

Chapter 2

COMBAT ANESTHESIA OVERVIEW

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THE BATTLEFIELD MEDICAL ENVIRONMENT

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THE BATTLEFIELD MEDICAL ENVIRONMENT

As key players in a small unit, the anesthesia providers in deployed hospitals have the ability to influence the most vital aspects of the unit's performance, both directly through their actions and indirectly through the examples they set. Delivering anesthetics for combat casualties is always challenging, frequently difficult, and occasionally dangerous. The patient population overseas will differ from the typical emergency room caseload in hospitals in the continental United States (CONUS). Combat casualties will include a great number of patients with high-velocity wounds and multiple surgical problems. In addition, military hospitals invariably become active in caring for casualties among the indigenous civilian population, who may present with any number of medical challenges. The operating room environment may be quite different from that found in the usual stateside fixed facility. The prospect of working in ISO (International Standards Organization) shelters and TEMPER (*t*ents, *e*xtendable, *m*odular, *p*ersonnel) tents with unfamiliar field anesthesia machines (eg, the Ohmeda 885A, manufactured by Ohmeda, Inc., Madison, Wis.) represents a dramatic departure from the norm. The growing emphasis on far-forward surgery introduces the likelihood that anesthetic procedures will be performed in tents or shelters of opportunity with draw-over devices. The pace of operations on the battlefield may also differ significantly from the routine in a civilian hospital. As opposed to carefully managed surgical caseloads planned weeks in advance, there will be unpredictable pulses of emergent patients that will temporarily overwhelm the surgical and evacuation systems. These periods may be followed by weeks or months of waiting—a condition of monotonous inactivity that many medical personnel find almost intolerable. To further complicate matters, all this usually takes place in a remote location at the end of a long and complex chain of logistical and technical support. In any deployment, there will be major problems to be mastered arising from not only the nature of the medical environment but also the support structure and the pace at which casualties are received and evacuated. However, the physicians and nurses of the U.S. Army Medical Department have a long and proud history of adapting to unusual circumstances and meeting difficult challenges. Wounded U.S. soldiers have always received

excellent medical care in the past. The continuation of that fine tradition depends in large part on the determination and skill of the people reading this book.

Technological and Logistical Support

The degree of sophistication and permanence of the medical environment may vary greatly from place to place, even at the same time and in the same war. During Operation Desert Storm (the Persian Gulf War, 1991), some hospitals attached to major armored units lived and operated under the most austere field conditions, moving frequently in desperate attempts to keep up with the extremely mobile tactile forces. Other medical units in this same conflict worked without interruption in hospitals in Riyadh, Saudi Arabia, with modern, first-rate equipment at their disposal. The former group had to learn field medicine in its most extreme form; the latter, only to decipher the labels on their machines (which were in French and Arabic). The anesthesia providers working from tents did very few spinal anesthetic procedures for a number of reasons, among them relatively low lighting levels, unstable tables, and ambient dust. The groups in the fixed facilities, however, were free to use whatever techniques they deemed appropriate for their patients.

Complexity of the Medical Network

An equally important consideration is the extent of the theater medical network. In the Persian Gulf War, the U.S. Army had 44 field hospitals and a highly developed evacuation system in place. It was possible, within limits, to transfer patients from one facility to another. This allowed for a certain amount of flexibility. In direct contrast, in Operations Continue Hope and Restore Hope in Somalia (1993–1994), the U.S. Army's task force had one 24-bed combat support hospital that served as the only facility for 3,000 U.S. soldiers and as the principal third-echelon facility for 20,000 other United Nations–coalition peacemaking troops. In this latter instance, there were four functional operating room tables in the theater. The fact that regional anesthetic techniques such as bupivacaine brachial plexus blocks were extremely rare had nothing to do with the nature of the soldiers' wounds. It was

a decision based on time, space, and the need to be constantly ready for the next influx of emergent cases.

Nature of the Evacuation Scheme

Operation Just Cause (Panama, December 1989) involved the initial use of forward surgical teams operating as the receiving and stabilization point for an evacuation plan that employed one (albeit one very long) move. After casualties received their surgical treatment in the field hospitals, they were transported by fixed-wing aircraft to CONUS hospitals in San Antonio, Texas, which functioned as the equivalent of third- and fourth-echelon deployed hospitals. The air-transport leg of the move took about 8 hours.

Casualties from the Persian Gulf War faced a 6- to 8-hour, fixed-wing flight from the deployed theater hospitals to fourth-echelon facilities in Germany. Because of the size and complexity of that conflict, there was some variation in the time to transport from the site of injury to the stabilizing hospitals. Additionally, there was some variation in the capabilities of the facilities in the chain proximal to Landstuhl, Germany.

Operations Continue Hope and Restore Hope in Somalia presented another variation on this theme. As in Panama, there was a single receiving and stabilization point, and the flight time to the facility in Landstuhl was quite long: 11 hours. However, casualties of the African conflict were stabilized in a mature field environment prior to transport. The U.S. Army's field medical treatment facilities in Somalia, although based in TEMPER tents, had a computed tomography scanner, sophisticated intensive care units, and other advanced technological support.

The plan for medical support of the operation in Haiti (Operation Restore Democracy, 1994) was quite different. In addition to four surgeons and five anesthesia providers being scheduled to jump in with the 82nd Airborne Division, the USN *Comfort* (an enormous and quite sophisticated hospital ship) was standing just offshore to receive casualties. Had the planned U.S. incursion met significant resistance, a great number of casualties with traumatic injuries would in all likelihood have been stabilized in the field and then evacuated by rotor-wing aircraft directly to the operating rooms of the *Comfort*. That environment would have been an almost exact parallel of a civilian

level 1 trauma center in a major urban center in the United States.

Pace of Operations

A mass casualty situation exists when the number of emergent patients exceeds a facility's resources. If there is one operating room table and one surgeon, then it only takes two casualties both triaged in the surgically "immediate" category to throw that facility into a mass casualty situation. On the other hand, if there are 20 operating room tables and 20 surgeons, then 19 simultaneous emergent casualties represent business as usual.

Two examples from recent conflicts illustrate this point. One week *after* the fighting had stopped in the Persian Gulf War, some U.S. Army field hospitals experienced a massive influx of Iraqi soldiers who had sustained serious but nonlethal wounds up to 2 weeks before surrendering. These circumstances created an instant backlog of nonemergent cases. In this unusual situation, the anesthesiologists had the luxury of doing regional techniques if they thought the operating room environment was suitable. There was no compelling need for their hospitals to operate at absolute maximum efficiency in order to be prepared for the next mass casualty situation.

Two years later, anesthesiologists in field hospitals in Somalia found themselves in exactly the opposite situation. During the 5 June and 2 October mass casualty situations in 1993, more than 50 emergency surgeries were performed in about that many hours. Every casualty was assumed to have a full stomach and underwent a rapid-sequence, general, endotracheal anesthetic, regardless of the site of injury. The determining factors in these two situations pertained to

- the limited surgical resources in theater,
- the impracticality of deploying timely medical reinforcements from Germany or CONUS, and
- the uncertainty of the tactical situation.

The foremost consideration was the most efficient way to use operating room time—to get as many cases done in as short a time as possible to free the operating rooms for the following wave of casualties.

Interventions Prior to Surgery

The general *ideas* involved in treating the trauma patient are quite simple. There are, essentially, four things to be done: (1) establish an airway, (2) establish high-capacity venous access, (3) replace volume appropriately, and (4) get the patient to the operating room as soon as possible for definitive treatment. Actually achieving these goals, however, may be difficult or even, at times, impossible.

The first order of business is, as usual, the airway. Many anesthesia providers involved in trauma care have independently arrived at a simple and effective way of determining airway competence: if a patient can talk, the airway is competent. The indications for intubation include coma or shock, as well as the need to protect the airway, relieve obstruction, deliver positive pressure breathing, or perform tracheal toilet. A semiconscious, combative, or otherwise uncontrollable patient may have to be paralyzed and intubated for further diagnosis and treatment to proceed. As a general rule, anesthesia providers should be fairly aggressive in their approach to questionable airways, especially among the many distractions of mass casualty episodes.

Most casualties intubated prior to entering the operating room will be facing one or more life-threatening medical problems. Many will be comatose. The wisest pharmacological approach to these patients is to do as little as possible in terms of depressing their cardiovascular systems while securing an airway. This means doing a lot of intubations with no drugs at all (or with only a muscle relaxant) and accepting a relatively high degree of postevent awareness.

One straightforward approach to the combat casualty with traumatic injuries is diagrammed in Figure 2-1; the following guidance pertains across the spectrum of combat casualty care:

- If the casualties arrive at a measured, controlled pace, if the available medical personnel match the number and kind of casualties, and if the equipment is optimal, then use the same techniques you would apply in your routine practice.
- If the casualties arrive at a controlled pace and do not outnumber the available medical personnel but if the equipment is less than optimal, then do the best you can with what you have.
- If the casualties outnumber the medical personnel required, then a mass casualty

situation exists and the casualties must be triaged into the appropriate categories.

All casualties are considered to have full stomachs. Nasotracheal intubation is rarely indicated when dealing with acute trauma. A blind approach in an unconscious casualty is generally unwise due to the high likelihood of vomiting and aspiration. Also, it is possible for a tube passed through the nose to enter the cranial cavity. Casualties who have significant facial trauma or who are unconscious should be treated as if they have unstable cervical spines. Most casualties with acute trauma, then, will be orally intubated using a rapid-sequence technique involving Sellick's maneuver while an assistant holds in-line manual traction.

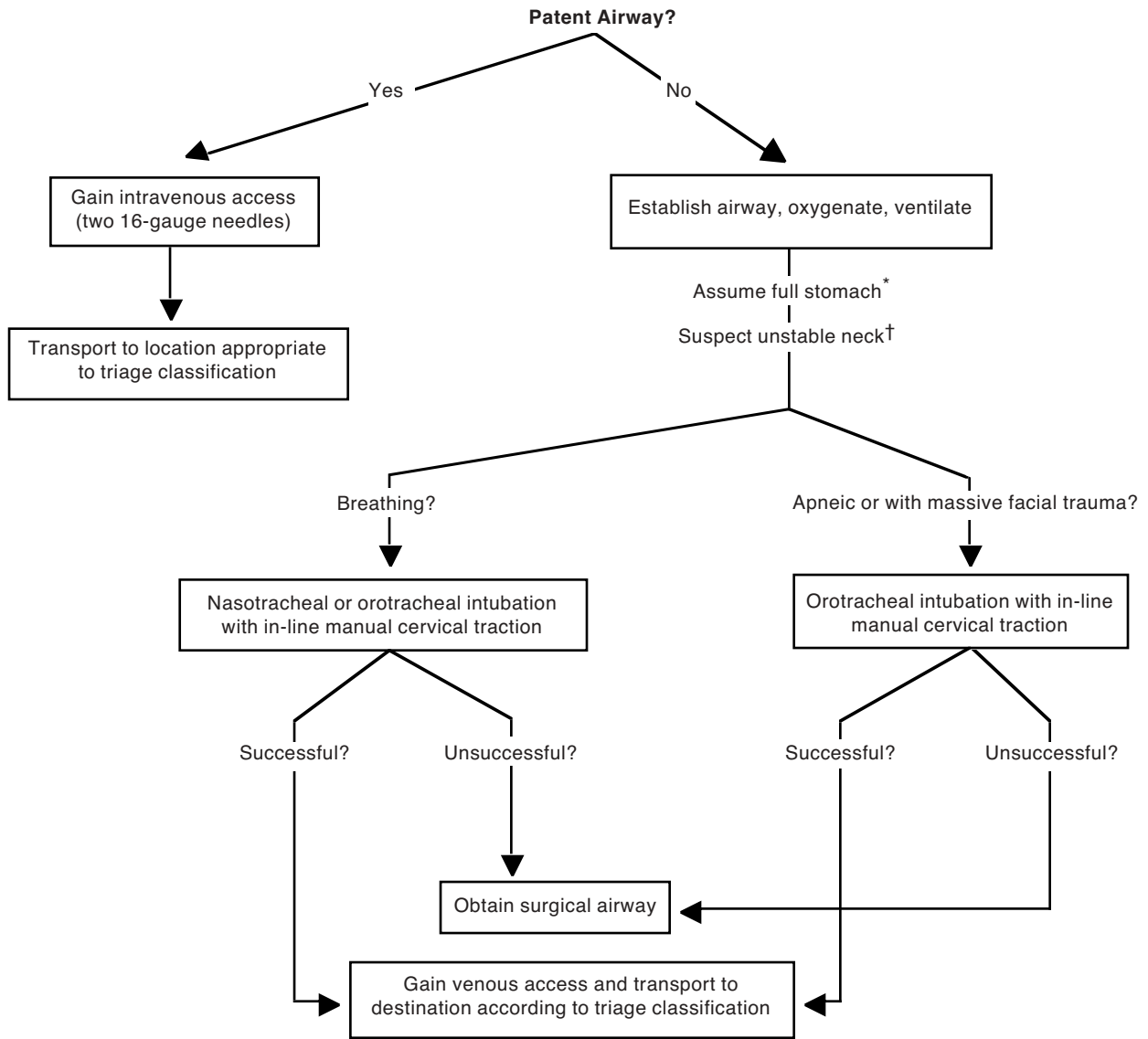
Safe Anesthetic Induction

Generally, severely injured casualties are intubated before they come to surgery. All patients with severe or multiple injuries should be placed on 100% oxygen. The reasonable assumption is that the casualty's condition is going to improve at some time during the surgery. As the patient's sensorium improves, so may his tendency to move. Therefore, the first drug administered is usually a muscle relaxant. Narcotics or inhaled agents are cautiously added as vital signs, urinary output, and other parameters of cardiovascular stabilization are manifested.

If the casualty reaches the operating room unintubated and conscious, then great care must be taken not to destabilize the situation with induction drugs. *Which* drug is used (ketamine and etomidate are two reasonable choices) is not as important as the *care* taken in its administration. Once again, a certain amount of awareness on the part of the casualty is unavoidable when dealing with trauma—not desirable, just inevitable.

Gaining Venous Access

Venous access is easy to talk about but can be incredibly difficult to achieve, especially in a hypothermic or hypovolemic casualty. Two 16-gauge intravenous lines should be considered the minimum, and some units routinely start three or four. The point is to get some sort of serviceable access quickly. Techniques to enter central veins and surgical cutdowns should be considered very early if initial attempts at peripheral sites are fruitless.



*All casualties with traumatic injuries should be treated as if they had full stomachs.

†In the absence of compelling historical or radiographic evidence to the contrary, unconscious casualties should be treated as if they have unstable cervical spines.

Fig. 2-1. Algorithm for initial treatment of casualties with traumatic injuries.

THE EXPANDED ROLE OF ANESTHESIA PROVIDERS IN BATTLEFIELD HOSPITALS

Education and Training Before Deployment

The familiar maxim holds true: during emergencies and times of crisis, a few people will rise to the occasion and perform unexpected heroics, but most of us will default to the level of our training. Ideally, education in emergency and trauma medicine

begins in nursing or medical school and progresses through specialty training. At least some exposure to trauma surgery prior to deployment is highly desirable, not only to reinforce the important anesthetic issues surrounding these cases but also to acclimate anesthesia providers to the pace and stress of this environment. A rotation through a level 1

trauma center during the second or third year of training is highly desirable. Not all U.S. Army anesthesia residency programs and certified registered nurse anesthetist (CRNA) training programs have formal trauma rotations. This issue is currently being addressed and will be changed in the near future.

Because deployed hospitals generally function as more-or less-isolated units and cannot expand their personnel rosters in response to emergencies, certain medical specialists may be forced to expand their professional borders. Anesthesiologists are particularly flexible members of the trauma team. These physicians, with special training in airway management and resuscitation, are capable of moving between the triage/emergency medical treatment/preoperative tent (usually called the emergency tent), the operating room, and the presurgery holding areas to support the most intense resuscitative efforts.

One of the most serious problems in managing protracted mass casualty exercises is the timely detection of significant deterioration in the patients awaiting surgery. When all the surgeons are in the operating rooms, the job of reassessing the casualties in the delayed and immediate triage categories who are awaiting surgery may fall to the anesthesiologist, who has some knowledge of trauma and may be able to leave the operating room, whereas the scrubbed-in surgeon cannot. A casualty with a gunshot wound to the abdomen who has stable vital signs may be triaged in the *delayed* category. However, if this casualty begins to bleed and becomes unstable, his category can change to *immediate* with little or no warning. A system that guarantees relentless, frequent reevaluation of all casualties awaiting surgery is essential to a well-run trauma facility. Clearly, a surgeon is the medical professional most qualified by training to perform this function; an anesthesiologist is perhaps the next best in a crisis.

If new casualties arrive at the facility after all the surgeons are already committed to the operating rooms, it frequently falls to the anesthesiologist (military occupation specialty [MOS] 60N) to participate in the initial triage and to act as an intermediary between the medical officers in the emergency tent and the surgeons in the operating room. Once again this job usually falls to the anesthesiologist because he is a known entity to the surgeon, has some knowledge of trauma and resuscitation, and has some freedom of movement. For this reason, all deployed physicians, not just emergency-treatment

specialists and surgeons, should have the training necessary to perform triage and to perform the initial assessment on casualties with multiple trauma and high-velocity missile wounds.

Certified registered nurse anesthetists (MOS 66F) not committed to the operating room may be stationed in the EMT (emergency medical treatment) area to provide immediate airway support for newly arriving casualties, or they may provide the same care to casualties in the intensive care unit whose condition is deteriorating. Certified registered nurse anesthetists have considerable expertise in achieving vascular access and placing intraarterial and intravenous monitoring lines. Physicians and nurses in the EMT, recovery room, and intensive care unit should be made aware of this expertise and be encouraged to ask for assistance from the anesthesia teams.

Because of the diversity of tasks that anesthesia providers may be expected to accomplish, anesthesiologists and nurse anesthetists should be particularly aggressive in seeking relevant experience in the emergency department and intensive care unit—both while they are in training and during their continuing medical education. Even if an anesthesia provider has had formal training in trauma, it is beneficial to direct a reasonable amount of continuing medical education effort in this direction. As a minimum, all providers should have the American College of Surgeons' current Advanced Trauma Life Support (ATLS) training. ATLS is directed toward care of civilians suffering blunt trauma, and it does not cover all aspects of war trauma. However, the ATLS system provides a solid background in casualty assessment, and the effectiveness of that program has been borne out in every conflict since Operation Urgent Fury (Grenada, 1983). If at all possible, reading and conferences should include enough material on high-velocity missile injuries to acquaint the provider with a basic idea of the differences between blunt and penetrating trauma (see Chapter 1, *Combat Trauma Overview*, in this textbook, and *The Medical Consequences of Conventional Warfare: Ballistic, Blast, and Burn Injuries*, an earlier (1991) volume in the *Textbook of Military Medicine* series). In addition, anesthesia providers should thoroughly review the areas of difficult intubations, hypovolemic shock, hypothermia, muscle relaxants in casualties with burns or traumatic injuries, and massive transfusion procedures.

One specific area of training for the field has been particularly problematic in the past decade: realis-

tic training with field anesthesia machines. Ohmeda's 855A field anesthesia machine (FAM) and its Universal portable anesthesia circuit (PAC), as they are marketed, do not meet all current safety requirements for routine use in CONUS in peacetime. This complex issue has been studied at great length at the highest levels of the U.S. Army Medical Corps' military preparedness community, and a workable solution is now being formulated. Under the guidance of Lieutenant Colonel D. M. Anderson, Consultant in Anesthesiology to The U.S. Army Surgeon General, training sites at Walter Reed Army Medical Center, Washington, D. C., Womack Army Medical Center, Fort Bragg, North Carolina, and Brooke Army Medical Center, San Antonio, Texas, have been established to provide carefully monitored instruction in the use of the draw-over device. Numerous machine monitors are added to the PAC when it is used in this setting. The patients are young and healthy, and their surgery does not involve the thorax, abdomen, or head (ie, they are in American Society of Anesthesiology [ASA] category I). An instructor, designated by the Consultant in Anesthesia to the U.S. Army Surgeon General, is either in the operating room or is immediately available. This augmented "teaching" PAC is always used in conjunction with a standard, modern anesthesia machine, which is positioned for immediate use, plugged in, and turned to the "stand-by" setting in case any need arises for additional support. As of January 1995, more than 45 operations using this draw-over teaching system had been performed at Walter Reed Army Medical Center and more than 250 at Womack.¹ The Joint Medical Readiness Training Command has developed a curriculum for instruction with the PAC and will implement this program in conjunction with the anesthesia services of Brooke Army Medical Center and Wilford Hall.

A protocol that will allow military anesthesia providers the opportunity to gain experience with the 855A FAM is also being developed. Carefully controlled conditions that involve both upgrading the machine-monitor capabilities, certification of instructors, and presence of standard back-up devices are being worked out to enable teaching the use of the 885A FAM. Two preliminary cycles of 885A FAM training have already occurred at Walter Reed, and an army-wide program should be in place by the end of 1995. With the growing emphasis on readiness, opportunities to train under realistic conditions can be expected to improve steadily in the coming years.

Training the Team After Deployment

Anesthesia providers tend to lead highly specialized, rather isolated, professional lives in peacetime. It is necessary to change this pattern during deployment. To a degree unequaled in any other aspect of medicine, trauma care is a team effort. Members of the anesthesia group must be prepared to shoulder some of the responsibility for planning and training the team to respond to mass casualty events. As a key member of the casualty-receiving, triage, and stabilization teams, as well as of the operating room's main effort, the military anesthesia provider's expertise, training, and problem-solving abilities are among the deployed hospital's most valuable assets. Anesthesia providers tend to become involved at every point in the care of casualties, from the initial assessment on the helipad to the transfer onto C-141s for out-of-theater evacuation. Because of this latitude of involvement, anesthesia providers are ideally placed to understand exactly what does and does not work in their team's efforts. Combat zone hospitals are not the place for a reticent specialist; everyone with the skill and the authority has the responsibility to participate fully in both planning and training.

It is incumbent on anesthesia providers to take a proactive position in the effort to train the non-medical members of the field hospital. Not only must basic skills be effectively taught, but all members of the unit must understand that their individual efforts are vital to the mission of caring for wounded soldiers. Anesthesia providers have great skill and experience in the areas of transport, intravenous access, monitoring for vital signs, and airway support. These basic skills must be rapidly imparted to personnel without much predeployment day-to-day exposure to patient care. An involved, supportive, leadership/instructor style is well suited to the field environment. By contrast, the more withdrawn, caustic style that is characteristic of many teaching institutions is not effective in this setting and is likely to be misunderstood.

Level 1 trauma centers in CONUS have the luxuries of large ancillary service staffs and a virtually unlimited supply of reinforcements. This is usually not the case with deployed units. When field hospitals go into a crisis-response mode, reinforcements will come from the nonmedical areas of the unit (motor pool, mess hall, laundry and bath, etc).

During overseas mass casualty exercises, for example, patient transport personnel are usually drawn from those sections of the deployed unit that

are not involved directly with patient care. During high-volume trauma incidents, the diesel mechanics and cooks assigned as litter bearers will suddenly become key members of the trauma team. It will be up to them to establish and maintain orderly, safe, and efficient patient flow under conditions that are fatiguing, uncomfortable, and sometimes hazardous. The effectiveness of these soldiers in the early phase of a mass casualty situation can set the tone, for better or worse, of an effort that may go on nonstop for days. Their training, no less than that of the medical officers and nurses, must be thorough and inclusive. They must be quite comfortable with the appropriate techniques for safely transferring patients to and from helicopters, fixed-wing aircraft, tracked vehicles, and field ambulances. For example, the off-loading and transport of a litter patient with an unstable cervical spine from a Huey helicopter, at night, under black-out conditions, is not only difficult but is also quite dangerous to all concerned. Litter bearers must also be able to deliver casualties to the minimal care, delayed, and expectant triage category areas without interfering with flow to and from the emergency tent and the operating room. The correct pathways through the tents, ISO shelters, and other structures that make up the maze of a field hospital must be learned thoroughly before the first emergency. Seemingly minor details—such as which entrances must be entered with the litter headfirst and which feetfirst—can take on immense importance in crises where every minute counts.

Not all postdeployment instruction involves taking personnel out of their primary specialties and teaching them new skills. Some of the most important training in this period entails expanding existing capabilities and increasing the breadth and depth of the individual soldier's knowledge. For example, during many of a deployed hospital's most important functions, the unit's radio operators become vital communications links between field medics, evacuation vehicle crews, and members of the emergency and operative services. The radio operators must be taught to understand and accurately record field telephone and radio messages from medics, flight nurses, and medical officers. In addition, these soldiers become an important part of the patient care delivery system, as they are trained to extract accurate information from helicopter crews bringing casualties to your facility. Although there are well-established, detailed, communications formats for medical evacuation, circumstances on the

ground or in the air may, understandably, distract the air crews or soldiers at the scene. The initial radio transmission may indicate little more than the fact that casualties are coming to your helipad. Well-trained radio operators can usually overcome the difficulties involved with intermittent or garbled transmissions and at least determine such basic information as the number of wounded, the anatomical sites of injuries, and whether all patients are conscious or at least breathing. Enlisted personnel in the Signal Corps are quite bright; they are well motivated and tend to have excellent judgment. If properly trained and encouraged, they can become great assets to the medical-care efforts. If you conscientiously help them expand their capabilities, they will make your unit's trauma-receiving efforts much more effective.

In times of crisis, almost everyone in your unit will play a direct or immediate support role in the care of casualties. As these two examples have demonstrated, nonmedical members of the field hospital play a key part in achieving a successful outcome during such emergencies. Because these soldiers will be asked to perform vital jobs outside their primary field of expertise with minimal supervision, they must know their jobs inside and out.

To the extent possible, units should train together prior to deployment. At the time of this writing (1995), vast strides are being made in improving the U.S. Army Medical Department's ongoing field training. However, there is no way to anticipate exactly either the environment or the clinical situations you will face. Perhaps more importantly, the inevitable professional isolation and heightened degree of individual responsibility cannot be realistically duplicated in stateside training exercises. For that reason, a planned series of exercises of graduated magnitude, pace, and complexity should begin as soon as possible after arriving in-country. These drills should begin within a few days of arrival at the facility outside CONUS and should continue until the teams have been through more than one real situation. Even if a full-scale mass casualty situation occurs on the first day, you should still go through a measured training cycle during the ensuing weeks, because it is difficult to make on-the-spot corrections or to try new ideas during a real emergency. The training sessions should begin as walk-throughs and proceed to more complex, realistic drills. Moulage is probably not worth the effort in this setting, but drills involving moving soldiers in combat gear on litters all the way through the system—from aircraft and vehicles to

the various destinations in the hospital—are essential. There should be no unannounced drills in hostile-fire environments. It should be made abundantly clear to all concerned that everything except announced practice exercises are the real thing and must be responded to without hesitation.

One of the truisms regarding trauma medicine in remote environments is this: if your team members have not worked on live, bleeding patients, they do not *know* whether they can perform effectively or not. U.S. Army field hospitals are sometimes deployed weeks or months before hostilities begin. In this period of quiet before the storm, the worst position to take is one of passive inaction. If the political, tactical, and logistical situations allow, the unit should accept injured coalition soldiers or patients from the indigenous population at a steady, controlled pace. Field hospitals, no less than tactical units, need to perform the equivalent of live-fire exercises. The logistical cost of doing at least one emergent surgical case every other day is small when compared to the dramatic increase in performance that will result from a sustained effort at improving combat casualty care.

Special Problems With Blood and Blood Products

As a part of the surgical team, you will be one of your unit's most important subject-matter experts on blood utilization. As such, you must be aware of the basic problems that face deployed field hospitals and help to develop plans to overcome these difficulties. It is in this area, perhaps more than any other, that the medical environment of the battlefield differs from that of civilian hospitals in the United States. Platelets cannot be stored for more than 48 hours, and it is quite likely that this component of blood therapy will not be available to you in many remote locations. A field plasmapheresis unit is under development but is not currently in distribution. This means that your unit must either be able (a) to reliably acquire platelets expeditiously in any emergency, (b) to use whole blood as a source of platelets, or (c) to accept a certain number of otherwise-preventable lethal exsanguinations. Fresh, whole-blood transfusions from local donors are not commonly performed in CONUS in peacetime, and therefore most physicians have some reservations about the process. Most field hospitals will not be able to screen for hepatitis viruses, human immunodeficiency virus, cytomegalovirus, or malaria in a timely fashion. The use of fresh, whole blood, then, will involve some unavoidable risks.

Fresh frozen plasma may also be difficult to use under some field conditions. During my own deployment to Somalia (1993–1994), the usability of fresh frozen plasma was seriously affected by two technical problems: the field warming unit took 45 minutes to thaw the fresh frozen plasma, and 50% of the bags ruptured during this procedure.

It is crucial that military physicians involved in trauma care overseas understand the essentials of the supply system that delivers packed red blood cells to their facility. A thorough comprehension of the routine delivery schedules and emergency replacement options is necessary so that appropriate stock levels may be maintained. To be able to respond effectively to mass casualty situations, stocks of blood and blood products must be kept at high levels. A single firefight or an incident such as a landmine being detonated by a truck loaded with soldiers can necessitate the expenditure of up to 50 units of blood. Conversely, during conflicts characterized by sporadic fighting, weeks or months may go by with little or no demand for blood or blood products. A high level of resource wastage due to outdated can be anticipated in this setting. Nevertheless, these periods of relative inactivity and the associated waste of a scarce and valuable resource should not lead to a lowering of stock levels. Unless the mission, the number of troops supported, or the essential nature of the conflict change, the deployed field hospital's state of readiness should not be downgraded in response to periodic variations in casualty rates.

It is customary for the chief of the laboratory services to publish a daily accounting of the number and type of units of blood products on hand. It may be beneficial to post this information in the operating room as soon as it is published. One of the most important reasons for the unit to become active in the management of trauma early in the deployment is to allow the medical, laboratory, and logistical elements concerned with blood utilization to learn to function together smoothly. Experience with administering massive transfusions in remote locations will also help medical personnel resist attempts by well-meaning logisticians to reduce blood stockage levels based on temporary declines in usage.

Essentials of Readiness: Equipment, Training, and Attitude

At least one operating room site should be set up for major trauma at all times. This includes an anesthesia machine, airway equipment, a well-

stocked cart, a functioning cart top (with resuscitative drugs drawn up and labeled), provisions for rapidly delivering blood and warmed fluids, electronic monitors, and extra supplies. On a broader scale, each hospital unit must establish some method for acquiring and storing the medical supplies necessary to support the dramatic surges experienced during mass casualty situations. The members of the anesthesia service must aggressively identify and solve all problems associated with critical supply items before the emergencies begin. Because the capability for immediate resupply is so limited, the involved medical specialists must take the responsibility of determining both their future needs and their current stock levels. For example, as the medical treatment facility's subject-matter experts on resuscitation, it is incumbent on the anesthesia provider to understand how much crystalloid solution must be readily at hand. In these instances, the training and operations officer (the S-3) is a valuable source of information. For example, if it were learned that an armored brigade had been attached to the division being supported by the field hospital, the training and operations officer should be able to provide a rough estimate of the increase in the number of burned casualties that could be expected in the near future. This information, and a quick inventory of the unit's intravenous fluid stocks, should allow for a reasonable assessment of the hospital's ability to support its expanded mission.

Obviously, key personnel must be in as high a state of readiness as is their equipment. Unless a unit is blessed with an extraordinary level of communication and transportation, at least one anesthesia provider should be in the compound at all times. A routine establishing which member of the anesthesia team will report to the emergency tent and which members will report to the operating room should be set and practiced until responses to incoming trauma are automatic.

Preparing for the Worst Case

Combat-related casualties and fatalities are quite rare among members of the Medical and Nursing Corps, but they do occur. All deployment plans should, at some point, be able to answer this question: Who is going to take care of the hospital's doctors and nurses if they get hurt? Plans should involve both interhospital contingencies and arrangements with other U.S. or coalition medical forces. The advisability of all anesthesia care pro-

viders or all surgeons or both traveling together in the same vehicles or aircraft should be carefully considered. Whether or not all members of the operating room team should bunk in the same area is also an issue worth considering in some environments.

Problems of Morale

As numerous afteraction reports have noted, the aspect of preparedness most difficult to maintain is probably the psychological one. The prolonged tedium between emergencies that becomes a part of almost every deployment seems to be especially damaging to the morale of medical department personnel. Physicians and nurses tend to be aggressive and problem-oriented, and they often find the lack of immediate challenge especially hard to bear. This is only one more reason to urge deployed facilities to stay as busy as the tactical and logistical situation will allow. Equipment, skills, attitudes, and systems quickly deteriorate in the vacuum of idleness. If the fighting dies down, consider offering your services to the special forces or civil affairs teams in the theater. An aggressive team of medical personnel can find a patient population in almost any environment. The importance of a smoothly operating trauma response team's maintaining its clinical skills cannot be overemphasized. Anesthesia providers, who always have the rank of at least captain, have a central position in most of the meaningful activities of the team. The influence of the morale of the surgical team on that of the entire hospital is profound; use your influence and authority to help the team stay busy and enthusiastic.

Preparing for the Future

Clearly, it is impossible to identify, in anything more than the most general terms, the nature of the operations the U.S. military's medical services will support in the future. Nor is it possible to predict what new technologies and therapeutic interventions will be introduced into the world of clinical anesthesia in the coming decade. What, then, must we do to prepare for the future?

In all the considerations of wound ballistics, evacuation strategies, plans, training, and logistics, it is possible to forget that what the U.S. Army really expects of its medical officers is that they take the best possible care of soldiers and their families. The single most important element in preparation for treating casualties of war is a strong graduate medi-

cal education program. Good residents and students make good doctors and nurses. To be most effective, medical personnel should be made aware of the field hospital environment, the nature of war, and the techniques of care of masses of casualties. However, the drive to educate doctors and nurses to the realities of field medicine must be balanced by the clear understanding that the most impor-

tant aspect of readiness is the acquisition and sustainment of clinical proficiency. Particular facets of strategy, climate, and geography may force medical personnel to modify their practices to accommodate the realities of any given deployment, but achieving the highest level of care possible under the circumstances should be the deployed hospital's unwavering goal.

REFERENCE

1. Reynolds P. Lieutenant Colonel, Medical Corps, US Army. Personal communication, January 1995.