REVIEW OF ANAESTHESIA AND ANALGESIA IN THE FIELD WITH EMPHASIS ON AIRBORNE MILITARY OPERATIONS

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ABSTRACT:

The purpose of this article is to discuss various factors associated with successful handling of mass casualties in the field with special reference to the airborne military operations. Various limitations specific to airborne operations are highlighted. Stress is laid on the importance of variables as they effect medical support and planning. Various analgesics, both opiates and non opiates including role of subanaesthetic doses of ketamine are discussed. Adequate knowledge and experience in wide ranging field techniques including improvisations is stressed. The facts are placed in a specific, original context through which new insight can be derived. The feasibility of incorporating light weight modern equipments in field anaesthesia are also brought out.

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KEY WORDS: Analgesia; Field anaesthesia; Ketamine; Mass disaster.

Introduction

Anaesthesia and resuscitation in a mass casualty situation in a field set up always poses a challenging task for the anaesthesiologist. The problems are further compounded in an airborne military operation due to its obvious factors and limitations. Needless to say that efficient handling of war casualties in such situations has tremendous morale boosting effect on the fighting troops. In a war scenario, at times help from civilian medicos is also sought to meet the crisis. It is therefore imperative that all of us are well conversant with the problems and techniques in such disaster situations in difficult terrains. It is rather unfortunate that the recent editions of text book on anaesthesiology are ignoring this aspect of anaesthesia, which should still remain an important chapter for the developing countries.

Modern Battlefield

The lethality of the modern battlefield has been extensively documented in the US (Army's) literature [1,2]. Quick strike with all modern weapons in a highly stressful and confusing environment can generate heavy casualties. This drastically affects combat power and its psychological impact has potential demoralising effect on the remaining forces. With the increasing risk of nuclear, biological and chemical warfare the problem seems to be further compounded for which even the most advanced countries may not have a solution. It will be quite practical to assume that 40% of the wounded casualties who would other-

wise survive, die before reaching a medical aid post [2].

Limiting factors in Airborne Military Operations

Dominant factors in airborne operations are flexibility, light weight, mobility, quick reaction time, physical robustness, mental alertness and high degree of motivation. Efficiency of medical cover in airborne operations tends to decrease due to certain limitations as follows:

(a)*Increased number of casualties:* Combat airborne assault casualty rate vary widely and can be as high as 25% [3]. The parachuting injuries themselves account for 6-8.9% injury rate [4,5] due to different variable factors like drop zone, weight of equipment, drop altitude, wind speed, night drop etc. Moreover medical personnel are also prone to such injuries. Stiff winds increase risks of lacerations, contusions and head injuries [6].

(b)*Limited medical resources:* Due to the constraints of airlift availability, the medical load, both in terms of manpower and equipments, have to be reduced at times. Replenishment of stores is also unpredictable.

(c)*Evacuation of casualties:* There is uncertainty about early and safe evacuation of casualties in airborne operations. Variable factors being terrain, weather, availability of ambulances, aircraft and helicopter, air superiority, capture of airfield, link up with ground forces, quantum of casualties etc. It may be noted that in a severely injured patient, survival is re-

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lated to severity and duration of trauma. Hence resuscitation in such patients should be done as early as possible, preferably within the critical first hour (The Golden Hour) [7].

(d) *Heavy equipment -poor manoeuvrability*: Some of the anaesthetic, surgical and patient carrying equipments are fairly heavy inspite of being specially designed for airborne operations. This drastically affects the prompt setting of the forward surgical centre (FSC) away from the dropping zone.

(e) *Night operations*: Parachute operations at night have almost double the day light injury rate [4].

(f) *Pace of modernisation*: Financial constraints remain the dominant factors for modernisation of equipments, keeping in mind their efficacy, portability, robustness, safety and above all low or zero maintenance.

(g) *Location*: Inaccessibility, remoteness, climatic conditions, unfamiliar and hostile environment are pertinent variables which affect medical support and planning.

Medical Planning

Modern warfare is highly skilled and technologically advanced, leading to mass casualties. Situation during war differs from other mass casualty situations in many aspects as discussed above. Efficient medical cover depends more on training, skill and adaptability than on availability of expensive and complicated equipments. Anticipation and improvisation are the key words.

For effective medical cover, prior planning and training, timely evacuation by ground and air resources, coordination, effective communication system and administration are the main factors. Periodic rehearsals and review of plan is important to ensure that the personnel with the key responsibilities are familiar with the various drills. Meticulous packing and cushioning of equipments during airborne operation is important to prevent damage during para drop. Adequate stock of pneumatic splints, MAST and light patient carrying equipment like paraguard stretchers, scoop stretchers etc, should be catered for.

First aid training for all ranks is the foremost important factor in view of mass casualties and limited medical resources. Adequate realistic and practical training in basic life support measures during peace time will go a long way in salvaging many lives and limbs. This should not be a problem in the modern set up due to better educational standard of soldiers.

Analgesia

Adequate analgesia and safe and timely evacuation to the nearest FSC remains the foremost aim at the remote battle field. This may have to be provided by the paramedical/trained comrade in the scattered areas. Use of a single disposable syringe with multiple disposable needles for different casualties is quite practicable in the field. Availability of multidose vials will be added advantage for packing and administration, compared to ampoules. Some of the analgesics which can be used are:-

(a) Opioids

(i) *Morphine*: It remains the main drug for treatment of acute severe pain. Tubunic ampoules are specially designed for battle field casualties for quick administration without the need of a separate syringe. But these are not always available. Moreover severely injured patients with decreased blood volume, may not benefit by I/M or S/C route due to poor perfusion and are more susceptible to hypotension and later may even collapse from overdose once circulation is restored [8]. Delayed toxicity may also be due to repeated injections of opiod in chilled skin area. [9] Titrated IV doses would be appropriate in such situations, but not considered safe at the hands of paramedical staff.

(ii) *Other opioid analgesics*. Pentazocine, which is in common use these days, has less abuse potentials and unlike morphine, it increases the BP and can be considered a useful alternative. For 10 mg of morphine equianalgesic dose is 30-60 mg of pentazocine. Meperidine has effects more or less similar to morphine (equianalgesic dose 75-100 mg). Among the newer opioids, nalbuphine is considered appropriate, as it increases blood pressure and cardiac output in shock [10] and has less dysphoric side effects. Moreover, it exhibits ceiling effect on respiratory depression in doses above 30 mg [9]. Adult parenteral dose varies from 10 mg to 20 mg. Buprenorphine is very potent analgesic with a long duration of action, but clinically unacceptable degree of ventilatory depression have been reported [11]. However, its high lipid solubility makes it suitable for sublingual administration [12]. Short acting opioids like fentanyl and its derivatives may not have a role in battle casualty on the spot.

(b) NSAIDS and other Analgesics.

With the growing menace of world-wide abuse of opioids, medical personnel are equally vulnerable. So there is a requirement to find suitable alternative. It is unlikely that NSAIDS can completely replace opioids

in severe pain. But since they exert effect by different mechanism, combination of lower doses of opioids with injectable NSAIDS can achieve optimum analgesia with lesser side effects [13,14]. Advantages over opioids include reduction in side effects like respiratory depression, nausea and vomiting, absence of tolerance or addiction potential and less sedation. They do not constrict the pupils and can also be given in patients with head injury and in whom opioids are not recommended. The potential complication of NSAIDS like GIT ulceration, decreased platelet aggregation, impairment of renal function etc, should not be hindrance in their short term use in trauma patients.

Presently ketorolac tromethamine (15,30 mg/ml vials), diclofenac sodium (25 mg/ml in 3 ml ampoules and 30 ml vials), tramadol (50, 100 mg/ml) and nefopam hydrochloride (20 mg/ml) are cheaply available in injectable forms and can be safely given for short duration in trauma patients. Ketorolac and tramadol can also be given IV [15].

(c) Role of Ketamine as Analgesic

Ketamine is known for its strong analgesic effect. This property can be utilised in the battle field. Analgesia occurs at considerably low blood levels than loss of consciousness [16]. The doses of ketamine for sedation and analgesia are [17]:-

- (i) 0.2-0.8 mg/kg IV over 2-3 min
- (ii) 2-4 mg/kg IM (onset 5 min, peak effect 20 min)
- (iii) 10-20 µg/kg/min infusion..

Notcutt used ketamine in doses of 1.5mg/kg in easing the pain during transport of patient with spinal metastasis [18]. Preservation of muscle tone, laryngeal reflexes and respiratory activity apart from cardiovascular stability in hypovolaemic patients, makes it an ideal analgesic in the battle field even in the hands of paramedical personnel (in analgesic doses only). It is available in 50 mg and 100 mg/ml in multidose vials and is thus convenient for packing and administration. A dose of 2-4 mg/kg IM is recommended and can be repeated on demand. Ketamine can be specially useful prior to air evacuation of casualty by helicopter or aircraft. Intramuscular ketamine may have a place as short term analgesic. Unpleasant emergence delirium may occur in a few cases in analgesic doses also [15]. Its incidence and intensity can be reduced by subsequent benzodiazepines. Role of ketamine in war casualties needs to be explored after further trials.

Role of Anaesthesiologist

Anaesthesiologist plays an important role in supervising resuscitation, anaesthesia, post operative care

and respiratory support to mass casualties. He should be able to adapt to difficult situations and modify techniques accordingly keeping in mind the limited manpower, resources and drugs. Following points should be kept in mind prior to handling war casualties:-

(a) *Full Stomach*: In an injured patient, gastric emptying will have stopped at the time of injury.

(b) *Restoration of blood volume*: Initial treatment in a haemorrhagic shock is restoration of blood volume and not red cells. Hence quick 1-2 venous accesses using 14 or 16 G intracath should be established and fluids (Crystalloids & colloids) given as per clinical assessment. Warming of IV fluids is important in cold patients in shock.

(c) *Sympathetic nervous system* gets exhausted in prolonged duration of haemorrhagic shock.

(d) *Laboratory investigation* may not be available readily though in a previously fit soldier, there should be no obvious systemic disorder.

(e) *Proper triage and allotting priorities*: Aim is to do maximum good to maximum number of casualties.

(f) *Correct clinical assessment of blood loss* by monitoring pulse, blood pressure, urine output, CVP if feasible.

(g) Flexibility and expertise in selection of technique and crisis management.

(h) Physical and mental capability to sustain stress and strain of overwork and set an example.

(i) Adequate experience of field techniques and judicious use of limited drugs and equipments. He should be able to improvise techniques within safety limits.

(j) Quick decision making and good administration.

(k) Depending on the situation, appropriate use "Stabilise at site" approach or "scoop and run" approach [7].

Anaesthetic Techniques and Equipments

Wide range of techniques are available for anaesthesia in the field. One should be able to use all methods from open drop ether to the latest feasible techniques, trying various combination as per the prevailing situation. Basic requirements are safety, simplicity and speed. Some of the points worth mentioning are;

(a) *Triservice Anaesthesia Apparatus*: It is considered most ideal for airborne situation and has been used successfully by the British army in Falkland campaign [19]. It is light weight, robust, simple and has two OMV vaporisers which permit both the non explosive agents halothane and trilane to be administered

by draw over system. Use of heavy oxygen cylinders is reduced to minimum. Visual signs of volume of respiration during spontaneous respiration can be provided by fitting an open ended reservoir bag to the expiratory part of the one way valve.

(b) *EMO*: Though still widely used in the field, it is not considered suitable for military use because flammable ether is dangerous in some military environments and for transportation by air. It is also bulky.

(c) *Portable Boyle's Machine*: Apart from being comparatively heavy, the requirement of N₂O and oxygen cylinders makes it a difficult choice due to logistic problems. Moreover, N₂O diffuses into air spaces in trauma patients and risk of accidental hypoxia also remains in old models. Newer models with Nitrous oxide lock and audio visual alarm system should be used if at all.

(d) *Dissociative Anaesthesia*: Ketamine either IV or IM with diazepam (or thiopentone 25-30) is most ideal for short painful procedures. It can be converted into GA if required.

(e) *Ketamine infusion*: by ordinary drip (0.1%) with relaxant +IPPV. Overall ketamine consumption is reduced by the infusion method.

(f) *OMV*: Military version of OMV should be equipped with widely splayed legs to minimise risk of tripping.

(g) *TIVA*: Using ketamine, diazepam or midazolam, vecuronium +IPPV and pentazocine/fentanyl. Small syringe pumps can be used if required.

(h) *Spinal/Epidural*: For sole anaesthesiologist with limited resources these techniques can be used in a few selected cases. Spinal needle size should be 22-24 gauge.

(i) *Doxapram and naloxone*: In selected cases these drugs can be used to save precious time in recovery.

(j) *Inhaled Anaesthetics*: Isoflurane provides greater overall safety margin than halothane or enflurane. Moreover, it does not sensitise the heart to endogenous or exogenous catecholamines, and is available in small handy containers.

(k) *Portable Oxygen concentrator*: It will be the most ideal equipment for continuous supply of oxygen, thus dispensing with bulky oxygen cylinders and unpredictable replenishment.

(l) *Blood Transfusion*: Under mass casualty situation in field, laboratory control may not be feasible. Hence all troops should have their blood group tested beforehand and recorded on identity disc so that homologous blood of same group can be given without

further check. In emergency situation, the additional source of blood can be lightly wounded persons, medical personnel and persons from base camp.

(m) *Electrolux*: Recently medical refrigeration and transportation of blood has been made easy with portable containers available in two sizes (RCB-12, RCB-25). It can carry 15-30 blood bags at required temperature for 7 days. It has polyurethane foam insulation and weighs between 20-40 kg including 4-5 kg of ice. Field trials have been successful (own study).

Future Prospects

With the rapid pace of modernisation in the field of anaesthesia, there is also a scope of modernisation in field anaesthesia. This depends on the financial constraints and overall permissible weight:-

(a) *Portable Pulse Oximeter*: Special battery operated model is available. Pocket size (Nonin Onyx) is ideal.

(b) *Portable ventilator*: It will be handy to save manpower.

(c) *Electronic infusion pumps*: Their increasing use during TIVA will minimise use of inhaled agents thus dispensing with bulky equipments and replenishments [20]. They are cheaper and do not need much servicing also. Because of its favourable pharmacokinetic and dynamic profile, propofol either with spontaneous ventilation or IPPV can be used during TIVA along with remifentanyl, a new ultrashort acting opioid [20,21].

(d) *Uniform pattern of equipment*: At times help may be sought from civil medical authorities or foreign countries in disaster situations. It is therefore imperative that universal standardisation is adopted so that it does not hamper the relief work. This problem was specially noted during Armenian earthquake disaster.

(e) *Red cell substitutes*: Presently investigations are still in progress on two artificial oxygen transporting fluids-stroma free haemoglobin (SFH) and perfluorochemical emulsions (PFC) [22]. Once their clinical use starts, it will be remarkable progress for management of acute haemorrhagic shock.

(f) *Modified foldable light weight hospital shelter*: These are easy to set up and provide effective shelter for OT in difficult terrain and are designed for mobility. OT shelters can be designed on the following pattern.

(i) Trell Tent System

(ii) DRASH-Deployable rapid assembly surgical hospital

- (iii) Mobile clinic system
- (iv) Swedish Field Hospital

Conclusion

Successful management of mass casualties in modern battle field depends on medical planning, coordination, training and rehearsals, keeping in mind the variables associated with such operation. The anticipation of casualties based on the variables can be made. Proper selection of manpower and equipment and packing is important specially in the airborne operations compared to the conventional warfare. Light weight equipments, shelters and modern drugs are desirable for efficient management of casualties in the battlefield.

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