation. All packing should be removed before evacuation, or specific instructions should accompany the patient concerning location, number, and types of packs with recommendations for time of removal. If intermaxillary fixation has been utilized, the patient should be retained for several days after surgery, taking a liquid diet, and tolerating fixation well before evacuation. If intermaxillary elastics are utilized, some type of pullout cords are indicated. In an alert patient who has a tracheostomy or absence of several anterior teeth, there is little likelihood of aspiration of emesis; therefore, any type of suitable fixation is acceptable.

16. Dressing changes: A patient who has had a debridement of a combat wound is considered to have a clean wound. The dressings should not be changed without good reason except in an operating room at the time of probable delayed primary closure. Contamination of the open wound may occur when the dressing change is conducted under less-than-optimal conditions. Neither the odor nor the staining of a dressing from blood or serum is an indication for a dressing change. Dressing changes are indicated only for serious complications, such as bleeding, unusually high fever, increasing pain, or swelling. The decision for a dressing change should be made by a physician.

17. Medications: Certain medications, such as antibiotics, narcotics and analgesics, should have a recorded "stop order" to avoid an undesirable extension of this course of therapy. It is essential that the physician ordering evacuation complete the flight tag accurately to assure antibiotic therapy continuation on schedule or discontinuation as required. Some medications are not normally available in standard supply, and when these are to be continued during patient transfer, an adequate supply must accompany the patient.

18. Medical attendants: Medical attendants, assigned to accompany seriously ill patients, should accompany those patients to the destination hospital. The attendant, in addition to providing clinical services enroute, is a vital link in the continuity of care between medical echelons. This is best accomplished by personally interfacing with the receiving medical officers and providing those clinicians with well-documented and complete medical records.

CHAPTER XIV

War Surgery Within the Division

INTRODUCTION

Physicians assigned to the unit and division levels may have the most arduous duties of any medical officer. From a medical treatment standpoint, the environment is relatively austere and the spectrum of responsibility broader. However, medical service at this level can result in great personal and professional satisfaction. Although much emphasis is placed upon the ability of the unit and division level medical officer to perform life-sustaining resuscitation during combat casualty care, the nature of combat wounds is such that the actual potential for such intervention is usually not great. The medical officer at the unit or division level will find that the major contribution to combat casualty care during battle will be to control the flow of casualties by effective triage and preparation of casualties for evacuation.

Triage of casualties at the unit and division levels is designed to recognize three categories of casualties: first, those who need immediate resuscitation and surgical intervention (e.g., shock from internal hemorrhage); second, those who have incapacitating but not immediately life-threatening injuries and are unlikely to return to duty (e.g., fractures); and third, those who can be promptly returned to duty (e.g., minor soft tissue fragment wounds).

About 10% of all wounded can be expected to be in frank shock. Three percent have severe dyspnea arising from thoracic wounds, about 1% have upper airway obstruction resulting from facial or neck wounds, and about 1% require airway management because of severe neurologic trauma. About 15% of all casualties leaving the battlefield require immediate resuscitation or surgery. Perhaps one-half of the remaining casualties will also require evacuation beyond combat zone medical treatment facilities. Assuring the stability and relative comfort of these casualties is an important part of the unit and division medical officer's duty. Casualties who have the potential for return to duty within the specified time constraints of the evacuation policy should be segregated from casualties with more severe wounds. The American experience in Vietnam was that casualties who could return to duty within a few days constituted the largest single fraction of the total combat casualty population. The unit and division level medical officer makes an important contribution to the conservation of our fighting strength by preventing the overevacuation of such casualties.

Certain basic tasks need to be performed on every casualty arriving at the aid station or medical company. First and foremost, a determination needs to be made whether the casualty constitutes a threat to the medical troops or other casualties. This is true not only when chemical or biological agents have been employed, but also in conventional warfare in which there is a need to be certain that the casualty is not carrying explosive ordnance Sufficient clothing should be removed to allow the medical officer to inspect the wounds and to determine whether immediate life-threatening conditions such as airway obstruction, inadequate breathing, or hemorrhage are present. The level of consciousness, blood pressure pulse, respiratory rate, and the time should be recorded on the field medical card. The time, dose, and route of administered narcotics, if any, should be noted. The prevalence of dehydration in combat casualties must be appreciated. If necessary, dressings and splints should be applied and preparations made for evacuation to the next echelon. Figure 22 is a flow diagram depicting some of the important combat casualty,care decisions that need to be made at the unit or division level.

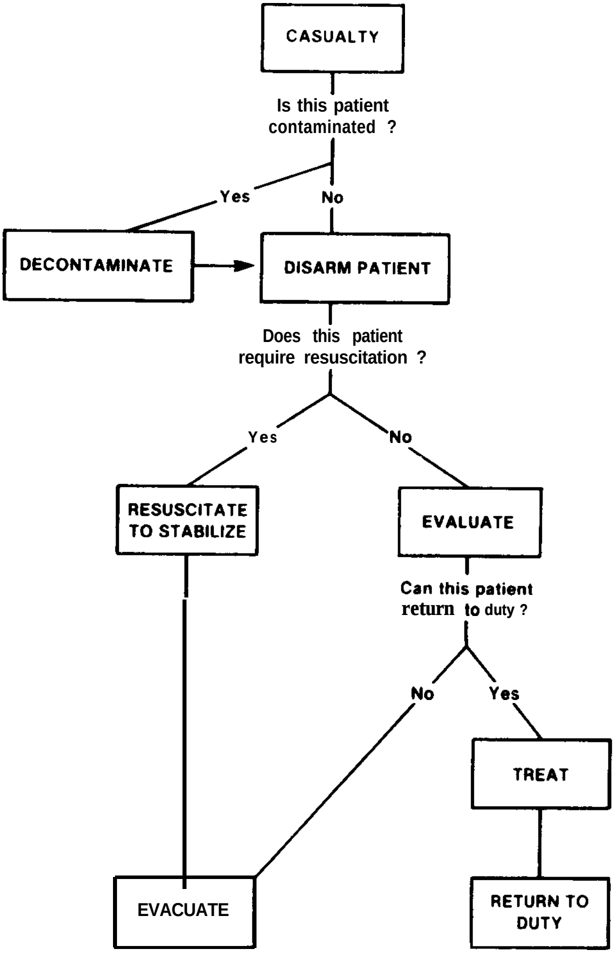

FIGURE 22.-Casualty care decision tree at the division level.

ORGANIZATIONAL AND'OPERATIONAL ASPECTS

One essential prerequisite for the effective discharge of the unit and division medical officer's medical duties is a knowledge of the tactical deployment of the units the officer supports and the current level of intensity of their operations. The following text covers several of the more important functions of medical platoons and companies. Although emphasis is placed upon the function of the battalion surgeon, most of this information is also applicable to the division level medical officer. Medical officers must not forget that what they are able to do and how they do it can be profoundly influenced by current operational doctrine and by the prevailing tactical situation. The latter will dictate whether or not medical evacuation is possible and by what means it can be accomplished.

The battalion surgeon has two primary missions:

(1) Insure the health of the command

- apprise the commander of ways to improve or preserve the health of the command
- conduct disease surveillance
- educate on preventive measures
- inspect the state of health, morale, and hygiene of subordinate units
- assess the medical threats for planned operations

(2) Provide combat casualty care

- provide the commander with medical annexes to operational plans
- supervise the battalion aid station
- triage casualties
- train combat medics
- supervise evacuation and extraction of casualties
- conduct medical reconnaissance*
- prevent overevacuation of those only slightly injured who can be quickly returned to duty

*This includes map or terrain reconnaissance to determine the most secure lines of evacuation and potential location of secure casualty treatment areas near the battle areas. This should be accomplished before the battle and is part of the medical annex to the operational plan.

The battalion surgeon is responsible for the location, operation, and deployment of the battalion aid station. This involves movement to a properly located site, usually co-located with battalion headquarters and battalion trains, as well as distribution of medical elements of the battalion aid station to the rifle companies.

Two factors must be balanced against one another in selecting a site for the battalion aid station. One considers the security of location versus its nearness to supported forces. The battalion aid station is austere in both equipment and personnel and *must* rely on the other elements of the battalion trains (maintenance, supply, communications, and other battalion headquarters troops) to provide the necessary security for the battalion aid station. Cover, concealment, and the choice of a position in defilade to direct enemy fire contribute to the security of the battalion aid station as well as its ability to perform the medical support mission. Many other factors are considered when deciding where to site the battalion aid station: proximity to lines of drift of sick or wounded troops, proximity to water, ease of ingress and egress by ambulances, protection from the elements (this can include the use of commandeered structures when available, i.e., barns, houses, shops), ease of abandonment of position to keep pace with the supported unit, ease of access by next higher echelon of medical care, and a landing zone for air ambulances. To take advantage of the protection afforded by the Geneva Convention, the battalion aid station site must be suitably marked.

The battalion aid station does not necessarily require shelter unless weather or night operation light discipline mandate cover. The battalion aid station should be considered an area rather than a facility. After an appropriate site is chosen, it must be further divided into functional areas: triage, immediate treatment, delayed or minimal treatment and sick call, expectant casualties, battle stress casualties, and morgue. Ease of casualty flow in either a linear or circular manner is an essential consideration. Each area of the battalion aid station should be marked with signs and the entrance to the battalion aid station must be obvious.

Battalion aid station medical equipment should be functionally arranged. The triage and immediate casualty areas must have lifesaving equipment and supplies near at hand. The sick call chest should be maintained near the minimal and sick call area, well clear of the triage and treatment area. Litters should be at the entrance to the battalion aid station for exchange by litter teams or for use by exhausted walking wounded casualties. All sections must have Field Medical Cards to insure appropriate and necessary recordkeeping.

Even though the tactical situation may allow the position of the battalion aid station to become relatively fixed and upgraded by physical improvements, it must always be prepared to rapidly advance or withdraw. Practiced and efficient set-up and take-down of the battalion aid station makes for responsiveness and mobility which allow the aid station to move more efficiently with changes in the tactical situation. This ability to respond to changes and move rapidly keeps the medical support close to those being supported.

ECHELONS OF CARE

The battalion surgeon is responsible for first echelon medical care. This equates to responsibility for supervision of the line medics assigned directly to infantry platoons as well as operation of the battalion aid station. The surgeon must be certain that all of his medics, whether assigned to rifle platoons or to the aid station, are trained and maintained to the highest possible standards achievable. Only by continual training of the medical personnel can the surgeon provide efficient and effective combat health care

The ambulance section transports casualties from the battlefield to the aid station. Higher echelon ambulances, either ground or air, will move the casualty from the aid station to a higher level of care or, depending on the circumstances, may evacuate directly from the battlefield to a surgical facility.

Medics are all formally trained to the same level; however, their duties and subsequent practical experience will vary. The medic in the field will be primarily concerned with the provision of first aid, dealing with the airway, applying compression dressings for hemorrhage, stabilizing fractures, and initiating intravenous fluid administration. The aid station medics assist the battalion surgeon with sick call and with combat casualty care. Aid station combat casualty care consists largely of resuscitative measures as described in other chapters of this text.

POSITION AND ACTIONS OF THE SURGEON DURING ENGAGEMENTS

The battalion surgeon must be apprised of the battle plan and the changing tactical situation. Only with this knowledge can the surgeon plan the best possible medical support and have the medics in the right place at the right time. The battle plan, evacuation capabilities, proximity, and readiness of a surgical care facility will determine where the surgeon is best utilized.

When battle lines are fluid and air evacuation difficult or impossible, surgeons may be best placed at aid stations where they can receive, triage, resuscitate and evacuate casualties emerging from the battle zone. This implies a far forward location of the aid station and the constant ability to move with the troops to avoid encirclement and capture.

If air evacuation capability exists, the surgeon may choose to follow the battle with the battalion commander in the tactical operations center. When large numbers of casualties are generated, the surgeon may be dispatched by aircraft to the battle scene to provide on-site triage. Casualties requiring urgent lifesaving surgical intervention may be triaged directly to a surgical care facility. Other casualties are moved to the aid station and may be accompanied by the surgeon. As an alternative, the surgeon may elect to send the senior medic or physician assistant to the scene to provide the triage and direct casualties to the aid station or to the surgical facility.

If distances to surgical care are great and air evacuation is not possible, the surgeon may request a surgical team to augment aid station personnel and to perform resuscitative surgical procedures.

Much of the guidance referable to the tactical deployment of the battalion aid station is also applicable to the medical company. The medical company must be readily accessible, as it represents the major site of triage in the evacuation chain. It is also the first level at which there is a limited holding capability for casualties. Being responsible for clearing casualties from the brigade area requires proximity to and the ability to move with the maneuvering elements. The fact that in some units the medical company is organic to the support battalion rather than an element of a division medical battalion may place certain constraints upon carrying out the medical mission. These can be resolved only when the medical officer in command actively participates in planning and decision making. Overall, none of these factors will adversely affect the triage functions but they may limit both the sophistication of the medical care and the holding capability of the unaugmented medical company.

Not surprisingly, medical officers at the division level will find that their most difficult challenges result from the requirement to move the treatment facilities in accordance with the flow of the battle. In the attack, it is essential that the medical company be in proximity to the battalion aid stations. The medical company must move as far forward as the tactical situation allows. In deep penetrations, elements of one medical company or, ideally, two or more medical companies can be sequentially deployed or echeloned so as to provide continuous medical support. During withdrawals, medical companies or their elements deploy to the rear of each successive delay position, where they set up to receive casualties. Withdrawing medical elements "leapfrog" past them to more rearward positions where they in turn set up. Clearly, coordination with higher command levels, especially for the purpose of allocating additional medical assets, is essential. The unit and division level medical officer should be aware that the history of war contains many examples in which nontransportable casualties have by necessity been left to be taken prisoner. The decision to leave casualties behind is a command, not a medical, decision, and one that requires a decision as to how many and what types of medical personnel must remain with the casualties.

It is likely that forward surgical facilities will be co-located with selected medical companies in support of heavily engaged brigades. Surgical teams are also likely to be attached to the medical companies of airborne or air-assault divisions. In either situation, the medical company triage officer will be responsible for determining which casualties will be treated locally rather than being evacuated to the corps level for surgical care.

There are two broad indications for local surgical intervention: casualties in immediate danger of dying and casualties who will be significantly affected by a prolonged delay in evacuation occasioned by an unfavorable tactical situation. Casualties at risk of dying are those with abdominal or chest wounds who are in shock, those who are not responsive to resuscitation, those with closed head injuries showing rapid neurological deterioration, and those casualties with extremity wounds requiring a tourniquet for control of bleeding. Casualties with the second indication include those with open cornminuted fractures of the femur and extensive soft tissue wounds in which anaerobic sepsis is likely to develop.

It is essential that the medical company triage officer be very selective in triage Past experience indicates that, as a rule, no more than 5-10% of the total casualty population requires immediate surgery. At the other extreme of the injury spectrum are those casualties with minor wounds and the potential for rapid return to duty. This group is typified by a casualty with one or more superficial fragment wounds or a perforating gunshot wound of the extremity with small wounds of entrance and exit and no evidence of bone or neurovascular injury. Individual judgment must be exercised, but overevacuation of such casualties must not occur.

THERAPEUTIC ASPECTS

Emergency lifesaving interventions are described in the appropriate sections of this manual. Relevant skills consist of the ability to create a surgical airway in the casualty with a severe facial wound, the insertion of an intercostal tube in the casualty with a hemo- or pneumothorax, the occlusion of a sucking chest wound, the ability to tamponade bleeding from major extremity arteries, and the infusion of therapeutic volumes of resuscitation fluids in those in shock.

Cricothyroidotomy, as shown in Figure 23, is an expeditious way to create a surgical airway. It is performed by palpating upward in the neck with the tip of the index finger to identify the cricoid cartilage. Place the tip of the index finger into the cricothyroid dimple just superior to the cricoid cartilage. By grasping the thyroid cartilage which lies just superior to the dimple, maintain the thumb and middle finger in place to steady the larynx. Stab the cricothyroid fibro-cartilaginous membrane with a #20 blade. The stab wound must be extended slightly to either side to accommodate an appropriately-sized tube.

Five to ten percent of battle deaths result from extremity exsanguination in which first aid could have controlled bleeding. Death due to hemorrhage from an extremity wound is preventable by simple direct compression. Medics must be taught to arrest high-grade hemorrhage by pressing the hand or dressing at the source until other means of control are established. A pressure bandage accomplishes this ideally when applied as a broad band of uniform tightness. If the tails of the battle dressing are tied too tightly, arterial flow may be occluded. Once immediate control of the hemorrhage has been accomplished and prior to the applica-

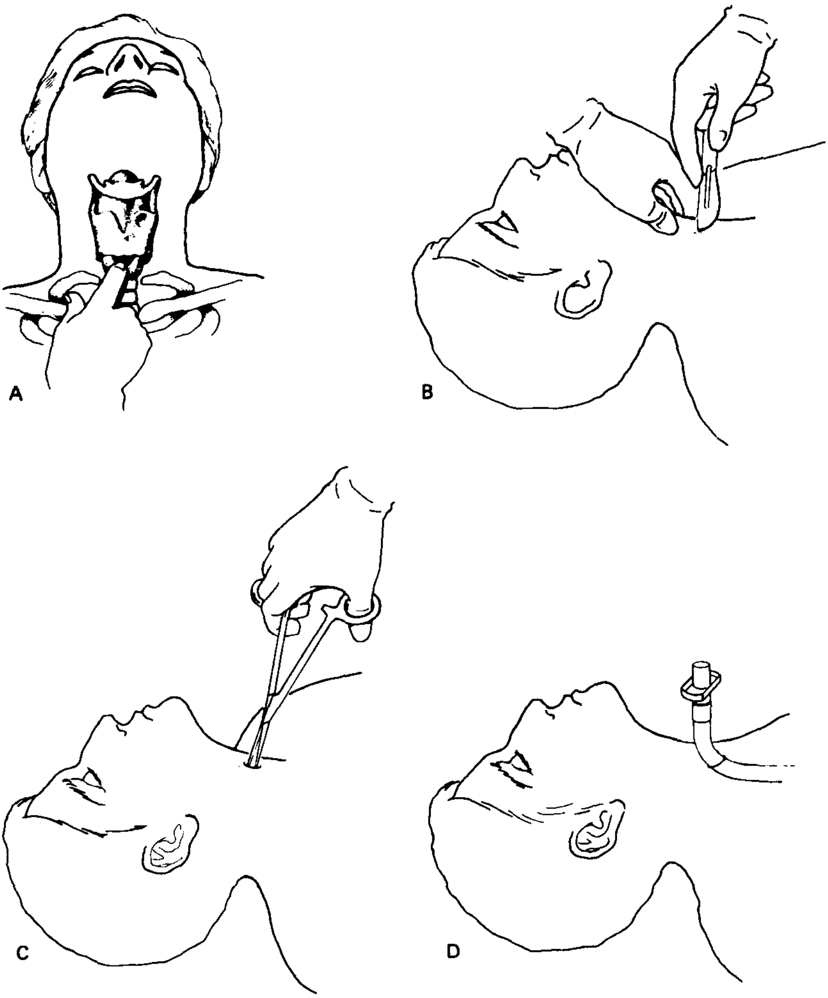

FIGURE 23.—Technique of cricothyroidotomy

tion of the pressure dressing distal pulses should be assessed. Use of pressure points is a temporary measure to control severe bleeding while the pressure dressing is applied. Only two pressure points are of practical value for field use: the femoral artery in the groin and the axillary artery against the humerus. If the first dressing becomes soaked, a second dressing should be applied over the first applying greater pressure Increased pressure is provided by tying the knot over a wad of material directly on top of the wound. One attempts, when possible, to preserve the distal pulse. The medical officer should bear in mind that the standard individual field dressing, when completely soaked, holds less than 250 cc of blood.

When pressure dressings fail to control the hemorrhage and the bleeding vessel is visible, a hemostat may be applied and incorporated into the dressing. Blind clamping is almost always futile. A tourniquet may be required to control hemorrhage, especially for the casualty with a traumatic amputation. A properly applied tourniquet, while endangering the limb, can save the life. An improperly applied tourniquet threatens both life and limb. A common mistake is inadequate compression which fails to occlude the artery but does occlude venous return. This results in an increased rate of blood loss. The tourniquet should be placed as distally as possible, just proximal to the wound. Once in place and adequately controlling hemorrhage, it should not be released until the casualty reaches a definitive care facility, The time and site of tourniquet application should be recorded clearly on the field medical card, and evacuation should be accelerated.

Intra-abdominal and intrathoracic hemorrhages require surgical intervention. When the intrathoracic bleeding is from the pulmonary circulation, it will usually be significantly diminished by tube thoracostomy and reinflation of the lung. Inn-a-abdominal bleeding may be diminished by application of a pneumatic anti-shock garment and inflation of both the extremity and abdominal compartments to at least 40mm Hg. Higher pressures have been employed, but there is no good evidence that they are advantageous and may in fact be deleterious if utilized for prolonged periods. The therapeutic effectiveness of the antishock garment is still very much open to question.

In the context of combat casualty care, there is very little hope for the exsanguinated, pulseless casualty. The salvage rate of traumatic cardiac arrest in the field approaches zero. Under these circumstances, the casualty that arrests after initial volume restoration and ventilation should be considered dead.

The civilian emergency medical doctrine which dictates that all trauma victims with possible injury to the cervical spine should have neck immobilization performed prior to transportation is not necessarily applicable to combat casualties. The overwhelming majority of combat casualties with penetrating wounds involving the head, neck, or upper chest who survive long enough to be treated do not have spinal cord injury or spinal injury which might predispose to a cord injury. There is likely to be little potential benefit from field immobilization of the combat casualty who does not have frank evidence of neurologic impairment. Bearing in mind the lethality of the battlefield with the resultant very substantial risk of performing time-consuming field medical pro cedures, medical personnel need to be selective in deciding which casualties need neck immobilization prior to evacuation from the battlefield.

Most often the medical officer's combat surgical practice does not involve managing acute life-threatening problems, but rather the splinting of extremity fractures and the dressing of soft tissue wounds. The earliest possible parenteral administration of antibiotics is mandatory in all casualties with penetrating abdominal injuries, open cornminuted fractures of extremity bones, and extensive soft tissue wounds. Cefoxitin, 2gm IM or (preferably) IV is an appropriate antibiotic in such circumstances.

CONCLUSION

Unit and division level medical officers are the most forward physicians on the battlefield. As such, their role is to facilitate accomplishment of the mission of the tactical elements to which they are assigned or support. Their greatest contribution to mission success is usually the maintenance of the health of the command. The efforts of all members of the combat health care delivery team must be ongoing at all times and not just during episodic battles. In war, the unit and division level medical officer's impact on the army's fighting strength is determined more by his efforts to maintain the health of the command than by his efforts to save life and limb. To accomplish this objective, unit and division level medical officers must establish direct dialogue with their line unit commander, as failure to communicate can result in an inordinately high loss of duty days and jeopardize the mission. In summary, unit or division level medical officers must go to whatever lengths possible to be certain that they and their medics are well trained; that their equipment is adequate, appropriate, and well maintained, that resupply is available; that medical support planning for tactical operations is meticulous; and that they and their unit are **flexible** in their responses to rapidly evolving tactical situations.

CHAPTER XV

Anesthesia and Analgesia

In order to achieve the best results in emergency surgery for battle wounds, anesthetic management must be provided by thoroughly trained and proficient anesthesiologists and nurse anesthetists. Therefore, it is imperative that the most experienced anesthetists available be assigned to forward surgical units in which lifesaving procedures are accomplished. In these instances, the choice and application of anesthesia carry the greatest risks and can be the most dangerous factors in that individual's total care.

The most experienced anesthetists, however, may be assisted by anesthetists of more limited training and experience, who can work under qualified supervision. Nurse anesthetists are employed throughout the U.S. armed forces and frequently outnumber anesthesiologists, as they do in many civilian hospitals in this country. Under emergency conditions when qualified anesthesia providers are scarce, other medical and dental officers without special training in anesthesiology may be employed for this purpose if instructed and supervised. In past conflicts, only a small portion of anesthesiologists deployed to combat areas were fully trained and/or board certified. With the progressive increase in the total number of physicians and with a different conceptual application toward anesthesia care, anesthesia will be delivered or directed by anesthesiologists who are fully trained and have attained expertise in trauma care as well as intensive care.

Enlisted paraprofessionals should be used only as technical assistants to maintain equipment, prepare patients, take vital signs, etc. Throughout the remainder of this chapter, the term "anesthetist" will refer to either physician anesthesiologists or nurse anesthetists.

In wartime, anesthetists in forward surgical units may be called upon to perform resuscitative measures, direct respiratory therapy, and manage other aspects of perioperative care in addition to the administration of anesthetics. The success of surgical treatment of the severely injured largely depends on the effectiveness of these efforts.

It is equally important that the quality of anesthesia care be evaluated on a regular basis to record morbidity and mortality as it relates to that care. Periodic evaluations of ongoing policies, drugs, and equipment are essential to assure appropriate care of the wounded.

The most significant alterations in the physiology of the trauma patient usually involve the circulatory and respiratory systems. Since basic resuscitative treatment will frequently have been initiated soon after wounding, the anesthetist should, before instituting additional measures, have a record of the events which occurred from wounding until arrival at the hospital. The patient's field medical card will usually provide this information. In particular, the anesthetist should know what fluids have been administered, what other resuscitative measures have been necessary, and the dosages and routes of administration of narcotics, sedatives, and other drugs.

Intraoperative management includes monitoring and restoration of homeostasis, maintenance of an operating environment, and measures to relieve pain and block noxious autonomic reflexes. It must also be ensured that an effective airway is maintained, secretions are evacuated, and supplemental oxygen is pro vided. The anesthetist is responsible for the anesthetic drugs, blood and blood products, plasma volume expanders, and electrolyte solutions during the surgical procedure. He institutes all other required supportive measures and directs the immediate postoperative care.

Prior to the patient's transfer to an intermediate or minimal care ward, the anesthetist must be certain that the vital signs have stabilized, that essential reflexes have returned, and that drug depression has abated satisfactorily.

ANESTHESIA EQUIPMENT

The demonstrated capability for more rapid evacuation of seriously wounded casualties from the battle area has resulted in an increase in the complexity of surgery performed at installations in the combat zone These changes have mandated a similar complexity of anesthesia equipment and techniques. Without the appropriate equipment, management of the seriously injured patient is impossible for even the most competent anesthetist.

Anesthesia equipment in a forward installation should include standard apparatus for administration of inhalation, intravenous, and regional anesthetics, as well as for oxygen supplementation and ventilatory support. An austere environment imposed by the tactical situation or geographical location may demand innovative approaches to what are normally routine clinical problems. For example, the scarcity of medical-grade compressed gas may require the anesthetist to use draw-over vaporizers, intermittent flow machines, or other techniques not in common practice in the U.S. There are many examples in the literature of improvised equipment and techniques that have served well in such difficult situations.

Complete airway equipment, including apparatus designed for pediatric use, should be readily available. An adequate suction, a defibrillator, and appropriate resuscitation drugs are required in any anesthetizing location. This is equally important regardless of whether general or regional technique is planned. It is also prudent to have a large-bore intravenous cannula or similar device handy to establish an emergency airway by cricothyroid puncture in the event of total upper airway obstruction. It should be kept in mind that ventilators are essential components of anesthesia delivery systems so that anesthesia personnel can resuscitate during surgical procedures Experience has shown that the anesthetist must be prepared to treat local civilian casualties, sometimes including substantial numbers of children and neonates.

Appropriate adapters and delivery systems, such as nonrebreathing circuits and pediatric circle systems, are essential for proper anesthetic management.

In medical facilities dedicated to definitive care, anesthesia equipment should be as close to state-of-the-art as time and the local situation permit. Once this sophisticated equipment is in place, it must be checked and calibrated on a routine basis to assure its safety. Support personnel with mechanical knowledge of anesthesia equipment, its calibration, and its maintenance will be vital to safe application of care. Replacement units and spare parts should be in the theater supply system.

MONITORING

Since the typical battle casualty is young and healthy prior to wounding, sophisticated invasive monitoring techniques are not routinely indicated in this patient population. However, during prolonged hypoxia or myocardial contusion, cardiac disease can be present in formerly young healthy adults. In these specific situations, CVP and the pulmonary artery catheter become valuable monitors. Electrocardiogram, blood pressure, and heart sounds are routine measures for every patient. Urine output and such physical signs as pulse rate and volume, skin temperature, and capillary refill are useful indicators of the adequacy of intravascular volume.

If the operative procedure were to involve a major chest wound, major blood loss, or a vascular injury with the potential of major bleeding, direct arterial pressure monitoring is indicated. Disposable transducers are available and may be a reasonable approach. If the tactical situation or geographical location will allow, pulse oximeters, capnographs, and automated arterial blood pressure apparatus should be considered necessary anesthesia equipment.

Respiratory gas and pH measurements of arterial and mixed venous blood were shown to be major indicators of pathology in Vietnam, and are early indicators of life-threatening pathophysiology, as well as reliable guides to therapy. In the absence of instruments for arterial blood gas analysis, measurement of urine pH with indicator paper has been used successfully as a guide for treatment of metabolic acidosis. The vigilance of the anesthetist is the most effective monitor of all.

PREOPERATIVE PREPARATION

In the most severe cases of massive hemorrhage, immediate surgical control of bleeding is the only means of saving life. In cases of massive ongoing hemorrhage, laparotomy or thoracotomy oftentimes may have to be performed on an inadequately resuscitated patient. With cases such as these, the patient is intubated, paralyzed, ventilated with oxygen, given life-supporting fluids and amnestics with analgesia added, while control is obtained over bleeding as blood pressure and perfusion indices allow. As blood volume is replaced, the patient will require additional anesthesia. Using these approaches, the patient who has lost more than 50% of his total blood volume can be salvaged.

During less drastic trauma care, the anesthesiologist in consultation with the triage physician can establish priorities as to when it is safe to induce anesthesia. During mass casualty periods, the anesthesiologist is usually too busy to spend a major portion of time in the triage area and must rely on the triage team. The latter requires a highly experienced surgeon with excellent executive ability. In every case, open communication and consultation between surgeon and anesthetist is essential. The evaluation of the efficacy of resuscitation and timing of operation in such casualties has been detailed previously (Chapter IX).

There is no assurance that either evacuation of gastric contents via nasogastric tube or induced emesis can lessen the hazard of aspiration in the trauma patient. Therefore, any battle casualty must be regarded as having a "full stomach," and the airway secured with a cuffed endotracheal tube by awake intubation or a rapid sequence induction.

Narcotics, sedatives, and other depressant drugs must be used cautiously in forward areas. Intramuscular or subcutaneous administration is not advised since drug absorption may be uncertain or erratic Depressant drugs given to the head-injured casualty may confuse neurological evaluation and depress respiration, and are therefore contraindicated. Barbiturates, narcotics, and benzodiazepines are frequently useful as supplements to regional or local anesthetic techniques. They allay apprehension in most patients and may also elevate the seizure threshold in cases of local anesthetic toxicity. With the use of modern general anesthetic agents, the routine administration of anticholinergic medications preoperatively is probably not necessary.

If it is necessary at all, preoperative medication is best given intravenously in the operative room just before induction. For patients in severe pain, judicious doses of intravenous narcotics can be given. It is imperative that suction apparatus, ventilating equip ment, and airway management equipment be readily available in the triage area. Judicious IV doses of narcotics in a 70 kg person would be in the range of 3-5 mg of morphine, 0.05 mg of fentanyl or 30-50 mg of meperidine.

ANESTHETIC TECHNIQUES

The three categories of anesthetic techniques are local, regional, and general.

LOCAL ANESTHESIA

While local infiltration techniques should be reserved for only the most minor of injuries, they do offer a fast and effective method to clean, suture, and remove small foreign bodies in for-. ward facilities. These techniques allow early return to duty. Lidocaine, 0.5-1.0%, is the most popular agent. All of the local anesthetics shown in Table 9 can be used satisfactorily. In a medical facility overwhelmed with casualties, there is a temptation to perform an excessive number of operations under local anesthesia. Caution must be exercised in patient selection to avoid infiltration of toxic doses of local anesthetic under such circumstances. Local infiltration is seldom satisfactory for extensive debridement required to properly manage major wounds. Table 9 lists the common local anesthetics and their dosages.

Local anesthetics can be absorbed into the systemic circulation and, in excessive doses, can cause myocardial depression, hypotension, apnea, and seizures. Seizures should be treated with a rapidly acting benzodiazepine; respiratory depression by oxygenation and ventilation; and hypotension by intravenous fluid resuscitation and use of vasopressors.

It should be remembered that life support equipment such as oxygen, ventilation apparatus, airways, laryngoscopes, endotracheal tubes, adequate suction devices and muscle relaxant paralyzing drugs are minimum requirements in the event that a patient receives an overdose of local anesthetic or has an allergic reaction. Epinephrine, steroids, benadryl, intravenous barbiturate, and benzodiazepine medication should be readily available. All medications necessary to support a successful cardiopulmonary resuscitation must be available before any anesthetic is begun.

TABLE S.-Local Anesthetic Agents

Anesthetic Agent and Application	Commonly Available Dosage Forms.	Recommended Maximum Dosage[1]
Subarachnoid Block[4]		
Tetracaine	1% solution or 20 mg ampule of soluble crystals	20 mg
Lidocaine	5% solution in 75% dextrose	100 mg
Bupivacaine	0.75% solution in 8.25% dextrose	15 mg
Infiltration, Epidural, and Major Nerve Block[2,3,4]		
Bupivacaine	0.25%. 0.5%, and 0.75 solution	3 mg/kg
Chloroprocaine	2% and 3% solution	15 mg/kg
Lidocaine	0.5%, 1%, 1.5%, and 2% solution	7 mglkg
Mepivacine	1% and 2% solution	7 mglkg
Prilocaine[5]	1% and 2% solution	8 mglkg
Intravenous Regional Block		
Lidocaine	05% (or more dilute) solution	3 mg/kg
Prilocaine	05% (or more dilute) solution	3 mg/kg
Topical Anesthesia		
Cocaine	1%-4% solution	25 mg/kg
Dyclonine	05% solution	3 mg/kg
Lidocaine	2%-5% solution, ointment, jelly, or viscous solution	3 mglkg
Tetracaine	0.2%-1% solution	1 mg/kg

Notes:

(1) These are general guidelines only. The smallest total dose necessary to accomplish satisfactory anesthesia should always be used. Consider patient age, physical status, debility, etc., in determining dosages.

(2) Dosage limits for infiltration. epidural, and major nerve block are calculated assuming epinephrine is added to solutions. Reduce dosage by approximately 50% if using plain solutions.

(3) Plasma levels vary widely within anatomical site of nerve block or infiltration. Consult standard texts for specific limits.

(4) Only single-dose. preservative-free preparations should be used for subarachnoid or epidural administration.

(5) Do not exceed 600 mg in the adult.

REGIONAL ANESTHESIA

Regional anesthesia can be a valuable and efficient technique in combat surgery. In a mass-casualty situation, the busy anesthetist may be able to safely administer more than one anesthetic at a time, with monitoring delegated to lesser-trained personnel. Shortly after establishment of the block, the anesthetist's attention can usually be directed intermittently

elsewhere withoutjeopardizing the safety of the patient. The advantages of regional anesthesia include the absence of nausea, vomiting, aspiration, and other pulmonary complications, and decreased bleeding.

Major nerve blocks are particularly appropriate for isolated extremity injuries. Regional anesthesia is not normally satisfactory for intra-abdominal exploration. The anesthetic level required to block sensation from visceral manipulation in such cases is usually dangerously high, necessitating both circulatory and ventilatory support.

Subarachnoid or epidural anesthesia is contraindicated in patients whose intravascular volume is inadequate or uncertain. It may be administered cautiously when fluid losses have been corrected by appropriate resuscitative measures. The sympathetic block from a subarachnoid or epidural anesthetic may be advantageous for the patient with a vascular repair of the leg, while a brachial plexus or stellate ganglion block may provide the same benefit to those with vascular injuries of the arm or hand. Another advantage of these techniques is that they often provide long acting postoperative analgesia without the use of depressant medications.

The intravenous regional or Bier block is a very useful technique for extremity injuries because of its ease of administration, reliability, and relative safety. It is not a satisfactory technique if the limb has multiple puncture wounds or jagged foreign bodies are embedded. Postoperative analgesia is usually of only brief duration.

Table 9 lists commonly available anesthetic agents and dosage forms. The maximum recommended dosage limits shown must be tempered by modifying factors such as patient size, condition, and site of incision.

GENERAL ANESTHESIA

Anesthetic drug requirements in the critically injured patient will usually be much less than under more normal conditions. Often intraoperative management is primarily a matter of achieving hemodynamic stability, optimizing oxygenation, and supporting ventilation. If the patient is in profound shock, oxygenation, fluid resuscitation, and muscle relaxation may be the only ‘anesthesia’ administered. Such patients rarely have recall of intraoperative events. In addition, blood flow is preferentially distributed to the heart and brain in the hypotensive patient, which may further decrease anesthetic requirements.

INDUCTION OF ANESTHESIA

Time constraints and the risk of aspiration usually dictate that induction be rapid and controlled. Several intravenous agents are available which are in common use in the trauma setting. These include the rapidly acting barbiturates (such as thiopental), the benzodiazepines, rapidly acting narcotics, etomidate, and ketamine The overriding factors in the decision as to which drug is best relate to the adequacy of blood volume, history of allergic reaction, or recent food intake. If the patient is markedly hypovolemic and there is insufficient time for fluid resuscitation, it is best to modify dosages of induction agents or use less cardiovascular depressant drugs, such as narcotics, etomidate, or ketamine. “Normal” dosages become lethal doses in the hypovolemic patient.

Some of the more important induction agents are:

Thiopental. This rapidly-acting barbiturate is quite familiar to most present day anesthetists. It has the advantages of fast onset, short duration, and good patient acceptance However, normal induction dosages may cause disastrous hypotension in the hypovolemic patient. An induction dose is 3-4 mg/kg intravenously, given over one minute in a solution of 2.5% or less in normal saline. This drug can be a potent cardiac depressant and can produce hypotension. It can cause laryngospasm immediately after or during induction, is a poor analgesic, and produces poor muscle relaxation. This drug is best used in combination with a muscle relaxant paralytic drug.

Etomidate This drug usually preserves cardiovascular stability in the intact elective surgical patient but probably has no advantage over thiopental in the case of hypovolemia. It also produces localized pain and myoclonic movements on rapid injection.

Ketamine. This agent is also fast acting, has analgesic properties, and supports the blood pressure by sympathetic stimulation. However, one must still be wary in the severely hypovolemic patient in whom sympathetic outflow may already be near maximal intensity. In these cases, the direct depressant effect on the myocardium may produce decreased cardiac output. Postoperative excitement and dysphoria, which is produced at times by this drug, may be minimized by using lower dosages or giving small amounts of benzodiazepines in combination with ketamine.

Narcotics. Rapidly acting narcotics, such as sufentanil, in conjunction with benzodiazepines are an alternative induction technique. If newer agents, such as the narcotic alfentanil, and the benzodiazepine midazolam prove safe in trauma cases, they should be considered also.

Regardless of the induction agent chosen, the risk of aspiration during induction (and emergence) remains a critical consideration. Drugs such as histamine receptor blockers, metaclopramide, and nonparticulate antacids offer promise as prophylactic measures; however, these agents will not be available on the battlefield, and the rapid and secure control of the airway remains the primary means of preventing this grave complication.

The anesthetist must ensure that an adequately functioning suction apparatus is close at hand and operational prior to induction or emergence.

MAINTENANCE OF ANESTHESIA

Inhalation Agents. These agents have the advantage of being relatively easy to titrate, thereby facilitating changes in anesthetic depth. There is a considerable body of experience in the use of inhalation anesthetics in trauma surgery. Halothane was used to a great extent during the Vietnam conflict. However, one must remember that all potent halogenated agents depress the respiratory and cardiovascular systems and that such effects are even more pronounced in the presence of hypovolemia. Often sub-minimal alveolar concentration (MAC) dosages are adequate to provide analgesia and amnesia in the critically injured casualty. Of the potent halogenated agents in current usage, isoflurane appears to offer the advantages of very limited metabolism and a lesser degree of cardiac depression than halothane or enflurane. These three halogenated drugs are potent bronchodilators and therefore are useful in the asthmatic patient.

Isoflurane has a MAC of 1.15 in oxygen; 0.5 in 70% nitrous oxide. Inspired levels must be maintained at 40% higher than MAC. For induction, one should use inspired gas concentrations 3-4 times the maintenance. This drug is a potent respiratory depressant, decreases peripheral vascular resistance, produces hypotension with little cardiovascular depression, can cause malignant hyperthermia, has good muscle relaxant properties, and allows rapid recovery due to low solubility. Nitrous oxide is usually safe, provided adequate oxygen is administered. Therefore, an in-line oxygen analyzer should be used in the circuit when nitrous oxide is given. The tendency for nitrous oxide to expand in any closed space in the body (e.g., pneumothorax, pneumocephalus, bowel obstruction) should also be kept in mind. Although diethyl ether has had widespread use as a battlefield anesthetic in the past, its flammability and lack of familiarity to most recently-trained anesthetists make it a less attractive choice. Cyclopropane, in addition to being highly explosive, is, like diethyl ether, no longer in common use and neither one should be used in modern combat anesthesia.

Intravenous Agents. Narcotics, such as fentanyl and morphine, are good analgesics and in adequate dosage are effective in blocking autonomic reflexes generated by noxious stimuli during operations. The combined use of nitrous oxide, muscle relaxants, and amnestics in a balanced anesthetic regime produces a "complete" anesthetic Although considerably less depressant than the potent inhalation agents, narcotics should be carefully titrated in the unstable patient.

Fentanyl is a short-acting narcotic. One hundred mcg (2 ml) is equivalent to 10 mg of morphine. This drug may be given as intermittent bolus injection of 1-2 mcg/kg or as a continuous infusion of 2-50 mcg/min as titrated against blood pressure, pulse, or evidence of reaction to pain. Side effects of fentanyl include respiratory depression, bradycardia, bronchoconstriction, vomiting, and muscle stiffness. The muscle stiffness may need to be treated by intravenous muscle relaxants. Fentanyl has minimal effect on blood pressure.

Newer agents, such as sufentanil and alfentanil, in conjunction with short-acting muscle relaxants, may provide effective short-duration anesthesia and be successfully used in outpatient surgical procedures. These can be especially useful when recovery ward or ICU staffing is limited. The newer agonist-antagonist type of opiate drugs, such as nalbuphine and butorphanol, have also proved to be effective trauma anesthetics.

Ketamine is an effective analgesic and dissociative maintenance agent which can be used either in incremental doses or as a continuous infusion. To prevent recall in a lightly anesthetized patient, anterograde amnesia can be induced with scopolamine or small doses of a benzodiazepine.

After an intravenous dose of 1-2 mg/kg rapid induction of anesthesia (within 30 seconds), an intense analgesia is produced. An endotracheal tube may not be required, but one must remember that respiratory depression, apnea, coughing, and laryngospasm are possible at any time. Ketamine produces increased salivation and tracheal secretions, and can cause unwanted tachycardia, hypertension, increase in intraocular and intracranial pressures, and eye movements.

This is an effective drug for treating bronchospasm that is resistant to commonly used bronchodilators. It is an excellent agent for induction of anesthesia in the asthmatic.

Ketamine's intense analgesia makes it useful in the treatment of the burn patient for repeated debridement and dressing changes.

Postoperative excitement and dysphoria, which is produced at times by this drug, may be minimized by using lower dosages or giving small amounts of benzodiazepines in combination with ketamine. A continuous infusion can be used to reduce the total dose required for an anesthetic. A solution of 1 mg/ml can be infused at a rate of 1-25 ml/min. A loading dose of 50 mg should be used in the adult.

Midazalam, a new short-acting benzodiazepine, is probably the intravenous agent of choice to reduce ketamine emergence reactions.

MUSCLE RELAXANTS

Succinylcholine is the most commonly used relaxant for rapid sequence intubation, although appropriate doses of nondepolarizing agents will also provide good intubating conditions reasonably quickly. Intravenous injection is followed by fasciculations and muscle cramps and after one minute a flaccid paralysis that requires ventilatory support and has a duration of 5-15 minutes. This drug may cause hyperkalemia in patients with burn or crush injuries but is usually safe in the acute injury situation and for the first several days post-injury. Hyperkalemia, cardiac arrythmia and arrest can occur in these patients after 48 hours and in patients with renal failure, spinal cord injuries, and severe sepsis. One must be aware that this drug can produce a rise in intraocular pressure, and (rarely) vomiting and aspiration secondary to abdominal muscle contraction, bradycardia, salivation, postoperative muscle pain, malignant hyperthermia, and prolonged apnea.

Pancuronium produces an atropine-like tachycardia that is normally not a problem in the young and healthy trauma patient, but may confuse the differential diagnosis of a rapid heart rate intraoperatively. This drug has an onset of paralysis in three minutes and a duration of forty minutes or longer, The initial dose for adults is 0.04-0.1 mg/kg intravenously.

D-Tubocurarine can cause significant histamine release and a resultant hypotension, which limits its usefulness in the hypovolemic patient. D-Tubocurarine and Pancuronium usually need to be reversed by neostigmine or edrophonium in combination with an anticholinergic drug intravenously.

Atracurium and Vecuronium are newer, short-acting, non-depolarizing muscle relaxants which have an onset time of 2-3 minutes and a duration of 20-40 minutes. These drugs can be used by single injection for short procedures or as a continuous infusion. These agents are not vagolytic and do not support the tachycardia or hypertension seen with pancuronium. They can be used to replace succinylcholine for rapid-sequence intubation. These drugs are metabolized by routes other than the kidney and therefore are useful in renal failure patients Atracurium can cause a small amount of histamine release, but this is usually not hemodynamically significant. Vecuronium is relatively free of cardiovascular side effects. The usual dose of vecuronium is 0.1 mg/kg, and for atracurium 0.3-0.4 mg/kg intravenously.

Use of a nerve stimulator to monitor the degree of neuromuscular blockade will facilitate the management of muscle relaxants and should be considered standard procedure.

POST-OPERATIVE MANAGEMENT

Hospitals dedicated to advanced resuscitation and surgical care must anticipate the sequelae of trauma, anesthesia, and operation. As a result of thoracic trauma, the likelihood of overhydration, or surgical manipulation, many of these patients will be unable to breathe adequately and will require mechanical ventilatory support. Ventilators used for these applications should be volume-cycled machines capable of delivering inspired oxygen concentrations up to 100% and of providing positive end-expiratory pressures. Ideally, they should have the same alarms, adjustments, and options (such as intermittent mandatory ventilation) as ventilators in current critical care applications.

Narcotics and analgesics must be judiciously managed in the postoperative surgical patient. Small doses administered intravenously are usually most effective in the immediate recovery period. Changes in position and the adjustment of pads, braces, pillows, etc., may do much to make the patient comfortable and decrease the need for pharmacological intervention. The use of regional blocks should provide effective analgesia while avoiding depressant medications. It must be borne in mind that restlessness and agitation may be signs of hypoxia rather than true pain.

Anesthetic techniques using short-acting narcotics, hypnotics, and muscle relaxants may reduce recovery room problems, but it still may be necessary to reverse narcotics or use additional muscle relaxant reversal drugs. It is equally important to be sure that each recovery site offers the safety of an oxygen supply in the event that a patient must be ventilated, as well as effective suction apparatus. Wherever logistically possible, the ability to measure blood gases should be available. Measurement of arterial or central venous oxygen tension gives the physician a working knowledge not only of lung function but also of metabolism, cardiovascular stability, and effectiveness of resuscitation. The addition of trained and experienced specialists in critical care medicine to forward medical facilities will enhance the quality of care provided and will free anesthesia personnel to concentrate their efforts in the operating rooms.

MASS CASUALTY MANAGEMENT

Anesthesia personnel should prepare for mass casualty situations by becoming involved in the planning for such functions as staffing, organization, and logistical support for the triage/preoperative area. Attention to details such as adequate electrical and oxygen outlets, suction devices, emergency airways, and supplies of intravenous fluids is mandatory. When the initial influx of patients begins, anesthetists may assist in fluid resuscitation, airway management, ventilatory support, and other critical measures. Once these procedures are in progress, they must usually dedicate themselves to their areas of primary responsibility, the operating and recovery rooms.

The anesthesiologist must serve as a continuous resource and consultant to assure safe pre-, intra-, and postoperative care. A theater consultant in anesthesiology with on-site knowledge of patient care, who is informed by periodic reports specifically related to anesthesia problems, will make valuable contributions to the quality of care given.