Chapter 37

MEDICAL SUPPORT OF SPECIAL OPERATIONS

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INTRODUCTION

The term *special operations* as applied to the military of the United States is used to describe a variety of missions carried out by highly select units from the Army, Navy, and Air Force. Historically, individuals in these units are subjected to rigorous selection and training in preparation for missions that are often extremely physically demanding and carried out with limited support from larger conventional forces. Special Operations Forces (SOF) units employ many highly specialized infiltration techniques in the conduct of their arduous missions, which may result in uncommon physiological problems and present unique challenges in the management of casualties. Providing optimal medical support to these units requires a detailed understanding of their organizational structure, the nature of the missions, the medical administrative tasks that must be addressed, and the management of combat trauma in this special environment. These issues have not previously been addressed in a single, comprehensive document. This chapter is designed to meet that need.

Command Structures of the US Military Special Operations Units

Although the US military has a rich history of small, highly trained units operating either behind enemy lines or in advance of the main forces, the configuration of SOF as it exists today is a relatively new one. The failure of the attempted rescue of the Americans held hostage in our embassy in Iran in 1980 is etched into the national memory. The ensuing investigations into the reasons for the failure at Desert One revealed a lack of interoperability of the special operations units involved that led to the decision that a single, unified command that controlled all SOF units would help prevent such occurrences in the future. In October 1986, the US Congress passed legislation calling for the creation of a unified command.

Before the needs for medical support of the special operations units of the various military services can be discussed, however, it is well to review the organization of the US government's unified command and the interconnectedness of its constituent parts. The president, and below him the secretary of defense, both of whom are advised by the chairman of the joint chiefs of staff, control nine unified commands, which are organized by (1) geographical areas and (2) function (Figure 37-1). The US Special Operations Command (USSOCOM) is one of the four unified commands that are based on a specific function. When the United States becomes a combatant in an armed conflict, the SOF units that will participate in that conflict are assigned (or "chopped") to the commander-in-chief (CINC) of the involved geographical command. There are five geographical unified commands:

1. US Atlantic Command (the Atlantic Ocean and the Caribbean),
2. US Central Command (Asia, the Middle East, and India),
3. US European Command (Europe and Africa),
4. US Pacific Command (the Pacific Ocean and its islands), and
5. US Southern Command (Central and South America).

USSOCOM was established on 16 April 1987.[1] This command is located at MacDill Air Force Base, Tampa, Florida. The CINC is a four-star flag officer, and the deputy commander is a three-star position. The senior medical officer in the special operations community is the USSOCOM command surgeon, who is an O-6. USSOCOM has approximately 47,000 active duty and reserve personnel from the Army, Navy, and Air Force. The organization of the USSOCOM is shown in Figure 37-2.[2]

The service components of USSOCOM—the Army, Navy, and Air Force commands—are discussed below. In addition, a triservice element—the Joint Special Operations Command (JSOC) has as its charter the development of joint operating doctrine.

US Army Special Operations Command

The Army component of USSOCOM is the US Army Special Operations Command (USASOC) and is by far the largest of the three service components. USASOC's command structure (Figure 37-3) consists of the Army Special Forces Command, the John F. Kennedy (JFK) Special Warfare Center and School, the Civil Affairs and Psychological Operations Command, the 75th Ranger Regiment, the 160th Special Operations Aviation Regiment, and the Special Operations Support Command. USASOC is located in Fort Bragg, North Carolina, the traditional home of the Army Special Forces.

The Army Special Forces Command is further divided into seven Special Forces (SF) groups. Each group of approximately 1,400 soldiers is divided into three battalions, with each battalion having

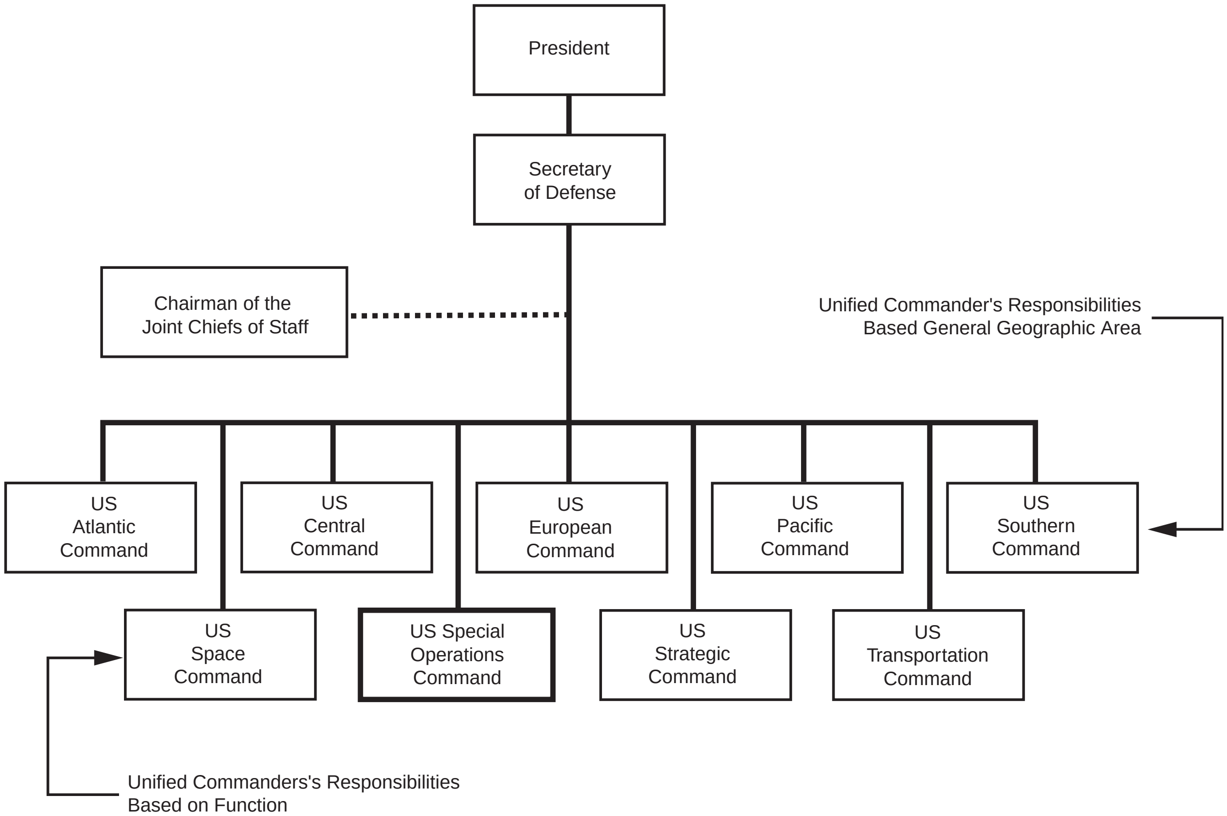

Fig. 37-1. United States Unified Command structure

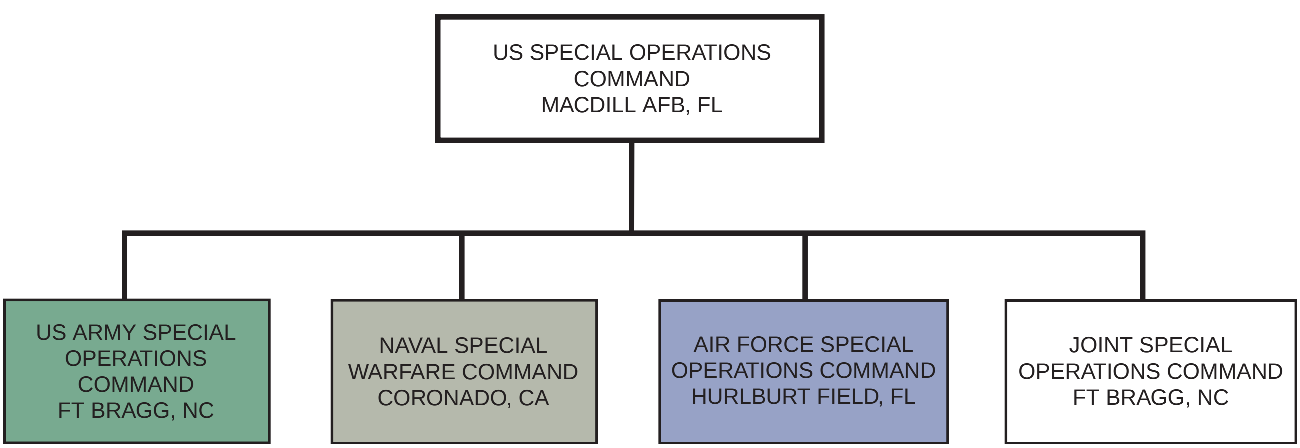

Fig. 37-2. United States Special Operations Command (USSOCOM) organizational chart

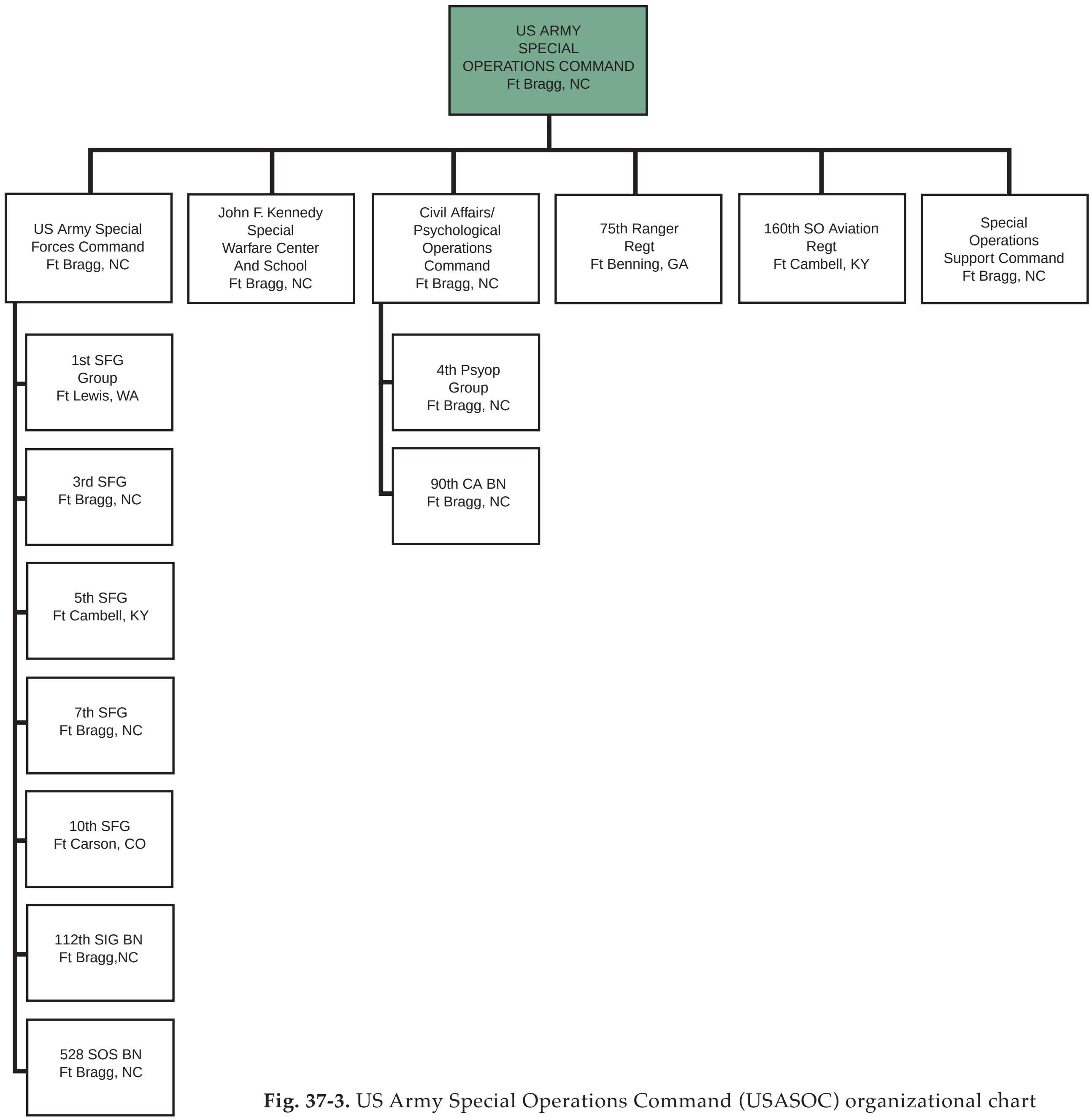

Fig. 37-3. US Army Special Operations Command (USASOC) organizational chart

three companies and each company having six A-teams (Operating Detachments Alpha, ODAs). The A-team is the basic operating unit in SF and comprises two officers and 10 senior enlisted men. Each company usually has one of its six teams qualified in high-altitude, low-opening (HALO) parachute operations and another qualified in self-contained underwater breathing apparatus (scuba) operations.[3] All officers and noncommissioned officers assigned to A-teams have passed the highly selective Special Forces Assessment and Selection course and the Qualification, or "Q," course taught at the JFK Center. In addition, they are all language qualified. SF A-teams are especially well qualified for Foreign Internal Defense missions (discussed below) but may be used for a wide variety of other special operations missions as well.

The 160th Special Operations Aviation Regiment (SOAR) supports SOF worldwide with their specially modified OH-60 (Little Birds), MH-60, and MH-47 helicopters.[1,4] Nicknamed the Night Stalkers, the

160th SOAR has its headquarters and two battalions in Fort Campbell, Kentucky, and another battalion at Hunter Army Airfield in Savannah, Georgia.[4]

The 75th Ranger Regiment is headquartered in Fort Benning, Georgia, and comprises the First Battalion (Hunter Army Airfield, Savannah, Georgia), the Second Battalion (Fort Lewis, Washington), and the Third Battalion (Fort Benning, Georgia).[5] Rangers have earned their designation at the challenging 9-week Ranger Qualification course. Enjoying a well-deserved reputation as the finest light infantry in the world, Ranger battalions have approximately 580 soldiers each, with each battalion having three rifle companies of 152 Rangers each and a headquarters company.[5] The Rangers are usually the SOF unit of choice when large assaults must be made against well-defended fixed targets.

The Civil Affairs and Psychological Operations Command, located at Fort Bragg, provides expertise in linking the SOF field commanders to the civil authorities in the operating area and in disseminating truthful information to foreign audiences in support of US policy and national objectives.[6] The seventh USASOC command, the Special Operations Support Command, is also located at Fort Bragg. It provides administrative and logistical support for the other major USASOC commands.

Naval Special Warfare Command

The Navy component of USSOCOM is the Naval Special Warfare Command (NAVSPECWARCOM), which is headquartered in Coronado, California, and is divided into six subordinate commands (Figure 37-4). Naval Special Warfare (NSW) Groups One and Two are based, respectively, in Coronado and in Norfolk, Virginia. Each of these groups contains three SEAL (*se*a, *a*ir, *l*and) teams and a SEAL delivery vehicle (SDV) team.[7] They also contain a number of subsidiary NSW Units, which are headquarters elements positioned in various locations outside the continental United States. The individual SEAL teams are divided into 10 operating platoons, each composed of two officers and 14 enlisted men.[2] SEAL platoons

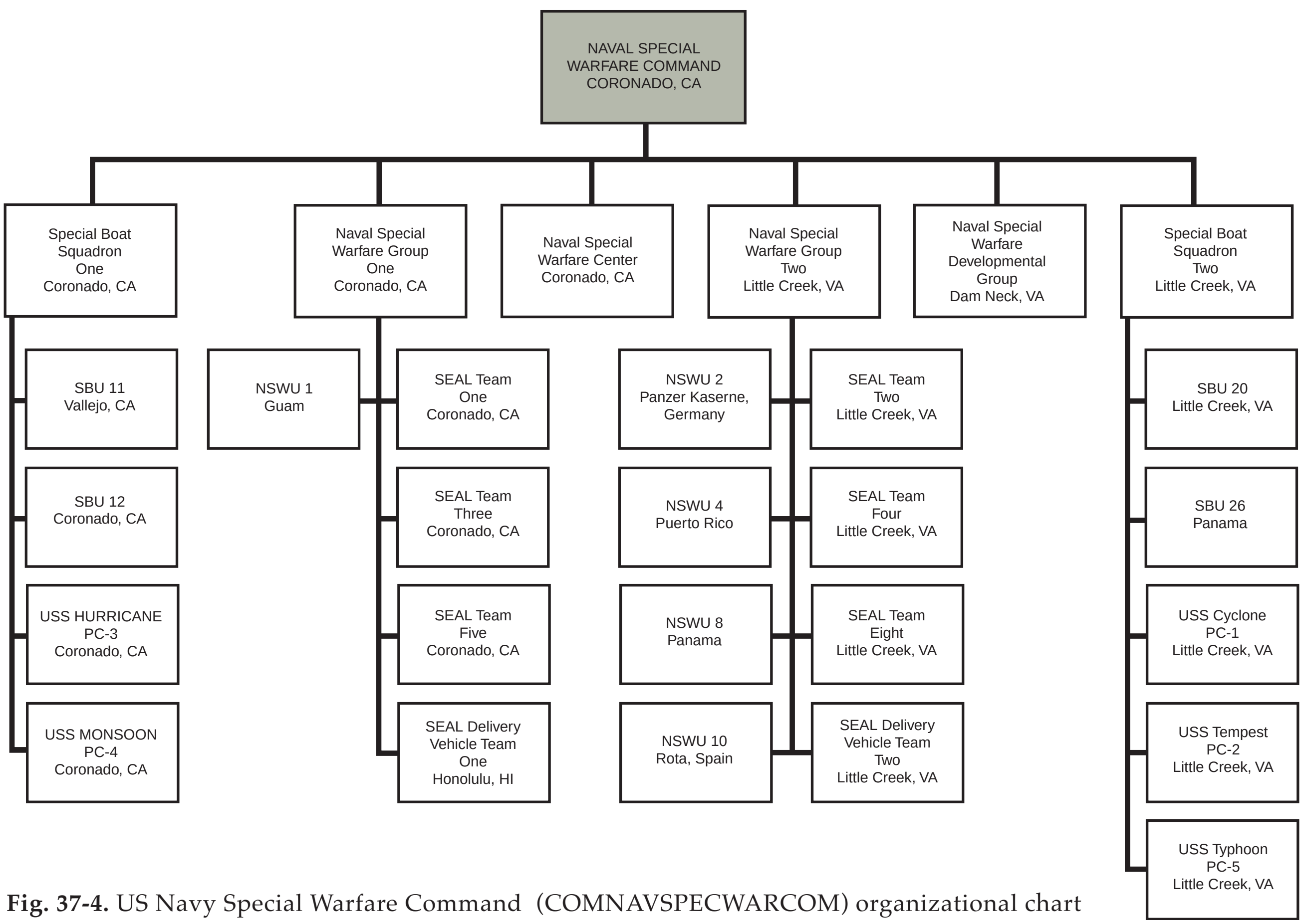

Fig. 37-4. US Navy Special Warfare Command (COMNAVSPECWARCOM) organizational chart

Fig. 37-5. The Mk V Special Operations Craft. Photograph: Courtesy of US Special Operations Command, MacDill Air Force Base, Tampa, Fla.

usually operate independently and are employed to carry out any of the wide variety of special operations missions discussed later in this chapter, especially those that entail a maritime element.

The SDV teams conduct combat swimmer operations using small, open-submersible SDVs. SDVs allow personnel and ordnance to be transported to target areas farther and faster than is possible with free-swimming divers. SDVs are typically transported to operating areas in dry deck shelter (DDS) complexes, which are fitted onto modified fast-attack and ballistic missile submarines.

Two other subordinate NAVSPECWARCOM commands, Special Boat Squadrons One and Two, are also based in Coronado and Norfolk and are the parent commands for the various craft that support SEAL operations. These craft include several sizes of rigid-hull inflatable boats (RHIBs), several types of high-spee□ boats (HSBs), the Mark V Special Operations Craft (Figure 37-5), and the 170-ft Cyclone-class patrol coastal craft (PCs).[2]

Another command, The Naval Special Warfare Development Group, is located in Dam Neck, Virginia, and provides centralized management for testing, evaluating, and developing current and emerging technology applicable to NSW forces.[7]

All NSW unit commanding officers, platoon personnel, and SDV pilots and navigators are SEAL operators. SEAL operators have successfully completed the demanding 26-week Basic Underwater Demolition/SEAL (BUD/S) training course conducted at the sixth NAVSPECWARCOM major command, the Naval Special Warfare Center in Coronado, California (Figure 37-6). Although the Underwater Demolition teams have now all been redesignated SEAL teams, the Underwater Demolition component in the course name has been retained as a reminder of the SEALs' origins. The Special Warfare designator, or Trident, is not awarded until operators have also successfully passed a probationary period with an operational SEAL or SDV team. The Naval Special Warfare Center also conducts advanced as well as basic training for NSW personnel.

a

b

Fig. 37-6. Basic Underwater Demolition/SEALS (BUD/S) training: (**a**) physical training with a log (Log PT) develops teamwork; (**b**) surface training swim. Photographs: Courtesy of US Special Operations Command, MacDill Air Force Base, Tampa, Fla.

Air Force Special Operations Command

The Air Force Special Operations Command (AFSOC) is headquartered at Hurlburt Air Force Base, Florida. As shown in Figure 37-7, it has four constituent parts: the 16th Special Operations Wing, the 18th Flight Test Squadron, the 720th Special Tactics Group, and the Air Force Special Operations School.

The primary AFSOC operational command is the 16th Special Operations Wing (SOW). The 16th SOW is further divided into a number of special operations squadrons (SOSs), which are organized by the type of aircraft flown. The basic C-130 airframe is modified into several different variations.[8] The AC-130U/H Spectre (16th SOS) is designed to serve primarily as a gunfire-support aircraft. The MC-130E and MC-130H Combat Talon aircraft (8th and 15th SOS) accomplish a variety of missions, including long-range insertion of SOF, resupply of ground forces in the field, gunfire support, and communications support. The HC-130 N/P Combat Shadow (9th SOS) provides an airborne refueling capability for SOF rotary-wing aircraft. The MH-53J Pave Low (20th SOS) and MH-60G Pave Hawk (55th SOS) are helicopters that can insert and extract SOF, provide limited gunfire support, and conduct combat search and rescue operations. The Pave Low aircraft has a longer operating range than the smaller Pave Hawk. AFSOC has one operational squadron, the 6th SOS, whose primary mission is to provide aviation-related foreign internal defense (Figure 37-8).

AFSOC also has administrative control of two operational groups, the 352nd in Mildenhall, United Kingdom, and the 353rd in Kadena, Japan. Each of

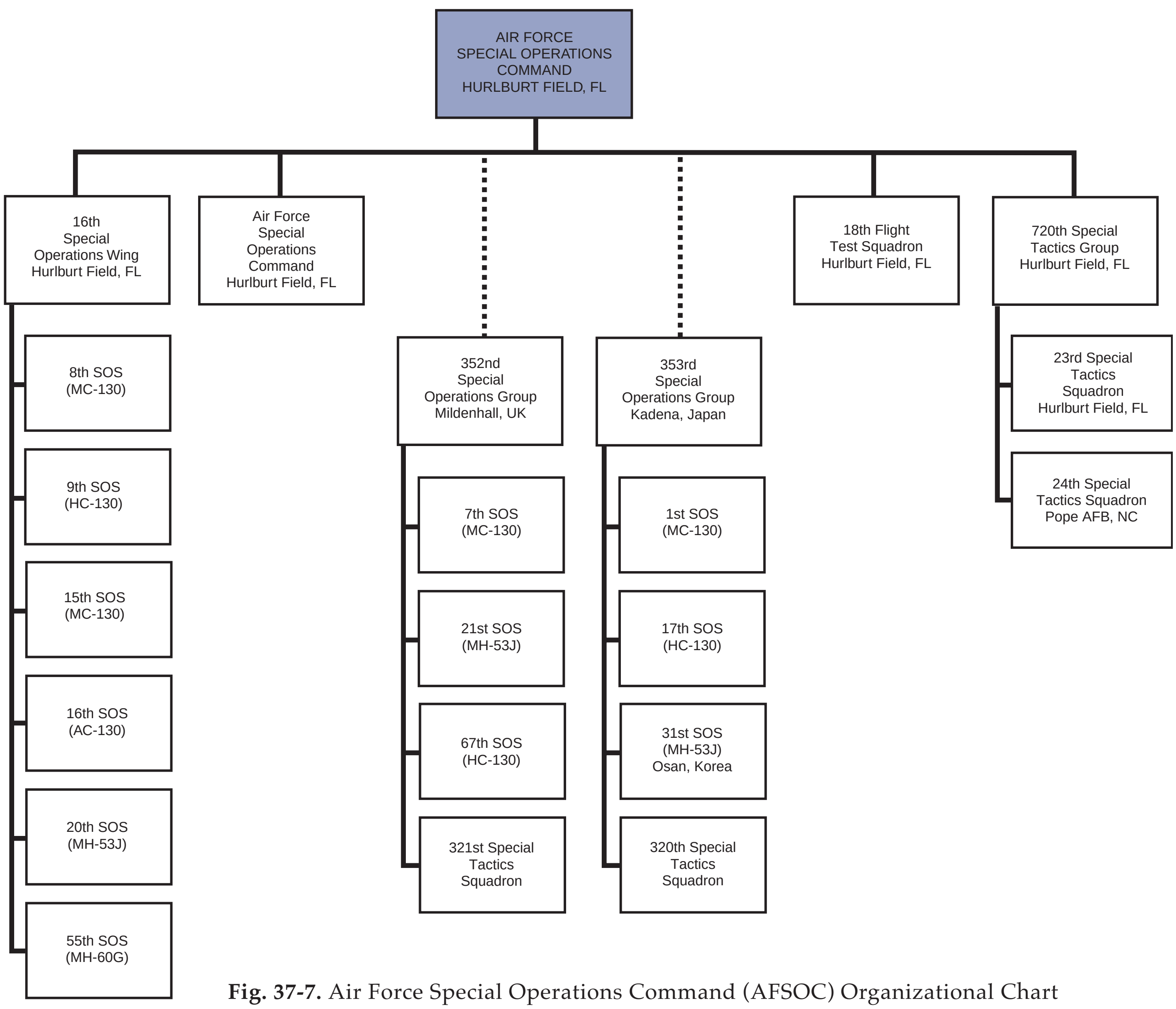

Fig. 37-7. Air Force Special Operations Command (AFSOC) Organizational Chart

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Fig. 37-8. (**a**) Air Force Special Operations Command (AFSOC) MH-53J Pave Low in flight. (**b**) US Army Special Operations Forces (SOF) troops fast-roping from an AFSOC MH-53J Pave Low aircraft. (**c**) AFSOC HC-130 Combat Shadow refuels a Pave Hawk. (**d**) AFSOC MH-60 Pave Hawk conducts a search-and-rescue mission. Photographs: Courtesy of US Special Operations Command, MacDill Air Force Base, Tampa, Fla.

these groups is subdivided into four SOSs.

The second AFSOC command, the Air Force Special Operations School, is located at Hurlburt Field and conducts a variety of courses to educate US and Allied military personnel in the geopolitical, psychological, sociological, and military considerations of US Air Force and Joint Special Operations.[9]

The third AFSOC command is the 18th Flight Test Squadron (FTS), also located at Hurlburt Field. This command is responsible for testing and evaluating proposed Air Force special operations and combat rescue aircraft and associated equipment.[10] The 18th Flight Test Squadron also develops and evaluates new tactics for AFSOC use.

The fourth AFSOC command is the 720th Special Tactics Group. The group has two squadrons, the 23rd STS at Hurlburt and the 24th STS at Fort Bragg, North Carolina. Squadrons are also attached to the 352nd and 353rd wings[11] and comprise small units called special tactics teams. These teams contain two specially trained types of individuals:

- combat controllers, who are air traffic controllers trained to survey, mark, and control airfields in austere and nonpermissive environments and to designate targets for air interdiction and close air support; and
- pararescuemen, also known as PJs, who are, like the SF medics and SEAL corpsmen, emergency trauma specialists and combatants combined.

Special tactics personnel are trained in military free-fall parachuting, open- and closed-circuit scuba, and airmobile employment methods.[11]

Types of Special Operations Missions

USSOCOM forces conduct a wide variety of missions during armed conflicts and peacetime.[2] Although SOF combat operations are often carried out in support of conventional forces, special operations missions typically involve relatively small force elements operating clandestinely in areas that are geographically remote from main bodies of conventional forces. SOF missions include all of the following[2]:

- Amphibious Warfare: direct action operations launched from the sea by naval and landing forces against a hostile or potentially hostile shore. These operations include preassault cover and diversionary operations, surf observation, hydrographic reconnaissance, and obstacle clearance.
- Civil Affairs: advise and assist commanders in establishing and maintaining relations among military forces, civilian authorities (both governmental and nongovernmental), and the civilian population in an area of operation.
- Coastal Patrol and Interdiction: a special reconnaissance activity in coastal regions involving area denial, interdiction, support, and intelligence. These operations are designed to halt or limit the enemy's warfighting capability by denying movement of vital resources over coastal and riverine lines of communication.
- Combat Search and Rescue: search and rescue missions conducted to recover distressed personnel during wartime and contingency operations.
- Counterdrug: active measures taken to detect, monitor, and counter the production, sale, trafficking, and use of illegal drugs.
- Counterproliferation: measures undertaken to combat the proliferation of weapons of mass destruction.
- Counterterrorism: both defensive and offensive measures undertaken to oppose and prevent terrorist activities.
- Direct Action: short-duration strikes and other small-scale offensives by SOF to seize, destroy, capture, recover, or inflict damage on designated personnel or material.

Fig. 37-9. Operations Other Than War: US Army Special Operations Forces (SOF) personnel conduct vehicle inspections in Haiti during Operation Restore Democracy. Photograph: Courtesy of US Special Operations Command, MacDill Air Force Base, Tampa, Fla.

- Foreign Internal Defense and Civic Action: missions that provide assistance to another country to help free and protect its citizens from subversion, lawlessness, and insurgency.
- Humanitarian Assistance: missions conducted to prevent or reduce pain, hunger, or loss of life resulting from natural or manmade disasters or endemic conditions.
- Operations Other Than War (OOTW): if we consider direct action missions to be at one end of a spectrum and humanitarian assistance operations at the other, then OOTW comprise the midpoint of the continuum. Examples of OOTW include providing security for the humanitarian famine relief effort in Somalia and augmenting local police and militia forces during Operation Restore Democracy in Haiti (Figure 37-9). Ideally, these missions are carried out without the use of arms, but volatile tactical environments (eg, Somalia) may quickly turn OOTW into direct actions.

INITIAL TRAINING IN MEDICINE OF SPECIAL OPERATIONS MEDICAL PERSONNEL

This chapter is being written at a major turning point in the history of SOF medical training, as the Joint Special Operations Medical Training Center (JSOMTC) at Fort Bragg, North Carolina, began operations in July 1996. The JSOMTC will conduct most SOF Combat Medical Training courses in the future. For completeness, the current training at the JSOMTC and the medical training prior to 1996 will both be described.

The JSOMTC is a subordinate command of the JFK Special Warfare Center and School in Fort Bragg, North Carolina. The primary course taught at this institution is the Special Forces Medical Sergeant (SFMS) course. This course is divided into two segments. The first, the Special Operations Combat Medic (SOCM) course, is 24 weeks long and provides basic combat trauma training for SOF combat medical personnel. The course includes anatomy and physiology, the American College of Surgeons' Advanced Trauma Life Support (ATLS) course, pharmacology, and Emergency Medical Technician–Paramedic (EMT-P) training. All SEAL corpsmen, SF medics, and Air Force PJs attend this course before being assigned to an operational unit.

The second segment of the SFMS course is the Advanced Special Operations Combat Medic (ADSOCM) course, which in 20 weeks covers advanced anatomy and physiology, pharmacology, infectious disease, and trauma care. SF medics attend this course and earn their 18 Delta qualification before being assigned to an operational SF unit. SEAL corpsmen are designated Navy Enlisted Code (NEC) 8492s after completing the SOCM course and are assigned to an operational unit. They return later in their careers to attend the ADSOCM course, where they earn the Navy NEC 8491. Air Force combat medical personnel are not currently anticipated to attend ADSOCM, although this issue is under review at the time this chapter is being written.

The medical dean of the JSOMTC is an Army O-6 medical officer and is responsible for recommending policy on medical training issues to the commander. In addition, a senior Army O-5 or O-6 line officer is responsible for administration and personnel. Both officers report to a flag officer (and/or his staff) at the next-higher echelon.[12]

Enlisted Medical Personnel

Army Medics

Special Forces 18 Delta Medics. Special Forces combat medics are known as 18 Deltas and earn this distinction by successfully completing the SFMS course (Figure 37-10). The first phase of this year-long course was previously conducted at Fort Sam Houston, San Antonio, Texas, and the second phase conducted at Fort Bragg. The 18 Delta candidates must be E-5 or higher and have passed the Special Forces Assessment and Selection course as well as

Fig. 37-10. US Army Special Operations Command (USASOC) 18-Deltas practice their combat trauma management skills. Photograph: Courtesy of US Special Operations Command, MacDill Air Force Base, Tampa, Fla.

the SF Qualification course. After completing the SFMS course, Special Forces medics are able to function independently, as defined by USASOC Regulation 350-9. They next report to a Special Forces Group where they are assigned to an operational A-team. Two medics are usually assigned to each team.

Ranger Medics. Ranger medics, who hold the Army Medical Occupational Specialty designator 91B, provide tactical medical support for the units of the 75th Ranger Battalion. They also attend the SOCM course taught at the JSOMTC in Fort Bragg. As SOCM graduates, they are all EMT-P qualified. One Ranger medic is assigned to each 40-man platoon. The training a Ranger medic receives does not include providing sick call care in garrison, so they receive on-the-job training in these skills at their units. Although completion of Ranger training is not a prerequisite for the Ranger medic, many of these individuals attend Ranger School while assigned to their units.

Navy SEAL Corpsmen

In the past, medical training for SEAL corpsmen began at the Navy Corpsman A School at Great Lakes, Chicago, Illinois, or San Diego, California, where students received 12 weeks of basic instruction in anatomy, physiology, nursing care, intravenous therapy techniques, pharmacology, and other general medical topics. This school was often followed by a tour in a hospital prior to receiving orders to BUD/S training. Corpsman A School may now be omitted if a BUD/S graduate subsequently attends the SOCM course, as would normally be the case. The corpsman receives no extra medical training during his 26 weeks at BUD/S, but is subjected to the same combination of selection and training as others in the course. After completing their SEAL training, corpsmen remain at the Naval Special Warfare Center for an extra 3 weeks of Special Operations Technician (SOT) training, where they receive additional training in the recognition and treatment of diving medical disorders and in the operation and maintenance of recompression chambers. Still prior to reporting to an operational SEAL team, the new SEAL corpsman attends Jump School at Fort Benning, Georgia.

In the past, SEAL corpsmen then went to Fort Sam Houston, Texas, to receive instruction in trauma care adapted from the 18 Delta course, but this training has now been replaced by the SOCM course. The corpsman then reports to his first operational SEAL team, where he is usually assigned as one of the two corpsmen in a SEAL platoon.

As noted previously, SEAL corpsmen who have taken only the 18 Delta Trauma Module or the SOCM are designated as NEC 8492s and have a more-limited scope of practice than SF 18 Deltas. Some SEAL corpsmen return to finish the remainder of the 18 Delta course and receive the NEC 8491 designation. These individuals may function as Independent Duty corpsmen. SEAL units may also have Diving Medical Technicians (DMTs) and other non-SEAL operator corpsmen attached to provide noncombat medical care.

Air Force Medics

AFSOC enlisted medical personnel are currently of three types. The first is the Medical Service Specialist, Air Force Specialty Code (AFSC) 4N0X1. Medical service specialists attend a 13-week Phase 1 School at Sheppard Air Force Base in Wichita Falls, Texas, followed by an additional 8 weeks at a Phase 2 training site. The medical service specialist course provides instruction in basic anatomy, physiology, cardiopulmonary resuscitation, nursing care, and clinical medicine. Graduates are qualified as EMT-Basic on completion of this course. The second type of medic is the Aeromedical Service Specialist, AFSC 4F0X1. Aeromedical service specialists attend a 12-week course at Brooks Air Force Base, San Antonio, Texas, where they receive instruction in many of the topics noted for medical service specialists as well as altitude physiology, flight medicine, and aviation physical standards. After finishing these schools, they receive an initial assignment to a hospital, clinic, or operational wing. Once they have achieved the rank of E-5 and have reached a minimum skill level of 5 by completing the Air Force Career Development course, they are eligible for assignment to AFSOC.

Prior to arriving at AFSOC, both types of specialists must also have taken the 10-week Independent Duty Medical Technician course at Sheppard Air Force Base and the 7-week Aeromedical Evacuation Technician course at Brooks Air Force Base. Both types of specialists are therefore EMT-Intravenous qualified and able to function as independent care providers on arrival at AFSOC. EMT-Paramedic training is conducted on an individual basis after arrival at AFSOC. Flight physicals and routine flight crew healthcare are provided by aeromedical service specialists under the supervision of the flight surgeon, with each squadron usually having one flight surgeon and two aeromedical service specialists. Medical service specialists are assigned to clinics or other fixed medical treatment facilities (MTFs). Both aeromedical service specialists and medical specialists may provide in-flight medical care in AFSOC aircraft but neither has the training in small arms and tactics to act as a combatant outside the aircraft when necessary to rescue downed aircrews.

That duty is the province of the third type of Air Force medical care provider, the pararescueman (PJ). The PJs first go to the 10-week Pararescue Indoctrination course at Lackland Air Force Base, San Antonio, Texas. Also known as "OL-H", for operating location H, this course is physically demanding and has a high attrition rate. After the successful completion of the Pararescue Indoctrination course, the candidate then goes to Jump School at Fort Benning (3 wk), Survival School at Fairchild Air Force Base, Spokane, Washington (3 wk), Military Free-Fall Parachute School at Fort Benning (4 wk), Special Forces Combat Diver School, Key West, Florida (4 wk), and the 26-week Pararescue School at Kirtland Air Force Base in Albuquerque, New Mexico. This course provides training in trauma care (EMT-Paramedic) as well as weapons, rescue techniques, and small-unit tactics. Although they do receive in-hospital experience in trauma care and endotracheal intubation, PJs do not attend Independent Duty Medical Technician School and their scope of practice is limited to trauma care. On completion of their training, they are assigned to the Special Tactics Teams and are considered primarily combat medics, much like a SEAL 8492.

Medical Officers

Army SOF Physicians

Not surprisingly, the three component services also vary considerably in their methods of training physicians to provide medical support for special operations. A first-tour Army SOF physician is usually assigned to an SOF unit following his internship. There is no formally required additional training before being assigned to an Army SOF unit, but medical officers often obtain tropical medicine training at Walter Reed Army Medical Center, Washington, DC (4 wk), the classroom phase of the diving medical officer (DMO) course at the Naval Diving and Salvage Training Center in Panama City, Florida (3 wk), airborne training at Fort Benning, Georgia (3 wk), and Army Flight Surgeon training at Fort Rucker, Alabama (6 wk). Training is usually done en route to the SOF command but may be done after reporting.

Most first-tour medical officers are captains and are assigned to an SF or Ranger battalion. These initial tours typically last 2 to 3 years, after which the physician returns for a residency in a clinical specialty. Medical billets at the group level or higher are usually filled by a senior major who has returned to a SOF billet after completing a residency and spending a tour practicing that specialty. Some SOF medical officers may get a chance to attend Ranger training, but they do not generally go to the SF qualification course. The senior physician in USASOC is the USASOC Command Surgeon, who is a senior O-5 or O-6.

Naval Special Warfare Diving Medical Officers

All NSW billets except for the single medical officer at each of the two special boat squadrons are filled by physicians who have successfully completed the Navy Undersea Medical Officer (UMO) course, which encompasses diving, submarine, and Special Warfare medicine. The submarine and Special Warfare medicine portions of the course (12 wk) are taught at the Naval Undersea Medical Institute in Groton, Connecticut, and the diving medicine portion (9 wk) is taught at the Naval Diving and Salvage Training Center in Panama City, Florida. On completion of the course, the DMO qualification is granted automatically, but designation as a submarine medical officer and UMO requires passing a submarine qualification exam, the completion of a thesis, and at least 30 days of service aboard a submarine. The physicians attending this course have usually just finished their internship, although some senior medical officers at the O-5 and O-6 level who are already board certified elect to attend.

Currently, three medical officers are at each of the two NSW Groups, two at the NSW Center, two at COMNAVSPECWARCOM (the commander's headquarters unit of NAVSPECWARCOM) and two at the NSW Development Group. After an initial tour in NSW, most medical officers return to residency training, although some of the individuals who have previously completed residencies may elect to stay for multiple tours in NSW. NSW DMOs do not go through BUD/S training. The senior physician in NSW is the COMNAVSPECWARCOM Force Medical Officer, who is a senior O-5 or O-6.

Air Force Special Operations Command Flight Surgeons

AFSOC Flight Surgeons have all been through the Aerospace Medicine Primary course, which is 8 weeks long and is taught at Brooks Air Force Base, in San Antonio, Texas. AFSOC has three operational flight medicine units; they are located in the 16th

SOW at Hurlburt Field, Florida; the 352nd Special Operations Group (SOG) at Mildenhall, England; and the 353rd SOG at Kadena Air Force Base, Okinawa. Each unit consists of a Senior (O-4/O-5) Flight Surgeon who has completed the 3-year Resident in Aerospace Medicine course at Brooks Air Force Base, several basic-trained flight surgeons (O-3/O-4), a medical service corps officer (O-3), and medical technicians (medical service specialists and aeromedical service specialists.) Squadrons have a medical element that consists of an O-3 flight surgeon and two aeromedical technicians. The senior physician in AFSOC is the AFSOC Command Surgeon, who is usually a senior O-5 or O-6.

ROUTINE MEDICAL SUPPORT OF SPECIAL OPERATIONS FORCES

When SOF units are not engaged in a conflict, they are engaged in a continuing cycle of training and operational exercises. SOF medical personnel play a critical part in helping their units maintain their operational readiness. In this setting, the need to care for combat casualties is not routinely encountered but the functions noted below are.

Primary Healthcare

SOF medical personnel must be able to deal with the routine problems encountered in providing healthcare and periodic physicals to a group of generally healthy, young and (lest we forget the colonels and the master chiefs) not-so-young individuals. The establishment of efficient and well-run sick call procedures for SOF units is essential. It is generally expected that most primary medical care for active duty SOF personnel will be provided by the medical personnel organic to the unit if at all possible. Care for dependents is less common, and pediatric and obstetrical–gynecological care may be best accomplished at a clinic that deals routinely with patients in these special categories. SOF medical personnel should work to establish a rapport with the local referral MTF so that consults to that facility will be handled promptly. It may be worthwhile to visit the facility periodically with a senior line commander and to invite the hospital or clinic leadership to visit the SOF compound for a demonstration of SOF missions and capabilities.

Sports Medicine

Navy SEALs, Army Special Forces and Rangers, and Air Force Special Tactics Teams are required to maintain extremely high levels of physical fitness to perform the many physically demanding activities encountered in their operations. This requirement necessitates a heavy emphasis on both strength and aerobic physical training in SOF units. Associated with these rigorous training schedules is a high incidence of traumatic and overuse musculoskeletal injuries. If these exercise-related injuries are not accurately diagnosed and treated with the most effective therapeutic measures available, unnecessarily long recovery periods may result. These delays may have detrimental effects on both the unit's operational readiness and the long-term health of the service member.

To ensure that the best possible care is obtained for these injuries, a proactive sports medicine program should (*a*) be a high priority of every SOF major command and (*b*) consist of a self-contained rehabilitation facility and regular supervision by physical therapists, physical therapy technicians, or athletic trainers. Most internships provide relatively little instruction and training in sports medicine. Unless they are already trained in sports medicine, SOF physicians should receive supplemental training in this area shortly after they report for duty. In addition, a periodic visit by a sports medicine specialist to examine difficult diagnostic or therapeutic patients is helpful. On-site specialty care can be obtained through personal liaison with the appropriate MTF or by contracting for civilian consultants.

Flight Medicine

Many SOF medical officers are assigned to units with aircraft and aircrews. These medical officers must perform the careful periodic flight physicals required for aircrews, make recommendations about crew suitability to fly after acute minor illnesses or injuries, and provide input to line commanders about the physiological aspects of flight operations as required.

Occupational Medicine

SOF medical personnel deal with many occupational medicine issues. For example,

- the requirement for extensive small-arms training entails a substantial risk of noise-induced hearing loss if an aggressive hearing conservation program is not implemented;
- the need to conduct prolonged training evolutions in harsh environments may result in heat or cold injury if reasonable guide-

- lines for preventing such injuries are not established and followed; and
- live-fire exercises in confined spaces present the potential for exposure to elevated ambient lead levels.

SOF medical personnel must be alert for the presence of such hazards and implement whatever measures are needed to reduce the risk and monitor the well-being of their units.

Medical Readiness

Shifts in national defense policy, a changing worldwide geopolitical picture, and advances in medical care create a constantly evolving environment for SOF; physicians and senior enlisted medical personnel must monitor changes in these areas and evaluate the ability of their personnel and equipment resources to meet their units' medical needs in light of these changes. Long-range planning for medical requirements is conducted through each component's Program Objective Memorandum (POM) process. The POM process, however, requires several years of lead time. More immediate medical needs may be addressed at the command level with Operations and Maintenance (O&M) funds. Needed purchases should be documented with memoranda to the unit commander. If the command needs to acquire medical equipment before the POM can provide it, the unit commander may elect to use O&M funds for these purchases. At all times, it is important to maintain a prioritized list of proposed equipment purchases; this list is often very useful as the end of the fiscal year approaches.

Diving Medicine

Physicians assigned to units with combat swimmers, such as SEAL teams, scuba-capable SF teams, and Air Force Combat Control Teams, must be able to deal with problems relating to diving medicine. Special needs of divers in SOF include fitness-to-dive evaluations and the recognition and treatment of diving disorders. Navy guidelines for physical standards for divers are found in the *Manual of the Medical Department*.[13] Medical supervision of SDV/DDS operations is a specialized area of diving medicine and will be addressed separately in the following section.

Most SOF diving operations are conducted with closed-circuit scuba. These underwater breathing apparatuses (UBAs) recycle the diver's exhaled gas through a carbon dioxide absorbent canister rather than allowing the exhaled gas to escape to sea. Compared with conventional open-circuit scuba, closed-circuit scuba has the following advantages:

- increased operating times; since all of the oxygen carried is available for metabolism, operations of up to 3 hours or longer can be carried out with a single small gas cylinder;
- the lack of escaping bubbles allows for clandestine diving operations to be conducted without the threat of compromise that results from a trail of bubbles rising to the surface; and
- closed-circuit UBAs can be designed with very low acoustical and magnetic signatures, which are critical in Explosive Ordnance Disposal operations.

Disadvantages include

- greatly increased cost of equipment, both in acquisition and maintenance;
- added diving complexity, with resultant increased training requirements; and
- increased risk of diving accidents.

The two main types of closed-circuit scuba are (1) closed-circuit oxygen, in which only a single bottle of compressed oxygen is used, and (2) closed-circuit mixed-gas, which employs a bottle of pure oxygen and a second bottle filled with either air or oxygen mixed with helium (heliox). Both types of closed-circuit UBAs use a canister filled with carbon dioxide absorbent to remove the carbon dioxide from expired air.

The closed-circuit oxygen UBA currently used by the US military is the Draeger LAR V Mk 28 Mod 2 (Figure 37-11). This rig is worn over the chest and abdomen of the diver, with the breathing bag and the canister contained in a fiberglass shell and the oxygen bottle attached to the bottom of the UBA. The LAR V offers the advantages of being very light (25 lb) and mechanically simple. The primary disadvantage of closed-circuit oxygen as compared with closed-circuit mixed-gas scuba is the depth limitations imposed by the risk of central nervous system oxygen toxicity. This is often not a significant problem in SEAL diving operations because many combat swimmer missions require only a dive depth sufficient to provide concealment at night.

The Mk 16 UBA is a closed-circuit mixed gas UBA, which uses a microprocessor to control the partial pressure of oxygen at 0.75 atmospheres absolute (atm). It contains two high-pressure gas bottles: one for oxygen and one for a diluent

Fig. 37-11. (**a**) A US Navy SEAL (*se*a, *a*ir, *l*and) diver is wearing the Draeger LAR V underwater breathing apparatus (UBA). (**b**) A SEAL diver is dressed in an Mk 16 UBA. Photograph: Courtesy of US Special Operations Command, MacDill Air Force Base, Tampa, Fla.

gas (either air or a heliox mix). As oxygen is consumed, three sensors in the breathing loop detect the falling partial pressure of oxygen (PO_2) and activate the oxygen-addition valve. The diver is able to monitor the status of his PO_2 on both a face mask–mounted primary display as well as a secondary display. Both gas bottles; the microprocessor; the breathing bag; and a large, circular carbon dioxide absorbent canister are all enclosed in a fiberglass casing worn on the diver's back. A manual bypass valve is available to add additional oxygen or diluent gas to the UBA if necessary. The large, well-insulated carbon dioxide absorbent canister on the Mk 16 achieves excellent operating durations, ranging from 100 to 400 minutes depending on the water temperature, dive depth, and gas used. Testing with Sofnolime in a resting diver scenario has produced even longer canister durations (currently classified) for SDV operations.

SEAL Delivery Vehicle and Dry Deck Shelter Operations

Operations involving SEAL Delivery Vehicles (SDVs) and Dry Deck Shelters (DDSs) provide a number of unique challenges for NSW physicians and diving medical technicians. Special decompression techniques are required for these operations.[14] Many SDV operations require use of both air and nitrox mixtures on the same dive. Calculation of decompression for these profiles may be done in several ways:

- The Combat Swimmer Multi-Level Dive (CSMD) procedures were developed by Thalmann and Butler[15] at the Navy Experimental Diving Unit (NEDU) in Panama City, Florida, in 1983 and have been used by the SDV teams since then. These procedures allow more precise calculation of the decompression obligation for long, multilevel dives by dividing the dive into transit periods (≤ 30 ft) and downward excursions (> 30 ft). These procedures are based on the 1957 Navy air tables and assume that the diver is breathing air at shallow depths; for depths greater than 70 feet of seawater (fsw) on the Mk 16, the equivalent air depth is calculated and used. This procedure does not allow the diver to receive decompression credit for the higher PO_2 of the Mk 16 during decompression stops but still results in substantial decompression savings, because the diver is not required to decompress as though the entire bottom time were spent at the deepest depth attained on the dive.
- The Naval Special Warfare Dive Planner was developed at the Naval Medical Research Institute (NMRI), Bethesda, Maryland, in 1993. This program uses a laptop computer version of the NMRI maximum likelihood nitrox decompression algorithm that has been approved by the Naval Sea Systems Command (NAVSEA) for use in SDV operations. The divers follow the CSMD procedures until they return to the launching submarine. At that point, they provide the DMO and Diving Supervisor with their dive profile. The profile is entered into the Dive Planner program and a customized decompression schedule calculated. The two primary benefits of the Dive Planner are that (1) it is able to give the diver credit for the long periods spent breathing from the Mk 16 at shallow depths and (2) it is able to provide decompression schedules for either air, Mk 16, or oxygen decompression. Version 6.0 of the Dive Planner software, which was approved by NAVSEA in June 1996, allows the DMO to track the decompression obligation for several dives simultaneously. The Dive Planner is the preferred method for calculating the decompression obligation for repetitive or long bottom-time dives because of its increased conservatism on this type of dive profile.

The DDS is a unique diving system with the potential for presenting medical personnel who support DDS operations with novel and complicated casualty situations (Figure 37-12). Some general guidelines concerning medical support of DDS operations and management have been issued for use by NSW DMOs.[16] The DMO should remain at the submarine control throughout DDS launch and recovery operations. In general, management of a medical emergency in the DDS consists of four phases:

1. Immediate movement of the casualty to the bubble.
2. Equalization of the transfer trunk to the hangar depth and transfer of the casualty to the transfer trunk.
3. The transfer trunk is drained to the appropriate level and the casualty is then moved to either the chamber or the submarine as indicated by his condition.
4. Definitive medical treatment is implemented.

Specific examples of the types of emergencies that may be encountered in the DDS environment and suggested management plans for each are found in the *Dry Deck Shelter Medical Emergency Procedures*.[16]

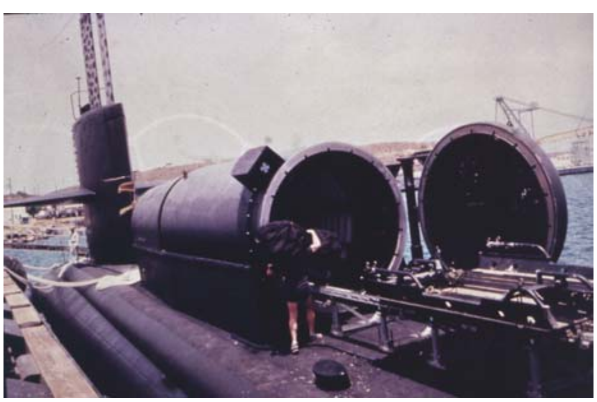
Medical Sustainment Training

SOF corpsmen, medics, and physicians require ongoing training in a wide variety of subjects. This training may be accomplished through lectures, practical skills refresher training, hospital or ambulance rotations, correspondence courses, or the Special Operations Interactive Medical Training Program discussed below in this chapter. As part of the EMT-P recertification process, all EMT-P–qualified individuals in SOF must attend the SOF Medical Sustainment course that is taught at Fort Bragg every 2 years.

Ensuring the Quality and Scope of Healthcare

Changes in the American healthcare delivery system are also impacting on the practice of medicine in SOF. One of the most significant changes in the last decade for healthcare professionals has been the imposition of more-stringent credentialing procedures. The goal of the credentialing process is to ensure that each individual healthcare provider has been properly trained to deliver the types of healthcare services that he or she wishes to provide. Not unlike military hospitals, SOF units must ensure that credentialing of physicians is accomplished in accordance with each component's medical department instructions. USASOC and AFSOC currently have their physicians credentialed at the

a



b

Fig. 37-12. (**a**) A Dry Deck Shelter (DDS) is being installed onto a host submarine. (**b**) US Navy SEAL (*se*a, *a*ir, *l*and) divers launch a SEAL delivery vehicle (SDV) from the DDS. Photographs: Courtesy of US Special Operations Command, MacDill Air Force Base, Tampa, Fla.

nearest hospital. NAVSPECWARCOM credentials its physicians through its own process, with the commander being the credentialing authority and the force medical officer administering the program.

Establishing the scope of care for nonphysician providers is more complex because of the various types of nonphysician medical training and interservice differences. Guidance for these issues is found in the Navy OPNAV and BUMED 6400.1 series of instructions and in USASOC Regulation 350-9.

Quality assurance is another process designed to ensure that the quality of healthcare delivered by SOF medical providers meets high standards. This process typically consists of reviewing a number of charts for each provider every month to check for appropriateness and proper documentation of care. Quality assurance procedures are also enumerated by the respective components in service-specific directives. Patterns of deficiencies identified in these reviews call for focused refresher training in the areas indicated.

IN-THEATER MEDICAL SUPPORT

Predeployment Preparation

Preparation for a combat deployment requires that SOF medical officers and senior enlisted personnel ensure that their deploying forces have adequately addressed area-specific medical intelligence, immunizations, medical equipment, the threat assessment for weapons of mass destruction, and predeployment training for medical personnel.

Area-Specific Medical Intelligence

The US Army Research Institute for Environmental Medicine (USARIEM), Natick, Massachusetts, publishes medical information summaries for areas of the world that are identified as potential locations for armed conflicts that may involve US forces. The medical officer should contact USARIEM (DSN: 256-4811; commercial telephone: 508-233-4509) to see if such a publication is available for the area to which the unit will be deploying.

Another source of medical intelligence about a specific region is the Armed Forces Medical Intelligence Center (AFMIC), Fort Detrick, Maryland, whose information about worldwide medical conditions and facilities is especially detailed and current. Much of this information is classified and not available in USARIEM publications. AFMIC can be contacted at DSN: 343-7603.

Immunizations

SOF units typically have an ongoing program of vaccinations and immunizations for their personnel. Once a specific area is identified as a deployment location, the immunization status of the personnel scheduled for deployment should be reviewed immediately. Potential sources of information about required immunizations are the service-specific preventive medicine units; the Centers for Disease Control and Prevention, Atlanta, Georgia; the office of the theater CINC surgeon; AFMIC; and service-specific directives.

Medical Equipment

Another important aspect of predeployment planning is to review the service-specific list of medical equipment that the physicians, corpsmen, and medics should have available to them. Because logistics are often initially problematic in-theater, it is important to ensure that the deploying forces have sufficient medical supplies to last for at least the number of days specified in the theater or the CINC operation plan. Medical equipment and supplies should include both combat casualty care equipment and supplies needed to care for the significant numbers of disease and nonbattle injuries (DNBI) that are encountered by deployed troops. These conditions include musculoskeletal injuries, as troops strive to maintain their physical readiness in-theater; acute gastroenteritis, as the troops make the acquaintance of the local enteric pathogens; the ubiquitous upper respiratory infections; and other infectious diseases specific to the area.

An adequate supply of medications to treat these and the other expected sick call maladies should be deployed with the SOF units to ensure that their medical readiness does not suffer as the transition to theater operations is effected. Every medication to be sent in-theater should be reviewed to ensure that the expiration date on medications or sterility has not passed. Medical reference sources that will be needed by the deployed medical personnel should be obtained and packed. Weight-efficient CD-ROM–based reference materials should be used if possible. The microprocessors used to support the CD-ROM–based medical references can also be used to support the medical tracking systems described below in this chapter.

Nuclear–Biological–Chemical Warfare Threat Assessment

The threat assessment data from AFMIC with respect to the theater nuclear–biological–chemical (NBC) warfare threat should be reviewed. Many SOF units do not routinely train in the use of NBC protective clothing, monitoring techniques, and decontamination procedures. If a significant threat is anticipated from these agents in the impending conflict, then procurement of the appropriate protective clothing and monitoring devices should be coordinated by the medical department prior to deployment and training conducted in their use.

Predeployment Medical Training

The final aspect of predeployment preparation is to conduct focused training for the medical personnel who will be going in-theater. Training should consist primarily of a review of the factual information and technical skills necessary to care for SOF operators injured in combat as well as training in the disease entities particular to the mission area.

In-Theater Procedures and Facilities

Ideally, each SOF component service should have at least one medical officer assigned to the task element commander. In addition, a senior SOF medical officer should be assigned to the Joint Special Operations Task Force (JSOTF) staff. Combat Casualty Transport Teams should be identified, and, if not organic to the SOF units deployed, then assigned as augmentation medical forces.[17]

Once the SOF contingent has left the United States and arrives in-theater, mobility, communications, and other aspects of unit operations will initially be somewhat disorganized. The approach outlined below provides a sequence of measures that the medical officer or senior enlisted medical person can undertake to set up a smoothly functioning medical department. The likelihood of being able to accomplish all the steps outlined below just as they are described is probably small, but the paragraphs below will at least offer some thoughts as to the items that need to be addressed.

Senior Theater Medical Officer

The Senior Theater Medical Officer may be the CINC Surgeon or the Joint Task Force Surgeon. The senior SOF medical officer assigned to the staff of the JSOTF commander should contact and preferably meet with this individual to ensure that SOF medical planning is consistent with the theater CINC operation plan. Issues that need to be addressed include casualty evacuation procedures for both combat injuries and DNBI, medical resupply, and appropriate theater preventive medicine measures. A coordination visit to the SOF compound by the Senior Theater Medical Officer may be helpful in demonstrating some of the unique aspects of planning battlefield casualty evacuation for SOF units.

Combat Casualty Evacuation Procedures

An appropriate plan to evacuate SOF casualties that occur in combat must be developed. Evacuation of SOF casualties from the battlefield (CASEVAC; the term "CASEVAC" should be used to describe the evacuation of casualties instead of the commonly used "MEDEVAC," because the Air Force uses MEDEVAC to describe noncombat medical transport) will most often be accomplished by AFSOC tactical rotary-wing air assets, but—depending on the operations to be conducted—may be accomplished with maritime craft, desert assault vehicles, or mobility assets provided by conventional forces. Determination of the assets that are to be used must be coordinated with the staff of the JSOTF commander. The potential CASEVAC assets should be visited and consideration of a number of issues considered: What is the best Combat Casualty Transport Team for that asset? What medical treatment and equipment are appropriate to each potential asset? How will casualties be loaded into the asset and best arranged for treatment? These issues should addressed promptly after the SOF contingent arrives in-theater.

Other details must be reviewed in particular for each mission: How will the SOF unit contact the CASEVAC asset, with primary and with back-up communications? In what general area will the force be operating? Geographical location is an important factor in deciding which MTF casualties should be evacuated to. How many personnel will be going on the mission? The JSOTF medical officer and the Combat Casualty Transport Teams need to know at least some of the details of any mission that takes place in-theater for which the possibility of casualty evacuation exists. Rehearsal of representative CASEVACs is invaluable in refining both operating techniques with the CASEVAC assets and coordination with the receiving MTF.

Medical Treatment Facility Coordination

As part of the development of casualty evacuation procedures, the senior SOF medical officer should visit the theater MTFs that may receive SOF casualties. Items to be reviewed at the MTF include casualty evacuation procedures, communications, and medical and surgical services offered. Probably the most important aspect of the visit is to identify several individuals to serve as points of contact if the SOF unit has casualties to send there, and to ensure that a reliable means of contacting these individuals is available. Cellular phones, very high-frequency radio, or satellite pagers may all be possibilities.

Sick Call Facilities

Another high-priority item in-theater is the establishment of a medical treatment capability in the SOF compound. Medical equipment and supplies should be secured in an environment that will prevent damage from rain, heat, or cold and will prevent unauthorized use. Treatment tables should be obtained or improvised and the best possible lighting, climate control, and cleanliness arrangements should be made. Unit sick call hours and procedures should be announced and maintained.

Hyperbaric Treatment Facility

If the SOF unit has a diving mission, coordination must be established with the nearest hyperbaric chamber in much the same manner as that described for the MTF. This may be difficult in many remote areas. Navy diving commands such as the Navy Experimental Diving Unit (DSN: 436-4351; commercial telephone: 850-234-4351) may be helpful in locating the nearest chamber. Civilian diving organizations such as the Diver's Alert Network, Durham, North Carolina (commercial telephone: 919-684-8111), or The Undersea and Hyperbaric Medical Society, Kensington, Maryland (commercial telephone: 301-942-2980), may also be able to provide assistance. If there is no in-theater chamber that can be reached reliably by casualty evacuation assets, and if diving operations are anticipated during the conflict, then coordination with the JSOTF staff should be made to have a transportable recompression chamber (TRC) deployed to the theater.

Wartime Diving Medicine

Diving procedures for the Navy and other US armed services are established by the Supervisor of Diving and Salvage at the Naval Sea Systems Command, usually based on the testing and recommendations of the NEDU. These procedures are described in the *US Navy Diving Manual*,[18] with interim changes transmitted by letter or message. Areas that impact directly on NSW diving operations are the oxygen-exposure limits, closed-circuit scuba canister operating limits, and decompression procedures.

During peacetime diving operations these guidelines are followed meticulously. In the setting of armed conflicts, however, operational exigencies may require that SOF combat swimmers go beyond the standards of accepted peacetime military diving practice. Special Warfare DMOs may be called on to advise operational commanders about the magnitude of hazard entailed in their swimmers' exceeding peacetime guidelines.

Take, for example, a proposed mission that requires a closed-circuit oxygen dive deeper or longer than allowed by the current US Navy limits.[18] What is the risk of a diver's having a convulsion if a more-severe oxygen exposure is attempted? How can the risk of oxygen toxicity be reduced for these divers? The DMO can use the information found in previous oxygen toxicity and Draeger LAR V purging studies[19–29] to provide risk estimations to his line commanders. Another potential source of questions in wartime NSW combat swimmer operations relates to operating times of the carbon dioxide canister. Both the Mk 16 and the Draeger LAR V UBAs have carbon dioxide absorbent canister operating limits that have been established through careful testing at EDU. These limits are not exceeded during peacetime NSW diving missions. On a combat operation, however, if an unexpected problem causes a delay during the mission, would the diver be more at risk from continuing to breathe from the UBA after reaching the end of the canister operating limit, or from surfacing in a hostile harbor? Information on closed-circuit UBA canister durations is found in a number of EDU reports[30–40] and may be of great use to the DMO in answering questions of this nature.

All of the references mentioned in this section are available to the in-theater DMO on the Special Operations Computer-Assisted Medical Reference System, which is described below. This CD-ROM–based information source is an important item for medical officers in-theater and a microprocessor with a CD-ROM capability should be standard equipment for medical officers supporting SOF operations in a conflict.

Additional Medical Support Measures

Medical Logistics. A medical resupply system must be established quickly after arriving in-theater. Resupply procedures should be spelled out in the theater operation plan, but reliable resupply of all necessary items of medical equipment may require coordination with the SOF parent units or other sources of support.

Preventive Medicine. Preventive medicine measures are an important aspect of in-theater medical support. Sanitation and hygiene inspections should be conducted to ensure that the deployed forces have the safest living and messing spaces possible. The medical department will need to help administer programs such as the successful planned rehydration efforts designed to help prevent heat injuries in the Persian Gulf War (1990/91). Medical officers should be aggressive in making recommendations to line commanders regarding such issues as thermal stress and sleep hygiene, since both of these areas may have a direct impact on operational success.

Medical Surveillance. A microprocessor-based system for tracking SOF DNBI as well as combat casualties should be established and maintained. DNBI often account for the loss of more combat troops than do combat casualties, and collection of epidemiological data might help to reduce these losses.

Continued Medical Training. Continued training in combat casualty care should be conducted in-theater. Additional training topics should include preventive medicine and the disease entities specific to the operating area.

TACTICAL COMBAT CASUALTY CARE IN SPECIAL OPERATIONS

The issue of tactical combat casualty care in the SOF environment has been addressed in a recent paper.[17] Trauma care training for SOF physicians, corpsmen and medics has historically been based primarily on the principles taught in the ATLS course.[41] ATLS provides a standardized approach to the management of trauma and has proven very successful when used in the setting of a hospital emergency department. The value of at least some aspects of ATLS in the prehospital setting, however, has been questioned.[42–64]

The importance of the prehospital phase in caring for combat casualties is evident from the fact that approximately 90% of combat deaths occur on the battlefield before the casualty reaches an MTF.[65] The standard ATLS course makes no mention of the exigencies of combat care, and the perceived shortcomings of ATLS in the combat environment have been addressed by military medical authors.[61,66–70] The need to make significant modifications to the principles of care taught in ATLS is obvious when considering the complicating effect of factors that occur in special operations, such as darkness, enemy fire, medical equipment limitations, longer evacuation times, and the unique problems entailed in transporting SOF combat casualties.[17]

These observations do not imply any shortcomings in the ATLS course. The ATLS course is well accepted as the standard of care once the patient reaches the emergency department of an MTF. Problems arise only as the military attempts to extrapolate the ATLS principles of care from the emergency department into the battlefield setting. This is an environment for which ATLS was clearly not designed and that needs to have its own standards of care. This section is designed to help address that need.

Stages of Care

It is useful to consider the management of casualties that occur during Direct Action SOF missions as being divided into three distinct phases[17]:

1. Care under fire: the care rendered by the medic or corpsman at the scene of the injury, while he and the casualty are still under effective hostile fire. Available medical equipment is limited to that carried by each operator on the mission or by the corpsman or medic in his medical pack.
2. Tactical field care: the care rendered by the medic or corpsman once he and the casualty are no longer under effective hostile fire. The term also applies to situations in which an injury has occurred on a mission but no hostile fire has occurred. Available medical equipment is limited to that carried into the field by mission personnel. The time prior to evacuation to an MTF may range from a few minutes to many hours.
3. Combat casualty evacuation (CASEVAC) care: care rendered once the casualty (and usually the rest of the mission personnel) have been picked up by an aircraft, vehicle, or boat. Additional personnel and medical equipment that have been prestaged in these rescue assets should be available at this stage of casualty management.

Basic Tactical Combat Casualty Care Plan

Having identified the three phases of casualty management in the SOF tactical setting, the next step is to outline in a general way the care appropriate to each phase. A basic tactical casualty management plan, consisting of a generic sequence of steps that will often require modification for specific SOF casualty scenarios, is important as a starting point from which development of individualized scenario-based management plans can begin. A detailed rationale for the steps outlined in the basic management plan for each of these stages of care has been presented.[17] A few of the major differences between this management plan and ATLS will be reviewed here.

Care Under Fire

A minimal amount of medical care should be attempted while the casualty and corpsman or medic are actually under effective hostile fire (Exhibit 37-1). The use of a tourniquet to manage life-threatening extremity hemorrhage is encouraged, however, because hemorrhage from extremity wounds is the leading cause of preventable death on the battlefield and was the cause of death in more than 2,500 casualties in the Vietnam War who had no other injuries.[71]

There is no requirement to immobilize the cervical spine prior to moving a casualty out of a firefight if he has a penetrating neck or head wound. Arishita, Vayer, and Bellamy[42] examined the value of cervical spine immobilization in penetrating neck injuries in Vietnam and found that in only 1.4% of patients with penetrating neck injuries would immobilization of the cervical spine have been of possible benefit. The risk of additional hostile fire injuries to both casualty and rescuer while immobilization is being attempted poses a much more significant threat than damage to the spinal cord from failure to immobilize the neck.[42]

EXHIBIT 37-1

BASIC SPECIAL OPERATIONS FORCES TACTICAL CASUALTY MANAGEMENT PLAN

Phase 1: Care Under Fire

1. The casualty remains engaged as a combatant if possible
2. Return fire as directed or required
3. Try to keep from getting shot
4. Try to keep the casualty from sustaining additional wounds
5. Stop any life-threatening external hemorrhage with a tourniquet
6. Take the casualty with you when you leave

Tactical Field Care and Combat Casualty Evacuation Care

If a casualty with traumatic wounds is found to be in cardiopulmonary arrest on the battlefield as a result of blast or penetrating trauma, attempts at resuscitation are not appropriate.[17] Prehospital resuscitation of trauma victims in cardiac arrest has been found to be futile even in the urban setting where the victim is in close proximity to trauma centers. One study[72] reported no survivors among 138 trauma victims who suffered a prehospital cardiac arrest in whom resuscitation was attempted. Only in nontraumatic disorders (eg, hypothermia, near-drowning, electrocution) should cardiopulmonary resuscitation be performed.

The airways of unconscious casualties should be opened with the chin-lift or jaw thrust maneuvers (Exhibits 37-2 and 37-3). In these patients, if spontaneous respirations are present and respiratory distress is absent, a nasopharyngeal airway is the airway of choice. The two main advantages of this device are that it is better tolerated than an oropharyngeal airway should the patient regain consciousness and that it is less likely to be dislodged during transport.[17]

Should an airway obstruction develop or persist despite the use of a nasopharyngeal airway, a more-definitive airway is required. The ability of experienced paramedical personnel to master the technique of endotracheal intubation has been well documented.[44,45,73–82] This technique may be more difficult to accomplish in the SOF tactical care setting, however,[17] and cricothyroidotomy is probably a better next step for most SOF combat medics and corpsmen. This procedure has been reported to be safe and effective in trauma victims.[83] It may well be the only feasible alternative for any potential intubationist when the casualty has sustained maxillofacial wounds in which blood or disrupted anatomy precludes visualization of the vocal cords.[61,83] This procedure is not without complica-

EXHIBIT 37-2

BASIC SPECIAL OPERATIONS FORCES TACTICAL COMBAT CASUALTY CARE PLAN

Phase 2: Tactical Field Care

1. Airway management
   - Chin-lift or jaw-thrust
   - For an unconscious casualty without airway obstruction: nasopharyngeal airway
   - For an unconscious casualty with airway obstruction: cricothyroidotomy
   - Cervical spine immobilization is not necessary for casualties with penetrating head or neck trauma
2. Breathing: consider tension pneumothorax and decompress with needle thoracostomy if a casualty has unilateral penetrating chest trauma and progressive respiratory distress
3. Circulation (Bleeding): consider removing tourniquet and controlling bleeding with direct pressure, if feasible
4. Establish intravenous (IV) access: start an 18-gauge IV line or saline lock
5. Initiate fluid resuscitation:
   - For controlled hemorrhage without shock: no fluids necessary
   - For controlled hemorrhage with shock: administer 1 L Hespan (6% hydroxyethylstarch, manufactured by Du Pont Pharmaceuticals, Wilmington, Del)
   - For uncontrolled (intraabdominal or thoracic) hemorrhage: no IV fluid resuscitation unless the casualty exhibits a decreased state of consciousness. In this instance, administer 500 mL Hespan initially. A second 500 mL may be given if needed, but 1 L should generally be the maximum volume infused.
6. Inspect and dress wound
7. Check for additional wounds
8. Administer analgesia as necessary: morphine: 5 mg (administered IV); wait 10 min; repeat as necessary
9. Splint fractures and recheck pulse
10. Initiate antibiotic therapy: cefoxitin: 2 g (slow IV push, over 3–5 min) for penetrating abdominal trauma, massive soft-tissue damage, open fractures, grossly contaminated wounds, or long delays before casualty evacuation.
11. Cardiopulmonary resuscitation should not be attempted in the Tactical Field Care phase on casualties who are in cardiac arrest as a result of penetrating or blunt trauma sustained in combat.

tions,[84,85] but SOF corpsmen and medics are all trained in this technique, and a prepackaged SOF cricothyroidotomy kit that contains the equipment for an over-the-wire technique has been developed at Walter Reed Army Institute of Research, Washington, DC, and approved by the FDA.

A presumptive diagnosis of tension pneumothorax should be made when progressive, severe respiratory distress develops in the setting of unilateral penetrating chest trauma. The diagnosis of tension pneumothorax on the battlefield should not rely on such clinical signs as breath sounds, tracheal shift, and hyperresonance to percussion because these signs may not always be present[86]; even if they are, they may be exceedingly difficult to appreciate on the battlefield. A casualty with penetrating chest trauma will generally have some degree of hemothorax or pneumothorax as a result of his primary wound, and the additional trauma caused by a needle thoracostomy would not be expected to significantly worsen his condition should he not actually have a tension pneumothorax.[82] All SOF corpsmen and medics are trained in this technique and should perform it without hesitation in this setting.

Paramedics are authorized to perform needle thoracostomy in some civilian emergency medical

EXHIBIT 37-3

BASIC SPECIAL OPERATIONS FORCES TACTICAL COMBAT CASUALTY CARE PLAN

Phase 3: Combat Casualty Evacuation (CASEVAC) Care

1. Airway management
   - Chin-lift or jaw-thrust
   - For an unconscious casualty without airway obstruction: nasopharyngeal airway, endotracheal intubation, Combitube (mfg by Sheridan Catheter Corp, Argyle, NY) or laryngeal mask airway
   - For an unconscious casualty with airway obstruction: cricothyroidotomy if endotracheal intubation or other airway devices are unsuccessful
2. Breathing
   - Consider tension pneumothorax and decompress with needle thoracostomy if the casualty has unilateral penetrating chest trauma and progressive respiratory distress
   - Consider chest tube insertion if a suspected tension pneumothorax is not relieved by needle thoracostomy
   - Administer oxygen, if available
3. Circulation (Bleeding): consider removing tourniquets and using direct pressure to control bleeding if possible
4. Establish intravenous (IV) access; start an 18-gauge IV line or saline lock if not already done
5. Initiate fluid resuscitation:
   - For casualty with no hemorrhage or controlled hemorrhage without shock, administer lactated Ringer's solution IV at 250 mL/h
   - For casualty with controlled hemorrhage with shock, initially administer 1 L (IV) Hespan (6% hydroxyethylstarch, mfg by Du Pont Pharmaceuticals, Wilmington, Del)
   - For casualty with uncontrolled (intraabdominal or thoracic) hemorrhage: no IV fluid resuscitation unless the casualty exhibits a decreased state of consciousness. In this instance, administer 500 mL Hespan initially. A second 500 mL may be given if needed, but 1 L should generally be the maximum volume infused.
   - For casualty with head wound: administer Hespan IV at minimal flow to maintain infusion unless hemorrhagic shock is concurrent
6. Monitoring: institute electronic monitoring of heart rate, blood pressure, and hemoglobin oxygen saturation
7. Inspect and dress wounds if not already done
8. Check for additional wounds
9. Administer analgesia as necessary: morphine: 5 mg IV; wait 10 minutes; repeat as necessary
10. Splint fractures and recheck pulse
11. Initiate antibiotic therapy, if not already given: cefoxitin: 2 g (slow IV push, over 3–5 min) for penetrating abdominal trauma, massive soft-tissue damage, open fractures, grossly contaminated wounds, or long delays before casualty evacuation

services,[77,82] but chest tubes are not recommended in this phase of care.[17] Tube thoracostomy is generally not part of the paramedic's scope of care in civilian EMS settings,[77,82] nor were any studies found that address the use of this procedure by corpsmen and medics on the battlefield.

Although standard trauma care involves starting two large-bore (14- or 16-gauge) intravenous catheters,[41] the use of an 18-gauge catheter is preferred in the field because of the increased ease of starting.[17] The larger catheters are needed to rapidly administer large volumes of blood products, but this is not a factor in the tactical setting because blood products will not be available. Crystalloid solutions can be administered rapidly through the 18-gauge catheters.[87,88] Although larger-bore catheters may need to be started on arrival at an MTF, prehospital intravenous infusions are often discontinued on arrival because of concern about battlefield contamination of the intravenous site.[89]

Despite its frequent use, the benefit of prehospital fluid resuscitation in trauma victims has not been established.[45–47,49–51,53,55,58,60,61,64,90] The beneficial effect from crystalloid and colloid fluid resuscitation in hemorrhagic shock has been demonstrated largely on animal models where the volume of hemorrhage is controlled experimentally and resuscitation is initiated after the hemorrhage has been stopped.[60,62] In uncontrolled hemorrhagic shock models, the animal data are clear that when there is an unrepaired vascular injury, aggressive fluid resuscitation is associated with either no improvement in survival or increased mortality.[48,49,55,56–60,62–64,91–96] This lack of benefit is presumably due to interference with vasoconstriction and hemostasis while the body attempts to adjust to the loss of blood volume and develop a thrombus at the bleeding site. Several studies noted that only after previously uncontrolled hemorrhage was stopped did fluid resuscitation prove to be of benefit.[95–97]

Three studies have addressed this issue in humans. First, a large study of 6,855 trauma patients found that although hypotension was associated with a significantly higher mortality rate, the administration of prehospital intravenous fluids did not influence this rate.[53] Second, a retrospective analysis of patients with ruptured abdominal aortic aneurysms showed a survival rate of 30% for patients who were treated with aggressive preoperative colloid fluid replacement; in contrast, there was a 77% survival rate for patients in whom fluid resuscitation was withheld until the time of operative repair.[98] Crawford, the author of that study, strongly recommended that fluid resuscitation be withheld until the time of surgery in these patients. And third, a large prospective trial examining this issue in 598 victims of penetrating torso trauma was recently published by Bickell and colleagues.[43,52] They found that aggressive prehospital fluid resuscitation of patients with penetrating wounds of the chest and abdomen was associated with a poorer outcome than that seen in patients for whom aggressive volume replacement was withheld until the time of surgical repair. Although confirmation of these findings in other randomized, prospective studies has not yet been obtained, no human studies were found that demonstrated any benefit from fluid replacement in patients with ongoing hemorrhage, and battlefield casualties with penetrating abdominal or thoracic trauma must be presumed to have ongoing hemorrhage prior to surgical repair of their injuries.

If fluid resuscitation is required for controlled hemorrhagic shock in the tactical field care phase, Hespan (6% hydroxyethylstarch, mfg by Du Pont Pharmaceuticals, Wilmington, Del) is recommended as an alternative to lactated Ringer's (LR) solution.[17] LR solution is a crystalloid, which means that its primary osmotically active particle is sodium. Since the distribution of sodium is the entire extracellular fluid compartment, LR solution moves rapidly from the intravascular space to the extravascular space. This fluid shift has significant implications for fluid resuscitation. One hour after 1 L of LR solution has been infused into a trauma patient, only 200 mL of that volume remains in the intravascular space to replace lost blood volume.[17] This is not a problem in the civilian setting, as the typical time for transport of the patient to the hospital in an ambulance is less than 15 minutes,[52,53] and once the patient has arrived at the hospital, infusion of blood products and surgical repair can be initiated rapidly. In the military setting, however, where several hours or more typically elapse before a casualty arrives at an MTF, effective volume resuscitation may be difficult to achieve with LR solution.

In contrast, the large hetastarch molecule in Hespan is retained in the intravascular space and no fluid is lost to the interstitium. Hespan actually draws fluid into the vascular space from the interstitium, such that an infusion of 500 mL of Hespan results in an intravascular volume expansion of almost 800 mL,[99] and this effect is sustained for 8 hours or longer.[100] In addition to providing more effective expansion of the intravascular volume, a significant reduction in the weight of medical equipment is achieved by carrying Hespan instead of LR solution into the field: 4 L of LR weighs almost 9 lb, while the 500 mL of Hespan needed to achieve a similar sustained intravascular volume expansion weighs just over 1 lb.[17] Although concerns have been voiced about coagulopathies and changes in immune function associated with the use of Hespan,[63,101–104] these effects are not seen with infusion of 1,500 mL or less.[103–105] Several studies have found Hespan to be a safe and effective alternative to LR solution for resuscitating patients with controlled hemorrhagic shock.[106,107] Hespan is also believed to be an acceptable alternative to LR solution for intraoperative fluid replacement.[108]

If the casualty is conscious and requires analgesia, it should be achieved with morphine, preferably administered intravenously.[17] This mode of administration allows for much more rapid onset of analgesia and for more effective titration of dosage than intramuscular administration. An initial dose of 5 mg is given and repeated at 10-minute intervals until adequate analgesia is achieved.

Infection is an important late cause of morbidity and mortality in wounds sustained on the battlefield. Cefoxitin (2 g, administered intravenously) is an accepted monotherapeutic agent for empirical treatment of abdominal sepsis[109] and should be given without delay to all casualties with penetrating abdominal trauma.[61,110,111] Cefoxitin is effective against Gram-positive aerobes (except some *Enterococcus* spp) and Gram-negative aerobes (except some *Pseudomonas* spp). It also has good activity against anaerobes (including *Bacteroides* and *Clostridium* spp). Because it is effective against the clostridial species that cause myonecrosis, cefoxitin is also recommended for casualties who sustain wounds with massive soft-tissue damage,[111] grossly contaminated wounds, open fractures, or those for whom a long delay until CASEVAC is anticipated.[112]

Scenario-Specific Tactical Combat Casualty Care Plans

The basic management plan described above provides a starting point from which to discuss the management of specific casualties, but, as mentioned above, a great many additional considerations may come into play. This section describes one approach to planning for casualties on such missions.

Combat Operations

A number of approaches or infiltration techniques may be part of SOF combat missions (Exhibit 37-4). A casualty with a specific hostile fire injury is then imposed into one of the elements in the mission scenario (Exhibit 37-5). Hostile fire is not the only possible source of injuries to SOF personnel on missions, however, so combat injuries that occur in a hostile environment but are not caused by enemy action must also be considered (Exhibit 37-6). If the mission is sustained for several days, the onset of acute medical conditions (eg, diarrhea, cough, allergic rhinitis, sneezing, vomiting) as well as sprains, fractures, and environmental injuries such as heatstroke are also possible. A mild cold with frequent sneezing or coughing or a severely sprained ankle may be minor annoyances in the usual course of events, but can lead to mission compromise and the loss of an entire patrol if the problem occurs, for example, on the second day of a 5-day sustained mission and is not effectively treated.

EXHIBIT 37-4

ELEMENTS OF SPECIAL OPERATIONS FORCES COMBAT OPERATIONS

1. Closed-circuit self-contained underwater breathing apparatus (scuba) diving
2. Dry Deck Shelter (DDS) launch and recovery
3. Helicopter cast (ie, jumping from a moving, airborne helicopter into the water) and recovery
4. High-speed boat transits
5. Surface swimming
6. Parachute insertions
7. Fast rope or helicopter rappel insertions
8. SEAL Delivery Vehicle (SDV) transits
9. Small-unit land warfare
10. Small boat transits
11. Submarine lock-outs and lock-ins
12. Winter warfare patrols
13. Helicopter transits
14. Fixed-wing aircraft transits

Another variable that must be considered is the number of casualties. A management plan may work very well for a casualty scenario that entails only one casualty but not at all for a scenario in which 6 members of a 12-man patrol are casualties. Yet another major variable is the outcome of the engagement in which the casualty is sustained (Exhibit 37-7). If hostile fire is incompletely suppressed or if the SOF unit is overpowered, managing the unit's casualties may be difficult or impossible. Other casualty variables must also be anticipated (Exhibit 37-8). A variety of casualty scenarios can be developed for SOF combat missions by using different combinations of the variables found in Exhibits 37-4 through 37-8. Several representative SOF casualty scenarios are presented in Exhibit 37-9.

Foreign Internal Defense and Civic Action

Medical support of foreign internal defense and civic action missions poses a different set of challenges than combat missions.[113] SOF medical personnel may have to function in areas devoid of sophisticated diagnostic equipment, specialty con-

EXHIBIT 37-5

REPRESENTATIVE WOUNDS THAT CAN OCCUR UNDER HOSTILE FIRE

1. Penetrating head trauma
2. Maxillofacial trauma with potential airway compromise
3. Penetrating chest trauma
4. Penetrating chest trauma with hemothorax and shock
5. Penetrating chest trauma with tension pneumothorax
6. Penetrating abdominal trauma without shock
7. Penetrating abdominal trauma with shock
8. Penetrating upper extremity trauma with hemorrhage
9. Penetrating lower extremity trauma with hemorrhage
10. Traumatic amputation
11. Penetrating neck trauma with massive external hemorrhage
12. Penetrating neck trauma without external hemorrhage
13. Burns
14. Blast trauma
15. Multiple shrapnel trauma

EXHIBIT 37-6

REPRESENTATIVE NON–HOSTILE FIRE COMBAT INJURIES*

1. Minor but debilitating extremity orthopedic trauma (severe ankle sprain or shoulder dislocation)
2. Major extremity orthopedic trauma (open fracture or fracture-dislocation)
3. Snakebite
4. Fall from a significant distance with unconsciousness
5. Fall from a significant distance with neck or back pain
6. Hypothermia
7. Hypoxia
8. Oxygen toxicity
9. Near-drowning
10. Severe jellyfish envenomation
11. Severe insect envenomation
12. Shark attack
13. Decompression sickness

*Injuries occurring in a hostile environment but not due to enemy action

EXHIBIT 37-7

REPRESENTATIVE OUTCOMES OF SPECIAL OPERATIONS ENGAGEMENTS

1. Hostiles (ie, enemy combatants) are all dead or withdrawn from the engagement
2. Standoff, with both sides firing from cover
3. Hostile force has fire superiority but organized withdrawal is possible; noncasualties outnumber casualties
4. Hostile force has fire superiority; no chance for organized withdrawal because of volume of fire or number of casualties
5. Friendly forces are defeated and overrun

EXHIBIT 37-8

OTHER CASUALTY VARIABLES

1. When in the mission was the casualty wounded?
2. What will be lost if the mission is aborted?
3. What is the extraction plan?
4. Can casualty evacuation (CASEVAC) occur at the casualty's location?
5. Is the casualty a corpsman or medic?
6. What is the weight of the casualty?
7. What is the risk to other operators or support personnel?
8. How critical is time-to-CASEVAC to the casualty's survival?
9. Is the mission a day or night operation?

EXHIBIT 37-9

REPRESENTATIVE SPECIAL OPERATIONS CASUALTY SCENARIOS

Underwater Explosion Scenario

- Ship attack
- Launch from coastal patrol craft 12 miles out
- One-hour transit in two Zodiacs (ie, inflatable boats)
- Seven swim pairs using Draeger LAR V closed-circuit oxygen underwater breathing apparatus (UBA)
- Zodiacs get to 1 mile from the harbor
- Water temperature 78°F; divers in wet suits
- Surface swim for half mile, then purge UBA and submerge
- Underwater explosion occurs while divers are under target ship
- One diver unconscious; other member of swim pair conscious

Oxygen Toxicity Scenario

- Ship attack
- Launch from coastal patrol craft 12 miles out
- One-hour transit in two Zodiacs
- Seven swim pairs using Draeger LAR V
- Zodiacs get to 1 mile from the harbor
- Water temperature 78°F; divers in wet suits
- Surface swim for half mile, then purge UBA and submerge
- Very clear, still night; transit depth 25 ft
- Diver notes that buddy is disoriented and confused with arm twitching

SEAL Delivery Vehicle Scenario

- Two SEAL Delivery Vehicles (SDVs) launched from Dry Deck Shelter (DDS)
- Two-hour transit to beach
- Target is a heavily defended harbor in a bay
- Water temperature 43°F; divers in dry suits
- Air temperature 35°F
- Boats bottomed (ie, grounded) for across-the-beach radio beacon placement
- Swim to shore using Draeger LAR V
- One man shot in the chest at the objective
- Hostile forces in pursuit as team begins to extract

Parachute Insertion Injury Scenario

- Twelve-man Special Forces team
- Interdiction operation for weapons convoy
- Night static line jump made from C-130 aircraft
- Four-mile patrol over rocky terrain to objective
- Planned helicopter extraction near target
- One jumper's canopy collapses 40 ft above the drop zone
- Open facial fractures with blood and teeth in the oropharynx
- Bilateral ankle fractures
- Open angulated fracture of the left femur

Snakebite Scenario

- Twelve-man Special Forces team
- Planned interdiction operation in arid, mountainous Middle Eastern terrain
- Two hostile trucks carrying surface-to-air missiles (SAMs) expected in several hours
- Estimated hostile strength is 10 men with automatic weapons in two armored personnel carriers (APCs)
- Helicopter insertion and extraction
- Six-mile patrol to target; can extract close to anticipated contact site
- While patrol is in position, one team member is bitten on the leg by an unidentified snake
- Over the next 5 minutes, the injured man becomes dizzy and confused
- Target convoy expected in 1 to 2 hours

Acute Gastroenteritis Scenario

- Twelve-man Special Forces team
- Dropped into unfriendly Middle Eastern country
- Four-day SCUD missile hunt
- Planned helicopter extraction at end of operation
- Lost communications: no casualty evacuation (CASEVAC) or extraction plan changes possible
- Patrolling in moderately populated area
- Two patrol members develop severe diarrhea and stomach cramps

sultations, modern surgical facilities, and adequate supplies of medications. In addition, the population being treated is often ravaged by the debilitating effects of malnutrition and chronic disease.[114] Cultural differences can make seemingly simple steps complex in their implementation. One report[115] documents the difficulty encountered by Air Force personnel trying to control an outbreak of rabies by using poisoned meat to rid the area of stray dogs. The local Buddhist spiritual leader required that two equal-sized pieces of meat (one poisoned and one not) be put out, thus giving the rabid dogs a choice. The same report discusses the difficulty in prescribing medications to a populace that not only speaks a different language from the healthcare provider but also often reads not at all. In such a setting, how do we ensure that the patients will remember the appropriate dosages and intervals for their medications?

Adequate quantities of medicines, vitamins, and medical supplies to treat the expected diseases must be determined and taken into the area with the SOF unit deployed. The providers' scope of care should be carefully outlined and procedures established for handling emergency cases that fall outside that prescribed scope of care. Both action and failure to act may have unfavorable consequences, so a careful examination of the medical ethics and the political realities of such dilemmas must be accomplished by the planners before the medical provider leaves for the mission.

The Department of Defense has a growing telemedicine capability that may be of some use in this environment. Foreign internal defense missions require a maximal effort to teach and train the populace in medical and preventive measures that they can implement themselves, because the presence of the US advisors must be assumed to be only temporary. First World medical care provided for a brief time is of little benefit if the population subsequently returns to its baseline state of healthcare. Before deployment, medical personnel must be familiar with the elements of the local culture and religion that are likely to impact on healthcare.

A final consideration is to provide the medical personnel on the mission with clear instructions on how to document and follow-up on human rights violations that may be encountered in rendering care to the local population.[115] Violations committed by the current power structure may be encountered. Immediate confrontation with the local authorities may result in a rapid breakdown in relations, so this eventuality in particular should be planned for in advance.

Humanitarian Assistance

Humanitarian assistance missions are often undertaken after another country has been ravaged by an armed conflict or a natural disaster. Such natural disasters often have more devastating effects in underdeveloped countries than in First World nations. An example is the cyclone that struck southeastern Bangladesh in 1991 with 160-knot winds and a 6-m storm surge, resulting in the loss of more than 140,000 lives.[116]

SOF personnel assisting on relief efforts such as this will typically have to contend with most of the considerations described above for foreign internal defense and civic action missions, but in addition will have the superimposed effects of the conflict or natural disaster. Some of the additional considerations in this circumstance are the need to provide security for personnel, equipment, and medications, as medical teams try to render care to what may be an impossibly large number of patients. Deployable clinics and medical facilities should be used as extensively as possible. Preventive medicine measures (eg, obtaining potable water, establishing adequate sanitation facilities) are a very high priority in caring for the victims of natural disasters and armed conflicts.[116] SOF efforts in such undertakings will have to be coordinated with theater medical personnel and other agencies involved with international relief efforts.

Operations Other Than War

Planning for medical support of OOTW may present the greatest challenge of all to SOF medical personnel, as OOTW may include elements of several other missions—from tactical combat casualty care to foreign internal defense to humanitarian medical assistance. SOF medical personnel may have to shift rapidly from rendering care to friendly foreign personnel to flying into a gunfight to evacuate multiple combat casualties. The potential for this rapid change in conditions was dramatically illustrated in the SOF actions during Operation Restore Hope in Somalia, in which a planned humanitarian relief effort quickly turned into a direct action combat situation.

Aspects of Postdeployment Medicine

Medical Afteraction Reports

After the conflict or mission has ended and SOF units return to business as usual, a thorough medical afteraction report should be written to provide documentation of the successes and failures of the medical aspects of the operation so that the military medical community may learn from both. There is no better method available in the military with which to bring about needed changes in medical equipment, manning, and training than a well-written afteraction report that identifies specific deficiencies in our current system and suggests appropriate changes with which to remedy these problems.

A case in point is the casualty evacuation experience in Mogadishu, Somalia, during Operation Restore Hope (1992). Narrow streets and rocket-propelled grenade fire made helicopter evacuation impractical. This observation has great importance for future urban warfare mission planners.

Disease Surveillance

Disease surveillance is critically important for individuals returning from a theater conflict, as they may be subject to large assortment of infectious diseases that are not frequently seen in the United States. These disorders may not be diagnosed promptly if a high index of suspicion is not maintained by the SOF medical officers.

BIOMEDICAL RESEARCH

In 1991, the Naval Special Warfare Command established a Biomedical Research Program to conduct biomedical studies designed to better safeguard the health of its operators and to identify possible biomedical enhancements to the probability of mission success. This program addressed a wide range of biomedical issues that were believed to be important to members of the SEAL community, who operate in a variety of hazardous environments (Figure 37-13). The results obtained from these studies were useful enough that funding for the program has significantly increased since 1991, and USSOCOM has expanded the scope of the program to address the biomedical research requirements of the Army and Air Force Special Operations Commands and the Joint Special Operations Command, as well. All of the reports generated from USSOCOM biomedical research projects are incorporated into the Special Operations Computer-Assisted Medical Reference System (SOCAMRS) each year as they become available so that they will available to medical officers and combat medical personnel in-theater and to future gen-

a

b

c

Fig. 37-13. (**a**) A US Navy SEAL (*se*a, *a*ir, *l*and) combat patrol is inserted from a riverine craft. (**b**) SEALs are dropped from a high-speed surface craft during a hydrographic reconnaissance operation. (**c**) A SEAL practices cross-country skiing techniques during cold weather training. Photographs: Courtesy of US Special Operations Command, MacDill Air Force Base, Tampa, Fla.

erations of SOF medical personnel. Some of the areas in which biomedical research has benefited the conduct of special operations are discussed below.

Medical Aspects of Mission Planning

The SOCAMRS is a customized CD-ROM designed to provide SOF physicians, corpsmen, and medics with a single comprehensive reference source that contains the entire spectrum of specialized information required to provide medical support to special operations. The SOCAMRS is updated each year and delivered to all SOF commands in sufficient quantities for every physician, corpsman, and medic to have his own copy. Customized and updated versions of this CD are prepared each year. The information contained on the 1996 5th edition of the SOCAMRS,[117] for example, includes

- approximately 1,000 clinical articles and research reports on various topics related to the conduct of special operations;
- the current edition of the *US Navy Diving Manual*;
- review materials for the American Heart Association's Advanced Cardiac Life Support (ACLS) and Basic Life Support (BLS) courses, and the ATLS course;
- the *Special Forces Medical Handboo*k;
- the *Navy General Medical Officer's Guide*;
- area-specific medical information manuals on Southwest Asia, Somalia, and Croatia, prepared by the US Army Institute for Environmental Medicine;
- a guide to Tactical Combat Care in Special Operations[17];
- the Combat Swimmer Multi-Level Dive procedures[15];
- the *Dry Deck Shelter Medical Emergency Procedures*[16]; and
- triservice manuals on the management of NBC warfare casualties.

Medical Sustainment Training

Special operations corpsmen and medics are required to maintain a wide variety of both medical and operational skills. Intense unit training schedules often require medical personnel to be away from their command a great deal of the time and make the scheduling of group medical training classes very difficult. This problem was addressed by the Naval Health Research Center in San Diego, California, in a 3-year research effort, which has resulted in the development of the Special Operations Interactive Medical Training Program (SOIMTP). This program contains instruction modules on 18 different medical topics such as diving medicine, tropical medicine, NBC warfare, combat casualty management, and ATLS. The modules have been written by physicians and senior enlisted medical personnel attached to special operations units and the program is contained on a CD-ROM. The SOIMTP provides both a training and a testing capability. The program has been approved by the Navy for the granting of continuing education unit credits, allowing formally recognized sustainment training to be accomplished by SOF medical personnel anywhere that a personal computer is available.

Casualty Management

Medical training for special operations corpsmen and medics has historically been based primarily on nationally recognized courses (ATLS and Emergency Medical Technician) that have been developed to train physicians and paramedics in the principles of trauma care as it would be delivered in a hospital emergency department or by ambulance attendants. These courses were supplemented by training in a field environment but did not address many of the factors that will be encountered on the special operations battlefield, such as hostile fire, medical equipment limitations, CASEVAC availability, and integration of casualty management into the tactical considerations regarding mission completion. As noted above in this chapter, this research has resulted in a management plan for combat trauma that is more appropriate for the battlefield. More specific scenario-based research into combat trauma management plans is currently ongoing.

The Special Operations CD-ROM Medical Translator, developed at the Naval Operational Medical Institute, Pensacola, Florida, allows a medical provider to conduct an interview with a non-English-speaking patient through the use of medical phrase menus contained on a laptop microprocessor with a sound board. The questions are presented to the patient in his own language and phrased so that the requested information is conveyed through nonverbal responses to the physician or corpsman. The 1995 version of this program contains 43 languages and more than 2,000 medical phrases. This program has already proven itself to be of great benefit in rendering care to victims of the conflict in the former Yugoslavia and to Special Forces medical personnel preparing for Foreign Internal Defense missions. Additional information on this device is available from SOF component medical departments or the Naval Operational Medical Institute.

Nutrition and Hydration

Preventing degradation of physical and mental performance during the conduct of long, stressful training and combat missions is of considerable importance to the special operations community. Ensuring that SEAL operators achieve the optimal nutrition and hydration status possible before and during physically arduous missions is a critical element in minimizing performance decrements. In 1992, a research project was undertaken to develop a nutrition guide for SEALs that would incorporate current scientific information regarding both the performance-enhancing and the long-term health aspects of nutrition into an understandable training manual. After an extensive review of the scientific literature on nutrition, hydration, and food supplements was conducted, the research was summarized and published in 1994 as *The Navy SEAL Nutrition Guide*.[118] This manual, which presents the material in a format which is easily understood by SEALs and other SOF operators, has been the most widely disseminated medical publication in the history of special operations.

Exercise and Mission-Related Physiology

When, if ever, can a SEAL dive after having had cataract surgery or a corneal transplant? Can a Special Forces combat swimmer dive with glaucoma or after having had a retinal detachment? A number of such questions have been asked but surprisingly little information was available to help ophthalmologists and DMOs make these decisions. This issue was addressed in 1994 and the resultant major review published in 1995 in the journal *Survey of Ophthalmology*.[119] Only approximately 10 such major reviews are published in the ophthalmology literature each year, so this paper was a significant contribution that has been of considerable use to the civilian diving community as well.

A study examining methods by which to quantify SOF mission-related performance was undertaken at NMRI in 1992 to determine which performance factors are most critical to mission success in special operations and to identify the best measures with which to quantitate these elements of performance. The investigators used extensive interviews with SOF operators to identify the performance factors they believed to be the most important to the successful completion of a variety of SOF missions. Then the investigators designed a battery of cognitive and physical tests to measure these factors. These tests are now being used in USSOCOM physiological studies that seek to identify decrements in performance associated with physiological stressors such as sleep deprivation or thermal stress. The tests will also be used to evaluate the efficacy of proposed interventions to improve SOF performance, such as food supplements, thermal protective garments, or pharmacological agents.

Decompression

An in-house NSW update to the CSMD procedures was completed in 1992 and subsequently approved by NAVSEA; the following improvements to the original CSMD procedures were incorporated:

- increased the maximum operational depth using the Mk 16 UBA from 70 fsw to 110 fsw;
- greatly improved the unplanned excursion procedures;
- allowed use of the Surface Interval Credit Table[18] to decrease the repetitive group designator during the overland or surface phases of operations;
- added provisions for altitude diving and flying after diving; and
- improved and simplified the CSMD worksheet.

A new nitrox decompression model based on the statistical principle of maximum likelihood as applied to the probability of suffering an episode of decompression sickness was developed at NMRI. This computer model allows for the precise calculation of decompression obligation for the very long, multilevel, multigas dives that are often necessary in SDV operations. A laptop version of this model was approved by NAVSEA for use in SDV/DDS operations on 16 May 1994. Called the NSW Dive Planner (mentioned above), this computer model was the first Navy use of such a device to calculate decompression for operational dives. Use of the Dive Planner has substantially reduced or eliminated the decompression required after many SDV/DDS dives.

As a follow-on project to the NSW Dive Planner, NMRI examined the use of 100% oxygen breathing in the DDS complex to reduce decompression time in the event of a SEAL operator suffering a traumatic injury or hypothermia during an operation and needing to be evacuated from the DDS complex as soon as possible. This NMRI study demonstrated that breathing 100% oxygen at a depth of 40 feet in a dry recompression chamber allows the total air decompression time as calculated by the NSW Dive Planner to be reduced by 80%. The Emergency Oxygen Decompression Procedures[120] have now been approved by NAVSEA for use in DDS/SDV operations.

Life-Support Technology

In 1990, the NSW community began to plan to acquire the Mk 16 for use in SDV operations. At that time, the operating limits of the Mk 16 canister were based on testing that studied free-swimming divers; they were thought to be too restrictive for SDV operations in which the divers had a lower oxygen consumption. In December 1990, COMNAVSPECWARCOM requested that NAVSEA task NEDU to retest the Mk 16 under conditions more appropriate for SDV operations. This study resulted in new Mk 16 canister limits for SDV operations. The increases vary for different water temperatures, but for most conditions, the canister limits were almost doubled, allowing for much longer SDV operations using the Mk 16.

SUMMARY

Medical support of special operations requires both a variety of specialized medical skills and that those skills be correctly applied to the unique training and mission scenarios encountered in special operations. Failure to recognize this fact may result in avoidable loss of lives and mission failures. Medical personnel must understand fully the demanding and difficult nature of SOF missions, and SOF line commanders must understand the unique contributions that adequately prepared medical personnel can make to the health of their force and the success of their operations.

SOF physicians, corpsmen, medics, and PJs have recently redefined combat casualty care in the tactical environment. AFSOC flight surgeons are currently supervising the critical altitude decompression sickness research needed to allow the new CV-22 Osprey aircraft to achieve its desired operating profile. SOF medical personnel have made invaluable contributions to special operations in the US military since their inception and will continue to provide the SOF warrior with the medical support he needs to help him meet the challenges of his unique profession.

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REFERENCES

1. US Special Operations Command. *United States Special Operations Command Fact Sheet.* Tampa, Fla: USSOCOM Public Affairs Office; 1994.

2. US Special Operations Command. *United States Special Operations Forces—Posture Statement*. Tampa, Fla: USSOCOM Public Affairs Publication; 1996.

3. US Army Special Operations Command. *The Special Forces A-Team.* Fort Bragg, NC: USASOC Public Affairs Office Publication; 1994.

4. US Army Special Operations Command. *Army SOF Aviation.* Fort Bragg, NC: USASOC Public Affairs Office Publication; 1994.

5. US Army Special Operations Command. *The 75th Ranger Regiment.* Fort Bragg, NC: USASOC Public Affairs Office Publication; 1994.

6. US Army Special Operations Command. *An Army Special Operations Forces Primer.* Fort Bragg, NC: USASOC Public Affairs Office Publication; 1994.

7. Naval Special Warfare Command. *Naval Special Warfare Command Fact File.* Coronado, Calif: COMNAVSPECWARCOM Public Affairs Office Publication; 1993.

8. US Air Force Special Operations Command. *Fact Sheet: Air Force Special Operations Command.* Hurlburt Field, Fla: AFSOC Public Affairs Office Publication; 1994.

9. US Air Force Special Operations Command. *Fact Sheet: US Air Force Special Operations School.* Hurlburt Field, Fla: AFSOC Public Affairs Office Publication; 1994.

10. US Air Force Special Operations Command. *Fact Sheet: 18th Flight Test Squadron.* Hurlburt Field, Fla: AFSOC Public Affairs Office Publication; 1995.

11. US Air Force Special Operations Command. *Fact Sheet: Air Force Special Tactics Teams.* Hurlburt Field, Fla: AFSOC Public Affairs Office Publication; 1994.

12. Cloonan C. Colonel, Medical Corps, US Army; Professor and Chairman, Department of Military and Emergency Medicine, F. Edward Hébert School of Medicine, Uniformed Services University of the Health Sciences, 4301 Jones Bridge Road, Bethesda, Maryland 20814-3799; formerly, Medical Dean, Joint Special Operations Medical Training Center, Fort Bragg, North Carolina. Personal communication, 17 September 2001.

13. US Department of the Navy. *Manual of the Medical Department*. Washington, DC: Chief, Bureau of Medicine and Surgery Publication; 1995. Change 111, Chap 15.

14. Butler FK, Smith DJ. US Navy diving equipment and techniques. In: Bove AA, ed. *Bove and Davis' Diving Medicine.* 3rd ed. Philadelphia, Pa: Saunders; 1997: 372–387.

15. Thalmann ED, Butler FK. *A Procedure for Doing Multi-Level Dives Using Repetitive Groups.* Panama City Beach, Fla: US Navy Experimental Diving Unit; 1983. EDU Report 13-83.

16. Commander, Naval Special Warfare Command. *Dry Deck Shelter Medical Emergency Procedures.* Coronado, Calif: NAVSPECWARCOM. Letter, 21 January 1993.

17. Butler FK, Hagmann J, Butler EG. Tactical combat casualty care in special operations. *Mil Med*. 1996;161(suppl):1–16.

18. Commander, Naval Sea Systems Command, US Department of the Navy. *US Navy Diving Manual*. SS521-Ag-PRO-010. Washington, DC: Naval Sea Systems Command. Rev 4 (20 Jan 1999); Change A (1 Mar 2001). NAVSEA 0994-LP-100-3199.

19. Butler FK, Thalmann ED. Central nervous system oxygen toxicity in closed circuit SCUBA divers. In: Bachrach AJ, Matzen MM, eds. *Underwater Physiology 8: Proceedings of the 8th Symposium on Underwater Physiology.* Bethesda, Md: Undersea Medical Society; 1984: 15–30.

20. Butler FK. *Closed-Circuit Oxygen Diving.* Panama City Beach, Fla: US Navy Experimental Diving Unit; 1985. EDU Report 7–85.

21. Butler FK, Thalmann ED. Central nervous system oxygen toxicity in closed circuit SCUBA divers, II. *Undersea Biomed Res.* 1986;13:193–223.

22. Butler FK. *Central Nervous System Oxygen Toxicity in Closed Circuit SCUBA Divers, III.* Panama City Beach, Fla: US Navy Experimental Diving Unit; 1986. EDU Report 5-86.

23. Butler FK. *Purging Procedures for the Draeger LAR V Underwater Breathing Apparatus.* Panama City Beach, Fla: US Navy Experimental Diving Unit; 1984. EDU Report 5-84.

24. Butler FK. *Underwater Purging Procedures for the Draeger LAR V UBA.* Panama City Beach, Fla: US Navy Experimental Diving Unit; 1986. EDU Report 6-86.

25. Harabin AL, Survanshi SS, Homer LD. *A Model for Predicting Central Nervous System Toxicity From Hyperbaric Oxygen Exposure in Man: Effects of Immersion, Exercise, and Old and New Data.* Bethesda, Md: Naval Medical Research Institute; 1994. NMRI Report 94-03.

26. Lanphier EH, Dwyer JV. *Diving With Self-Contained Underwater Operating Apparatus.* Washington, DC: US Navy Experimental Diving Unit; 1954. US Navy Experimental Diving Unit Report 11-54.

27. Donald KW. Oxygen poisoning in man, I. *Br Med J.* 1947;1:667–672.

28. Donald KW. Oxygen poisoning in man, II. *Br Med J.* 1947;1:712–717.

29. Yarborough OD, Welham W, Brinton ES, Behnke AR. *Symptoms of Oxygen Poisoning and Limits of Tolerance at Rest and at Work.* Washington, DC: US Navy Experimental Diving Unit; 1947. EDU Report 1-47.

30. Middleton JR, Thalmann ED. *Standardized NEDU Unmanned UBA Test Procedures and Performance Goals.* Panama City Beach, Fla: US Navy Experimental Diving Unit; 1981. EDU Report 3-81.

31. Clarke J, Russell K, Crepeau L. *MK 16 Canister Limits for SDV Operations.* Panama City Beach, Fla: US Navy Experimental Diving Unit; 1993. EDU Report 2-93.

32. Knafelc ME. *Mk 15 Mod 0 Alternate Carbon Dioxide Absorbent Materials.* Panama City Beach, Fla: US Navy Experimental Diving Unit; 1987. EDU Report 11-87.

33. Keith JS. *Unmanned Evaluation of the US Navy MK 15 and Modified MK 15 Closed-Circuit UBA.* Panama City Beach, Fla: US Navy Experimental Diving Unit; 1984. EDU Report 10-84.

34. Zumrick JL. *Manned Evaluation of the MK 15 UBA Canister Duration in 13 Degrees C Water Using a Resting Diver Scenario.* Panama City Beach, Fla: US Navy Experimental Diving Unit; 1984. EDU Report 2-84.

35. Crepeau LJ. LAR V Canister Duration Limits for HP Sodasorband *L-Grade Sofnolime.* Panama City Beach, Fla: US Navy Experimental Diving Unit; 1994. EDU Report 1-94.

36. Presswood CG. *Unmanned Evaluation of Five Carbon Dioxide Absorbents Which Were Frozen Prior to Use With the Draeger LAR V UBA.* Panama City Beach, Fla: US Navy Experimental Diving Unit; 1986. EDU Report 3-86.

37. Middleton JR, Keith JS. *Unmanned Evaluation of Six Carbon Dioxide Absorbents With the Draeger LAR V UBA*. Panama City Beach, Fla: US Navy Experimental Diving Unit; 1985. EDU Report 4-85.

38. Giedraitis RB. *Recommended Storage Time Following Prepacking UBA MK 16 Mod 0 With HP Sodasorb.* Panama City Beach, Fla: US Navy Experimental Diving Unit; 1992. EDU Technical Memorandum 92-06.

39. Knafelc ME. *Mk 16 Mod 0 Underwater Breathing Apparatus: Manned and Unmanned Canister Duration*. Panama City Beach, Fla: US Navy Experimental Diving Unit; 1986. EDU Report 9-86.

40. Zumrick JL. *Manned Evaluation of the EX 15 Mod 1 UBA Carbon Dioxide Absorbent Canister.* Panama City Beach, Fla: US Navy Experimental Diving Unit; 1986. EDU Report 4-86.

41. Committee on Trauma, American College of Surgeons. *Advanced Trauma Life Support Program for Physicians: Instructor Manual.* 5th ed. Chicago, Ill: American College of Surgeons; 1993.

42. Arishita GI, Vayer JS, Bellamy RF. Cervical spine immobilization of penetrating neck wounds in a hostile environment. *J Trauma.* 1989;29:332–337.

43. Bickell WH, Wall MJ, Pepe PE, et al. Immediate versus delayed fluid resuscitation for hypotensive patients with penetrating torso injuries. *N Engl J Med*. 1994;331:1105–1109.

44. Honigman B, Rohwder K, Moore EE, et al. Prehospital advanced trauma life support for penetrating cardiac wounds. *Ann Emerg Med.* 1990;19:145–150.

45. Smith JP, Bodai BI. The urban paramedic's scope of practice. *JAMA*. 1985;253:544–548.

46. Smith JP, Bodai BI, Hill AS, et al. Prehospital stabilization of critically injured patients: A failed concept. *J Trauma.* 1985;25:65–70.

47. Dronen SC, Stern S, Baldursson J, et al. Improved outcome with early blood administration in a near-fatal model of porcine hemorrhagic shock. *Am J Emerg Med.* 1992;10:533–537.

48. Stern SA, Dronen SC, Birrer P, et al. Effect of blood pressure on hemorrhage volume and survival in a near-fatal hemorrhage model incorporating a vascular injury. *Ann Emerg Med.* 1993;22:155–163.

49. Chudnofsky CR, Dronen SC, Syverud SA, et al. Early versus late fluid resuscitation: Lack of effect in porcine hemorrhagic shock. *Ann Emerg Med.* 1989;18:122–126.

50. Bickell WH. Are victims of injury sometimes victimized by attempts at fluid resuscitation? *Ann Emerg Med.* 1993;22:225–226.

51. Chudnofsky CR, Dronen SC, Syverud SA, et al. Intravenous fluid therapy in the prehospital management of hemorrhagic shock: Improved outcome with hypertonic saline/6% Dextran 70 in a swine model. *Am J Emerg Med.* 1989;7:357–363.

52. Martin RR, Bickell WH, Pepe PE, et al. Prospective evaluation of preoperative fluid resuscitation in hypotensive patients with penetrating truncal injury: A preliminary report. *J Trauma.* 1992;33:354–361.

53. Kaweski SM, Sise MJ, Virgilio RW. The effect of prehospital fluids on survival in trauma patients. *J Trauma.* 1990;30:1215–1218.

54. Gross D, Landau EH, Klin B, et al. Treatment of uncontrolled hemorrhagic shock with hypertonic saline solution. *Surg Gynecol Obstet.* 1990;170:106–112.

55. Deakin CD, Hicks IR. AB or ABC: Pre-hospital fluid management in major trauma. *J Accid Emerg Med.* 1994;11:154–157.

56. Bickell WH, Bruttig SP, Millnamow GA, et al. Use of hypertonic saline/Dextran versus lactated ringer's solution as a resuscitation fluid after uncontrolled aortic hemorrhage in anesthetized swine. *Ann Emerg Med.* 1992;21:1077–1085.

57. Dontigny L. Small-volume resuscitation. *Can J Surg.* 1992;35(1):31–33.

58. Krausz MM, Bar-Ziv M, Rabinovici R, et al. "Scoop and run" or stabilize hemorrhagic shock with normal saline or small-volume hypertonic saline? *J Trauma.* 1992;33:6–10.

59. Gross D, Landau EH, Assalia A, et al. Is hypertonic saline resuscitation safe in uncontrolled hemorrhagic shock? *J Trauma*. 1988;28:751–756.

60. Kowalenko J, Stern S, Dronen S, et al. Improved outcome with hypotensive resuscitation of uncontrolled hemorrhagic shock in a swine model. *J Trauma*. 1992;33:349–353.

61. Zajtchuk R, Jenkins DP, Bellamy RF, eds. *Combat Casualty Care Guidelines: Operation Desert Storm.* Washington, DC: Department of the Army, Office of The Surgeon General, and Borden Institute; 1991.

62. Krausz MM, Klemm O, Amstislavsky T, et al. The effect of heat load and dehydration on hypertonic saline solution treatment on uncontrolled hemorrhagic shock. *J Trauma.* 1995;38:747–752.

63. Napolitano LM. Resuscitation following trauma and hemorrhagic shock: Is hydroxyethyl starch safe? *Crit Care Med*. 1995;23:795–796.

64. Krausz MM. Controversies in shock research: Hypertonic Resuscitation—Pros and cons. *Shock*. 1995;3:69–72.

65. Bellamy RF. The causes of death in conventional land warfare: Implications for combat casualty care research. *Mil Med*. 1984;149:55–62.

66. Bellamy RF. How shall we train for combat casualty care? *Mil Med*. 1987;152:617–622.

67. Baker MS. Advanced Trauma Life Support: Is it adequate stand-alone training for military medicine? *Mil Med.* 1994;159:587–590.

68. Wiedeman JE, Jennings SA. Applying ATLS to the Gulf War. *Mil Med*. 1993;158:121–126.

69. Heiskell LE, Carmona RH. Tactical emergency medical services: An emerging subspecialty of emergency medicine. *Ann Emerg Med*. 1994;23:778–785.

70. Ekblad GS. Training medics for the combat environment of tomorrow. *Mil Med*. 1990;155:232–234.

71. Maughon JS. An inquiry into the nature of wounds resulting in killed in action in Vietnam. *Mil Med.* 1970;135:8–13.

72. Rosemurgy AS, Norris PA, Olson SM, et al. Prehospital cardiac arrest: The cost of futility. *J Trauma*. 1993;35:468–473.

73. Sladen A. Emergency endotracheal intubation: Who can—Who should? *Chest*. 1979;75:535–536.

74. Stewart RD, Paris PM, Winter PM, et al. Field endotracheal intubation by paramedical personnel: success rates and complications. *Chest*. 1984;85:341–345.

75. Jacobs LM, Berrizbeitia LD, Bennet B, et al. Endotracheal intubation in the prehospital phase of emergency medical care. *JAMA*. 1983;250:2175–2177.

76. Pointer JE. Clinical Characteristics of paramedics' performance of endotracheal intubation. *J Emerg Med*. 1988;6:505–509.

77. Lavery RF, Doran J, Tortella BJ, et al. A survey of advanced life support practices in the United States. *Prehospital Disaster Med*. 1992;7:144–150.

78. DeLeo BC. Endotracheal intubation by rescue squad personnel. *Heart Lung*. 1977;6:851–854.

79. Stratton SJ, Kane G, Gunter CS, et al. Prospective study of manikin-only versus manikin and human subject endotracheal intubation training of paramedics. *Ann Emerg Med*. 1991;20:1314–1318.

80. Trooskin SZ, Rabinowitz S, Eldridge C, et al. Teaching endotracheal intubation using animals and cadavers. *Prehospital Disaster Med*. 1992;7:179–182.

81. Stewart RD, Paris PM, Pelton GH, et al. Effect of varied training techniques on field endotracheal intubation success rates. *Ann Emerg Med.* 1984;13:1032–1036.

82. Cameron PA, Flett K, Kaan E, et al. Helicopter retrieval of primary trauma patients by a paramedic helicopter service. *Aust N Z J Surg*. 1993;63:790–797.

83. Salvino CK, Dries D, Gamelli R, et al. Emergency cricothyroidotomy in trauma victims. *J Trauma*. 1993;34:503–505.

84. McGill J, Clinton JE, Ruiz E. Cricothyrotomy in the emergency department. *Ann Emerg Med*. 1982;11:361–364.

85. Erlandson MJ, Clinton JE, Ruiz E, et al. Cricothyrotomy in the emergency department revisited. *J Emerg Med*. 1989;7:115–118.

86. Mines D. Needle thoracostomy fails to detect a fatal tension pneumothorax. *Ann Emerg Med*. 1993;22:863–866.

87. Aeder MI, Crowe JP, Rhodes RS, et al. Technical limitations in the rapid infusion of intravenous fluids. *Ann Emerg Med*. 1985;14:307–310.

88. Hoelzer MF. Recent advances in intravenous therapy. *Emerg Med Clin North Am*. 1986;4:487–500.

89. Lawrence DW, Lauro AJ. Complications from IV therapy: Results from field-started and emergency department-started IV's compared. *Ann Emerg Med*. 1988;17:314–317.

90. Kramer GC, Perron PR, Lindsey DC, et al. Small volume resuscitation with hypertonic saline dextran solution. *Surgery*. 1986;100:239–245.

91. Shaftan GW, Chiu C, Dennis C, et al. Fundamentals of physiological control of arterial hemorrhage. *Surgery*. 1965;58:851–856.

92. Milles G, Koucky CJ, Zacheis HG. Experimental uncontrolled arterial hemorrhage. *Surgery*. 1966;60:434–442.

93. Krausz MM, Horne Y, Gross D. The combined effect of small-volume hypertonic saline and normal saline in uncontrolled hemorrhagic shock. *Surg Gynecol Obstet*. 1992;174:363–368.

94. Bickell WH, Bruttig SP, Wade CE. Hemodynamic response to abdominal aortotomy in anesthetized swine. *Circ Shock*. 1989;28:321–332.

95. Landau EH, Gross D, Assalia A, et al. Treatment of uncontrolled hemorrhagic shock by hypertonic saline and external counterpressure. *Ann Emerg Med*. 1989;18:1039–1043.

96. Rabinovici R, Krausz MM, Feurstein G. Control of bleeding is essential for a successful treatment of hemorrhagic shock with 7.5 percent NaCl solution. *Surg Gynecol Obstet*. 1991;173:98–106.

97. Landau EH, Gross D, Assalia A, et al. Hypertonic saline infusion in hemorrhagic shock treated by military antishock trousers (MAST) in awake sheep. *Crit Care Med*. 1993;21:1554–1561.

98. Crawford, ES. Ruptured abdominal aortic aneurysm [editorial]. *J Vasc Surg*. 1991;13:348–350.

99. Marino PL. Colloid and crystalloid resuscitation. In: *The ICU Book*. Malvern, Pa: Lea & Febiger; 1991: 205–216.

100. Mortelmans Y, Merckx E, van Nerom C, et al: Effect of an equal volume replacement with 500 cc 6% hydroxyethyl starch on the blood and plasma volume of healthy volunteers. *Eur J Anaesthesiol.* 1995;12:259–264.

101. Lucas CE, Denis R, Ledgerwood AM, et al. The effects of Hespan on serum and lymphatic albumin, globulin, and coagulant protein. *Ann Surg*. 1988;207:416–420.

102. Sanfelippo MJ, Suberviola PD, Geimer NF. Development of a von Willebrand–like syndrome after prolonged use of hydroxyethyl starch. *Am J Clin Path*. 1987;88:653–655.

103. Strauss RG. Review of the effects of hydroxyethyl starch on the blood coagulation system. *Transfusion*. 1981;21:299–302.

104. Dalrymple-Hay MB, Aitchison R, Collins P, et al. Hydroxyethyl starch-induced acquired Von Willebrand's disease. *Clin Lab Haematol*. 1992;14:209–211.

105. Macintyre E, Mackie IJ, Ho D, et al. The haemostatic effects of hydroxyethyl starch (HES) used as a volume expander. *Intensive Care Med*. 1985;11:300–303.

106. Falk. Choice of fluid in hemorrhagic shock. *Crit Care Clin*. 1992;330–338.

107. Shatney CH, Krishnapradad D, Militello PR, et al. Efficacy of hetastarch in the resuscitation of patients with multisystem trauma and shock. *Arch Surg*. 1983;118:804–809.

108. Ratner LE, Smith GW. Intraoperative fluid management. *Surg Clin North Am*. 1993;73:229–241.

109. Shands JW. Empiric antibiotic therapy of abdominal sepsis and serious perioperative infections. *Surg Clin North Am.* 1993;73:291–306.

110. The Medical Letter, Inc. *The Medical Letter Handbook of Antimicrobial Therapy.* New Rochelle, NY: The Medical Letter, Inc; 1994: 53.

111. Bowen TE, Bellamy RF, eds. *Emergency War Surgery NATO Handbook*. 2nd rev US ed. Washington, DC: Department of Defense, Government Printing Office; 1988: 175.

112. Ordog GJ, Sheppard GF, Wasserberger JS, et al. Infection in minor gunshot wounds. *J Trauma*. 1993;34:358–365.

113. Luz JA, DePauw JW, Gaydos JC, Hooper RR, Legters LJ. The role of military medicine in military civic action. *Mil Med.* 1993;158:362–366.

114. Blount BW, Krober MS, Gloyd SS, Kozakowski M, Casey L. Nutritional status of rural Bolivian children. *Mil Med*. 1993;158:367–370.

115. Geiger HJ, Cook-Deegan RM. The role of physicians in conflicts and humanitarian crises. *JAMA*. 1993;270:616–620.

116. Sharp TW, Yip R, Malone JD. US military forces and emergency international humanitarian assistance. *JAMA*. 1994;272;5:386–390.

117. US Naval Special Warfare Command. Special Operations Computer-Assisted Medical Reference System, Coronado, Calif: NAVSPECWARCOM; 1996.

118. Deuster P, Singh A, Pelletier P. *The Navy SEAL Nutrition Guide.* Bethesda, Md: Uniformed Services University of the Health Sciences; 1994.

119. Butler FK. Diving and hyperbaric ophthalmology. *Surv Ophthalmol*. 1995;39(5):347-366.

120. Naval Medical Research Institute. *Emergency Oxygen Decompression Procedures Using the NSW Dive Planner.* NAVSEA LTR, 8 June 1995.

RECOMMENDED READING

Commander of the Special Operations Command, Office of the Command Surgeon, et al. *Special Operations Forces Medical Handbook.* Jackson, Wyo: Teton NewMedia; 2001.

Committee on Trauma, American College of Surgeons. *Advanced Trauma Life Support Program for Physicians: Instructor Manual.* 5th ed. Chicago, Ill: American College of Surgeons; 1993.

Cummins RO. *Advanced Cardiac Life Support: ACLS Provider Manual.* Dallas, Tex: American Heart Association; 2001.

Department of the Navy. *General Medical Officer Manual.* Washington, DC: Bureau of Medicine and Surgery, DN; 2000. NAVMED P-5134. Available at http://www.vnh.org.

Stapleton ER, Aufderheide TP, Hazinski MF, Cummins RO, eds. *Basic Life Support for Healthcare Providers.* Dallas, Tex: American Heart Association; 2001.

US Department of the Navy. *US Navy Diving Manual*. SS521-Ag-PRO-010. Washington, DC: Naval Sea Systems Command. Rev 4 (20 Jan 1999); Change A (1 Mar 2001). NAVSEA 0994-LP-100-3199.