Chapter 6

DEPLOYABLE HOSPITALS

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INTRODUCTION

No modern general will go into battle without taking with him at least a rudimentary hospital system. When the tempo of warfare was governed by the speed of marching men and horses, existing deployable hospitals were usually able to keep pace with combat units. The primitive nature of medicine and surgery minimized the logistical and transportation needs of such hospitals, which were frequently nothing more than tents with cots. The imperatives of modern medicine and surgery, together with the advent of mechanized warfare, have vastly increased the challenge of providing medical support—especially surgical care for combat casualties. The problems implicit in designing mobile hospitals were not especially apparent during the positional warfare that characterized much of World War I, but they became obvious during World War II. Medical commanders soon recognized that unless hospitals capable of providing surgical care for combat casualties were able to accompany rapidly moving armored units, casualties would necessarily be subjected to a lengthy evacuation. For many, this was incompatible with survival. Furthermore, the lifesaving potential of modern surgery could be realized only if operations were carried out shortly after wounding had occurred. To wait for the combat casualty to reach a communications zone hospital, as was done in World War I, was to minimize the value of modern surgery.

Fig. 6-1. The mobility and simplicity of World War II–vintage surgical teams are apparent in this photograph taken in Italy in 1944. Several jeeps with trailers and a small truck were found to be sufficient to transport the surgical personnel and specialty equipment. Tents, cots, and other equipment were provided by the unit being supported. Note that several members are watching the sky, possibly for enemy aircraft. Their actions emphasize how far forward surgical teams were deployed. Reprinted from Brewer LA III, Burford TH. Administrative considerations in the Mediterranean (formerly North African) Theater of Operations. In: Berry FB, ed. *Thoracic Surgery*. Vol 1. In: Coates JB Jr, ed. *Surgery in World War II*. Washington, DC: US Department of the Army, Medical Department, Office of The Surgeon General; 1963: 88.

The need for hospitals that had the tactical mobility of combat units became apparent to the U.S. Army during the campaigns in North Africa and Italy in 1943. It was recognized that a small fraction of those wounded in action (perhaps 10%) were "nontransportable": they could not survive evacuation from the battlefield to the corps-level hospitals. The major achievement of military surgery by the U.S. Army in World War II was forward surgical care for such casualties. Small ad hoc surgical hospitals (30–60 beds) were created and attached to, and could move with, division-level medical units. The basic hospital module was a platoon-sized unit, three of which constituted an existing Table of Organization and Equipment (TOE) unit: the field hospital. Teams of surgeons and anesthesia providers were attached to the field hospital platoons from army level medical replacement units known as auxiliary surgery groups. Mobility for the combined surgical team–field hospital platoon was provided by its own *organic* (ie, intrinsic; included in the TOE) vehicles (Figure 6-1). Simplicity to the point of austerity was their dominant feature; for example, operating rooms were tents or buildings of convenience (Figures 6-2 and 6-3). The equipment believed to be essential by World War II surgical teams is listed in Exhibit 6-1. The field hospital platoon supplied the tentage, cots, and ancillary equipment for the casualties, while logistical and administrative support was provided by the supported division.

Only casualties who were considered to be likely to die or to develop life-threatening complications during evacuation to a corps-level evacuation hospital were treated by the surgical team–field hospital platoon. In general, the following categories were treated in forward surgical hospitals[1]:

Fig. 6-2. A forward surgical unit set up somewhere in France in 1944. Several tents house the operating room, the shock or resuscitation ward, and the postoperative/recovery ward. Environmental control was obviously not optimal by today's standards, nor was there much protection against enemy action. Reprinted from Odom CB. Third US Army. In: Carter BN, ed. *Activities of Surgical Consultants*. Vol 1. In: Coates JB Jr. *Surgery in World War II*. Washington DC: US Department of the Army, Medical Department, Office of The Surgeon General; 1962: 305.

Fig. 6-3. A World War II surgical team performing an operation. The notable austerity is in marked contrast to what is found in today's DEPMEDS (Department of Defense's Deployable Medical Systems)-equipped hospitals. Yet all the components required to perform life-saving surgery are present. Reprinted from Odom CB. Third US Army. In: Carter BN, ed. *Activities of Surgical Consultants*. Vol 1. In: Coates JB Jr. *Surgery in World War II*. Washington DC: US Department of the Army, Medical Department, Office of The Surgeon General; 1962: 309.

EXHIBIT 6-1

ESSENTIAL EQUIPMENT FOR WORLD WAR II SURGICAL TEAMS

1. Adequate transportation assigned permanently to the team
2. Adequate lighting: at least 200 W candlepower for each operating table
3. A portable oxygen apparatus, with a large-cylinder reducing valve
4. A simple transfusion set for giving whole blood with citrate as the anticoagulant
5. A large autoclave for sterilizing towels, gowns, and sheets
6. Two covered metal sterilizers for boiling instruments
7. Two stoves for sterilizing
8. Three large, 30-gal galvanized cans for washing, waste, and soaking dirty and bloody linen
9. Linen, including 200 towels, 20 gowns, and 40 sheets; drapes for the surgical tents to keep out dirt and dust
10. A positive-pressure anesthesia machine and a portable suction apparatus
11. Basic surgical instruments as well as specialty instruments needed for such operations as a thoracotomy
12. A walled or pyramidal tent to furnish living quarters for the surgical team

Adapted from: Brewer LA III, Burford TH. Administrative considerations in the Mediterranean (formerly North African) Theater of Operations. In: Berry FB, ed. *Thoracic Surgery*. Vol 1. In: Coates JB Jr, ed. *Surgery in World War II*. Washington, DC: US Department of the Army, Medical Department, Office of The Surgeon General; 1963: 88–89.

- casualties with multiple wounds, who remained in shock despite intensive therapy;
- casualties with abdominal wounds, particularly those with possible concealed hemorrhage;
- casualties with large, sucking chest wounds or massive intrathoracic hemorrhage;
- casualties with thoracoabdominal wounds; and
- casualties with wounds about the face and neck that caused mechanical interference with respiration.

Most casualties—those with orthopedic, soft-tissue, and head injuries—were sent to evacuation hospitals in the rear after being given initial care by the division-level medical unit with which the surgical hospital was collocated. The decision as to whether a casualty would be sent to the forward surgical hospital was made by the triage officer of the host division-level medical unit. The latter unit was also responsible for evacuation of treated casualties. Strangely enough, although professional relationships were clearly defined, formal command-and-control relationships among the three units—the surgical team (army level), the field-hospital platoon (corps level), and the supported division—were ill defined. In all, about 100,000 operations were performed in the European theater by auxiliary surgery group surgical teams. Probably one half were carried out in forward surgical hospitals, of which there may have been several hundred.[2]

Given the great success of the surgical team–field hospital approach to providing forward surgical care, it is not surprising that after World War II, it was decided to develop a formal TOE surgical hospital. From this decision came the famous mobile army surgical hospital (MASH) of the Korean War. Ironically, the conditions that gave rise to the forward surgical hospital during World War II were absent in Korea: after the first 9 months, a static battlefield reminiscent of World War I had developed. The MASHs remained immobile and, in fact, became functionally identical to other hospitals (ie, they no longer were dedicated to the treatment of only the most severely wounded casualties).

The MASH concept underwent considerable refinement during the period between the end of the Korean War in 1953 and the United States' intervention in Vietnam in the 1960s. One obvious defect in the MASH and its World War II predecessor was that the use of canvas tents precluded environmental control: a clean operating room was not possible. Furthermore, not only was there a potential for pollution from the environment but the tents offered no protection against chemical and biological warfare agents. To correct this, an advanced-technology approach was undertaken, with the goal of creating an environmentally controlled hospital with both strategic and tactical mobility. By 1963, this program had led to the development of the medical unit, self-contained, transportable (MUST) hospital.

The MUST hospital consisted of hard-walled, expandable shelters for certain parts of the facility (eg, the operating room), and inflatable shelters for other areas (eg, patient wards) (Figure 6-4). The facility was transportable using special transporter vehicles; electricity, air conditioning, and water were supplied via utility packs. The utility packs were large units powered by a gas turbine that burned jet engine fuel (JP4), and they provided heating and cooling to all the inflatable and hard-walled shelters (Figure 6-5). The utility packs worked well but consumed large amounts of fuel. In 1966, the first MUST hospital was deployed to Vietnam. Four more were deployed before the war ended.

In retrospect, the MUST cannot be judged a success. Part of the reason for its relative failure arose from the nature of the Vietnam War. Small U.S.

Fig. 6-4. An inflatable shelter in use in Vietnam, 1967. The MUST (medical unit, self-contained, transportable) surgical hospital used two characteristic structures: hard-walled, expandable shelters that contained the operating rooms and supporting services; and inflatable shelters that served as patient wards. Although representing an advanced-technology approach to providing a deployable surgical facility, inflatable shelters were probably not worth the effort. Setting them up was not easy and the equipment required to keep them inflated was labor-intensive. The inflatable shelters were also notably sensitive to battle damage.

Fig. 6-5. The mechanical equipment used to operate a MUST (medical unit, self-contained, transportable) hospital consisted of a gas turbine, a generator, and an air-cooling unit, which together constituted a utility pack. Large tubes acted as conduits to provide cooled or heated air to the treatment areas.

Army units deployed from base camps into the surrounding enemy-held territory. By World War II standards, distances in Vietnam were small, control of the air complete, and the number of casualties slight. It was, therefore, much more reasonable to fly casualties into hospitals established in the base camps than to move the hospitals with the combat units. Given the nature of the Vietnam War, MUST hospitals were never used the way they were envisioned: as mobile hospitals to provide resuscitative surgery only to the most seriously injured. Thus, MUST hospitals became immobile and increasingly lost their primary function. For example, it was not unusual for the prototype MUST—the 45th Surgical Hospital—to function as a station hospital and hold daily sick call for other units assigned to the Tay Ninh base camp.

The major deficiencies of the MUST facilities were as follows:

- They were not as adaptable to changing mission requirements nor as deployable as originally intended.
- The inflatable shelters were easily damaged by enemy action and difficult to maintain.
- Fuel consumption and the cost of supplying power to the utility packs were unacceptably high.
- MUST-equipped hospitals lacked commonality among the army, navy, and air force.

Consequently, the U.S. Congress ended the MUST program in 1979, and mandated in 1981 that all future North Atlantic Treaty Organization (NATO) third- and fourth-echelon hospitals would be standardized among the military services. This standardization program led to what is now known as the Department of Defense's Deployable Medical Systems (DEPMEDS).

HISTORY OF DEPLOYABLE MEDICAL SYSTEMS

In June 1982, the Department of Defense established the Military Field Medical Systems Standardization Steering Group, which consisted of general and flag officers of the U.S. Army, Navy, Air Force, and Marine Corps, and was responsible for directing the development of DEPMEDS.[3] Their mission was to standardize DEPMEDS to the degree that would still allow the four services to accomplish their distinct missions. DEPMEDS would (*a*) improve on the MUST's modular design and reassembly and (*b*) be more flexible and easier to deploy. To this end, the Military Field Medical Systems Standardization Steering Group established that DEPMEDS equipment sets be adequate, affordable, austere, maintainable, modular, transportable, usable in multiple service-specific configurations, usable by all four services, and suitable for transportation by strategic airlift. Other requirements came from the Health Service Support Tenets, which stress (*a*) providing healthcare as far forward as possible and (*b*) maximizing the number of soldiers who return to duty. DEPMEDS was designed for use only in the third and fourth echelons of medical care.

The most important task for the Military Field Medical Systems Standardization Steering Group was to select medical and nonmedical equipment and supplies that were not only acceptable to all four services but would also adhere to their individual requirements. To do this, the steering group convened 21 panels of medical experts from all four services. The panels selected the medical equipment after reviewing and studying the Combat Zone Assessment and Requirements (CZAR) model.

The original DEPMEDS database contained 316 patient conditions, which encompassed most of the workload expected to be seen if war were to occur in the NATO theater of combat. These 316 patient conditions were accompanied by brief descriptions of the conditions and their treatment. The treatment briefs, developed in late 1985, summarized the procedures recommended for each hypothetical patient. Because each hypothetical patient repre-

EXHIBIT 6-2

SELECTED DEPMEDS TREATMENT BRIEFS AND DEFINITIONS OF PATIENT CONDITIONS

No.	Injury	Description	Degree of Severity
1.	Cerebral concussion	Closed, with or without nondepressed linear skull fracture	Severe; loss of consciousness 2–12 h
3.	Cerebral contusion	Closed, with or without nondepressed linear skull fracture	Severe; loss of consciousness > 24 h, with focal neurological deficit
4.	Cerebral contusion	Closed, with or without nondepressed linear skull fracture	Moderate; loss of consciousness 12–24 h, without focal neurological deficit
5.	Cerebral contusion	Closed, with intracranial hematoma, with or without nondepressed linear skull fracture	Severe; large hematoma (including hematoma) with rapidly deteriorating, comatose patient
7.	Cerebral contusion	Closed, with depressed skull fracture	Severe; with associated intracerebral hematoma and/or massive depression
9.	Cerebral contusion	Open skull fracture	Severe; with intracranial fragments and/or depressed skull fracture
10.	Cerebral contusion	Open skull fracture	Moderate; without intracranial fragments and/or depressed skull fracture
45.	Wound: upper arm	Open, penetrating, lacerated, without fracture, with nerve and/or vascular injury	Severe
46.	Wound: upper arm	Open, penetrating, lacerated, without fracture, without nerve or vascular injury	Moderate
47.	Wound: upper arm	Open, with fractures and nerve and vascular injury	Arm not salvageable
48.	Wound: upper arm	Open with fractures and nerve injury, without vascular injury	Arm salvageable
83.	Injury: lung	Closed (blast, crush) with pneumo-hemothorax	Severe, one lung with pulmonary contusion and acute, severe respiratory distress
85.	Wound: thorax (anterior or posterior)	Open, superficial, lacerated, contused, abraded, avulsed	Requires major debridement
87.	Wound: thorax (anterior or posterior)	Open, penetrating, with associated rib fractures and pneumohemothorax	Acute, severe respiratory distress
94.	Thermal burn: trunk	> 20% but < 30% of TBSA	Full thickness
95.	Thermal burn: trunk	> 10% but < 20% of TBSA	Full thickness
96.	Wound: abdominal wall (anterior or posterior)	Lacerated, abraded, contused, avulsed without entering the abdominal cavity	Severe, requiring major debridement
130.	Wound: lower leg	Open, lacerated, penetrating, perforating, with fracture and nerve/vascular injury	Limb not salvageable
131.	Wound: lower leg	Open, lacerated, penetrating, perforating, with fracture and nerve/vascular damage	Limb salvageable
134.	Wound: ankle, foot, toes	Open, lacerated, contused, without fractures	Requiring major debridement
135.	Wound: ankle, foot, toes	Open, lacerated, contused, without fractures	Not requiring major debridement
136.	Wound: ankle, foot, toes	Open, penetrating, perforating, with fractures and nerve/vascular injury	Limb not salvageable

Adapted from Scotti MJ, chairman. Defense Medical Standardization Board. *DEPMEDS Policies/Guidelines: Treatment Briefs*. Fort Detrick, Frederick, Md: 1990: E-1, E-2, E-4.

Exhibit 6-2 *continues*

EXHIBIT 6-2: PATIENT CONDITIONS (*continued*)

PATIENT CONDITION 9:

CEREBRAL CONTUSION WITH OPEN SKULL FRACTURE, SEVERE—WITH INTRACRANIAL FRAGMENTS OR DEPRESSED SKULL FRACTURE OR BOTH

LENGTH-OF-STAY MATRIX

	Echelon 3	Echelon 4	Echelon 5	Total Days
ICU	3	3	7	13
ICW	0	5	143	148
MCW	0	0	0	0
Total days	**3**	**8**	**150**	**161**

BLOOD USAGE

	Blood	Hemorrhage Class
Echelon 3	2	II
Echelon 4	0	

NATO Echelon 2

Assumptions: Litter, unconscious; moderate neuro deficits; responds to painful stimuli only; vital signs—moderate tachycardia; rapid shallow resp; some require assisted ventilation; blood pressure normal; minimal-to-moderate hemorrhage; 4% die at this echelon.

Treatment: Stabilize head and C-spine; start IV; intubate 80%; dress and bandage open head wound. Transport on litter, head-up 15°–30° position.

NATO Echelon 3

Assumptions: Litter; neuro status unchanged; Class II hemorrhage; vital signs same as Echelon 2; X ray shows depressed skull fracture with intracranial frag; requires craniotomy; (50% died in hospital).

Treatment: *Emergency Medical Treatment area*: Place endotracheal tube in 20%; assist ventilation 100%; cardiac monitor in 100%; IV to keep open 1 L Ringer's lactate; inspect and dress head wound; nasogastric tube; Foley cath; neurosurg meds; antibiotics; protect neck; X ray: skull, cervical spine; 100% portable chest; Lab: complete blood count, electrolytes, type and crossmatch 3 units

Operating Room: 100% have craniotomies; central venous pressure monitor; 2 units blood; endotracheal tube; antibiotics; 2 L Ringer's lactate; operating room table time 150 min.

Wards: *Intensive Care Unit*: hyperventilate via endotracheal tube with 40% O_2; Ringer's lactate 3 L 1st day; change head dressing; insert tube feeding; abdomen X ray; 100% tube feeding 2nd day; steroids; Foley; IV to keep open after tube feeding begun; may require mannitol; IV antibiotic; cardiac monitor while on ventilator, possible 5% cardiac arrest; complete blood count, electrolytes every other day; transcutaneous O_2 for 3 days. Remove central venous pressure monitor on day 3.

NATO Echelon 4

Assumptions: Litter; 50% conscious/50% unchanged; all require assisted ventilation x 2 days; all on tube feeding; vital signs stable.

Treatment: *Emergency Medical Treatment area*: Check vitals, check IV, suction: ventilate; transport to ward; complete blood count and electrolytes in emergency treatment area on 20%.

Operating Room: 100% have tracheostomies (30 min); operating room table time 60 min.

Wards: *Intensive Care Unit*: control ventilation with tracheostomy; continue IV; continue tube feeding; continue monitoring; continue antibiotics; steroids; disconnect ventilator at day 2; complete blood count & electrolytes every other day; continue Foley; transcutaneous O_2 monitor 2 day; *Intermediate Care Ward*: vital signs; heparin lock to continue IV antibiotics and steroids; tube feeding to continental United States; continue Foley to continental United States; parenteral pain meds; prepare to transfer to Veterans Administration hospital Echelon 5.*

Ancillary Support: occupational therapy/physical therapy evaluation.

*Echelon 5 hospitals are within the continental United States, not in the theater

Reprinted from Scotti MJ, chairman. Defense Medical Standardization Board. *DEPMEDS Policies/Guidelines: Treatment Briefs*. Defense Medical Standardization Board, Fort Detrick, Frederick, Md: 1990: Rev 7/90.

sents the *average* in the spectrum of a particular injury or disease, each treatment brief described (*a*) the average amount of time and equipment needed and (*b*) the average number of personnel and procedures required to treat a given injury.

The lists of equipment the panel had selected were reviewed by a group of senior physicians representing each service—the Joint Services Clinical Review Group—which, along with Logistics, Dental, Nursing, and Pharmacy Quad-Service Review Groups, continues to review DEPMEDS equipment and supplies to ensure that the items are reliable, compatible, complete, and ready to use. There have been numerous annual revisions; major changes were made in 1987 and 1990, and a major update and revision occurred in March 1992.

Once the Joint Services Clinical Review Group review was completed, the Medical Assemblage Design Branch of the Academy of Health Sciences, Fort Sam Houston, San Antonio, Texas, organized the items into functional modules known as medical material sets (MMSs). It is these sets that allow the armed services to deploy medical facilities with markedly different capabilities and still maintain the mandate for standardization. Three types of sets were created[4(p8)]:

- the basic MMS, which contains all the equipment, durable goods and a 3-day supply of consumable equipment for a specific module in the hospital (eg, the Operating Room MMS D301);
- the special-module MMS, which contains equipment for additional capability (eg, the Orthopedic Cast Clinic MMS D314); and
- the resupply MMS, which contains expendable and some durable goods, and can be configured as needed for each individual hospital.

In June 1984, the standardization mission of the Military Field Medical Systems Standardization Steering Group was given to the Defense Medical Material Board, which was renamed the Defense Medical Standardization Board. The Defense Medical Standardization Board continues to direct the development of DEPMEDS and to standardize all medical equipment to the extent consistent with the missions of the individual military services.

The DEPMEDS MMSs were initially tested in November 1984 at Fort Hood, Texas. In November 1985, the DEPMEDS database was again reviewed by a quad-service panel of medical experts. Based on the panel's review, final changes to the MMSs were made, and in March 1987, the Assistant Secretary of Defense for Health Affairs approved the sets as the Department of Defense DEPMEDS sets. DEPMEDS was further evaluated and tested by the U.S. Navy during Operation Safe Haven (1987), the U.S. Army with Joint Task Force Bravo in Honduras during the 1980s, and the U.S. Air Force during REFORGER exercises (1984–1988). Changes based on these experiences resulted in the 1990 version of DEPMEDS, which was more streamlined and fully capable of meeting the quad-service field medical requirements. Based on the experience gained from the Persian Gulf War, DEPMEDS was again updated in March 1992.

The Defense Medical Standardization Board, located at Fort Detrick, Frederick, Maryland, publishes *DEPMEDS Policies/Guidelines Treatment Briefs*, most recently in July 1990.[4] This manual is neither a set of orders nor standing operating procedures for the care of *individual* patients but is the doctrinal basis for medical care in a theater of combat. It contains the concept of operation for DEPMEDS and treatment briefs for the 339 patient conditions used currently in the development of DEPMEDS (examples are shown in Exhibit 6-2). It must be emphasized that these patient conditions were designed to facilitate planning for manpower, equipment, and supply needs; they were never intended to predict every wartime injury nor were they intended to dictate therapy. The patient conditions, which are based on a combination of historical data, computer modeling, experience, and enlightened speculation, provide planning parameters for medical treatment facilities. Of note is the changing number of patient conditions, which occur as patient conditions are added, deleted, or coalesced depending on the threat and changing medical modeling requirements:

> The treatment briefs should be viewed as a living document that will require continual review for currency. At periodic intervals particular types of diseases or injuries will have to be modified due to the advent of new treatment modalities or the change in the medical threat.[4(p92)]

The patient conditions did not change substantially after the Persian Gulf War.

The DEPMEDS manual also contains specific policies for specialties (including anesthesiology), and guidelines for emergency medical treatment, fluid resuscitation, laboratory tests, the use of cell savers, and the use of blood. Anesthesiologists and nurse anesthetists who are deploying with a DEPMEDS-equipped unit should review the manual and note the following policies[4(p49)]:

- Pulse oximetry is available intraoperatively and postoperatively.
- Halothane and isoflurane are the only inhalational anesthetics currently available.
- Nitrous oxide is not available.
- Patients recover in an intensive care unit adapted for that purpose.
- The care of postoperative patients is one of the most important responsibilities of anesthesia personnel.
- In-line oxygen monitoring is available (end-tidal carbon dioxide monitoring currently is not available but was recommended as a part of the monitoring package at the March 1992 update).
- Regional anesthesia kits are supplied for spinal and axillary blocks only (an epidural kit has been requested).
- Draw-over vaporizers are available for use when other methods are unavailable in extremely austere environments.

DEPLOYABLE ANESTHESIA EQUIPMENT

Most of the equipment used by anesthesiologists is currently contained in Operating Room MMS D301. The March 1992 revision strongly recommended that a *separate* anesthesia MMS be created to facilitate accountability, periodic review, maintenance, and rapid accessibility. The only significant piece of equipment not included in the Operating Room MMS for which anesthesia providers have expressed a desire is for a 5-mm flexible, fiberoptic bronchoscope. This instrument is contained in Central Material Supply Special Augmentation Set D342.

Physiological Monitors

The physiological monitors that are part of DEPMEDS include electrocardiographs, automated blood pressure machines, several types of thermometry (including glass oral and rectal thermometers), electronic esophageal stethoscopes, central venous manometers, transcutaneous peripheral nerve stimulators, and pulse oximeters. Monitoring of arterial blood gases is considered vital: DEPMEDS purchased a GEM-STAT blood-gas analyzer (manufactured by Mallinckrodt Sensor Systems, Ann Arbor, Mich.) for the Persian Gulf War and it was included in the 1990 database. Active duty TOE units have this monitor.

Resuscitative Equipment

Resuscitative equipment available includes one defibrillator for each operating room; one external, noninvasive pacemaker in each Emergency Medical Treatment module; and two invasive, external pacemakers, all of which are included in each Medical Services Augmentation set (D413) at the fourth echelon. Gas-powered volume ventilators (the Ohmeda 7000, manufactured by Ohmeda, Inc., Madison, Wis.) and the Ohmeda PAC (portable anesthesia circuit, manufactured by Ohmeda, Inc., Madison, Wis.) unit have been added to the armamentarium. Pressure transducers are not part of the DEPMEDS equipment, but were recommended and requested at the March 1992 update. The Uni-Vent 750 ventilator (manufactured by Impact Medical Corp., West Caldwell, N.J.), a compact, portable ventilator used to provide short-term ventilatory support for an intensive-care-unit patient population, was first made available to the U.S. Army Medical Department (AMEDD) during the Persian Gulf War. Approximately 1,900 units are currently in the DEPMEDS inventory.[5]

Medical Gases

Medical gases are supplied in the operating room MMS. Oxygen tanks include the D cylinder for use as back-up on the Ohmeda 885 Field Anesthesia Machine (manufactured by Ohmeda, Inc., Madison, Wis.) and the M cylinder for use as the central source. H cylinders (6,900 L) are also available. The D cylinder contains approximately 360 L of oxygen and the M cylinder contains 2,835 L at standard temperature and pressure. Medical Supply, a part of Medical Logistics, is responsible for receiving, storing, and issuing all necessary supplies consumed during an operation, including delivery of and exchanging of medical gas cylinders in the operating room. Oxygen tanks are changed on a regular basis and the potential for errors related to the oxygen supply exists, making the in-line oxygen monitor a valuable device. Preventive and corrective maintenance is very limited. An anesthesiologist assigned to a DEPMEDS unit should check with Medical Logistics once the hospital is set up to determine not only what replacement equipment is available but also the extent of the biomedical repair staff's repair capability.

Blood-Recovery Equipment

Blood-recovery equipment is contained in the Blood Recovery/Delivery System Augmentation set (D343) and currently consists of one Haemonetics Cell Saver 4 (manufactured by Haemonics Corp., Braintree, Mass.) machine and the equipment necessary to perform 100 cases (including harnesses, bags, tubing, sterile fluids, and heparin). The blood-recovery system is expected to be used in the preoperative and intraoperative periods in cases of massive hemorrhage. The system is also approved for use in cases of gross blood contamination.

Setup and cleaning are the responsibility of the operating room technicians, and intraoperative use is the responsibility of anesthesia personnel. Efficient intraoperative use of the blood-recovery system requires a second person besides the primary anesthesia provider.

A Level 1 blood-warming infusion device (manufactured by Level 1 Technologies, Inc., Rockland, Mass.) is currently available in DEPMEDS (one Level 1 for every two operating room beds).

Anesthetic Drugs

The pharmacological armamentarium of anesthetics and anesthetic adjuvants available in the operating room set was revised in March 1992 (Table 6-1). At the onset of Operation Desert Shield (ie, the build-up phase of the Persian Gulf War) in August 1990, the primary induction agents were pentothal, ketamine, and diazepam. Maintenance agents were fentanyl and halothane. Muscle relaxants were succinylcholine and pancuronium. The local anesthetic agents were lidocaine, bupivacaine, mepivacaine, and tetracaine. Anesthetics that were deleted at the 1992 update include diazepam, pancuronium, Demerol (meperidine; manufactured by Sanofi Winthrop Pharmaceuticals, New York, N. Y.), and curare. Drugs that had not been available in the basic Operating Room MMS but were added at the March 1992 update include phenylephrine, vecuronium, esmolol, labetalol, nitroglycerin (intravenous preparation), isoflurane, propofol, preservative-free morphine, sufentanil, midazolam, sodium citrate, metoclopramide, 7.5% bupivacaine in dextrose, dexamethasone, albuterol inhalers, and verapamil.

Miscellaneous Equipment

Miscellaneous equipment items that were added at the March 1992 update include epidural kits, hygroscopic humidifiers, Y-type blood-administration sets, and 8.5 French central venous catheter kits. Also added were 3.0- to 6.0-mm (internal diameter) uncuffed pediatric endotracheal tubes, 22-gauge intravenous catheters, and mini-drip intravenous-infusion sets. At the March 1992 update, it was also recommended that a discrete monitoring package be adopted for DEPMEDS. The prototype for this would be the PROPAQ 106 monitor (manufactured by Propaq Systems, Beaverton, Ore.) and ideally would include the ability to monitor the electrical activity of the heart, oxygen saturation, blood pressure (noninvasive), end-tidal carbon dioxide, and to measure two invasive pressures (ie, arterial and central venous pressure).

Essential characteristics for a new field anesthesia machine to replace the Ohio 885 were also submitted by anesthesia representatives to the March 1992 update. Shortcomings of the Ohio 885 include obsolete technology and heavy reliance on compressed gas. Most importantly, because the machine does not meet American Society for Testing and Materials (ASTM) standards, it cannot be used during peacetime for training or patient care. Ideally, the new machine would

- be a small, compact, durable, closed-circuit system;
- be powered by compressed gas (45 psi), an oxygen concentrator, or an air compressor;
- be a multiagent (isoflurane and halothane) vaporizer; and
- meet all ASTM standards.

Work on the development of and procurement for this machine is in progress. Market and industry surveys, development, field testing, and procurement will probably take 3 to 5 years.

The anesthesia drugs and equipment were selected to provide general anesthesia via mask or endotracheal tube, with either controlled or spontaneous ventilation; and regional anesthesia including Bier, axillary, spinal, epidural, and peripheral

TABLE 6-1

ANESTHESIA-RELATED DRUGS CONTAINED IN THE BASIC OPERATING ROOM MEDICAL MATERIAL SETS*

Drug	Concentration or Amount	Quantity or Size Dispensed
Albumin	25 %	100 mL
Albuterol inhaler†	—	17 g
Atropine	0.4 mg/mL	20 mL
Benzoin	—	1 pint
Bupivacaine	0.5%	30 mL
Bupivacaine HCl in dextrose†	7.5 mg/mL	2-mL ampule
$CaCl_2$	100 mg/mL	10-mL syringe
Dyphenhydramine HCl	50 mg/mL	1 mL
Dantrolene sodium	—	20-mg vial
Dextrose in H_2O	5%	50-mL bag
Droperidol inj†	2.5 mg/mL	2-mL ampule
Dexamethasone sodium phosphate inj†	4 mg/mL	5-mL vial
Epinephrine inj USP†	1 mg/mL	1-mL ampule
Epinephrine inj	0.1 mg/mL	10-mL syringe
Esmolol HCl†	10 mg/mL	10-mL vial
Ephedrine sulfate	25 mg/mL	1-mL ampule
Fentanyl citrate inj USP	25 µg/mL	2-mL ampule
Glycopyrrolate inj†	0.2 mg/mL	20-mL vial
Halothane	—	250 mL
Heparin sodium	1,000 units/mL	10 mL
Hetastarch in NaCl	500-mL bag	—
Hydralazine†	20 mg/mL	1-mL vial
Isoflurane USP†	—	100-mL bottle
Isopropyl alcohol USP	—	1 quart
Ketamine HCl inj	50 mg/mL	10-mL vial
Lidocaine	40 mg/mL	25 mL, for infusion
Lidocaine	1%	50 mL
Lidocaine	2%	20-mL vial
Lidocaine HCl + dextrose†	5%	2-mL vial
Lidocaine ointment	5%	35 g
Lidocaine and USP epinephrine inj	1%	20 mL
Lidocaine HCl	1% inj	10-mL syringe
Labetolol HCl inj USP†	5 mg/mL	20 mL
Lubricant, ophthalmic	—	—
Mepivacaine HCl inj†	20mg/mL	50 mL
Midazolam HCl†	5 mg/mL	1-mL vial
Morphine sulfate inj	10 mg/mL	1-mL ampule
Morphine sulfate inj, preservative-free†	—	5-mg vial
Naloxone	0.4 mg/mL	1 mL
Nitroglycerine	5 mg/mL	10-mL vial
Neostigmine	1 mg/mL	10 mL
Nitroprusside†	5 mg/mL	10 mL
Povidone-iodine topical solution	—	3.8 L
Phenylephrine HCl†	1%	1-mL vial
Propofol inj†	10 mg/mL	20-mL ampule
Ringer's lactate	—	1,000-mL bag
Soda lime cartridge	—	—
Sodium bicarbonate	8.4% syringe	50 mL
Sodium chloride inj USP	—	1,000-mL bag
Sodium citrate and citric acid†	oral solution	—
Succinylcholine	20 mg/mL	10-mL vial
Succinylcholine	—	1 g powder
Tetracaine	—	20-mg ampule
Thiopental sodium inj	—	5-g bottle
Vecuronium bromide†	—	10 mg powder, vial
Verapamil†	2.5 mg/mL	2-mL vial
Water for inj, sterile	—	5-mL vial

inj: injection
*As of March 1992
†Recommended additions from the March 1992 DEPMEDS update. These drugs will have to be approved and then purchased before they are placed in DEPMEDS hospitals.
Adapted from Scotti MJ, chairman. Defense Medical Standardization Board. *DEPMEDS Policies/Guidelines: Treatment Briefs*. Fort Detrick, Frederick, Md: 1990: App D.

nerve blocks. Anesthetic drugs and equipment may be available for other techniques to be performed, depending on the experience and innovation of the anesthesiologist or nurse anesthetist.

Fluid Resuscitation

Fluid resuscitation has been stressed appropriately in the outfitting of DEPMEDS facilities. Lactated Ringer's solution and normal saline are the primary crystalloid resuscitative solutions. Hetastarch and albumin are the colloid solutions available and are supplied for use in patients whose estimated blood losses exceed 1,500 mL. Blood products including packed red blood cells, fresh frozen plasma, and platelets (which are typically provided as 200- to 300-mL "six-packs") are also available.

DEPMEDS-EQUIPPED HOSPITALS

DEPMEDS-equipped hospitals are designed to be used in all situations by all four armed services of the U.S. military. By 1990, the army had decided on fielding six types of DEPMEDS-equipped hospitals: general, station, field, evacuation, combat support, and MASH, which have differing mobility, missions, numbers of operating rooms, numbers and types of beds, and types of patients. Physically, DEPMEDS-configured hospitals consist of expandable metal boxes, which, although they are somewhat similar to the hard-walled expandable shelters of the MUST, are really quite different; and TEMPER (*t*ents, *e*xtendable, *m*odular, *per*sonnel) tents, which replaced the MUST program's inflatable shelters. The equipment needed to make the International Standards Organization (ISO) shelters and TEMPER tents functional in their various configurations is contained within MMSs. Electricity is provided by 100-kW, diesel-powered generators.

The expandable shelters were made to conform to the dimensions established for cargo containers by the ISO, and for this reason they are known as ISO shelters. An ISO shelter is, however, not simply a box. Its walls are composed of several layers that, when folded out, can be reconfigured into one or two additional boxes. Thus, the internal volume of a single ISO shelter can be doubled (2:1) or tripled (3:1) (Figure 6-6).

TEMPER tents are the second major component of DEPMEDS hospitals. They differ from standard army tents by having a magnesium-alloy frame instead of wooden poles and a covering that is made of vinyl-covered fabric rather than canvas. In contrast to standard-issue tents, TEMPER tents have fabric floors, a feature that not only limits dust and mud within the patient treatment areas but also makes possible more-efficient cooling and heating of the enclosed space. Individual modules are 8 ft long x 20 ft wide and are extended into either two- or eight-section tents (Figure 6-7). The triage / emergency medical treatment / preoperative module and the postoperative / intensive care units are both composed of eight-module TEMPER tents.

Each DEPMEDS hospital is composed of the same integral components, including (*a*) the patient treatment areas: operating room, emergency medical treatment area, intensive care unit, intensive care ward, and minimal care ward; and (*b*) the ancillary support areas: the clinical laboratory and blood bank, the radiology area, and the pharmacy, among others. The exact configuration of these various areas can be changed depending on the tactical situation and patient flow. These functional areas are not likely to change with Medical Force 2000 (MF2K, which is discussed later in this chapter); the

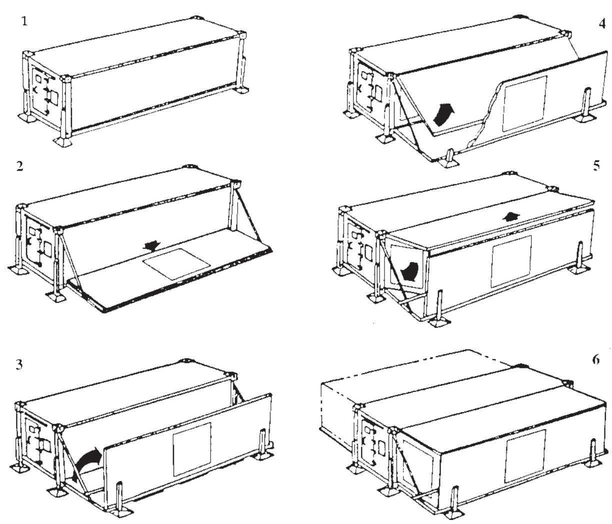


Fig. 6-6. The construction of a 2:1 ISO (International Standards Organization) shelter (**1–5**). The side wall of the original box consists of three individual walls that are folded out to enclose the additional space. A 3:1 ISO shelter can be formed by a similar process performed on the opposite wall (**6**). Adapted from Department of the Army. *Deployable Medical Systems*. Washington, DC: Headquarters, DA; 1990. TC 8-13: 3-21–3-26.

Fig. 6-7. Two TEMPER tent modules have been combined to form the tent on the left, while eight modules have been combined to form the tent shown in the rear. TEMPER: *t*ents, *e*xtendable, *m*odular, *per*sonnel.

equipment contained in them, though, will continue to change as technological advancements are made.

Patient Care Areas

The operating room in a DEPMEDS facility is a 3:1 ISO shelter, which houses two operating tables and the necessary equipment to perform two operations simultaneously (Figure 6-8). The layout of the operating room specifies that both operating room tables face in the same direction, which allows the anesthesia provider more flexibility in monitoring patients. The anesthesiologist is equipped with an Ohmeda 885 Field Anesthesia Machine, Ohmeda 7000 volume ventilator, anesthesia cart, intravenous infusion pole, and suction from an operating room suction machine. The main oxygen supply (two M cylinders per operating room table) and both a fluid and a blanket warmer are all located within the operating room. The operating room layout is schematic and can be changed depending on the type of surgery. Having two operating room tables in one room allows personnel to be used more efficiently and creates a mutual back-up system for equipment and supplies. An associated operating room preparation MMS was supposed to be available, but this appears not to have been deployed.

The emergency medical treatment area is set up to provide initial medical evaluation and treatment, triage, and resuscitation, and to serve as a preoperative holding area when no surgical delay is anticipated (Figure 6-9). Each emergency medical treatment area has space for 12 litter patients and is capable of monitoring vital signs including oxygen saturation and the electrical activity of the heart in a limited number of patients. It is equipped to provide Advanced Trauma Life Support (ATLS; discussed in Chapter 1, Combat Trauma Overview) care to all patients, and mechanical ventilation to a very limited number (but only to two patients at a time). Depending on the size of the hospital, two or more emergency medical treatment sets were designed into the new MF2K structure to accommodate the hypothetical number of incoming casualties.

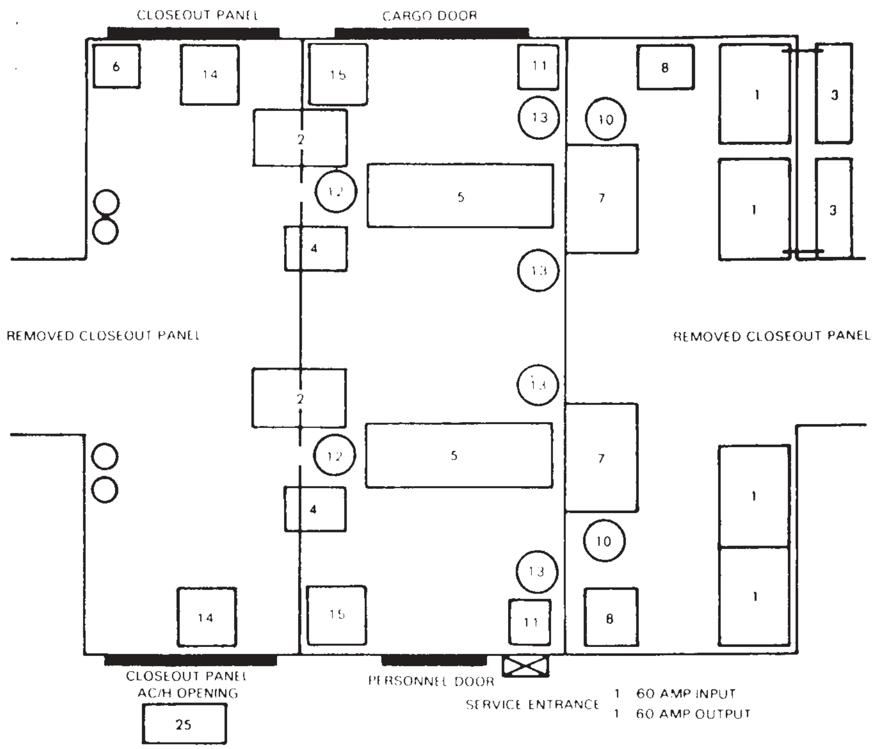
The intensive care unit is designed to provide care to the most seriously injured and to sick patients of all types (Figure 6-10). Each intensive care unit has 12 beds and can mechanically ventilate six patients using volume ventilators. The unit is capable of monitoring the patients' electrocardiographic status and oxygen saturation but, as is the case throughout DEPMEDS, does not currently have the capability for any type of invasive blood pressure monitoring except central venous pressure via manometry. The intensive care unit may also be used as a postanesthetic recovery area.

The intermediate care ward is designed to provide care to acutely injured or sick patients of all types. The ward does not normally care for patients who require continuous monitoring or life-support devices, but the level of acuity can vary greatly depending on the type of conflict or catastrophe. The intermediate care ward can also serve as a specialty area (ie, a burn ward). It has the capacity for 20 patients.

The minimal care ward provides care to medical and surgical patients who are ambulatory and partially self-sufficient. No intravenous fluids or parenteral medications are administered on this ward. The primary focus on the ward is the physical and psychological conditioning of soldiers expected to return to duty. The ward has a capacity of 40 patients housed in two general purpose, large (GPL) tents.

The relative mix of anesthesia-relevant MMSs, ISO shelters, and TEMPER tents depends on the type of hospital. The authorization matrix for the 1990 version of DEPMEDS is shown in Table 6-2. Updating of the matrix is continuous, however, and this information has already been changed by MF2K.

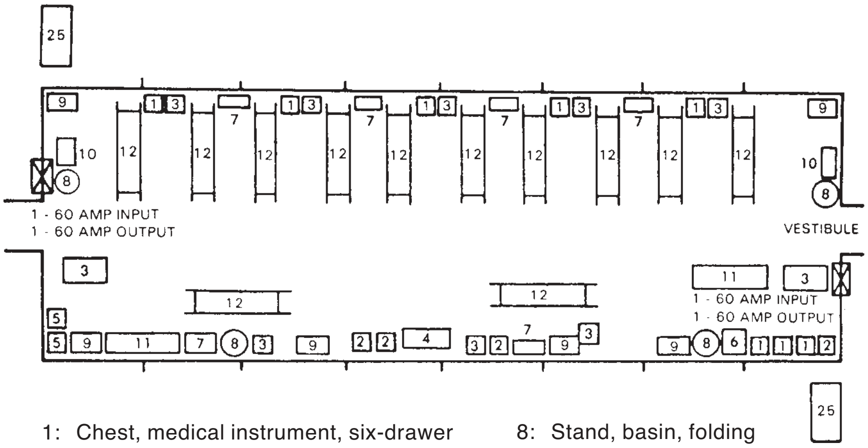
a



1: Cabinet, pharmacy, base
2: Cart, anesthetic equipment
3: Cabinet, pharmacy, upper
4: Apparatus, anesthetic
5: Table, operating, field
6: Regulator, thermo
7: Table, surgical instrument
8: Table, surgical instrument and dressing
10: Stand, basin, folding
11: Apparatus, electrosurgical
12: Stool, revolving
13: Pail
14: Cloth, frame
15: Apparatus, suction
25: Air conditioner/heater

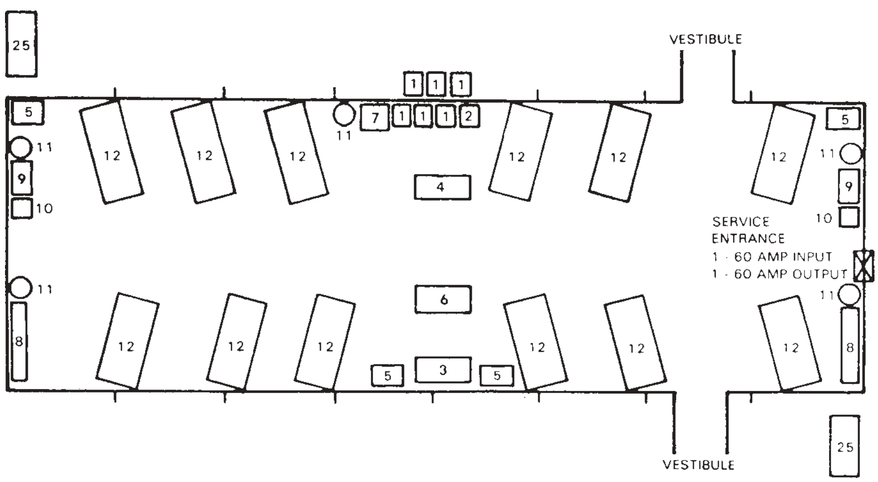
b

Fig. 6-8. (**a**) The recommended arrangement of the DEPMEDS operating room medical material set in a 3:1 ISO shelter. (**b**) The two operating tables in a 3:1 ISO face in the same direction, which allows the anesthesia provider more flexibility in monitoring patients. DEPMEDS: Department of Defense's Deployable Medical Systems; ISO: International Standards Organization. Diagram (a) : Reprinted from Department of the Army. Deployable Medical Systems. Washington, DC: Headquarters, DA; 1990. TC 8-13: 2-2.



1: Chest, medical instrument, six-drawer
2: Chest, medical instrument, #3 field
3: Chest, medical instrument, two-shelf
4: Cart, resuscitation, mobile
5: Chest, medical instrument (utility)
6: Refrigerator-freezer, mechanical
7: Stand, surgical instrument
8: Stand, basin, folding
9: Light, floor, operating
10: Sink unit, surgical
11: Table, folding legs, laboratory
12: Litter
25: Air conditioner/heater

Fig. 6-9. The recommended arrangement of the DEPMEDS triage/emergency medical treatment area/preoperative room medical material set in an eight-module TEMPER tent. This facility may or may not be connected to the operating room by an interposed operating room preparation area medical material set. DEPMEDS: Department of Defense's Deployable Medical Systems; TEMPER: *t*ents, *e*xtendable, *m*odular, *per*sonnel. Reprinted from Department of the Army. *Deployable Medical Systems*. Washington, DC: Headquarters, DA; 1990. TC 8-13: 2-36.



1: Chest, medical instrument, two-shelf
2: Chest, medical instrument with 22-drawer insert
3: Cart, resuscitation
4: Desk, field with folding chairs
5: Light, floor, operating and exam
6: Cart, surgical dressing
7: Refrigerator-freezer
8: Shelf, chrome, 1848
9: Sink unit, surgical
10: Frame, cloth basket, folding
11: Stand, basin, folding
12: Bed, adjustable, hospital
25: Air conditioner/heater

Fig. 6-10. The recommended arrangement of the DEPMEDS postoperative/intensive care unit medical material set in an eight-module TEMPER tent. This facility would be connected to the end of the operating room medical material set opposite the triage/emergency medical treatment area/preoperative room medical material set. DEPMEDS: Department of Defense's Deployable Medical Systems; TEMPER: *t*ents, *e*xtendable, *m*odular, *per*sonnel. Reprinted from Department of the Army.*Deployable Medical Systems.* Washington, DC : Headquarters, DA; 1990. TC 8-13: 2-32.

TABLE 6-2

DEPLOYABLE MEDICAL SYSTEMS–MEDICAL MATERIAL SET AUTHORIZATION MATRIX

	DEPMEDS-Equipped Hospitals (Number of Sets)						
Medical Material Set	**MASH**	**CSH**	**EVAC**	**STA 300**	**STA 500**	**FH**	**GH**
Operating room	2	2	3	1	2	3	3
Triage area	1	1	1	1	1	3	1
Intensive care unit	5	4	4	2	4	3	8
Intermediate care	0	4	8	9	15	9	30
Minimal care	0	4	10	5	8	9	15

MASH: Mobile Army Surgical Hospital; CSH: Combat Support Hospital; EVAC: Evacuation Hospital; STA 300: Station Hospital, 300 beds; STA 500: Station Hospital, 500 beds; FH: Field Hospital; GH: General Hospital
Adapted from US Department of the Army. *Deployable Medical Systems: Tactics, Techniques, and Procedures*. Washington, DC: Headquarters, DA; 7 Dec 1990. Training Circular 8-13, Table 2-1, p 2-24.

Ancillary Support Areas

The laboratory section of a DEPMEDS-equipped facility consists of two parts: the clinical laboratory and the blood bank. The clinical laboratory provides basic hematology, chemistry, urinalysis, microbiology, and serology; cytology and pathology can be performed only if an augmentation team with equipment is added to the hospital. The complete list of tests provided is contained in the *DEPMEDS Policies/Treatment Briefs*; Table 6-3 includes only tests of particular interest to anesthesiologists.

There are two types of blood bank sections: the Liquid Blood Bank MMS D304 and the Liquid/Frozen Blood Bank MMS D404. The liquid blood bank can store 500 units of packed red blood cells and can issue 250 units for transfusion in a 24-hour period. Each patient's blood is ABO grouped and Rh typed. A single-tube (major-side saline, immediate spin) cross-match is performed on each patient. The liquid blood bank can draw and type 180 units of fresh whole blood for extreme emergencies. The liquid/frozen blood bank can store 500 units of packed red blood cells, 485 units of frozen red blood cells, 10 units of fresh frozen plasma, and 5 packs of platelets, and is capable of reconstituting 180 units of frozen red blood cells per 24 hours. It can issue up to 250 units of blood for transfusion in a 24-hour period. It has the same emergency blood-drawing capabilities as the liquid blood bank. The storage and transfusion shelf life of the different blood products was established in accordance with the Military Blood Program 2004 Study (which is available from U.S. Army Medical Department [AMEDD] Center and School, Fort Sam Houston, San Antonio, Tex.).

Several assumptions and planning factors are used in calculating blood usage:

- Only blood that is actually to be transfused is ordered.
- Patients with hematocrits of 0.21 or lower will frequently require blood transfusions.
- Single units of blood will not be requested.
- Fresh frozen plasma is transfused at a ratio no greater than 1 unit per 10 units of red blood cells infused into the same patient.
- Platelets are transfused at a ratio no greater than 1 unit per 20 units of red blood cells infused into the same patient.
- Each platelet transfusion is expected to raise the platelet count in a 70-kg man by 30,000 to 80,000 platelets/mm^3.

Both platelets and fresh frozen plasma supplies are extremely limited in the theater of action, and the current recommendation is that they be used only for documented thrombocytopenia or coagulopathy. The transfusion ratios were established using accepted standards of transfusion medicine in trauma settings. However, these are guidelines, and the decision to administer any blood products is a clinical one that is the medical officer's responsibility. A more detailed discussion can be found in Chapter 15, Military Transfusion Practice.

Radiographic support is provided by a fixed, high-capacity, combination X-ray and fluoroscopy unit, and by portable machines. The radiographic capabilities include plain X-ray examinations

TABLE 6-3

LABORATORY PROCEDURES PERFORMED AT THE THIRD AND FOURTH ECHELONS

Test	Task No.	Description	Third Echelon	Fourth Echelon
Chemistry	E001	Blood gas estimation	+	+
	E002	Electrolyte levels (Na^+, K^+, Cl^-, HCO_3)	+	+
	E003	Total serum protein level	+	+
	E004	Urinary protein level	+	+
	E005	Serum creatinine level	+	+
	E007	Serum amalyse level	+	+
	E008	SGPT level	+	+
	E009	CK level	+	+
	E010	Blood glucose	+	+
	E011	BUN level	+	+
	E012	Serum bilirubin	+	+
	E013	Spinal-fluid sugar	+	+
	E014	Spinal-fluid protein	+	+
	E015	SGOT level	—	+
	E017	Calcium level	+	+
Hematology/Urinalysis	E020	CBC (WBC, Hgb, Hct)	+	+
	E021	White cell count	+	+
	E022	Hematocrit level	+	+
	E024	White cell differential count	+	+
	E025	Prothrombin time	+	+
	E026	PTT	+	+
	E028	Spinal fluid cell count and differential	+	+
	E029	Urinalysis with specific gravity	+	+
	E030	Microscopic urinalysis	+	+
	E031	Platelet estimate	+	+
	E032	Platelet count	+	+
	E033	Fibrinogen level and fibrin split products	—	+

SGPT: serum glutamic-pyruvic transaminase (alanine aminotransferase); CK: creatine kinase; BUN: blood urea nitrogen; SGOT: serum glutamic-oxaloacetic transaminase (aspartate aminotransferase); CBC: complete blood count; WBC: white blood cell; Hgb: hemoglobin; Hct: hematocrit; PTT: partial thromboplastin time
Adapted from Scotti MJ, chairman. Defense Medical Standardization Board. *DEPMEDS Policies/Guidelines: Treatment Briefs*. Fort Detrick, Frederick, Md: 1990: 82.

and some special studies (eg, upper gastrointestinal series, intravenous pyelogram, and single-shot angiography). Although only the portable X-ray unit is available in the operating room, the unit can be taken throughout the hospital. A refined C-arm module is in the process of approval and was suggested for procurement and fielding by the year 2000.

The pharmacy stocks a number of drugs that are not part of the operating room MMS. Once the hospital has deployed, the actual placement and distribution of drugs may vary depending on the standing operating procedures of the hospital. The handling of controlled substances will likewise vary depending on the situation and the guidance of the hospital commander.

DEPLOYABLE HOSPITALS IN THE PERSIAN GULF WAR

Forty-four DEPMEDS-equipped hospitals were deployed to Saudi Arabia in support of the Persian Gulf War (Table 6-4).[6] The enormous size and complexity of a typical DEPMEDS-equipped hospital is apparent in Figure 6-11, which shows two evacuation hospitals collocated in the same base camp in the Arabian desert during the Persian Gulf War. Ad hoc forward surgical teams (FSTs) were also deployed and were used in support of combat arms units far forward in the combat zone. These elements were not DEPMEDS-equipped owing to mobility constraints; important components of DEPMEDS equipment (eg, ISO shelters, TEMPER tents, C-arms, laundry units, and other bulky equipment items) were found to be incompatible with high mobility. The ISO shelters require specially designed dolly sets for their movement; they are not designed to be transported by truck, a significant drawback in a war characterized by movement. The DEPMEDS equipment is too heavy and too complex, and the reassembly is too time-consuming for modern maneuver warfare. The afteraction reports from Operation Desert Storm are replete with statements that hospital equipment cannot be moved rapidly enough to support the needs of a highly mobile army:

> There were strong feelings in regard to the mobility of DEPMEDS equipment, especially in this conflict when hospitals had to move long distances in short periods of time, and then rapidly prepare to receive casualties.[7(p8–24)]
>
> . . . .
>
> A hospital following the forward maneuver units and providing surgical care should be capable of establishing the Emergency Medical Treatment (EMT) section and one to two operating rooms (OR) in 1 to 2 hours, and the entire hospital in 6 to 8 hours. The hospital should be able to break down and be prepared to move in less than 12 hours. The hospital should be capable of moving in sandy and rough terrain.
>
> In Operation Desert Storm, most forward hospitals took 3 to 4 hours to have an operating room set up, 6 to 8 hours to set up the EMT section, and almost 24 hours to establish the entire hospital. Thirty-six to 48 hours were required to break down and pack the hospital. Thirty 5-ton trucks were required to move the hospital, with only approximately 10 contained in the unit TOE. Each truck also had an attached dolly set. Each dolly set required 8 to 12 people a half hour (or more at night) to attach. The dolly set had only a 12-inch clearance, causing it to be easily hung up, in the front, in rough terrain (offroad).[7(p1–11)]

TABLE 6-4

HOSPITALS DEPLOYED TO SAUDI ARABIA (1990)

Hospital	Number Deployed
Mobile Army Surgical Hospital	8
Combat Support Hospital	9
Evacuation Hospital	22
Station Hospital	1
Field Hospital	3
General Hospital	1
Total	**44**

Hospitals deployed during the Persian Gulf War included both active duty and reserve or National Guard units. By August 1990, very few active duty units had converted to DEPMEDS. Those that had invariably suffered from shortages of equipment and pharmaceuticals. The training sets that reserve and National Guard hospitals were issued contained only minimal essential equipment, while the complete hospital sets were placed in storage as prepositioned material configured in units and sets (POMCUS) or primary mobilization stations (PRIMOB). Shortages were attributed to the newness of the system, delays in purchase from the industrial base, and sometimes delayed decisions from clinical groups that reviewed equipment and drug selection. The following priority sequence was used in fielding DEPMEDS:

1. unequipped reserve and National Guard units,
2. active duty, rapid-deployment units,
3. regional training sites, and
4. active duty TOE hospitals.

At the time of deployment, the decision was made to modernize in theater. Therefore, equipment sets that had been packed for long-term storage were lacking (ie, short) some equipment and were not functionally operational when they arrived in country. These equipment shortages led to the ship-short concept: the package of missing equip-

Fig. 6-11. Two evacuation hospitals, the 148th in the distance on the left and the 410th in the near right, deployed in the Kuwaiti Theater of Operations during the Persian Gulf War. TEMPER tents form much of the central portion of the 410th. ISO shelters can be identified by their lighter color. Hospital personnel are billeted in the complex of canvas tents that occupy the right side of the hospital. TEMPER: *t*ents, *e*xtendable, *m*odular, *per*sonnel; ISO: International Standards Organization. Photograph: Courtesy of Public Affairs, Office of The Surgeon General, US Army.

ment (ie, the push packet) would be sent to the units in theater as soon as it could be procured. Correction of shortages was actually a complex process; it involved six independent, functional areas that procured equipment and supplies. Delivery to specific hospitals in theater then required the coordinated efforts of the Medical Supply, Optical, and Maintenance (MEDSOM) Battalion (which is now called the Medical Logistics Battalion).

Communication—both between hospitals and between air force and army evacuation assets—was frequently a problem. Deployed personnel cited premobilization instruction in theater communications networks and standing operating procedures as critical information to help avoid future problems.

Afteraction reports by anesthesiologists (60N) and nurse anesthetists (66F) expressed concerns about the following missing equipment:

- noninvasive blood pressure machines,
- pulse oximeters,
- electrocardiographs,
- adequate suction devices,
- regional anesthesia kits and needles,
- oxygen tubing, and
- medications (eg, isoflurane, vecuronium, midazolam, reversal agents, and pentothal).

It must be emphasized, however, that many of the items and drugs (including isoflurane, vecuronium, and even nitrous oxide) that deployed personnel expected to have, were *never* on the TOE for DEPMEDS hospitals, and therefore should not have been expected. However, the Office of The Surgeon General decided to attempt to provide non-TOE pharmaceuticals if such were requested by deployed physicians. In addition to standard U.S. Army channels, sources for equipment procurement included local purchase, Air Force logistics, and even personal mail from hospitals in the continental United States. All hospitals were operational by the onset of the ground war.

Work load, patient type, and frequency of movement varied widely among the 44 DEPMEDS hospitals deployed to Saudi Arabia. Patient categories included U.S. and allied military battle injury and nonbattle injury, civilian disease and injury, and Iraqi prisoners. The variety of patient conditions encountered emphasized the need for the DEPMEDS system to be able to support all aspects of clinical anesthesia: emergency and elective (neurosurgical, thoracic, abdominal, vascular, etc), and regional, obstetrical, and even pediatric anesthesia. The percentages of multiple-trauma cases varied widely in the afteraction reports.[7]

The most frequently used anesthetic agents included isoflurane, succinylcholine, vecuronium, thiopental, ketamine, local anesthetics, and fentanyl. By far the most commonly used general anesthetic technique was a rapid-sequence induction with tracheal intubation, followed by a balanced anesthetic. Packed red blood cells were frequently used, but the use and availability of fresh frozen plasma or platelets was minimal to nonexistent. Oxygen supplies, particularly for refilling tanks, were frequently inadequate. Sterile water was supplied in plastic bottles.

The Persian Gulf War provided the first true test of the DEPMEDS system. As with any new system, problems were encountered and weaknesses uncovered; nevertheless, the conversion to DEPMEDS was completed in theater and all hospitals were ready by the time the ground offensive commenced. Overall, the system worked well under often adverse conditions, although the limited number of casualties makes an assessment of DEPMEDS' true value difficult to make. The Defense Medical Standardization Board will continue to conduct a review of equipment and drugs approximately every 2 years; changes will be made as necessary. The system will always be in transition so that it can keep up with changes in warfare, medical doctrine, and new developments in medical technology. The structure of the medical force will continue to evolve. Changes in war-fighting doctrine, changes in the nature and sophistication of threat forces, and the increasing requirement for AMEDD to be involved in peacetime missions will necessitate constant changes and force modifications.

MEDICAL FORCE 2000

While DEPMEDS is essentially a system describing the characteristics of hardware, Medical Force 2000 (MF2K) deals not only with equipment but also with personnel and organization. Four types of hospitals—MASH, combat support, field, and general—and a medical holding company were initially envisioned by MF2K. Under MF2K, station and evacuation hospitals will be deleted from the system, and the MASH configuration will change dramatically. These changes will largely be made to prevent duplication in the system and to streamline the patient-evacuation flow. The original concept calls for the MASH to be changed from a 60-bed, DEPMEDS-configured facility to a more-mobile, 30-bed, non-DEPMEDS unit. The MASH remains a surgical unit only, with minimal medical-treatment or patient-holding capability. Likewise, for mobility considerations, the MASH will not use ISO shelters. The combat support, field, and general hospitals will remain DEPMEDS equipped. The numbers of anesthesiologists and nurse anesthetists proposed for each type of hospital are found in Table 6-5. The third echelon includes the MASH, combat support hospital, and medical holding company; the fourth echelon includes field and general hospitals. Like DEPMEDS, MF2K is subject to revision, the process being known as the medical reengineering initiative (MRI).

The MF2K designs for the combat support, field, and general hospitals are built using a four-module concept:

- Hospital Unit, Base (HUB)
- Hospital Unit, Surgical (HUS)
- Hospital Unit, Medical (HUM)
- Hospital Unit, Holding (HUH)

The HUB, a base, can operate independently and is located in each hospital as the initial building block. The exact composition of the base may vary among the different hospitals. The other modules contain the necessary equipment, supplies, and assigned personnel to accomplish the particular mission (eg, to provide an operating room capability for a certain number of operating tables, in the case of the HUS). Future AMEDD force-structure doctrine, as expressed in MF2K and MRI, will emphasize the tailoring of medical assets for the proposed mission, an undertaking less easily accomplished with previous DEPMEDS-configured hospitals designed for a high-intensity war.

Mobile Army Surgical Hospital

The original MF2K design for the MASH converted the existing 60-bed hospital to a highly mobile 30-bed facility designed to function in the rear area of the division or the forward area of the corps. Surgical capability was based on three operating room tables for general, orthopedic, and thoracic surgery. Preoperative and postoperative acute nursing care for up to 30 patients was provided in three wards. The following services were planned: pharmacy, clinical laboratory, liquid-blood bank, radi-

TABLE 6-5

MEDICAL FORCE 2000 ANESTHESIA STAFFING

Hospital	Anesthesiologists* (Number)	CRNAs† (Number)
MASH	1	4
Combat Support Hospital	3	15
Field Hospital	1	2
General Hospital	3	15

*60N
†66F
MASH: Mobile Army Surgical Hospital; CRNA: Certified Registered Nurse Anesthetist
Source: Perkins DE. Colonel, Medical Corps, US Army. Washington, DC: Walter Reed Army Medical Center. Personal communication, June 1995.

ology, and food services. Unfortunately, it soon became apparent that the reduction in weight and volume was less than desired: in 1992, a MASH weighed 240,500 lb and occupied 17,514 ft^3, and the MF2K MASH weighed 184,331 lb and occupied 15,498 ft^3.[8] In the future, neither the 30- nor the 60-bed MASH will be fielded.

The configuration of the army's forward surgical hospitals has undergone a great deal of study, analysis, and field testing during the last half century and an entirely satisfactory design is not yet available. In no other type of hospital is the tension between the perceived need for ever-increasing medical sophistication and complexity and the military logistical requirements for a high degree of strategic and tactical mobility more apparent. One of the implicit assumptions behind DEPMEDS was to match the standards of civilian hospitals while also being able to care for the massive casualty load expected to be generated by a high-intensity war in Europe. Planners tacitly assumed that transportation capability would appear when needed. In essence, bed capacity and sophistication of care were favored over mobility and sustainment. The MASH, which has long been criticized as being too heavy and bulky to have the needed degree of strategic or tactical mobility, was more affected by this design philosophy than was any other DEPMEDS hospital. The commander of the 5th MASH during the Persian Gulf War has written of the need to reverse the DEPMEDS approach to the design of deployable hospitals by first defining weight and volume limits compatible with strategic and tactical mobility. Weight and volume limits should then be used to determine the number of beds, surgical capability, and staffing.[9]

Forward Surgical Team

The MASH is to be replaced by a TOE unit to be known as the FST. This unit, of which at least 30 are planned, will have 2 operating tables and 8 beds. It will be staffed by 3 general surgeons and 1 orthopedic surgeon; 2 nurse anesthetists; 1 each operating room nurse, intensive care nurse, medical-surgical nurse; and 11 medics. The FST will be housed in lightweight collective protective equipment developed by the U.S. army and known as chemical biological protective shelters (CBPS). The tents are made of synthetic materials, and will be moved in six high-mobility, multipurpose, wheeled vehicles (HMMWVs) (Figure 6-12). The CBPS, which looks superficially like the Vietnam War–era MUST shelter (see Figure 6-4), has a rib structure and is inflated by a compressor integral to the HMMWV. The inflated, insulated CBPS has airlocks for both litter and ambulatory access.[10]

An FST is eminently air-transportable and can, with its organic vehicles, be moved by two C-141 missions (or possibly only one). By way of contrast, the 1990 version of the MASH required no less than 32 C-141 missions for its deployment.[9] Standard DEPMEDS MMSs will not be used. Supplies will be available for 72 hours of continuous operations, during which period 30 major operations can be performed. Supplies include 60 units of Group O, Rh-negative blood.

The original plan called for the FST to be collocated with a brigade- or division-level medical company, with the patient flow being through the medical company. The critically injured casualties were to be sent directly to the FST, with the remainder of the casualties to be evacuated after resuscitation to third-echelon hospitals. Because a medical company may not always be available, or because logistical and personnel constraints may have reduced the capability of the medical company, an additional option has been formulated: the FST can be deployed with both a holding and a treatment squad, the combined unit being called a Medical Readiness Task Force.

Command and control of the FST was to have been from the combat support hospital to which the FST was originally attached (but not part of) when not deployed, but it is now likely that the FST will be controlled by the corps-level medical brigade. Regardless of the resolution of the command-and-control issues, today's FST is nearly identical in form and function to the forward battlefield surgical team of World War II (see Figures 6-1 through 6-3).

The effect of advanced technology has been more incremental than revolutionary on AMEDD's ability to care for gravely wounded, nontransportable casualties. Numerous incremental changes, however, can have a significant total impact. Compare the following points with the list of essential equipment that was compiled by World War II surgeons (see Exhibit 6-1):

1. Transportation is now accomplished on HMMWVs, which are much more mobile and capacious than jeeps.
2. Modern lighting, including the use of headlights by the surgeons, is a fundamental improvement on previous equipment. This is an example of a seemingly minor change that is, in fact, extremely beneficial to surgeons and therefore to combat casualty care.
3. Heavy oxygen cylinders and other equipment need no longer be transported to

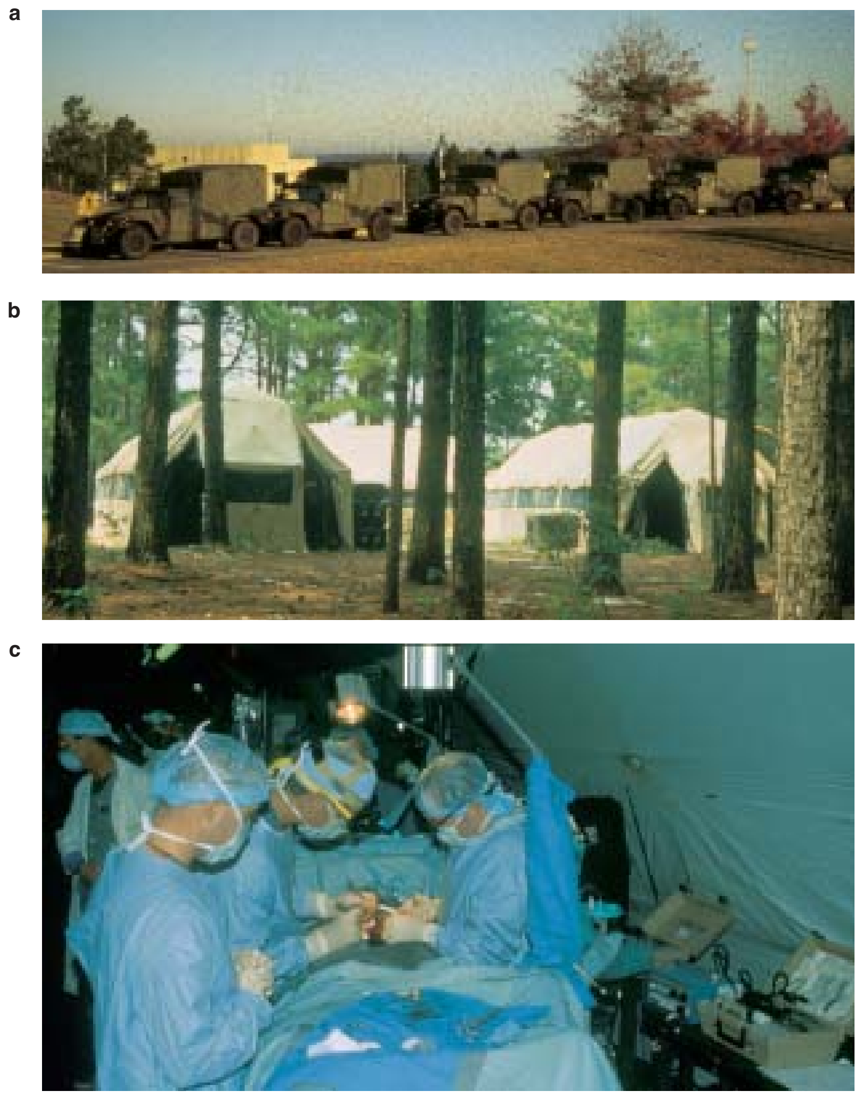


Fig. 6-12. The *d*eployable *r*apid *a*ssembly *sh*elter (DRASH) was used in early prototype forward surgical teams (FSTs), before the decision was made to use the chemical biological protective shelter (CBPS). These photographs of DRASHs were taken during a field exercise carried out by the 274th Forward Surgical Team of the 44th Medical Brigade, Fort Bragg, North Carolina, in November 1995. They illustrate some of the similarities to and changes from forward surgery during World War II (see Figures 6-1 through 6-3). (**a**) The entire team and its equipment are deployed in six high-mobility, multipurpose, wheeled vehicles (HMMWVs). (**b**) The FST works in three interconnected shelters. The first tent is for receiving and resuscitating casualties; the second contains two operating tables, draw-over anesthesia equipment, and surgical instruments; and the third, which has eight beds, is the intensive care and recovery area. The DRASH could be set up and made fully functioning within 1 hour; an individual CBPS, using only three men, in 15 minutes.[1] (**c**) An actual operation is seen in progress in the operating tent. (1) Gander TJ. *Jane's NBC Protection Equipment.* 5th ed. Surry, United Kingdom: Jane's Information Group Limited; 1992: 203. Photographs: Courtesy of Major Thomas E. Knuth, MD, MPH, Medical Corps, US Army; Eisenhower Army Medical Center, Fort Gordon, Ga.

forward hospitals. Oxygen concentrators are part of DEPMEDS equipment, and oxygen can be manufactured in situ.

4. The vagaries and possible complications of using fresh blood donations have been obviated by the availability of the hospital's own blood bank and the blood transfusion program.
5. Autoclaving is not used in FSTs; surgical instruments are chemically sterilized. This improvement has relieved the logistical demands of transporting heavy autoclaving equipment.
6. The laundry function of the hospital has been supplanted by the use of disposable towels, gowns, sheets, and other linen.
7. CBPS tents are made of a high-performance fluoropolymer/aramid laminate, in contrast to the heavy canvas that has been used since at least World War I. The lightweight synthetic material can be decontaminated easily and protects personnel inside against chemical and biological warfare agents (liquid and vapor). In addition, individual CBPS units can be connected to make complex collective protection modules.[10] These improvements may provide a more pleasant, climate-controlled environment for casualties and medical personnel, but they do not necessarily translate directly into lower mortality in combat casualty care.

Anesthesiologists in command-and-control positions need to assure the proper use of the FST. In a conventional war, in which the casualty load may fluctuate in a widely unpredictable manner, the FST should be used to care for *only* the critically wounded, the transportable casualties being evacuated to the combat support hospital. If this is not done, the meager resources of the FST may be exhausted just when they are needed to care for an influx of gravely wounded soldiers. Members of the FST and commanders of medical companies in a position to refer casualties *must* understand the role of the FST in the overall context of field medical support. By way of contrast, in operations other than war (OOTW), such as when an FST is deployed to support a small unit not engaged in combat operations, the FST will probably assume treatment functions going beyond the exclusive care of the critically wounded.

Combat Support, Field, and General Hospitals

The mission of the combat support hospital is to stabilize patients for further evacuation and to return to duty those soldiers who fall within the corps evacuation policy. This hospital is capable of handling all types of patients and will be employed in the corps area. Surgical capability is based on eight operating room tables (each used for 18 h/d), for a surgical capacity of 144 operating room–table hours per day. Hospitalization for up to 296 patients includes 96 intensive care beds. The combat support hospital has, organic to its TOE, 35% of the vehicles needed for a tactical move; it is DEPMEDS configured.

The field hospital provides hospitalization for general classes of patients and reconditioning or rehabilitating services for those who can return to duty within the theater evacuation policy. Most patients at this facility will be there for rehabilitation. The field hospital will usually be located in the communication zone. Hospitalization for up to 504 patients includes 36 intensive care beds. Surgical capability is based on two operating room tables, for a capacity of 24 operating room–table hours per day. All movement requirements are the responsibility of theater transportation units. This hospital is DEPMEDS configured.

The general hospital, a 476-bed facility, serves as the main conduit for patient evacuation to the continental United States. It provides stabilization and hospitalization for general classes of patients. Surgical capability is based on eight operating room tables for a capacity of 144 operating room–table hours per day. Intensive nursing care is available for up to 96 patients. The general hospital relies on theater transportation units for movement and is DEPMEDS configured.

MEDICAL REENGINEERING INITIATIVE

The characteristics of U.S. Army deployable hospitals continue to change. The need for change arises from the design of MF2K deployable hospitals, which was based on a high-intensity NATO war-fighting scenario that anticipated vast numbers of combat casualties. The recent U.S. Army experience in the Middle East, Somalia, Haiti, and Bosnia suggests a less apocalyptic battlefield. To meet the multiple deployment contingencies in the early 21st century, the MRI envisions one basic hospital design (not the seven of the original DEPMEDS or the four of MF2K), composed of small but self-sufficient modules. The MRI hospital size and the mix of its beds (eg, intensive care, minimal care) will differ from that of DEPMEDS hospitals. The basic hospital will consist of 248 beds: 48 in intensive care and 200 in intermediate care. Minimal care beds will be provided by a separate medical detachment that will be added to the basic hospital as needed. The basic hospital design calls for five operating tables disposed in three operating room modules. Two of these modules will have two tables each; the third will have one table plus a C-arm for radiographic studies and an operating microscope. The major component of the basic hospital, an 84-bed module, is fully deployable forward with one of the two-table operating room modules.

The new MRI hospital will be able to provide general, orthopedic, thoracic, and oral maxillofacial surgical care. Neurosurgery and eye, ear, nose, and throat surgical capabilities can be added to the basic hospital by attaching a Hospital Augmentation Team–Head and Neck, which will include computed tomography capability. Additional Hospital Augmentation Teams are proposed, including those for Renal Dialysis, Infectious Disease Pathology, and OOTW. Typically civilian medical and public health problems are likely to be encountered in OOTW, and that team will include a pediatrician, pediatric nurse practitioner, community health nurse, obstetrician–gynecologist, midwife, preventive medicine physician, and primary care physician. DEPMEDS equipment, including shelters, will be used in the basic MRI hospital. Lighterweight shelters, based on the recently fielded CBPS system, may become available in the near future.

Fig. 6-13. The USNS *Comfort* as viewed from the stern. The helicopter flight deck, designated by the cross, is forward. In addition to having access by two elevators, one next to the helicopter flight deck and one forward, casualties can enter the ship through two water-level loading portals. The *Comfort* and her sister, the *Mercy*, each have an overall length of 894 ft, a beam of 105 ft 9 in., a draft of 32 ft 9 in., a displacement of 69,360 tons, a maximum sustained speed of 17.5 knots, and an endurance of 13,420 nautical miles. Photograph: Courtesy of Colonel James Collins, MD, Medical Corps, US Army, Commandant, Uniformed Services University of the Health Sciences, Bethesda, Md.

A major difference between the MRI hospital and its DEPMEDS/MF2K predecessors is the heavy emphasis in the former on telemedicine and hospital information and communications systems. At present the order of priority will be to develop (1) intrahospital communication with telephones, either wired or cellular; (2) local and wide-area networks for interhospital communications; (3) digital radiology; and ultimately, (4) full-motion video teleconsultation.

The proposed MRI hospital will be deployed to both the corps and the echelon above corps, differing only in that the latter may have fewer organic transportation assets and therefore will be less mobile. Far forward resuscitative surgery will be provided by FSTs as proposed in MF2K.

HOSPITAL SHIPS

The U.S. Navy's hospital ships are the ultimate deployable hospitals. Although the ships are obviously not AMEDD assets, U.S. Army anesthesia providers need to know about their capabilities because of the increasing interdependence of the nation's military medical services. The U.S.N.S. *Mercy* (T-AH 19) and *Comfort* (T-AH 20) were originally 80,000-ton supertankers. During the mid 1980s they were converted into hospital ships with a 50-bed casualty receiving area, 12 operating rooms, 500 acute care beds (20 recovery room, 80 intensive care, and 400 intermediate care beds), and 500 minimal care beds (Figure 6-13). Staffing consisted of 77 physicians, 160 nurses, and 250 enlisted personnel.

During the Persian Gulf War, the ships were given the resources to receive 200 casualties per day for 30 days. The internal organization of the ship's medical treatment facilities and the casualty flow plan, from the helicopter flight deck through the treatment areas to the patient wards, was designed to be simple and rational (Figure 6-14). Although a hospital ship is a remarkable facility with extraordinary treatment capabilities, medical officers should remember that like any hospital, it is useful only if it can be reached by casualties. For the casualty who requires resuscitative surgery, a hospital ship is useful only if the combat occurs near a coastline.[11]

SUMMARY

A modern army must take a hospital system with it. To be useful, the deployed hospitals must have some degree of strategic and tactical mobility. Tactical mobility is essential for hospitals that are to care for combat casualties since, to be optimally effective, surgical care must be rendered far forward on the battlefield. During World War II, this was achieved by attaching small teams of surgeons and anesthesia providers to platoon-sized units from field hospitals. Austere surgical hospitals in tents were set up in the division rear area, where they were collocated with medical units organic to the division. The MASH, a TOE version of the World War II surgical team–field hospital platoon, was

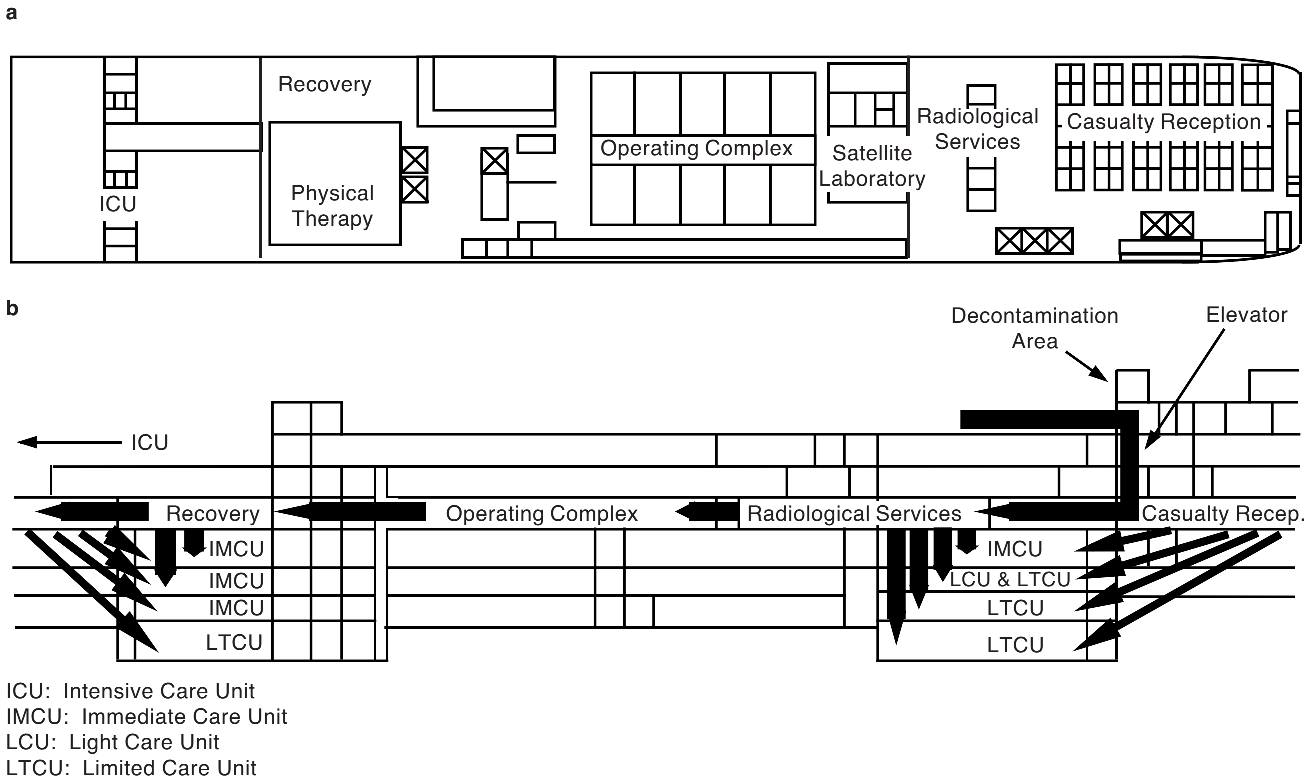


Fig. 6-14. Casualty flow in the USNS *Comfort* as it was originally configured prior to its service in the Persian Gulf War; (**a**) the arrangement of the main deck of the ship and (**b**) a cross-section of the ship with arrows indicating the casualty flow. The most important medical treatment facilities—the casualty receiving area, the operating rooms, and the intensive care wards—are all amidship on the main deck. This location ensures minimal rocking and rolling in a seaway and provides maximal protection from enemy action. Reprinted from Auxiliary and Special Mission Ship Acquisition Project Office. *FY 83 Shipbuilding Program*. Naval Sea Systems Command, Washington, DC; February 1984. T-AH 19 Hospital Ship. Diagram: Courtesy of Captain T.G. Patel, Medical Corps, US Navy, Bureau of Medicine and Surgery, Washington, DC.

used in the Korean War. During the Vietnam War, the MUST, an advanced-technology approach, replaced the tented MASH with an environmentally controlled facility. The MUST's complexity and cost detracted from its value. During the 1980s, DEPMEDS, another advanced-technology approach, was begun. DEPMEDS was based on an extensive systems analysis of field medical needs, and a variety of modular hospitals housed in special tents and metal boxes were fielded. Although DEPMEDS both improved the level of medical care in deployed hospitals and simplified equipment procurement, excessive weight and volume gravely compromised deployability.

Analysis of afteraction reports from the Persian Gulf War raised questions regarding the appropriateness of DEPMEDS equipment and the lack of mobility of deployable hospitals. Owing to the fluidity of the deployment, and particularly of the ground offensive itself, deployed hospitals were frequently required to relocate on short notice. Distances traveled and the degree of mobility varied widely. Transportation assigned to the unit was sometimes inadequate. The time required to become fully operational varied from several hours to 2 weeks. All personnel assigned to the hospital were required to help pack and unpack equipment for movements. Logistical supply lines were usually able to keep pace with this often-rapid forward deployment, however, and few chronic shortages of supplies and equipment were experienced by the onset of the ground war.

MF2K and MRI are refinements of DEPMEDS. These systems will decrease the number and types of hospitals and make it possible to tailor medical assets by mission. Perhaps the two most important changes are the deletion of the MASH and its replacement by the FST, and the design of one single hospital type to replace the present multiple hospital types.

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