

MILITARY MEDICINE

Provision of a Trauma Resuscitation and Anesthesia Service in an Advance Field Military Hospital in Northern India

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Learning Objectives: 1) To understand the challenges inherent in the provision of trauma care, specifically anesthesia services, in remote areas of military operations and 2) to compare the anesthesia equipment and drugs that have been adopted for use in remote medical facilities.

Trauma is a leading cause of death and debility in India. Anaesthesiologists are commonly involved in providing acute management of such patients. A trauma anaesthesiologist as a resuscitation specialist, as a part of mobile resuscitation team,¹ or as a member of a critical care transportation team² will ensure the optimal clinical state of the patient on his arrival at the trauma centre. While provision of anaesthesia and critical care for such victims is always a challenge, the requirements dictated by a patient's medical condition do not vary with location. However, difficult environments restrict the ability to provide high quality care. All trauma patients require an organized prehospital response and definitive care followed by rehabilitation to achieve the best outcome.³ In an ideal world, intensive care management of the seriously injured patient would start in the prehospital setting and continue until no longer necessary or considered to be futile.⁴

The development of military anesthesia dates back to the discovery of anaesthesia itself. Morton administered ether to the wounded close to the field of battle in 1864 during the American Civil War.⁵ Each war and conflict has required anaesthesiologists to adapt to new challenges in different environments. Whether the terrain is a snowbound area along the line of control (LOC) or counter insurgency operations

(CIOPS) in jungles, all present unique problems.

A complex military conflict has continued in Northern India since 1989, causing numerous military and civilian casualties. The cross-border terrorism turned into war in mid-1999. Liberal use of small arms as well as artillery shelling and air raids followed. During military operations in Kargil, more than 400 Indian soldiers died and about 600 suffered serious injuries.⁶ Though the conflict officially ended in July 1999, hostile exchanges have continued, with morbidity and mortality of troops. In addition, this sector is faced with harsh climate, difficult terrain, and inadequate logistic support. In this environment, field resuscitation and anaesthesia aim at minimizing delay and preserving life and limb. This can be accomplished only with meticulous planning and rehearsed protocols. This article provides an insight into the working of a forward military trauma care centre located in the conflict area of northern India.

Trauma Care Set Up of the Armed Forces Medical Services

In contrast to civilian counterpart organizations, the Indian Armed Forces Medical Services has a well-evolved system of trauma care,⁷ which features

- Level III facilities: Forward Surgical Centre (FSC), field hospital, or static border hospital
- Level II facilities: Base hospitals or zonal hospitals with multidisciplinary surgical care
- Level I facilities: Command hospitals/Army hospital with tertiary rehabilitative surgical care

The most remote surgical service in the Indian army is a FSC with a single anaesthesiologist, a surgeon, and ancillary staff, including operating room assistants and radiology and laboratory technicians.

Key Problems Encountered

The importance of teamwork is critical in the management of trauma victims with limited resources. Resuscitation, analgesia, and anaesthesia may need to be practiced simultaneously, requiring coordination between anaesthesiologists, surgeons, operating room assistants (ORA), and other ancillary staff. Anaesthesiologists working in a FSC dealing with battle casualties assume the responsibility of guiding all members of the team. Individuals must clearly understand the important role that each plays. Adaptability is the key to achieving optimal results.

The main challenge in this harsh environment is completing essential tasks in a timely manner. Of particular concern for resuscitation and anaesthesia are the following:

- Loss of the "Golden Hour" due to location and difficulties in evacuation
- Hostile weather conditions and inadequate warming equipment
- Non-availability of blood products and radiology facilities
- Compromise in sterility and asepsis
- Lack of conventional anaesthesia and surgical equipment
- Lack of facilities for equipment repair
- Lack of manpower and difficulties with staff turnover

Evacuation. Evacuation of the injured is a difficult task. Northern India is at high altitude, with extreme cold and high



Figure 1. Difficult terrain of far North India.

wind velocity (Fig. 1). Soldiers are assessed for fitness and undergo very strict acclimatization before deployment. Posts are provided with high altitude pulmonary oedema (HAPO) bags and special equipment to counter cold injuries. Besides the altitude and cold, the steep gradient and loose rocky surface make the region prone to avalanche. In addition to the threat of shelling and mortar attack, much of the area is heavily mined.

Selected soldiers are trained by medical units on a regular basis to provide battlefield first aid. These soldiers are called battlefield-nursing assistants (BFNA). The BFNAs provide first aid and cardiopulmonary resuscitation and help with evacuation of casualties to the FSC, where the medical officer nearest the site of action provides care.

Before evacuation, rapid dressing of wounds and splinting of fractures site are usually done. Because of the terrain, rapid evacuation of the casualties is often not possible. A road opening party (ROP) checks every inch of vehicle routes each morning before movement of vehicles is allowed. Soldiers are then placed every 10 to 15 metres along the route to ensure security. Ambulances and helicopters are used for evacuations. The mode of evacuation depends largely on the time of occurrence, number of casualties, and access to the site. Ambulances are generally used, but in the afternoons helicopters are available until 1600 hours. Later in the day, victims can be transported only by road accompanied by a Quick Reaction Force (QRF), which consists of a minimum of 50 heavily armed men, who move on mine-prone roads at risk of ambush. In winter, when forward bases are cut off by snow, helicopters are also unable to land. It may take up to 16 hours to bring a patient to the nearest road head or helipad. Six-member stretcher-bearer squads carry the injured. Soldiers in their 16-piece winter gear move through waist-deep snow to reach a point from which patients can be evacuated. This is a challenging job on a steep climb, even with scoop stretchers incorporating local modifications with bamboo and blankets.

Golden Hour. Speed is vital in all cases; however, the goal of reaching the FSC within the Golden Hour is rarely achieved.⁸ Despite the enormous difficulties outlined above, the majority of the wounded do receive medical attention within the first 60 minutes. Ambulances are equipped with resuscitation equipment to provide care, which during evacuation shortens delays and improves patient condition on arrival. With these resources, we managed 574 casualties over a 2-year period (November 1999 to August 2001) (discussed below).

Initial Management. The trauma centre organization recognizes that trauma care requires highly trained resuscitation and anaesthesia personnel to achieve optimal outcomes. In our advance field surgical hospital, where a single anaesthesiologist is available, the job of the anaesthesiologist starts with prehospital care. A team of three ORAs and the nurses serve as assistants. The anaesthesiologist secures the airway; ensures adequate ventilation; gives appropriate fluid management, sedation, and anaesthesia; and looks after the safe transport of patients.

Obtaining a history and physical examination is difficult within the time constraints. Communication with other soldiers, stretcher bearers, and surgeon helps to gather information. A general trauma survey is conducted to identify or exclude all injuries. The mechanism of injury determines the pattern of associated injuries, and this knowledge focuses treatment priorities. For example, effects of blunt trauma often evolve with time and require re-evaluation, whereas penetrating thoracic trauma resulting from shrapnel, missiles, or bullets requires immediate intervention. Penetrating injuries in the neck region can seriously jeopardize the airway, so early intubation is essential and the best protection against aspiration.

Securing the airway can be very difficult if a fiberoptic bronchoscope and laryngeal mask airway are not available. Intubation can be facilitated with the use of improvised devices such as a spoon or torchlight. In difficult cases, awake intubation after superior laryngeal nerve block and transtracheal injection of local anaesthetic is our preferred method. Surgical airway is reserved for patients who cannot be intubated orally or nasally. Cricothyrotomy is the preferred technique. The anaesthesiologist needs to be comfortable with both needle cricothyrotomy and cricothyrotomy with insertion of a tracheostomy tube.

Great debate continues on the subject of how much and which fluid should be used in multi trauma patients.^{9,10} At our centre, all staff follows a fluid administration protocol that involves insertion of two 14G intravenous (IV) cannulae in the upper extremity if possible and may involve venous cutdown. Warmed IV colloids and crystalloids are administered to all casualties to avoid precipitating or worsening hypothermia. Warm water baths are used in the absence of heat-exchanger devices. An inflated blood pressure cuff around the IV fluid bags facilitates rapid administration. Following assessment of blood loss, the anaesthesiologist monitors the patient's response to therapy to guide further fluid and blood administration. A list of blood donors is kept in the hospital at all times; therefore, fresh whole blood is readily available for transfusion.

Definitive Treatment

Life- and limb-saving surgery with cardiovascular and respiratory stabilisation are the primary concerns. Various adaptations have been made to meet these goals.

Operating Facility. The main operating theatre is inside an underground bunker. The bunker contains a preoperative resuscitation room; an instrument room with an autoclave; a postoperative room; and a storeroom, which is also used as a



Figure 2. Foot-operated suction apparatus.



Figure 3. Resuscitation area.



Figure 4. Boyles machine.



Figure 5. Surgical ward beds.

Table 1. Mode of Injuries

Mode of Injury	No. of Cases (%)
Shrapnel	183 (37.5)
Gunshot wounds	160 (32.8)
Landmine blast	105 (21.5)
Grenade blast	39 (8)

changing room. The floor has a polyvinyl covering. There is an adjustable operating table and portable operating light. Both electrical and foot-operated suction is available (Fig. 2) and a vehicle battery system is kept as standby in case of generator failure.

The cold climate, high wind velocity, and high wind chill factor may lower the temperature of operation theatre to as low as -25°C (Fig. 3). Hypothermia correlates with a very poor outcome. Therefore, warming the theatre is a major priority and is accomplished with blower-type heat convectors, which

rely on a generator. Casualties are also kept warm by being covered with blankets. Irrigation of body cavities is performed with warmed saline solution.

We managed a total of 574 casualties between November 1999 and August 2001. This included all battle casualties and accidents as well as weather-related injuries, mountain sickness, and HAPO. Of these, 487 patients underwent surgical intervention at our centre (Table 1). Primary wound debridement and foreign body removal accounted for 77% (375 of 437) of the procedures.

Anaesthesia Equipment. Military anaesthesia requires small, lightweight, versatile, and easily transportable anaesthesia machines for use in a frontline field surgical unit. A portable Boyles machine with a backup cylinder supply system is available in our hospital (Fig. 4). It is a rugged and robust machine that has withstood the test of time despite problems with a lack of safety features, gas leaks, and the inability to use a closed circuit. A Goldman vaporiser, which is a variable bypass, flow over without wick, out of circuit, nonthermocompensated vapouriser, is used for the administration of halothane. An Epstein-Macintosh-Oxford (EMO) vaporiser is also available but is seldom used.

While total intravenous anaesthesia (TIVA) has a role in difficult environments, we are unable to use this technique because infusion pumps and suitable IV anaesthetic agents are not available. However, ketamine has been used increasingly, with satisfactory results. Dissociative anaesthesia was used in 40% of cases, general anaesthesia induced by halothane in 30%, and regional local anaesthetic techniques in 30%. Over a period of 22 months, 141 cases of isolated extremity trauma were managed with regional local anaesthetic techniques with good results. Despite numerous advantages of regional techniques over general anaesthesia, they are probably still underutilised.

Patients requiring postoperative ventilation are moved to an acute surgical ward for further management (Fig. 5). The East Radcliffe, the Drager Evita, and the Compaq ventilators are available and sufficiently robust and versatile for use in our difficult environment.

There are limitations to the monitoring devices available.

The best monitor is clinical assessment, with frequent conventional blood pressure measurement and pulse measurements. A pulse oximeter and a defibrillator electrocardiography monitor are available. Bladder catheterisation and urine production are used as indicators of fluid balance and renal perfusion. Central venous lines are not available. Some patients require transfer to a tertiary level centre. Patients are monitored during transport and a portable ventilator provides ventilation. As the monitors are generally single items in each FSC, their absence from the operating theatre during transfer can seriously hinder the management of patients and their surgery.

Conclusion

Trauma care continues to be an important part of medical practice. With improved resuscitation and definitive care, military experience has seen a reduction in mortality and morbidity of soldiers. Despite enormous difficulties, in the recent conflict in India, Army doctors working in advance surgical units have saved innumerable lives. The presence of expert care at a forward post is a major moral boost for troops, who recognize that prompt optimal care gives the best chance of recovery. There are numerous challenges for anaesthesiologists involved in trauma care in an advance field surgical unit. Improving the available level of care with the limited resources and minimization of morbidity and mortality continue to be our goals.

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