

Chapter 41

HUMANITARIAN OPERATIONS AND AID AGENCY ANESTHESIA

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INTRODUCTION

Humanitarian Assistance as an Additional Mission

Traditionally, the focus of military medicine has been care of the wounded during combat operations. While this continues to be the primary focus, military personnel are increasingly involved in secondary humanitarian assistance (HA) efforts as well. The distinction between a primary and secondary mission is important. For example, in deployments such as the United Nations Mission to Haiti, 1994–1996, and Operation Iraqi Freedom, 2003–2011, the focus of medical care is in support of deployed troops and authorized civilians. HA is a secondary mission. Both Role 2 (the US Army's forward surgical teams and the Navy's Forward Resuscitative Surgical System) and Role 3 (the Army's combat support hospitals, the Navy's fleet hospitals, and the Air Force's expeditionary hospitals) medical units are outfitted to meet expected combat trauma, their primary mission. Typically, these units do not have instruments and equipment sets for specialty surgery and are extremely limited in their ability to care for pediatric patients.

Additionally, it is vital that HA efforts initiated in theater be cleared through command surgeon channels up to the health affairs attaché in the US embassy. Also, there must be host nation approval for these projects consistent with the existing Status of Forces Agreement between the two involved countries and their allies. When approval is obtained for HA projects and with security permitting, the initial approach should be to assist local medical authorities in local hospitals. If required care is beyond the capability of the local hospital, the next step is to arrange for evacuation to a suitable civilian institution in theater. Another option is to treat HA patients at the Role 2 or 3 medical facility. It must be clear that in these circumstances, military trauma takes priority over HA patients and local civilians will be discharged after postoperative recovery. In a few rare cases, arrangements may be made to evacuate a patient with a treatable medical or surgical condition outside of theater, possibly to a medical center in the United States. This option requires close coordination at all levels and support of a nongovernment agency willing to sponsor the patient.

Humanitarian Assistance as a Primary Mission

Outside of combat operations, military personnel are also involved in primary HA missions. During these missions assistance is provided to a local populace by predominantly US forces in conjunction with military operations and exercises.¹ This assistance is specifically authorized by Title 10, United States Code, Section 401, and funded under separate authorities. Under these provisions, the assistance must fulfill unit training requirements and is limited to (a) medical, dental, and veterinary care provided in rural areas of a country; (b) construction of rudimentary surface transportation systems; (c) well drilling and construction of basic sanitation facilities; and (d) rudimentary construction and repair of public facilities.² Since 2006, primary HA missions have been conducted annually in an effort to promote goodwill and the national interests of the United States. These missions alternate between countries in the Pacific region and Southeast Asia and Central and South America.

Humanitarian Assistance Supporting Disaster Relief

In addition to planned HA missions, the US military is also called upon to assist civilian authorities in disaster relief (DR) operations both within the United States and in foreign countries. Interventions in the past decade include relief efforts in Southeast Asia following the tsunami in 2004, assistance following the Hurricane Katrina disaster in 2005, and humanitarian aid to victims of the Haitian earthquake in 2010 and the victims of the Japanese earthquake and nuclear disaster in 2011.

Today, the US military provides HA in a variety of situations. These missions differ in size, scope, and platform. They vary from targeted interventions that support a larger combat operation to large-scale missions with a global outreach objective. In each of these situations, as with combat operations, anesthesia personnel perform a critical role in assisting with the coordination and delivery of surgical and pain management services. Understanding that role and the circumstances unique to the HA mission will better prepare the anesthesia provider deployed on such a mission.

HUMANITARIAN ASSISTANCE MISSIONS: A GENERAL OVERVIEW

Hospital Ships

Large-scale humanitarian operations are generally carried out aboard the military's two hospital ships,

USNS *Mercy* (T-AH 19) and USNS *Comfort* (T-AH 20). Built in 1976 as oil tankers, both vessels were later acquired by the US Navy and converted to hospital ships. USNS *Mercy* was put into service in 1986 and USNS

Comfort in 1987. The primary mission of these ships is to provide an afloat, mobile, acute surgical medical facility to the US military that is flexible, capable, and uniquely adaptable to support expeditionary warfare. Their secondary mission is to provide full hospital services to support US DR and humanitarian operations worldwide.^{3,4}

Both ships are capable of providing Role 3 care including triage, resuscitation, transfusion, laboratory testing, radiology services (including computed tomography and interventional procedures), dental care, initial and definitive surgery, postoperative care, intensive care, and patient holding capacity. Each ship can provide care to patients of all ages, with a total patient capacity of 1,000 hospital beds (including 80 intensive care, 20 postoperative recovery care, 280 intermediate care, and 120 light care beds), twelve operating rooms, and ancillary services similar to shore-based facilities.

Mission Overview and Process

HA annual missions (Pacific Partnership 2008 and 2010 in the Pacific region and Southeast Asia, and Partnership for the Americas 2007 and Continuing Promise 2009 and 2011 in Latin America) range in length from 4 to 6 months and occur between April and October. The number of countries visited, the time spent in each country, and the services provided depend on the overall strategic plan as well as other factors such as budget, staffing, and mission duration. Once the budget, staffing, and schedule are determined for a mission, an initial planning conference is held. Members from the involved military command (Pacific Command [PACCOM] or Southern Command [SOUTHCOM]), the US Public Health Service, nongovernmental organizations (NGOs), and host nation ministries of health meet to discuss and set the objectives for the mission. Next, several weeks prior to the start of the mission, predeployment site survey teams visit each country to meet with US embassy and ministry of health personnel, distribute a surgical capability list, and initiate country-specific plans. Then an advance coordinating element team will review and finalize plans with each country several days prior to the arrival of the mission crew. During these visits, each host nation compiles a manifest identifying the diagnoses of the patients to be evaluated. This preidentification of surgical patients facilitates the preoperative process and simplifies operating room scheduling.⁵

Upon arrival at each site, teams consisting of surgeons, anesthesia providers, and support personnel screen patients ashore. Basic laboratory and radiology tests are performed and the patients are assigned a surgery date. On the day before surgery, the patients

are transported by either boat or helicopter to the hospital ship. This allows for a review of information and compliance with preoperative fasting. Typically, surgeries are scheduled until 1 to 2 days prior to departure to allow for appropriate postoperative care and discharge of all patients.⁶

Disaster Relief

In contrast to the HA mission, extensive advance planning is rarely possible when responding to a disaster. Consequently, maintaining a state of readiness and utilizing personnel trained for such missions is critically important in maximizing efficiency and decreasing response time.

Other key differences with a DR mission include the level of urgency and types of injuries treated. The care provided during an HA mission focuses on improving quality of life, whereas the goals of DR are saving life and restoring basic services to the affected population. Medical treatment involves emergent care of trauma-related injuries, and surgical procedures are aimed at saving life, sight, or limb. Additionally, unlike the HA mission, the emergent and chaotic nature of the disaster situation leaves little time for patient evaluation. This, in particular, makes the process of patient triage an essential component in the overall DR operation. Triage quickly prioritizes patients based on extent of injury to ensure maximum chances of survival and the most efficient use of resources.

During Operation Unified Response (2010) in Haiti, little information was available in advance about the number of people injured or the extent of their injuries. To address this problem, patient triage was quickly implemented on shore to rapidly evaluate earthquake victims and facilitate an orderly process for patient movement. Each day a member of the surgery team, usually a trauma surgeon, evaluated patients on shore and communicated pertinent information to staff on the ship. This allowed for the proper allocation of personnel and resources in treating the more critical patients first.

Host Nations and Nongovernmental Organizations

The number of host nations visited varies according to overall mission objectives and length. Host nations are often revisited, though on-site locations may change. One example is Haiti. In 2007 patients were screened at a general hospital in the capital city, Port-au-Prince. For the Continuing Promise mission in 2009, the screening site was a coast location in the city of Killick. Site locations change for a number of reasons including host nation needs, available resources,

logistics and transportation capabilities, and security concerns.

During an HA mission, host nations and NGOs participate extensively throughout the operation. Representatives from these groups are involved in the initial planning process and other personnel assist with implementation and delivery of aid on site. Two such NGOs are Operation Smile and Project HOPE. These organizations have provided assistance in both the Pacific and Latin American missions that remain ongoing today. In 2007, during the Partnership for the Americas mission, Project HOPE augmented the surgical staff with a full-time surgeon, an operating room nurse, and anesthesiologists in six countries.⁵

In a disaster situation, support from NGOs is especially vital to achieving an effective response and outcome. The level of urgency and limited preparation time makes mobilization of resources and personnel with the necessary skills a challenge. NGOs can provide staff with specific skills and capabilities appropriate for the situation.

Medical Personnel

The number and mix of medical personnel varies depending upon the scope of the mission and the identified needs of host nations. For example, a majority of personnel deployed on an HA mission are adult and pediatric primary care providers, whereas a greater number of critical care and trauma specialists are involved in the DR situation. Additional specialties (infectious disease, cardiology, pathology, radiology) are included to support the overall mission.

Active duty anesthesiologists and certified registered nurse anesthetists constitute the core group of anesthesia providers. Fellowship-trained pediatric anesthesiologists are included in this group, as well as those with skills in pain management procedures. The size of this core group typically ranges from six to seven providers for an HA mission and is increased during a disaster or combat situation. During HA and DR missions, additional personnel from volunteer organizations and, occasionally, the military reserve complement this core group. Civilian volunteers are

not usually involved in combat operations.^{5,7,8}

Due to the elective nature of the cases selected during an HA mission, surgery is rarely performed at night. However, providers are scheduled to be available if a need arises. In contrast, during a combat or disaster situation, operating rooms function continuously. During the DR mission in Haiti, two of the ten operating rooms were used around-the-clock daily for approximately 6 weeks. To maintain this level of productivity, appropriate assignment of staff is critically important.

Surgical Services

The schedule followed during Continuing Promise 2009 (Table 41-1) is typical for the delivery of surgical services during an HA mission. At each site, during Continuing Promise 2009, the first 2 days were reserved for preoperative screening. Surgical cases were scheduled over the next 5 to 6 days, leaving the last 2 days for patient discharge. Average surgical caseload was 25 cases per day. Although typical, this schedule can vary due to factors such as length of site visits, number of patients treated, and complexity of cases.

The surgical services provided during an HA mission are diverse, with general surgery and ophthalmology accounting for the greatest number of cases. Procedures most commonly performed include inguinal hernia repair, umbilical hernia repair, cataract removal, and soft tissue mass excision. Cleft lip and palate repair procedures are also common.

In a disaster situation, the array of surgical services expands to include trauma, burn, and neurosurgery specialties. In Haiti, during Operation Unified Response, approximately 840 surgeries were performed in all, with nearly 700 procedures completed in the first 3 weeks. The majority of these cases were orthopedic trauma involving extremity and pelvic injuries. These included repairs of 33 pelvic fractures, more than 100 femur fractures, 32 primary amputations, and numerous amputation revision procedures. In addition to the orthopedic cases, 16 burn debridement procedures, 16 craniotomies, 44 spine surgeries, and 75 head and neck procedures were also performed.

TABLE 41-1
SURGERY SCHEDULE, USNS COMFORT (T-AH 20), CONTINUING PROMISE 2009

Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
Prescreen	Prescreen	OR	OR	OR	OR	OR	OR	Discharge	Discharge

OR: operating room

PRACTICAL CONSIDERATIONS FOR THE ANESTHESIA PROVIDER

HA missions can present unique and challenging situations for the anesthesia provider. Patient populations often have little or no previous medical care and poor access to healthcare services. Disease states not typically seen in developed countries are frequently encountered. Also, time constraints do not always allow for the optimization of disease processes that would otherwise occur prior to the administration of anesthesia. To assist the anesthesia provider in managing these situations, several factors that affect the delivery of anesthesia are discussed below. Strategies used on previous missions are also presented.

Preoperative Assessment

Patient Evaluation and Selection Criteria

Prior to arrival, host nations will have compiled a manifest of surgical candidates. These lists, however, are often incomplete and not very reliable. Additionally, the patient prescreening process (Figures 41-1 and 41-2) occurs over a 1- to 2-day period, leaving very little time for lengthy preoperative evaluations and optimization of comorbid conditions. Consequently, to facilitate efficiency and patient safety, patient selection criteria should be discussed and agreed upon by the medical providers prior to arrival and throughout the site visits. The goal is to select cases that provide the best possible outcome while minimizing surgical risk. Patients that are declined are referred, when possible,

to other organizations for care. The screening criteria (Table 41-2) and overall process (Figure 41-3) followed during the Pacific Partnership 2008 mission provides good examples.⁷

Patient Demographics

Data from previous missions provides some information regarding demographic characteristics of patients selected for surgery. Though reporting is not uniform, the data shows a majority of patients were assigned to an American Society of Anesthesiologists physical status category 1 or 2. This is consistent with and reflects the goal of selecting surgical candidates with minimal risk.

Another important characteristic is patient age. Approximately one-third of cases were performed on patients 18 years old or younger.⁹

Uncommon Disease

HA missions are conducted in areas where access to medical care is very limited. As a result, patient populations often present with extremes of common disease states, such as malignant hypertension and profound anemia, as well as diseases not typically seen in developed countries. An example is tuberculosis. Rates range from 50 per 100,000 in Latin America to more than 200 per 100,000 in some parts of Southeast Asia.¹⁰ Tuberculosis spreads by droplet contamination. Precautions using special protective gear and



Figure 41-1. Anesthesia prescreening station, Colon, Panama, USNS *Comfort*, Partnership for the Americas, 2007.



Figure 41-2. Surgical screening area, Central America, USNS *Comfort*, Partnership for the Americas, 2007.

TABLE 41-2
ANESTHESIA SCREENING CRITERIA BY SYSTEMS, USNS *MERCY*, PACIFIC PARTNERSHIP 2008

System, Condition, or Age	Criteria for Cancellation of Cases
Cardiovascular	HTN: SBP > 160 or DBP > 90 or PP > 80 mm Hg CAD: MI within past 6 months or remote MI not revascularized CHF: evidence of uncompensated CHF Arrhythmia: frequent symptomatic palpitations Valvular disease: type III/VI or diastolic murmurs; aortic stenosis; mitral regurgitation
Respiratory	Asthma: active wheezing or decreased breath sounds Chronic obstructive pulmonary disease: symptomatic shortness of breath Obstructive sleep apnea: snoring, daytime somnolence, witnessed apneic events Difficult airway: recognized difficult airways
Endocrine	Diabetes mellitus: fasting blood glucose > 300 mg/dL or evidence of end organ damage Thyroid: goiters evaluated by computed tomography and surgeon before surgery; complicated lesions (ie, intrathoracic involvement) Obesity: body mass index > 35
Neurologic	Cerebrovascular events: any residual deficit or frequent transient ischemic attacks Gait disturbance: cancel all Seizures: new onset or history of epilepsy
Obstetrical/gynecologic	Pregnant: cancel all Breast, ovarian, or cervical cancer: cancel all Postpartum: if < 2 months postpartum; counsel re: breastfeeding
Oncology	Any current cancer: cancel all
Pediatric	Age: < 6 months Syndromic appearance: cancel all CHD: known lesions/any cyanotic history; refer all murmurs to cardiologist for evaluation Upper respiratory infections: symptoms within past 4 weeks

CAD: coronary artery disease
 CHD: congenital heart disease
 CHF: congestive heart failure
 DBP: diastolic blood pressure

HTN: hypertension
 MI: myocardial infarction
 PP: pulse pressure
 SBP: systolic blood pressure

Data source: King HC, Baker W. Pacific Partnership 2008: the surgical mission, surgical screening process, and the anesthetic management of uncontrolled, untreated hypertensive patients. *Mil Med.* 2010;175(1):33–40.

negative-pressure ventilation are required to prevent the spread of the disease to others. Though isolation is available on the hospital ships, it is limited to the intensive care unit, making it difficult to treat these patients. Because of these limitations, patients with active tuberculosis infection are generally not candidates for elective surgery aboard. All patients and escorts are evaluated for tuberculosis and receive a chest radiograph during the prescreening process. The presence of active disease generally results in case cancellation. If the patient is accepted, additional preparation is required.

Intraoperative Anesthesia Management

Anesthetic Techniques

As Role 3 facilities, both USNS *Mercy* and USNS *Comfort* are capable of providing general and regional anesthesia to adult and pediatric patients in a manner similar to that of shore-based hospitals. In addition to standard equipment, both ships have devices for difficult airway management, including fiberoptic bronchoscopes and GlideScopes (Verathon Inc, Bothell, WA), and portable ultrasound units for use with

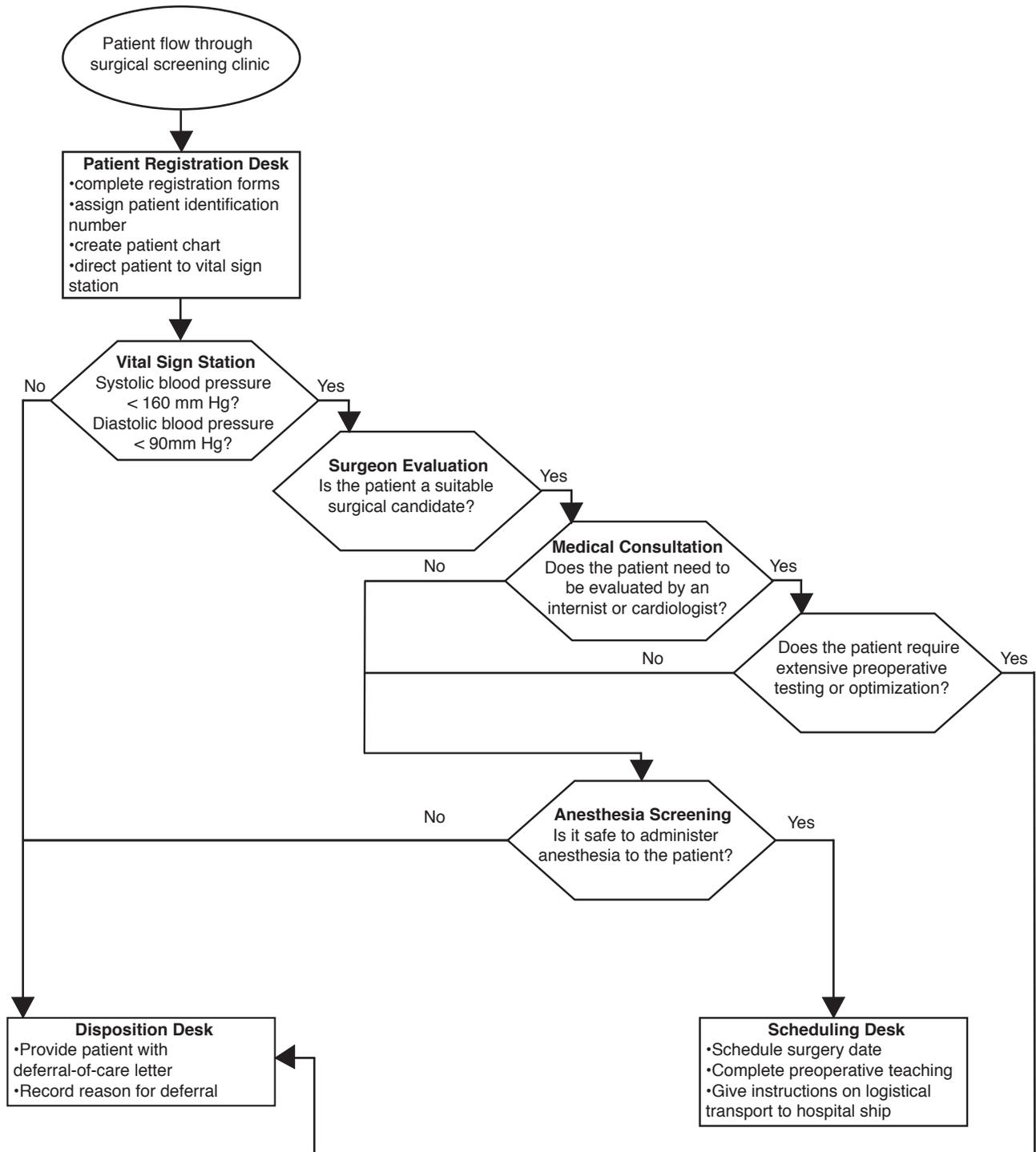


Figure 41-3. Surgical screening patient flowchart, USNS Mercy (T-AH 19), Pacific Partnership 2008. Reproduced from: King HC, Baker W. Pacific Partnership 2008: the surgical mission, surgical screening process, and the anesthetic management of uncontrolled, untreated hypertensive patients. *Mil Med.* 2010;175(1):34.

regional anesthesia procedures and insertion of central vascular catheters.

Reported data shows the majority of cases (approximately 83%) are performed under general anesthesia. The use of local anesthesia with and without sedation accounts for the rest. The majority of the local anesthesia cases are retrobulbar blocks administered for ophthalmology procedures. With the exception of a few cases, neuraxial techniques and peripheral nerve blocks are largely performed as adjuncts to general anesthesia and management of postoperative pain. During past missions, such as Partnership for the Americas and Continuing Promise 2009, epidural and caudal procedures were performed for postoperative pain management in patients who underwent abdominal hysterectomy, open cholecystectomy, and pediatric inguinal hernia repair.⁵

Overall, the use of regional anesthesia is limited during an HA mission for several reasons. Language barriers make communication and patient cooperation more challenging. Interpreters are helpful but not always available. The majority of surgical procedures are low-risk cases that do not require regional anesthesia for postoperative pain management. These patients are typically discharged within 24 to 48 hours following surgery. Additionally, the limited time at each site makes it nearly impossible to evaluate patients for late complications, and host nations often lack the resources to address these situations.

In contrast to the HA mission, the use of regional anesthesia is beneficial during a DR operation despite the aforementioned challenges. The number of patients requiring acute care can be significant. Trauma patients undergo more extensive surgery and require a more intense level of pain management. The use of regional anesthesia addresses the needs of these patients and helps decrease the burden on staff, who can quickly become overwhelmed. The number of injured from the 2010 earthquake in Haiti was staggering, and the USNS *Comfort* became the busiest orthopedic trauma hospital in the region. Using nerve stimulators and ultrasound guidance, peripheral nerve blocks (Table 41-3) were performed in children and adults both awake and under general anesthesia without any known complications. The benefit of regional anesthesia in caring for these patients was tremendous, demonstrating the utility of regional anesthesia in the disaster response situation.

Blood Products

The availability, storage, and utilization of blood products are significant concerns aboard the US military's hospital ships and other vessels with medical

TABLE 41-3

PERIPHERAL NERVE BLOCKS ADMINISTERED IN OPERATION UNIFIED RESPONSE, USNS COMFORT

Block Type	Number
Femoral	60
Sciatic	30
Lumbar plexus	1
Popliteal/saphenous	4
Interscalene	1
Supraclavicular	6
Radial/median/ulnar	4
Transabdominal plane	1

capabilities. In contrast to land-based facilities, greater challenges exist with storage capacity and resupply issues at sea. To address these issues, the US military has the ability to utilize options not available in civilian practice. One of these is the use of frozen packed red blood cells. Though approved for use by the Food and Drug Administration, this product may have quality degradations (class D blood > 10 years old) and needs special reagents for processing before use. During Operation Unified Response in 2010, a total of 348 units of packed red blood cells were used, and of these, 46 units were frozen. No adverse events from the use of frozen blood were reported. Another option available to the military is instituting the "walking blood bank," a program in which military members are typed and cross-matched to serve as a readily available pool for emergency whole blood donations.

In contrast to the combat or disaster situation in which blood transfusion is frequently necessary, the goal during an HA mission is to minimize the use of blood products, so elective surgeries with the potential for significant transfusion requirements are not routinely performed.

Postoperative Care Considerations

Management

Cases that require a prolonged and intensive postoperative recovery are typically not performed during an HA mission. Though medical and surgical capabilities on both hospital ships are extensive, host nation resources are often very limited, making transfer of care difficult. The majority of cases performed usu-

ally require a level of care equivalent to ambulatory surgical procedures, and these patients are admitted to ward beds. Patients who require any greater degree of care and monitoring (eg, abdominal hysterectomy, open cholecystectomy, thyroidectomy) are sent to the intensive care unit. In the disaster situation, the treatment and care of trauma patients is more complex, involving ongoing resuscitation and pain management. Many patients require intensive care monitoring and postoperative mechanical ventilation.

Patient Transport

The transport of patients (and staff) is a complex process and must be considered during mission plan-

ning. It is affected by whether the hospital ship is anchored in port or off shore. If the hospital ship is anchored pier-side, transport time for patients (and staff) is greatly decreased. However, due to the size and excessive draft of these ships, access to many ports is limited. Consequently, the hospital ships are frequently anchored off shore and patients are transported by boat or helicopter. Small boats can only transport a limited number of people and operations are subject to sea conditions. Regulations permit the landing of only one helicopter at a time on the ship's flight deck. These limitations significantly increase the number of trips required to transport patients to and from shore. If transport time is excessive, it can affect the ability to deliver care.

AUSTERE AND RESOURCE-LIMITED ENVIRONMENTS

The previous sections describe the approach undertaken by the US military operating from well-equipped and resourced ships. The situation can be very different in austere, resource-limited environments. These situations are well described by Robin Coupland, a Red Cross surgeon, writing in the *British Medical Journal*¹¹ about experiences in Afghanistan in 1992. He describes how the surgical team could only work for a few hours each day (due to the proximity of the battle), so they gave priority to patients needing operations for abdominal wounds. Coupland notes that patients rushed into the operating room with severe injury usually died due to insufficient preoperative resuscitation, and others died postoperatively due to lack of postoperative care. This is a clear contrast to the current situation in NATO hospitals in Afghanistan. A key lesson from Coupland's paper is that the severely injured die unless adequate people and infrastructure are there to care for them, and that triage must be done with this in mind or precious resources will be wasted. The extensive resuscitation and surgery that current improvised explosive device casualties receive at US and UK hospitals in Afghanistan could not be undertaken in a resource-limited environment such as most NGO hospitals.

The Red Cross publication *Hospitals for War Wounded* describes three triage categories^{12(p91)}. Category I, priority for surgery, are those needing urgent surgery and with a good chance of recovery. Category II, no surgery, are those with either minor injury or nonsurvivable injury. Category III are those who need surgery but can wait. The book also gives guidance for managing a limited supply of blood, including setting limits of four to six units for patients with a hemoglobin concentration less than 8.0 g/dL, or calculating that every

100 war-wounded casualties admitted to the hospital will need about 45 units of blood.

The current edition of the Red Cross's *War Surgery*¹³ contains basic guidance on anesthesia and analgesia. The following are key areas to note:

- In austere environments equipment such as suction apparatus will be manually operated. Intraoperative ventilation will also be by hand.
- Oxygen concentrators will be used to preserve gas cylinder supplies.
- The type of surgery and resuscitation that can be carried out in an austere situation will be dictated by availability of equipment, consumables, and utilities (water, power, and gases).
- The security of the environment (location of fighting, timings of curfews, travel constraints) will also affect what a surgical team can and cannot deliver.

All of the above conditions influence the choice of anesthesia that can be delivered, and the choice of anesthesia in turn influences the conduct of surgery.

Anesthesia Techniques

Anesthesia techniques common in austere settings include the following:

- Infiltration of local anesthetic, single shot nerve blocks, and single shot spinal or epidural techniques. These may or may not be supplemented by systemic analgesics and anesthetics.
- Ketamine administered orally, intramuscularly, or intravenously. Intramuscular ketamine

can be (and is) used as the sole agent in many resource-limited environments. Intravenous ketamine may be given as intermittent bolus or continuous infusion from a drip. Benzodiazepines may be used along with ketamine to minimize hallucinations and dreams associated with ketamine, although they reduce the airway-protective reflexes that ketamine usually leaves intact. Atropine may also be used with ketamine to dry oral secretions, but this effect must be balanced against the associated tachycardia.

- Anesthesia produced by inhalational agents and delivered by draw over apparatus with or without supplement by the techniques described above.

In turn the patient may be allowed to breathe spontaneously or undergo muscle relaxation, endotracheal

intubation, and manual ventilation depending on the surgery planned and the resources available. Examples of intramuscular and intravenous regimes used by the authors are given in Table 41-4. Many others can be found in the published literature.

To give a practical example of these techniques in use, one of the authors (PFM) has observed the following approaches to emergency cesarean section while working with aid agencies in Africa and Asia:

- Intramuscular ketamine followed by local infiltration of skin and muscle layers.
- Single shot spinal anesthesia
- Intravenous ketamine followed by spontaneous ventilation of air, oxygen, and halothane.
- Rapid sequence induction with thiopentone and suxamethonium, and endotracheal intubation followed by manual ventilation with air, oxygen, and halothane.

TABLE 41-4
ANESTHESIA REGIMES FOR AUSTERE ENVIRONMENTS

Delivery (Based on Required Duration)	Regime Examples
Induction and bolus maintenance for short procedures	<ul style="list-style-type: none"> • Midazolam 5 mg or diazepam 2–5 mg IV with a small dose of morphine IV, followed by ketamine 80–100 mg IV over 20 seconds. Intermittent boluses of ketamine IV, one quarter of the induction dose, every 15 minutes. Doses of benzodiazepines or opioids as necessary added in response to increasing vocalization or purposeful movements with surgical stimuli.¹ • Midazolam 0.07mg/kg IV, followed 2 minutes later by ketamine 1 mg/kg IV. In mass casualty events, ketamine 7 mg/kg IM may be used.² • Atropine, diazepam, or midazolam followed 3 minutes later with ketamine 1–4 mg/kg IV, with intermittent boluses.³ • 1–2 mg/kg ketamine IV over 60 seconds providing anesthesia for approximately 10 minutes.⁴ • 10 mg/kg ketamine IM given 5–10 minutes before surgery providing anesthesia for approximately 12–25 minutes.⁴
IV infusions bags	<ul style="list-style-type: none"> • Ketamine infusion (0.5 mg/mL ketamine in a liter of normal saline) titrated to effect following IV ketamine bolus induction.⁵ • 40 mL of 1% propofol, 250 µg fentanyl (5 mL of 50 µg/mL) and 250 mg ketamine (5 mL of 50 mg/mL) added to 50 mL saline. This gives an infusion of 4 mg propofol, 2.5 mg ketamine, and 2.5 µg fentanyl per milliliter of solution. Using a 20 drop/mL giving set (tubing allows 20 drops per mL), use one drop per second to deliver 150 µg/kg/min propofol infusion (assuming patient weight of 80 kg).⁶

IM: intramuscular

IV: intravenous

(1) Paix BR, Capps R, Neumeister G, Semple T. Anaesthesia in a disaster zone: a report on the experience of an Australian medical team in Banda Aceh following the “Boxing Day tsunami.” *Anaesthes Intensive Care*. 2005; 33:629–634. (2) Grande CM, Baskett PJ, Donchin Y, Wiener M, Bernhard WN. Trauma anesthesia for disasters: Anything, anytime, anywhere. *Crit Care Clin*. 1991;7:339–361. (3) Dalenius E, Asaker BM. Training for wartime anesthesia in Sweden. *AANA J*. 1989;57:250–256. (4) Wood P, Mahoney PF. Anaesthesia and analgesia. In: Ryan J, Mahoney PF, Greaves I, Bowyer G. *Conflict and Catastrophe Medicine: A Practical Guide*. London, England: Springer; 2002:341–351. (5) Giannou C, Baldan M. *War Surgery: Working With Limited Resources in Armed Conflict and Other Situations of Violence*. Vol 1. Geneva, Switzerland: International Committee of the Red Cross; 2009; 305–317. (6) Mahoney PF, McFarland CC. Field anaesthesia and military injury. In: Smith CE, ed. *Trauma Anesthesia*. 1st ed. Cambridge, England: Cambridge University Press; 2008: 343–359.

Similar approaches have been successfully used for managing anesthesia for other procedures such as limb amputation.

Postoperative Care

The central role of postoperative care is illustrated by Coupland.¹¹ Postoperative care can be considered as immediate and longer term. Immediate care includes fluids, analgesics, antibiotics, and oxygen, and the people to deliver them. Longer term care in the current US and UK military systems means strategic air evacuation to Role 4 and Role 5 hospitals. Evacuation may not be possible in austere environments and future conflicts, so the likely postoperative and critical care requirements of a severely ill or injured patient must form part of the triage process and decision on

whether they should or should not have initial surgery.

Immediate postoperative care may have to be delegated to people with minimal experience or limited reading and mathematical skills. A number of approaches can be used to help these personnel, such as drawing simple clock pictures on intravenous fluid bags (to show when different volumes need to have completed) or sun and moon pictures to illustrate day and night timings for care or medication delivery. Surgical ward routines are described further by the Red Cross.¹²

Longer term postoperative care may include prolonged critical care and the complex rehabilitation pathway needed by the current generation of allied war wounded. If a health care system cannot provide this level of care, providers must carefully consider whether to begin surgery for highly complex injuries.

CONCLUSION

Today, medical personnel in the military are deployed in a variety of situations: combat operations, HA missions, and disaster relief efforts all around the world. As they do in combat operations, anesthesia providers play a key role in the HA mission, assisting in the coordination and delivery of surgical services. When working in an austere or resource-limited en-

vironment, anesthesia providers must adapt their techniques accordingly and understand the constraints that may be placed on patient care. Although the focus of this chapter is the large-scale HA missions that are conducted aboard the US military's hospital ships, much of this information can also be applied to other missions with similar objectives.

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