Current Concepts In The Epidemiology And Management Of Battlefield Head, Face and Neck trauma

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Abstract

There has been a significant increase in the incidence of head, face and neck (HFN) injuries in the 21st century in comparison to that experienced in the previous century. In the majority of HFN injuries the primary cause of death is secondary to airway compromise and with the exception of severe neck wounds haemorrhage is an unusual cause of death. Emergency cricothyroidotomy and semi- elective tracheostomy are skills that should be taught to deploying surgeons. There are now significantly increased numbers of potentially salvageable HFN injuries resulting from new and effective armour that protects the torso and abdomen. Equivalent armour to protect the neck and face is not yet effective and requires development. We describe the current epidemiology and management of battlefield head, face and neck trauma.

Introduction

There has been a significant increase in the incidence of head, face and neck (HFN) injuries in the 21st century in comparison to that experienced in the previous century [1- 7]. The term 'head, face and neck' should be now be used instead of the traditional 'head and neck'. This is based upon the International Classification of Diseases [8] criteria in which the three terms (head face neck) are the anatomical headings under which further sub-classifications allow detailed, accurate and reproducible coding of injuries [5]. It is also the classification upon which both the British and American Joint Theatre Trauma Registries (JTTR) are based. A simplified explanation of this classification is demonstrated in Table 1.

Head	Face	Neck
Scalp Intracranial Base of skull fracture Skull vault fracture	Skin and muscle Nose Ear Eye Facial bony fracture Nerve	Skin and muscle Oesophagus Larynx and trachea Great vessels Nerve

Table 1: A simplified explanation of ICD-9 classification

It is generally agreed that the increased incidence of HFN injuries most likely reflects improvements in body armour in conjunction with the increased use of improvised explosive devices (IEDs) [1]. Some authors [9] have also postulated that in current conflicts the unprotected face of a soldier wearing body armour is not only exposed but may also be directly targeted by the enemy.

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A review of 'head and neck' injuries between 1914 and 1986 found the average incidence to be 16% of total injuries [2], ranging from 4% in World War II to 31% in some armies during World War I. Separate reviews from US forces in Iraq and Afghanistan in the 21st century describe incidences of 'head, face and neck' injuries ranging from 21% [1], 28% [3] and 29% [4]. The first review of HFN injuries sustained by British servicemen in the 21st century [5] found these injuries accounted for 18% of battle injuries in 2006, 28% in 2007 and 23% in 2008. Currently the primary cause of HFN injuries to servicemen on deployment in both British and American forces is blast injury from IEDs; gunshot wounds now account for only 17% of British HFN injuries [5].

This article will provide an overview of the current concepts in management of battlefield head, face and neck wounds in the pre-hospital and Role 3 settings; ophthalmological injuries are covered elsewhere in this edition.

Pre-hospital Management

In the majority of cases of military trauma involving the head, face or neck, the primary cause of death is secondary to airway compromise. Haemorrhage is an unusual cause of death with the exception of severe neck wounds. Despite this all military patients sustaining head, face and neck trauma should be resuscitated using the <C>ABC paradigm [10] in which control of catastrophic haemorrhage must come before airway, breathing and circulation. This is because in the modern battlefield, polytrauma is the predominant pattern of injury and the head, face and neck area is rarely injured in isolation [5, 11, 12]. Severe pain is generally not a feature of face and neck injuries; mobile, painful facial fractures can be temporarily supported with a bandage or roll of field dressing.

All patients sustaining significant head, face or neck injuries should undergo endotracheal intubation unless the clinician is confident that the patient can safely maintain their airway. Oro-pharyngeal tubes are a useful interim measure and should be used in preference to naso- pharyngeal tube in HFN injuries as it is impossible to exclude base of skull fractures in the acute setting. Comminuted mandibular fractures may result in loss of tongue

support, resulting in the tongue moving backwards and obstructing the airway. This may be temporarily resolved by placing a single suture through the tongue allowing the tongue to be pulled towards the chin. Conscious patients with this form of injury often want to sit upright and clinicians should be wary of laying these patients supine where the tongue may rapidly occlude the airway.

Should intubation be impossible in a pre-hospital setting because the skills to perform it are not available or the facial trauma too extensive, other methods of providing a definitive airway must take precedent. The ability to perform an emergency cricothyroidotomy is a necessity for deployed medics, which can be simplified using prefabricated kit such as the Portex © II Mini-Trach. Cricothyroidotomy must always be seen as a temporary procedure and when the appropriate skills become available a tracheostomy should be performed (generally on arrival to a Role 3 setting).

It is current policy to place all unconscious or intubated patients sustaining head and neck injury in cervical spine immobilization. It has however recently been suggested that penetrating ballistic trauma to the neck will rarely result in an unstable cervical spine in survivors [13]. In an austere environment the risk/benefit ratio of mandatory spinal immobilisation is unfavorable and may place medical teams at prolonged risk. In addition cervical collars may hide potential life-threatening conditions [13].

There is limited scope for the clinician in managing haemorrhage from the head, face or neck in the pre- hospital setting. External bleeding from wounds that are not immediately fatal can usually be managed by direct pressure with a dressing and sitting the casualty upright [14]. Novel haemostats such as Haemcon or Quikclot are not licensed for use in the head and neck and although they could potentially be used in the management of penetrating neck trauma, there have been no reports of their successful use in the literature. Scalp wounds can bleed profusely and simple measures such as an approximate apposition of the wound edges with interrupted sutures can temporarily arrest haemorrhage.

Role 3 Management

Once the patient with HFN wounds arrives at a Role 3 facility, primary and secondary surveys will be undertaken in the emergency department. Patients exposed to IEDs must be assessed for burn- related injuries, and a low threshold for endotracheal intubation or tracheostomy is indicated [15]. CT scanning is usually recommended as seemingly minor injuries may mask severe underlying damage (Figure 1). In those few cases where isolated head and neck injury may not immediately warrant CT scanning, a simple chest radiograph will usually highlight inhaled foreign bodies such as teeth. Evacuation times may be protracted due to operational requirements and patients can arrive hypotensive, hypothermic and acidotic; these patients require aggressive resuscitation measures and often multiple surgical interventions [16].

The three primary sources of bleeding in the head and neck are scalp vessels, the maxillary arteries and the great vessels in the neck. Penetrating neck injury has a high mortality and a low threshold for surgical exploration is essential. Midface fractures can cause profuse bleeding from the maxillary artery. Dental mouth props can be used to elevate a loose maxilla in the presence of an intact mandible and thereby tamponade the maxillary artery. Epistaxis following nasal trauma may be severe and its management will be discussed below. *In extremis,* with a definitive airway *in situ*, the whole oral cavity can be packed.

Superior aesthetic outcomes can be achieved with face and neck wounds if initial gross irrigation, debridement and packing are carried out as soon as possible. American authors suggest this should even be carried out in the emergency room once the patient has been stabilised without waiting for an operating theatre to become available [15].

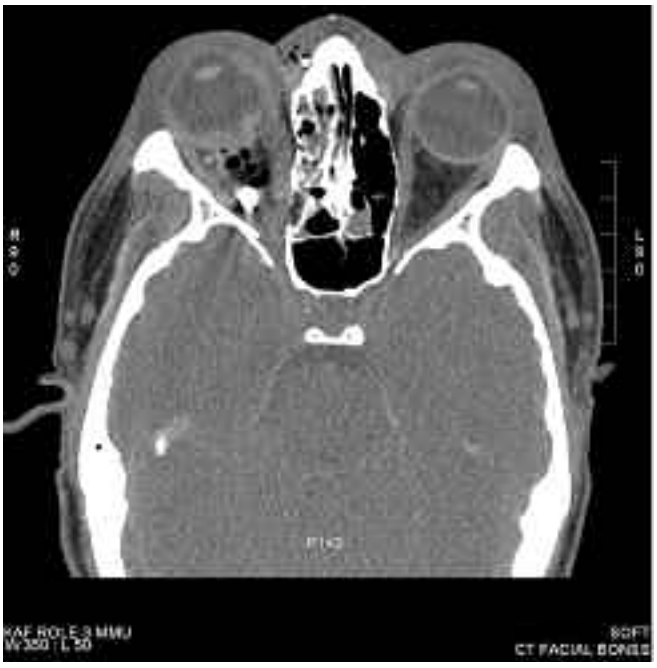

Figure 1 CT scan showing an orbital fragment from an IED. The patient sustained an apparently minor injury, but was immediately and permanently blind in the right eye

Bony facial injury

Initial surgical treatment of HFN wounds can differ dramatically from the surgical management of injuries to other body areas. Following debridement and conservative wound excision, careful consideration should be given to preservation of tissue and those bone fragments retaining their periosteal attachment. This type of tissue may be retained and can become useful in reconstruction. Facial fractures are generally managed conservatively prior to evacuation. Immediate fixation of mandibular fractures is indicated when flail anterior mandibular fractures result in airway impingement of the tongue and when continuing haemorrhage from fracture sites threatens the airway. In the case of midfacial fractures, immediate fixation is indicated in the case of severe posterior fracture displacement or haemorrhage obstructing the airway.

Temporary stabilisation of bony fragments can be achieved through the use of circumdental wires or drill- free bone screws attached to elastics. Drill- free bone screws (Figure 2) are a simple and quick method of establishing intermaxillary fixation (IMF) around teeth, requiring a minimum amount of specialist training or equipment. These screws offer significant advantages over other methods of IMF and are well suited for use in military casualties [17]. Undertaking this form of simple fracture stabilisation provides better pain control than narcotic analgesics alone; it also improves wound management, thereby decreasing the likelihood of wound infection [18].

Figure 2 Drill free intermaxillary fixation (IMF) screws

If a surgeon with the appropriate training is present, bony facial fractures may be fixed using standard miniplates or through the use of external fixators. The use of internal rigid fixation in fragmentation injuries to the face has resulted in high wound dehiscence and infection rates in recent conflicts [15]. Traditionally both British and American surgeons have tended not to internally fix facial fractures on coalition soldiers in the Role 3 setting [15]. This practice was challenged recently [19] in a paper detailing in-theatre repair of facial fractures on 18 American servicemen. Strict selection criteria however were used and the numbers of patients treated were small. It is therefore still unlikely that significant numbers of in- theatre repairs of facial fractures will be undertaken on British servicemen in the near future.

In the civilian setting external fixators are now rarely used for the management of bony facial trauma. However the complex patterns of facial fractures seen on the modern battlefield [20] are ideally suited to their use, especially when there is avulsion of soft tissue and bony fragments. Specially constructed facial external fixators (Figure 3) are becoming available to deployed surgeons, but the Hoffman II fixator, familiar to orthopaedic surgeons for its use in wrist fractures, has been used successfully to treat both mandibular and midface fractures [15, 16].

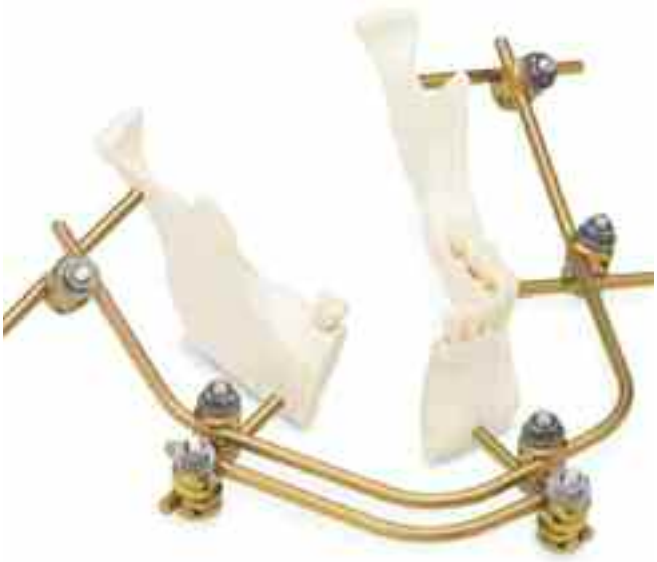

Figure 3 The Synthes II mandibular external fixator

Neck trauma

Conventional body armour provides little protection to the neck. Issued supplementary neck protectors are rarely worn by deployed British servicemen except when performing top-cover. Current Osprey body armour provides some protection to the lower third of the neck (zone 1) but the upper two- thirds together with the face are unprotected [21].

Neck trauma can be divided into penetrating and blunt. Blunt trauma may be managed conservatively in the absence of hoarseness or change in voice quality, dysphagia or surgical emphysema. All casualties however who have suffered significant blunt trauma to the neck require a definitive airway.

Penetrating neck injury in the contemporary battlefield remains a highly lethal insult, even with the availability for rapid aerial casevac to a forward surgical facility. The important signs of penetrating neck trauma can include stridor, hoarseness, crepitus, expanding haematoma, active external haemorrhage, bruit or thrill, dysphagia, haemoptysis, cranial nerve dysfunction and/or brachial plexus injury [18]. Those injuries causing significant vascular damage usually die rapidly and any attempt at medical intervention is unlikely to be successful. Exsanguination is the most common cause of death in penetrating neck trauma followed by tracheal disruption [14]. All penetrating neck injuries require a definitive airway, as the extent of injury is often under-estimated. The absence of angiography and interventional radiology in a Role 3 setting mean that all injuries where the platysma has been penetrated, must be surgically explored (Figure 4), even in asymptomatic casualties [14].

Figure 4 Surgical management of a penetrating neck injury secondary to an IED. Following tracheostomy the neck injury was explored, the internal jugular vein ligated, the thyroid cartilage repaired and his facial fractures internally fixed

Ear trauma

Middle and external ear damage has recently been documented as occurring in 10% of head, face and neck injuries [5]. Pinna haematoma necessitates prompt incision and drainage to avoid cartilaginous haematoma [14]. Tympanic membrane rupture is common and is often associated with more serious injuries elsewhere [14]. Tympanic membrane rupture should be suspected in all servicemen subjected to blast injury, even if there are no obvious head, face and neck injuries. All servicemen who have been subjected to blast injury should have an audiogram performed when at a Role 4 facility.

Nasal trauma

Nasal trauma may result in fracture or septal haematoma. Septal haematoma requires prompt incision and drainage to prevent infection and cartilaginous necrosis. Epistaxis should be managed by anterior and if necessary posterior nasal packing. Anterior packing can be performed with nasal tampons or BIPP ribbon gauze. Posterior packing should be undertaken with 12G or 14G Foley catheters, which are inflated in the nasopharynx to three-quarters capacity and pulled anteriorly until they impact.

Soft tissue wounds

Battle injuries commonly result in devastating facial injuries causing severe tissue damage well beyond the apparent visible surface margin of the injury [18]. However the rich vascularity of the face means that tissue can often be preserved, unlike other cutaneous areas of the body [20]. Reports from the literature indicate that the majority of procedures performed to the head and

neck region, both whilst deployed and also when evacuated to a role 4 facility are soft tissue debridement, exploration and repair [11, 12, 23] (Figure 5 A&B).

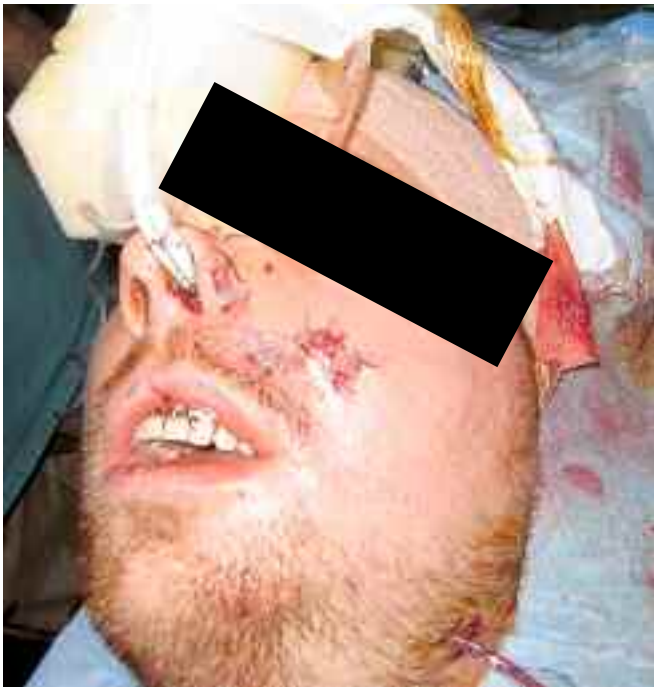

Figure 5 A) A small facial wound from an IED explosion. The sutured wound can be seen above the left corner of the mouth. B) The plain skull radiograph demonstrating a large retained IED fragment in relation to the small entry wound

There has been a gradual shift in the literature towards multiple staged reconstructions for facial trauma. Although early primary reconstruction prevents soft-tissue scarring and contraction [24], the majority of facial bony wounds on the modern battlefield contain multiple devascularised bony segments, which are invariably contaminated. High- energy transfer results in soft tissues that may initially appear viable but often necrose within days. Late repair ensures a clean, segregated wound bed but faces the irreversible effects of contracture [20]. The hard tissue base should be stabilised to support the soft tissue envelope and prevent wound contracture before primary reconstruction [25]. Late tissue ischaemia in IED injuries often occurs, which increases the area of necrosis as the effects of shear injury on vascular tissues gradually declare [26].

Pulsed lavage is a tried and tested technique in orthopaedics but its use by civilian head and neck surgeons is rare. It has successfully been used recently by both British and American deployed Maxillofacial surgeons [25] and is recommended in both Australian and American military facial treatment protocols [18].

Early introduction of healthy tissue will reduce infection, scarring and produce an early return to function. If soft tissue has been lost over the course of serial debridement then it has been suggested [25] to use vascularised flaps (Figure 6) before the development of scar contraction. Recently this has been challenged by American authors, who believe that vascularised flaps should usually be postponed until there is minimal risk of infection or additional tissue loss [15].

Figure 6 Nasal reconstruction using forehead flap

Facial soft tissue wounds have a profound effect upon patients' self esteem and interpersonal relationships. Early psychological intervention is essential in the Role 4 setting to help servicemen come to terms with potentially lifelong facial disfigurement.

Nutritional status

Prompt assessment of the nutritional status of all servicemen sustaining head, face or neck injury reduces the risk of infection and hastens recovery. The majority of coalition servicemen will be well nourished but that may not be the case for local coalition servicemen or civilians. It is generally accepted that in the military environment, supplementary nutrition should be started on any critically ill patient who is unlikely to have adequate oral intake for greater than 24 hours [27]. This is especially important when considering that RAF Critical Care Air Support Teams (CCAST) will be managing patients for up to 13 hours in the air evacuation to a Role 4 facility during which feeding may not be possible [28]. Early placement of an oro- or naso- gastric tube allows feeding with a high calorie, protein rich, liquid diet. Naso-gastric feeding should not be undertaken unless a base of skull fracture can be definitively excluded [29]. For patients who may require a lengthy period of oral rehabilitation placement of a percutaneous gastrostomy should be considered if the facilities and skills are available.

Infection

All blast injuries should be considered contaminated. Skin is commonly peppered with dirt, gravel, grass, wood and other organic materials [16]. Human tissue incorporated into a blast injury can seed atypical bacteria deep into the wound bed. These injuries usually require delayed primary closure with aggressive antibiotic therapy [20]. Patients returning from Afghanistan have been documented by both American [30] and Canadian authors [31] as being colonised by unusual microbiological flora such as *A. baumannii*. This bacterium is resistant to numerous classes of antimicrobials and suspected cases require isolation upon evacuation to a Role 4 setting [25]. Facial wounds do however have a lower incidence of *A. baumannii* infections because of higher oxygen tension levels [18].

Future training and developments

Current civilian surgical training in the western world has resulted in highly specialised surgical skill sets. This preparation is not optimal for the battlefield surgeon who has in the past relied upon their broad surgical skill mix [22]. Today's general surgeons are primarily taught skills directed towards limb, abdominal and thoracic injuries. Military planners need to recognise these changes and respond by deploying teams of specialist head and neck surgeons. Such teams should include otorhinolaryngologists, maxillofacial surgeons, neurosurgeons and ophthalmic surgeons.

The increase in the incidence of head, face and neck injuries has led to changes in the pre- deployment training of British Military Surgeons. One whole day of the new five- day Military Operational Surgery and Trauma (MOST) course is dedicated to teaching the surgical management of head, face and neck trauma. Finally there is an increasing awareness in both the British and American militaries [7] of the importance of developing new methods of protecting the vulnerable head, face and neck regions in light of the increased incidence of these injuries on the modern battlefield.

References

1. Xydakis MS, FravelI MD, Casler JD. Analysis of Battlefield head and Neck Injuries in Iraq and Afghanistan. Otol Head and Neck Surg 2005; 133: 497-504
2. Dobson JE, NewelI MJ, Shepherd JP. Trends in Maxillofacial Injuries in Wartime (1914-1986). Br J Oral Maxillofac Surg 1989; 27: 441-450
3. Bilski T, Baker B, Grove JR, et al. Battlefield casualties treated at camp Rhino, Afghanistan: Lessons Learned. J Trauma 2003; 54: 814-82
4. Owens BD, Kragh JF Jr, Wenke JC, Macaitis J, Wade CE, Holcomb JB. Combat wounds in operation Iraqi Freedom and operation Enduring Freedom. J Trauma 2008; 64: 295-9
5. Breeze J, Gibbons AJ, Midwinter M, Shieff C, Banford G, Bryant DB. Head, Face and Neck injuries sustained by British servicemen in Iraq and Afghanistan: 01 March 2003- 31 Dec 2008. J Trauma in press
6. Rustemeyer J, Kranz V, Bremerich A. Injuries in combat from 1982-2005 with particular reference to those to the head and neck: A review. Br J Oral Maxillofac Surg 2007; 45: 556-60
7. Wade AL, Dye JL, Mohrle CR, Galarneau MR. Head, face, and neck injuries during Operation Iraqi Freedom II: results from the US Navy-Marine Corps Combat Trauma Registry. J Trauma 2007; 63: 836-40
8. International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM), Sixth Ed (2008)
9. Peterson K, Hale RG, Hayes DK, Blice JP. Prevention and management of combat related infections of the maxillofacial, head and neck region: a review. J Trauma 2008; 64 (Suppl): S265-276
10. Hodgetts T, Mahoney PF, Byers M, Russel MQ. ABC to <C> ABC: Redefining the military trauma paradigm. Emerg Med J 2006; 23: 745-746
11. Breeze J, Gibbons AJ, Opie N, Monaghan AM. Military Maxillofacial Injuries Treated at the Royal Centre for Defence Medicine: June 2001 to December 2007. Br J Oral Maxillofac Surg in press
12. Breeze J, Monaghan AM, Williams MD, Clark RNW, Gibbons AJ. Five months of surgery in the Multinational Field Hospital in Afghanistan with an emphasis on Oral and Maxillofacial injuries. J R Army Med Corps in press
13. Ramasamy A, Midwinter M, Mahoney P, Clasper J. Learning the lessons from conflict: Pre-hospital cervical spine stabilisation following ballistic neck trauma. Injury in press
14. The British Military Surgery Pocket Book. Editor Roberts P; Crown Copyright 2004
15. Will MJ, Goskel T, Stone CG, Doherty MJ. Oral and Maxillofacial Injuries Experienced in Support of Operation Iraqi Freedom I and II. Oral Maxillofacial Surg Clin N Am 2005; 17: 331- 339
16. Goskel T. Improvised Explosive Devices and the Oral and Maxillofacial Surgeon. Oral Maxillofacial Surg Clin N Am 2007; 17: 281-287
17. Gibbons AJ, Baden JM, Monaghan AM, Dhariwal DK, Hodder SC. A drill-free bone screw for intermaxillary fixation in military casualties. J R Army Med Corps 2003; 149(1): 30-32
18. Reed B, Hale RG, Gliddon M, Ericson M. Maximising outcomes for maxillofacial injuries from improvised explosive devices by deployed health care personnel. ADF Health 2008; 9: 36-42
19. Lopez MA, Arnholt JL. Safety of Definitive In-Theater Repair of Facial Fractures. Arch Facial Plast Surg. 2007; 9(6): 400-405
20. Kincaid B, Schmitz JP. Tissue injury and healing. Oral Maxillofacial Surg Clin N Am 2005; 17: 241- 250
21. Montgomery SP, Swiecki CW, Shriver CD. The Evaluation of Casualties from Operation Iraqi Freedom on Return to the Continental United States from March to June 2003. J Am Coll Surg 2005; 201: 7- 13
22. Banfield G. High velocity penetrating neck injury. J R Army Med Corps in press
23. Brennan J. Experience of first deployed otolaryngology team in Operation Iraqi Freedom: the changing face of combat injuries. Otolaryngol Head Neck Surg 2006; 134(1): 100- 105
24. Gibbons AJ, Patton DW. Ballistic injuries of the Face and Mouth in War and Civil Conflict. Dent Update 2003; 30: 272- 278
25. Powers DB, Will MJ, Bourgeois SL, Hatt HD. Maxillofacial Trauma Treatment Protocol. Oral Maxillofacial Surg Clin N Am 2005; 17: 341- 355
26. Wang Z, Liu Y, Lei D, et al. A new model of blast injury from a spherical explosive and its special wound in the maxillofacial region. Mil Med 2003; 168: 330- 332
27. Henning J, Scott T, Price S. Nutrition of the critically ill patient in field hospitals on operations. J R Army Med Corps 2008; 154(4): 279-281
28. Turner S, Ruth M J, Bruce DL. 'In flight catering': Feeding critical care patients during aeromedical evacuation. J R Army Med Corps 2008; 154(4): 282-283
29. Spurrier EJ, Johnston AM. Use of nasogastric tubes in trauma patients- a review. J R Army Med Corps 2008; 154(1): 10-13
30. Scott P T, Peterson K, Fishbain J et al. Acinetobacter baumannii infections amongst patients at military medical facilities treating injured US service members, 2002- 2004. MMWR Morb Mortal Wkly Rep 2004; 53 (45): 1063- 1066
31. Tien HC, Battad A, Bryce EA et al. Multi-drug resistant Acinetobacter infections in critically injured Canadian forces soldiers. BMC Infectious Diseases 2007; 7: 95