REVIEW ARTICLES

A Clinical Review on Basic Management of War Injuries / Mass Casualties

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Summary:

Managing war injury is no longer the exclusive preserve of military surgeons. Increasing numbers of non-combatants are injured in modern conflicts, and peacetime surgical facilities and expertise may not be available. Although all resources are not always available, adherence to the basic management principles following ATLS guideline, can be made in injured patient care in any situation ranging from single person "Buddy" first aid through to major hospital multiple member trauma teams. This article addresses the management of war wounds including mass casualties by non-specialist surgeons with limited resources and expertise. The Initial measures for treating war casualties are similar to those for any severe injury. The warfare Injured patient management is performed into the following levels: a .Management at the site of incident. b. Management en-route to the hospital. c. Hospital management. The primary objectives of injury patient management are: 1. Rapid and accurate assessment of the patients' condition. 2. Resuscitation and stabilization. 3. Ensuring a smooth and rapid hospital transfer. Management is divided into four phases: a. Primary survey b. Resuscitation. c. Secondary survey and d. Definitive care. These proceed sequentially, with the exception that the primary survey and resuscitation should be started at the site of incident & usually proceed simultaneously, with life threatening situations being managed as soon as they are found. A repeat of the secondary survey (Tertiary survey) may also be performed 24 hours later.

(J Bangladesh Coll Phys Surg 2009; 27: 30-38)

Introduction:

Managing war injury is no longer the exclusive preserve of military surgeons. All surgeons require a sound grasp of the subject. Increasing numbers of non-combatants are injured in modern conflicts, and peacetime surgical facilities with expertise may not be available[1-2].

One of the hallmarks of war injury is the early lethality of wounds to the head, chest, and abdomen; therefore, limb injuries form a high proportion of the wounds that present at hospitals during conflicts[3].

However, it is still appropriate to be aware of the "Gold standard" of management[4].

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Received: 27 November, 2007 **Accepted:** 15 November, 2008

Aim

The aim of this clinical review article is to describe the sequence of events of managing war injuries including mass casualties with triage, resuscitation and initial wound surgery by non-specialist surgeons with limited resources and expertise.

Objectives

1. To understand the epidemiology of warfare injuries / mass casualties.
2. To know the fundamentals of wound ballistics and injury mechanisms.
3. To understand the principles of wound management.
4. To have a sound grasp of initial management principles when dealing with mass casualties .

Materials & Methods:

This review article has used the published literature, recent journals, and review of Surgery text books including my experience in management of mass casualties at Combined Military Hospital, Dhaka Cantonment, Bangladesh from 1999 to 2005. & also few war injuries at UNMIL in Jan 2006 to Feb 2007.

Epidemiology

1. Penetrating missile wounds, injuries from blast phenomena & burns are the typical features of

modern conventional war, civilian terrorists or urban guerilla warfare.

2. Missile wounds are caused by bullets or by fragments from exploding bombs, shells & mines.

Missile / Bullets Injury

Low velocity missile injury: e.g. Bullets from pistol traveling at 400 miles/sec which lacerates and crushes the tissues along the missile tract.

High velocity missile: e. g. Rifle bullets traveling at1000-2000 miles/sec may give up more energy to cause temporary cavitations in addition to laceration and crushing of tissues. The extent of cavitations depends upon the density and elasticity of the target organ and is associated with tissue injuries many centimeters around the missile tract [5-6].

Features of Missile Injuries :

1. Low energy causes limited injury .
2. Cavitations in solid organs are often fatal .
3. Cavitations in bone create secondary missiles .
4. Cavitations in muscle create the dead culture medium.
5. Devitalization of muscle surrounding the missile tract in the depths of the wound provides a perfect media for the growth of pathogenic bacteria which are sucked in from the entrance of the wound.

Blast Injury

Wounding may also be inflicted by explosive munitions such as rockets, aerial bombardment, mortars, and grenades. A small volume of explosive is converted to a large volume of gas in a very short time. This results in high pressure at the point of detonation, leading to the acceleration of gas molecules away from the explosion, a so called blast wind, the leading edge of which is the shock front [7] .

Primary blast injury is typically experienced by casualties close to the explosion and is due to the interaction of this shock front on air-filled cavities within the body (middle ear, lung, bowel).

Secondary blast injury is due to impact on the body of items energized by the explosion. Modern munitions contain preformed metallic fragments; lacking aerodynamic features, such fragments rapidly lose velocity, resulting in low energy transfer pattern wounds.

Tertiary blast injury is seen when the victim is accelerated by the blast and thrown against a fixed object such as a wall.

Quaternary blast injury is that caused by collapse of any building secondary to a blast event.

Victims of blast often have multisystem injury, complicated by the presence of blunt and penetrating injury and burns.

Hall marks of modern war injury :

1. The aim of modern warfare is to incapacitate, not to kill.
2. Fragments are the commonest wounding agents in surviving casualties than a bullet.
3. Multiple injuries to different body systems .
4. The early & high lethality of wounds to the head, chest, and abdomen; therefore, limb injuries form a high proportion of the wounds that present at hospitals during conflicts.
5. No characteristic war wound.
6. Varieties of injuries require intuitive care.

Trimodal Distribution of Death

1. The most deaths occur within the first hour of injury, before the patient arrives at hospital are due to severe brain or cardiovascular injury for which counter measures are of very limited value.
2. The second peak in deaths occurs, between1-4 hours (golden hour) due to uncompensated blood loss, with competent accident service - most are preventable.
3. The third peak mortality rate appears several weeks later due to late complications of trauma and multiple organ failure.

So it is very important to evaluate the injuries according to the severity with well-defined stages.

Management

- Initial measures for treating war casualties are similar to those for any severe injury [8].
- In warfare injuries, patient numbers may for a time exceed the capacity of medical teams to

render normal care. Under these circumstances, it is necessary to sort casualties on the basis of need so that available resources and personnel can render the 'most for the most', to quote an American military surgeon. This is **'triage'** and it is outlined below.

- Triage is a dynamic process and needs to be repeated at each level of care from point of injury until arrival in hospital**.**
- In general, field triage is for evacuation to the hospital.
- Once in hospital, triage is for access to resuscitation and to operating rooms.

The Primary Objectives of Injury Patient Management

1. Rapid and accurate assessment of the patients' condition.
2. Resuscitation and stabilization.
3. Ensuring a smooth and rapid hospital transfer.

The management is performed into the following levels:

1. Management at the site of incident.
2. Management en-route to the hospital.
3. Hospital management.

Management at the site of injury*:*

At this level a swift and co-ordinate management is required. Medical staff and resources should reach the scene of injury at the earliest possible times. Then takes an adequate patient history and account of incident with triage and start the life saving management simultaneously following ABCDE of ATLS guideline.

The doctor arriving at the scene should be able to ensure patent airway, adequate ventilation, arrest haemorrhage, combat shock, splint fractures and transport to the nearest hospital [9-11].

The Advanced Trauma Life Support approach:

Following the death of his wife and serious injury to his three children in an air crash in the 1970s, an American orthopaedic surgeon, Dr. James Styner, introduced a structured trauma management training program which was soon adopted by the American college of Surgeons and developed into the ATLS educational package now in widespread use in the UK and in other countries.

This approach is now regarded as the gold standard in early trauma initial assessment and resuscitation.

ATLS management is based on a 'treat lethal injury first, then reassess and treat again'' strategy.

The Steps in the ATLS philosophy

1. Primary surveys with simultaneous Resuscitation-—identifies & treat what is killing the patient.
2. Secondary survey — proceeds to identify all other injuries.
3. Definitive cares — develop a definitive management plan.

Elements of the primary survey & resuscitation

Airway with cervical spine protection

Breathing and provision of oxygen

Circulation with control of bleeding

Dysfunction of the central nervous system

Exposure in a controlled environment

Airway with cervical spine protection

1. Initial assessment of the airway patency is to ask for answer a question.
2. Unconscious patient with breathing difficulties, the angle of the jaw is pulled forwards and the head extended. A finger may be inserted in to the mouth to ensure that breathing is not being obstructed by the tongue, false teeth, or any foreign body.
3. The cervical spine should be maintained in a neutral position, with manual immobilization by a second person if necessary (i.e, during orotracheal intubation).

Breathing and provision of oxygen

Breathing may be inadequate.

a. High-flow oxygen using reservoir mask.
b. Inspection of neck & chest – Evidence of wound, surgical emphysema or tracheal deviation with the conditions of neck veins, symmetry of the chest, respiratory effort & rate to be noted.

c. Percussion & Auscultation

d. Tension pneumothorax– A clinical diagnosis; no time for radiographs!

Immediate decompression, with insertion of a needle into the pleural space in the MCL two fingerbreadths below the clavicle, followed by insertion of a chest drain.

e. Open wound of the chest wall (Sucking wound) should be covered with a three-sided dressing strapped firmly in position followed by immediate insertion of an intercostal drain.

Circulation with control of bleeding

1. **Haemorrhage control**: External bleeding can usually be stopped by pressure bandage or firm pad.
2. **Cardiac temponade** - Life-threatening condition.

   Beck's triad for diagnosis - Muffled HS, Reducing BP, Distended neck veins

   A cardiac needle through subxyphoid approach aiming for the angle of left scapula & aspirating with a syringe.
3. **Hypovolumic shock** - *Intravenous access *Permissive hypotension *Timely surgical intervention.

Disability/Dysfunction of the central nervous system

Rapidly reviewing neurological status, with AVPU scale

A – Alert

V – Response to Voice

P – Response to Pain

U – Unresponsive

Or a quick **GCS,** and **Pupillary** size with response to light.

Exposure in a controlled environment

1. **Fracture splintage:** A fractured arm can be easily splinted by bandaging it to the trunk and leg by tying it to the other limb [12].
2. **Care of spine:** Twisting and flexion must be avoided. The patient should be carried on to a stretcher by three persons ''in one piece'' to avoid further damage to the spine.
3. **Transfer:** The aim should be for rapid and smooth transfer of patients from the scene of the incident to a hospital that is well equipped and adequately stuffed, with trained personnel to deal quickly and efficiently with all of the injuries encountered.

   A 'scoop and run' policy is best where transfer time to hospital is short.

   A 'stay and play' policy may be required in the face of entrapment but prehospital personnel must be properly trained and equipped.

Management enroute to the hospital:

Resuscitation and evaluation continues at this stage of management.

Following management should be undertaken -

- care of airway
- ensure ventilation
- arrest of bleeding
- fluid replacement
- relief of pain by analgesics
- wound care

Management in Hospital:

After severe injury the risk of falling into second mortality peak with death occurs from 'hypovolumic shock'. This period is the golden hour during which effective resuscitation can save a life. There are 3 stages of care in the emergency room, ICU, OT and post-operative ward.

General Principle of Management (4 R):

1. Resuscitation
2. Review
3. Repair
4. Rehabilitation

Resuscitation

Ensure patent airway - If airway is not checked earlier

- Obstructing element should be removed.
- Reflexes present → Airway tube.
- Reflexes absent → Low pressure cuffed ETT.

- Tracheostomy / Emergency Cricothyroidotomy:

  -awake emergency cricothyroidotomy is a rapid, relatively easy and relatively safe procedure in a cooperative patient who requires an urgent definitive surgical airway.

Breathing and provision of oxygen

Ventilation may be inadequate.

a. High-flow oxygen using reservoir mask.

b. Inspection of neck & chest – Evidence of wound, surgical emphysema or tracheal deviation with the conditions of neck veins, symmetry of the chest, respiratory effort & rate to be noted.

c. Percussion & Auscultation

Immediately Life-Threatening Injuries

1. Airway obstruction
2. Tension pneumothorax
3. Open pneumothorax
4. Massive haemothorax
5. Flial chest
6. Cardiac Temponade

Tension pneumothorax– A clinical diagnosis; no time for radiographs! Immediate decompression, with insertion of a needle into the pleural space in the MCL two fingerbreadths below the clavicle, followed by insertion of a chest drain.

Open wound of the chest wall (Sucking wound) should be covered with a three-sided dressing strapped firmly in position followed by immediate insertion of an intercostal drain.

Massive haemothorax – (more than 1.5 liters of blood) causes shift of the mediastinum, compression of the lung on the effected side, with reduction of breath sound & hypovolumic shock – a surgical emergency & operative control of bleeding is required [13].

Flail chest requires endotracheal intubation and positive pressure ventilation.

Cardiac temponade -Life-threatening condition.

Beck's triad for diagnosis - Muffled HS, Reducing BP, Distended neck veins

- A cardiac needle through subxyphoid approach aiming for the angle of left scapula & aspirating with a syringe.

Circulation

External haemorrhage may be controlled by pack, pressure and bandage as a temporary measure followed by emergency exploration and haemostasis.

The potential internal sites of haemorrhage are chest, abdomen, retroperitoneum and into muscle compartments in fracture of long bones, pelvis etc must be identified (aphorism-`blood on the floor & four more`).

Control of haemorrhage is more important than aggressive fluid resuscitation.

General Measures:

It should be continued and side by side a head to toe evaluation should be done.

- Wide bore i.v. canulation and fluid replacement – any fluid, until blood is replaced.
- CVP line
- Analgesia – Best narcotic analgesics by i.v. route
- Antibiotics
- ATG
- Immobilization – Fracture by splint
- NG tube & Bladder catheterization (don't place a U. catheter if urethral injury is suspected)
- Assisted ventilation (if necessary)
- O2 administration

Review

Adjuncts to the primary & secondary survey

1. **Assessment**.
2. **Monitoring**: ECG, Non-invasive BP & Pulse oxymetry.
3. **Physical Examination**: A careful top to toe survey of the undressed & stable patient must be done. Care must be taken to identify any truncal penetrating injury, without forgetting the back and buttocks, perineum, and axillae.
4. **Special tests** : -
   - Blood is obtained for cross-matching, haematocrit & biochemistry.
   - X-ray for suspected fracture or FB chest.
   - Other special tests according to injury [FAST, CT scan/MRI, DPL].

Tertiary Survey – Maul & his colleagues have introduced the concept of the tertiary survey in an attempt to reduce the incidence and morbidity of missed injuries. When the `dust has settled` after major trauma & the patient is in the surgical intensive care unit, the tertiary survey consists of another head-to-toe examination and a review of all available laboratory and imaging results.

Repair

Aims:

- Restore intravascular volume
- Restore CO and distribution
- Ensure gas exchange
- Ensure renal perfusion

Arrangement of injuries in order of priority
Highest priority:

1. Cervical spine injury.
2. Respiratory impairment.
3. CV insufficiency.
4. Severe external bleeding.

High priority:

5. Intraperitoneal and retroperitoneal injuries.
6. Brain and spinal cord injuries.
7. Extensive soft tissue injury.

Low priority:

8. Lower gut injury.
9. Peripheral vessels, nerves, tendon injury.
10. Fracture dislocation.

Definitive Treatment

Wound Assessment (Limb wounds):

Each wound must be assessed and recorded as follows:

- Site and size
- Presence of a cavity and degree of contamination
- Anatomical structures that may have been injured
- Distal perfusion
- Presence of fractures
- Whether a limb is reconstructable or not.

Wound Exision : The entrance and exit wounds should be explored to see the depth of tissue damage. Foreign bodies; e. g. mud, pieces of cloth, metal fragments of mine, shell, bomb, grenade etc are removed but it is not necessary to remove every piece of small fragments/splinters [14-17].

- Dead muscle is dusky in colour, shows little tendency to bleed, and does not contract to forceps pressure, must be excised. Where there is doubt about the viability; the bruised muscle should be excised.
- Neurovascular bundles in the wound tract are to be identified.
- Severed nerves are marked with sutures but repair should not be attempted at this stage. Nerves may be repaired later on or in case of loss of segment may be repaired by free graft or pedicle graft.
- Major artery or vein damages must be repaired. If tension is likely; a reversed vein graft may be inserted to bridge the arterial gap and the repair must be covered by muscle.
- Tendon repair should not be performed at this stage. Tattered ends should be trimmed.
- Bones may be shattered by high velocity missile.
- At operation most of the fragments will be found to have attachment to the periosteum or muscle. On no account fragments are discarded because loss of bone may result in nonunion or limb length discrepancy.
- Internal fixation not to be employed at the time of initial surgery.
- External fixation is very useful where there is soft tissue loss.
- Joints should be thoroughly explored and irrigated with saline and foreign body should be removed. Any exposed articular cartilage should be covered by synovium, muscle or skin.
- Traumatic amputations should be surgically tidied, completed at the lowest level possible & the skin left open for delayed primary closure.
- At the end of the procedure the wound should be washed with copious quantities of saline and then left open.
- Apply a dry, bulky, sterile dressing, and the patient can be returned to the ward for continued monitoring and analgesia.

Delayed primary closure:

- If the wound shows no signs of infection, necrosis, or residual contamination, it can be closed by suture or a split skin graft/flap.
- However, multiple debridement may be required:

  -in an ICRC series of amputations, only 45% were suitable for closure at first relook, with 33% of cases needing one further debridement and 22% needing two or more [18-23].

Principles of Gunshot / Missile Injury Surgery:

- Preserve skin
- Divide fascia
- Repair vessels not nerve
- Remove dead tissue
- Stabilize bone with external fixation
- Clean and close joint cavities
- Leave wound open for delayed primary closure within 4-7 days after injury

Wounds of the head:

High velocity missile wound of the brain is lethal.

The management of low velocity penetrating wounds depends initially on the maintenance of airway and restoration of blood volume in order to maintain adequate oxygenation of brain.

Indriven bone fragments may be raised and wound excision is carried out by gentle irrigation and suction to remove necrotic brain and bony fragments.

Dura is to be closed by piece of temporalis fascia.

Intermittent positive pressure ventilation assists in reduction of intracranial pressure by reducing brain swelling.

Chest Injuries:

90% of the chest wounds can be treated by drainage of the pleural cavity by formal tube thoracostomy and excision of the wounds in the chest wall.

Formal thoracotomy is most urgently indicated for:

- > 1.5 L initial blood loss
- Continued haemorrhage from tube drain (> 200 ml/hour)
- Suspected mediastinal injury.
- Persistent air leak.
- Retained foreign body > 1.5 cm diameter in the lung.

Abdominal Injuries:

- **Abdominal missile wounds**
  - Every penetrating & perforating missile wound of the abdomen should be explored by a full midline laparotomy with early Resuscitation, NG tube & Bladder catheter.
  - Laparotomy may be the part of resuscitation without any time for planning (Damage control surgery).
  - Firmly packing with gauze swabs to arrest bleeding.
  - Sequentially removal of packs & carrying out a thorough inspection.
- **Liver injuries:** - In 50% cases who survive to reach a surgical centre bleeding stops spontaneously.
  - Manual compression & perihepatic packing / damage control surgery
  - In suitable situations, finger fracture with exposure of bleeding points followed by individual ligation, or more formal resection procedures with adequate external drain may be needed.
- **Splenic & pancreatic injury:**
  - Damage to the spleen & tail of pancreas may require resection, although splenic conservation in the form of partial resection, suture repair or mesh wrapping has become an accepted practice in recent years in certain circumstances.
  - Missile injury of the head of pancreas is usually fatal. In a very few cases it may be possible to apply a Roux loop of jejunum to create an internal fistula.
- **Mesenteric tear and small gut injuries** may require bowel resection and anastomosis.
- **Colonic or rectal injury**- ? Mandatory faecal diversion
  - ❒ For most injuries of right colon - Primary repair or resection is satisfactory except where severe wounding with extensive contamination.
  - ❒ On left side – One stage procedure may be done if favourable circumstances exist;e.g, minimal peritoneal contamination, limited blood loss & a time interval <8 hrs.

- ❒ In pelvic injuries, difficult haemostasis may require ligature of the internal iliac artery.

- **Renal injuries:** -May be treated conservatively. Immediate nephrectomy is seldom required. A divided ureter may be repaired 'over pigtail' stent.

  - For bladder and urethra – urethral catheter should not be placed if urethral injury is suspected, suprapubic cystostomy and placement of retropubic drain after wound excision is needed.

- **Peritoneal toilet**– Using warm saline, it is important to assist the removal of all spilled bowel contents & blood clots.

- **Closure**- The laparotomy wound is closed by mass closure technique. The missile entrance & exit wounds should be excised as described earlier & left open initially with a view to delayed primary closure at 4-6 days [24-25].

Indications of laparotomy in blunt abdominal trauma patient:

- Evidence of hypovolumia or ongoing internal bleeding not responding to the treatment.
- Tense, tender, distended silent abdomen
- X-ray revealed pneumoperitoneum
- Fracture in 9,10,11 ribs on left side or lower ribs
- FAST – haematoma, collection, internal organ injury
- Fracture pelvis with intra-peritoneal bladder injury with clinical evaluation
- Peritoneal lavage (DPL) revealed – blood, bile, faecal matter

Post Operative / Surgical Intensive Care Unit

- Secondary haemorrhage
- Abdominal compartment syndrome
- Second look surgery
- Sepsis
- Multi organ failure
- Nutrition
- Fluid therapy

Rehabilitation

- Aim is to minimize the functional impairments or disabilities along with the impact of the social and environmental consequences of those impairments.
- An effective management requires co-ordination between the patient, carers, medical therapy, nursing, psychological staff and social services to facilitate the maximum potential independent and productive living for disabled people within the community.

A comprehensive rehabilitation is extremely challenging and resource intensive, but can be tremendously rewarding [26-28].

Conclusion:

Managing potentially large numbers of combat casualties, a collaborative / team approach involving health professionals (doctors, nursing staffs, paramedics, first aid cadres, stretcher bearers / transporters) throughout the chain of care is required in all conventional war or peacekeeping and counter-insurgency missions. A break in the chain at any point is likely to affect outcome adversely.

Although all resources are not always available, adherence to the basic management principles following ATLS guideline, can be made in injured patient care in any situation ranging from single person "Buddy" first aid through to major hospital multiple member trauma teams.

The rapid initial assessment and resuscitative management should be started at the site of incident following ATLS guide line and to be continued during transportation, which should be smooth and rapid to a nearest and well equipped hospital, where early care with emergency surgery can save life & limb.

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