

BATLS

Battlefield Advanced Trauma Life Support (BATLS)

A new BATLS manual has now been prepared under the Authority of the Professor of Military Surgery. In order to disseminate this information widely within the Corps, this Manual will appear in sections in the Corps Journal. This version of the Manual supercedes all previous versions and is now in use on current and future courses.

CHAPTER 1 INTRODUCTION

History of Advanced Trauma Life Support

0101. There are marked differences in the epidemiology of trauma in different countries. In 1983, only eight people died from gunshot wounds in the United Kingdom. In the same year, the figure in West Germany was 53, approximately one per million of population. Canada had the same ratio with 20 deaths, but in the United States of America with a population of 226 million the figure was 10,838. By 1994, this figure had risen to a shattering 37,500 deaths due to firearms related injury from all causes. In the same year, the United Kingdom with a population of 58.5 million had 261 deaths from firearms. It is not surprising the Americans have a concept of trauma that we in Britain do not have. In America there is also a geographical problem: the nearest major trauma centre can be 150 miles away.

0102. In February 1976, a surgeon piloting his own aeroplane crashed in a rural cornfield in Nebraska. He was badly injured, his wife was killed, three of his children had critical injuries and a fourth child minor injuries. He considered the treatment that he and his children received to be woefully inadequate and said *"When I can provide better care in the field with limited resources than what my children and I received at the primary care facility, there is something wrong with the system and the system has to be changed."* (Sic).

0103. As a consequence of this incident the need for training was identified. With the help of the Lincoln Medical Education Foundation and the Southeast Nebraska Emergency Medical Services, a prototype Advanced Trauma Life Support (ATLS®) course was devised.

0104. The project developed and was adopted in 1979 by the American College of Surgeons Committee on Trauma. As a result and with further revisions, a national trauma

programme was established. The original targets were those doctors who do not normally deal with trauma as part of their daily lives, but now all doctors are expected to be capable of managing the trauma patient during the immediate post-trauma phase.

0105. The Advanced Trauma Life Support courses are now run in many centres throughout the United Kingdom. It has also been modified in various parts of the world. In Australia, for example, it has become the Early Management for Severe Trauma (EMST) course.

0106. In the United Kingdom, road traffic accidents are the most common cause of trauma deaths in peacetime; this is still true in most states in America but the proportion of penetrating trauma (gunshot and stab wounds) is much higher.

In America and Australia, trauma services are regionalized with all major cases bypassing the smaller hospitals in favour of a regional trauma centre. In general, this does not apply in the United Kingdom.

History of Battlefield Advanced Trauma Life Support

0107. Following the attendance on one of the American courses by the late Brigadier Ian Haywood, a former Professor of Military Surgery, the need was identified for a similar course modified for military requirements. The Department of Military Surgery at the Royal Army Medical College [now the Royal Defence Medical College (RDMC)] and the Army Medical Services Training Group [now the Defence Medical Services Training Centre (DMSTC)] were tasked with devising a course for the British Army.

0108. Although the Battlefield Advanced Trauma Life Support (BATLS) Course is about training doctors for war, there is nothing new in this. Medical officers in former times had to deal with the injuries of the day - contusions, lacerations, penetrating wounds and broken bones - and under the primitive conditions prevailing at the time.

The Modern Era

0109. Today's medical services still have to deal with similar wounds, but they also have to contend with injuries produced by modern weapons - including not only gunshot wounds, but more importantly, multiple injuries produced by fragments with relatively high velocities and capable of

producing high energy-transfer wounds. They also have the problems of the effects of blast and the horrors of extensive burns.

Fragments and bullets

0110. Bombs, shells, grenades and other explosive devices, cause death and injury due to victims being hit by primary and secondary fragments and due to the effects of blast. In older weapons, primary fragments were derived from the weapon casing and, as such, had wide variation in size, shape and weight. These weapons produced *random fragmentation*.

0111. Modern fragmentation munitions are designed to deliver many hundreds of preformed fragments of different types. These fragments are much more uniform in size, shape and weight. Examples include, the pre-notched wire in a hand grenade, flechets in bomblets and etched plates in shells and mortar bombs. These weapons are referred to as *improved (pre-formed) fragmentation devices*.

0112. Improved fragmentation devices are designed not to increase lethality but, to increase the likelihood of a hit. In fact, the lethality has fallen (See Table 1-1). The concept of the use of these weapons is a simple one: increase the likelihood of a hit, generate more enemy casualties and choke his logistic evacuation chain. The same concept also applies when these weapons are used by the enemy against friendly forces!

Table 1-1 Lethality of penetrating missiles

Type	Lethality
Random fragmentation devices	1 in 5 (Shell) 1 in 10 (Grenade)
Improved (Pre-formed)	1 in 7 (Shell)
Fragmentation devices	1 in 20 (Grenade)
Military bullet	1 in 3

0113. Early rifle bullets depended on their mass and shape in order to produce injury, velocity was less important. For modern rifle and machine gun bullets, mass has fallen considerably but velocity risen dramatically. Given that the energy of a missile is derived from the formula $1/2MV^2$ [M = mass, V = velocity], this means the available energy in a modern military bullet has risen several fold. The potential lethality of these bullets is shown in Table 1-1 and well illustrated by the figures in Table 1-2.

Table 1-2 Site of injury and outcome for 67 soldiers injured by Armalite rifle bullets (5.56mm), Northern Ireland 1969-1979 (1)

Site of Injury	Dead on arrival	Died in hospital	Survived
Head (brain)	7	1	
Head (face)			4
Neck			2
Chest	7	2	9
Thoracoabdominal		1	1
Abdominal		4	5
Upper limb			11
Lower limb			13
Total	14	8	45

Injuries caused by fragments and bullets

0114. The severity of injuries caused by fragments and bullets is not just a question of what hits you and what is struck, it is multifactorial. Amongst the many factors that determine the severity of injury caused by missiles are:

- Mass
- Velocity
- Shape and stability: both are determinants of the amount of energy deposited in the tissue struck.
- Density of tissue: the denser the tissue the greater the retardation of fragment or bullet allowing for higher absorption of energy with more tissue damage.
- Length of wound track: the longer the track the greater the chance of energy exchange.
- Cavitation/shock wave: high-energy transfer wounds caused by military rifle bullets cause both. The role of cavitation in causing tissue damage remains controversial, the role of the shock wave in damaging structures such as bone, arteries and nerves is well established.

0115. The ballistic characteristics of a fragment or bullet should not be confused with the pathophysiological effects of injury. A bullet may enter a thigh, hit the femur and deposit all its energy. In so doing, it can shatter the femur causing considerable tissue damage. The same bullet can enter the thigh, miss the femur and exit without hitting any vital structures causing considerably less tissue damage. The ballistic characteristics are the same, the pathophysiological results are fundamentally different.

0116. Despite advances in weapon technology, the hospital mortality following battlefield injury has been reduced significantly during this century; from 8.1% in World War One, to half that in World War Two (due mainly to advances in resuscitation and surgery) and reduced still further in Korea and Vietnam.

0117. In the Falklands Campaign of 1982 there were over 250 deaths; the majority occurring before arrival at a surgical facility. Those casualties who reached a field hospital had a survival rate of 99.5%. In the Gulf War of 1991, casualties were fewer than anticipated and the survival rate was high. In one British Army field hospital, 63 casualties with penetrating missile injuries underwent surgery; most had multiple fragment wounds involving two or more body systems, ranging from 1 to 47 hits with an average of 9 hits. The average lag-time before surgery was over 10 hours for allied casualties and 24 hours for enemy casualties.

0118. To continue to improve survival rates we must look at the situation before casualties reach hospital. They must be kept alive from point of wounding to arrival at a

surgical centre, otherwise the expert facilities there will be to no avail.

The aim of BATLS is to give the surgeon a live casualty.

Scope of the BATLS/BARTS Course

0119. Much research has been devoted to finding out why and when casualties die. A United States Army Medical Corps officer, Colonel Ronald F Bellamy, has analysed a large number of deaths in battle. His data are supported by analysis of various British campaigns including that of Urban Terrorist activity in Northern Ireland. These data provide a model for a military trauma population and for the role of resuscitation in the field.

Killed in action (KIA)

0120. This group are those who die on the battlefield before reaching a fixed medical facility; 90% of US soldiers fatally wounded in Vietnam were in this category and 70% of these died within five minutes of wounding.

0121. The common causes of KIAs are:

- Exsanguinating haemorrhage (46%)(2):
- 80% bleeding from major vessels and structures within the torso (non compressible haemorrhage).
- 20% bleeding from major vessel and soft tissue injury in one or more limbs (compressible haemorrhage).
- Penetrating brain injury (21%)(2). These are devastating injuries and offer little potential for improved outcome even with early surgical intervention.
- Respiratory injury (4.5%)(2):
- Airway obstructions.
- Open pneumothorax.
- Tension pneumothorax.
- Combinations of the above (9%)(2). A combination of brain injury and exsanguination is the most common.
- Mutilating blast injury (10%)(2).

Died of wounds (DoW)

0122. These are casualties who expire after reaching a fixed treatment facility and constitute 10% of this military trauma population. Available data indicate half of them die within 24 hours of wounding. There are three main causes of death:

- Brain injury (4%).
- Hypovolaemic shock (2%). This was usually due to continued bleeding from the liver and/or pelvis with or without coagulopathy.
- Sepsis and multi-organ failure (4%).

0123. Analysis of mainly civilian trauma data shows a trimodal death distribution:

- *Instantaneous*. These occur within seconds to minutes of injury and include injuries

to the brain, spinal cord, heart and major vessels.

- *Early*. These extend from the first few minutes to a few hours. Examples include airway and respiratory compromise, continuing haemorrhage and subdural and extra-dural haematomas. It is in this phase, often referred to as The Golden Hour of trauma management, that properly trained individuals can save many lives.
- *Late*. These occur from a few hours to days or even weeks after injury. The majority are due to sepsis with associated multi-organ failure.

The role of BATLS and BARTS

0124. The concept of managing the severely injured within the *golden hour* may be applicable during operations other than war. In war fighting, this concept will be severely constrained by the tactical situation on the battlefield, particularly the problems of time and distance. So where does BATLS fit into the concept of medical care on the battlefield in war fighting? Rather than consider a trimodal death distribution, it is probably better to think of three casualty population groups:

- KIAs (17-20%). This group have fatal injuries and will die irrespective of the level of sophistication of available medical care.
- Moderate to minor injuries (65-70%). This group require the well documented methods of battlefield care for example, analgesia, antibiotics, limb splintage and soft tissue wound excision. The majority of this group are limb injuries.
- Severe but potentially survivable injury (10-15%). A favourable outcome for this group is effected by timely application of sophisticated trauma care. This group is recognised by appropriate triage and includes; airway and respiratory compromise, management of compressible haemorrhage, recognising those with non compressible haemorrhage needing urgent or early surgery and appropriate use of intravenous fluid resuscitation. BATLS and BARTS training is aimed at giving you the skills to save lives in this third group. You can also significantly influence the late outcome (death due to multi-organ failure) by vigorous and correct initial management, for example: restoration of tissue perfusion - oxygenation, minimizing wound sepsis and, vitally, by recognising the need for early surgical intervention, followed by intensive medical and nursing care.

0125. The battlefield casualty's chance of survival improves significantly after arrival at a field hospital. Military constraints limit how far forward hospital surgical facilities can be deployed. This is why it is vital to

provide trauma life support in the pre-hospital phase of casualty management. Despite changing concepts of the deployment of surgical teams on the battlefield of the future, it is vital that:

Every medical attendant possesses the basic skills to keep casualties alive at Role One and Role Two or until they reach a surgical facility.

0126. The BATLS course concentrates on teaching these skills. You must learn to assess casualties using the five senses, tempered by the sixth sense - commonsense! These are likely to be the only diagnostic aids available to you until the casualty is moved to a field medical facility. The correct application of BATLS/BARTS principles, particularly in an austere and potentially hostile environment with limited equipment and diagnostic aids, will enable you to save lives.

0127. The responsibility for BATLS training rests with the Professor of Military Surgery. Under his guidance, a group of experienced lecturers from all three Services - both Regular and Reserve, form the BATLS Training Team.

0128. Satisfactory performers receive a BATLS or BARTS certificate. The certificate is valid for six years for BATLS and four years for BARTS, after which a revalidation course is necessary.

References

1. Derived from Hostile Action Casualty System Survey of British Service personnel injured - NI.
2. Percentage figures derived from the collective date referred to in paragraph 0119.

CHAPTER 2 INITIAL ASSESSMENT & MANAGEMENT

0201. On successfully completing this topic, you will be able to:

- Identify the correct sequence to be followed in assessing and managing battlefield casualties.
- Understand the concept of *primary and secondary survey*.
- Carry out an *initial assessment and management survey on a casualty*.

Trauma Management

0202. Managing trauma is stressful even in a good working environment. On the battlefield, conditions are far from ideal. It may be dark and uncomfortable, noisy, wet and cold; it will certainly be dangerous and you may be tired, hungry and frightened.

0203. Training allows you to respond automatically regardless of fear and environment. In military terms you acquire a drill. In the heat of battle you can perform, with a minimum of mental effort, a drill (a

practical skill) that you have learnt in peacetime.

0204. When dealing with casualties you must consider their management in four phases:

- **Primary survey** Identify life-threatening problems
- **Resuscitation** Deal with these problems
- **Secondary survey** Top-to-toe examination
- **Definitive care** Specific management

Primary Survey

0205. The primary survey is the most important phase; it is easily remembered as

A B C D E

Airway and cervical spine control.

Breathing and ventilation.

Circulation and haemorrhage control.

Disability (Displaced brain) or neurological status.

Exposure depending on environment.

0206. Do the primary survey as follows:

- **Airway and cervical spine control.** Do not be distracted by other injuries; the airway must take priority. BATLS does not attribute the same emphasis to potential cervical spine injury as the equivalent civilian course (ATLS®). Nevertheless, the integrity of the cervical spine must be considered. It is always safer to assume a cervical spine fracture in casualties with multiple injuries, especially if there is blunt injury above the level of the clavicle or in an unconscious casualty. Then consider:
- **Breathing and ventilation.** Look at the neck to see if the trachea is deviated or the neck veins engorged. Look at the casualty's chest to see if it is expanding equally and for obvious open chest wounds. If there is compromised ventilation:

What is the reason? Do something about it!

Remember that of all those who die from chest injuries, 25% die unnecessarily and 85% of these could be saved by primary care! Then consider:

- **Circulation and haemorrhage control.** Haemorrhage must be arrested if possible and the circulating volume restored to an acceptable level. This applies to casualties with compressible haemorrhage. Uncontrollable (non compressible) haemorrhage requires urgent surgical intervention and a different approach to fluid volume restoration (see paragraph 0527 and Table 5.2). Only now should you consider:
- **Disability or neurological status.** This is a simple **AVPU** assessment of the casualty's

level of consciousness and pupil state. You want to know if the casualty is:

Alert. Voice responsive. **Pain** responsive.
Unresponsive.

You also want to know if the pupils are equal, the pupillary size and if they react to light (indicating **D**isplaced brain). There is not much you can do about the neurological state at this stage other than ensuring cerebral oxygenation and perfusion, but you need to record the findings so that any change can be appreciated later. Remember that the level of consciousness not only reflects the neurological status, but can be influenced by hypovolaemia and hypoperfusion.

- Exposure. In hospital, this must be total but at Role One and Role Two there may be constraints.

0207. Remember also to speak to the casualty at the very beginning; an alert response can tell you a lot about his respiration and cerebral perfusion. To be able to speak, the casualty must:

- Have a patent airway.
- Have a reasonable tidal volume to phonate.
- Have reasonable cerebral perfusion to comprehend and answer.

Resuscitation

0208. The resuscitation phase is carried out simultaneously with the primary survey, with life-threatening conditions not only identified but managed as they are found.

0209. If available, administer supplementary oxygen to all serious casualties with maximum flow rate through a tight-fitting mask and reservoir. Establish and maintain a minimum of two large-calibre intravenous lines; 16 gauge is the smallest adequate size. Assess resuscitation efforts and monitor the casualty by measuring physiological parameters. These include:

- Alertness, is it improving or deteriorating?
 - Respiratory rate
 - Pulse rate and rhythm
 - Pulse pressure
 - Capillary refill time
 - Blood pressure (presence of radial, femoral, or carotid pulse (See paragraph 0517))
 - Urinary output
 - Arterial blood gases (if facilities are available)

0210. Consider the insertion of urinary and nasogastric catheters during this phase. Once you have successfully completed the primary survey and resuscitation phases, you can then proceed to the secondary survey.

Secondary Survey

0211. You carry out the secondary survey when the casualty is stable. Remember that casualties have backs and sides as well as fronts; bottoms as well as tops; and lots of holes, both natural and as a result of injury. You must be systematic, going through a top-to-toe process as follows:

- Scalp and vault of skull
- Face and base of skull
- Neck and cervical spine
- Chest
- Abdomen
- Pelvis
- Remainder of spine and limbs
- Neurological examination

0212. Do not forget the holes. *Every orifice merits a finger, a light or a tube.*

Definitive Care

0213. In the forward areas, you will rarely be concerned with definitive care. This is more likely to take place in the rear areas. Nevertheless, it is important to realize that definitive care forms the fourth and final phase in BATLS management. It is equally important to remember that if you do not get the primary survey and resuscitation phases correct, definitive care may be in the hands of the War Graves Commission!

Summary

- No matter where you are, remember - as you approach every casualty the following questions should be going through your mind;
- Is the airway patent?
- Is the casualty breathing?
- Is there life-threatening external or internal blood loss?

A consistent, systematic approach to the primary survey is vital to the casualty's survival.

The BATLS manual is prepared by the BATLS Training Team under the authority of the Professor of Military Surgery who remains responsible for its technical content.

BATLS

Battlefield Advanced Trauma Life Support (BATLS)

CHAPTER 3

TRIAGE

Aim

0301. On successfully completing this topic you will have a sound understanding of how to prioritise casualties for treatment and evacuation, so that the survival of the maximum number is ensured.

Introduction

0302. The management of a single seriously injured casualty in peacetime military or civilian practice is frequently problematic. On the battlefield, problems are compounded by: environment, difficult terrain and tactical constraints. The situation is even more difficult when faced with large numbers of casualties.

0303. If a system for prioritisation of care of the injured is not in place, many salvageable casualties may die unnecessarily. Triage (from the French verb *trier*, to sieve or to sort), has evolved through military conflicts dating from the Napoleonic Wars to recent civilian disasters.

Definition

0304. The process of triage is complex. The preferred definition is:

Sorting casualties and the assignment of treatment and evacuation priorities to wounded at each role of medical care.

Triage Priorities

0305. There are four triage priorities:

- *Priority One (P1)*. Those needing immediate life-saving resuscitation and/or surgery.
- *Priority Two (P2)*. Those needing early resuscitation and/or surgery, but some delay is acceptable.
- *Priority Three (P3)*. Those who require treatment but where a longer delay is acceptable.
- *Dead*.

0306. This is the P (*Priority*) System, of triage. Triage must be repeated at every link of the evacuation chain and the priority adjusted to reflect deterioration or improvement in the casualty's clinical condition.

Mass Casualties

0307. A mass casualty situation overwhelms the available medical and

logistic capabilities (JSP 110). In these circumstances the aim of the medical services must be to give care to the greatest benefit of the largest number - that is '*to do most for the most*'.

0308. The term mass casualties is reserved for a situation when medical resources are overwhelmed. When resources are adequate, the incident is said to be '*compensated*'. In a military setting, an '*uncompensated*' situation may exist temporarily or over a prolonged period. It may be appropriate for the local commander to introduce mass casualty triage without a formal declaration having been made by a higher authority.

0309. The triage system in an uncompensated situation thus becomes;

- *P1 - Immediate Treatment*. Those needing emergency life-saving treatment. Procedures should not be time consuming and concern only those with a high chance of good quality survival. Examples are remedial airway obstruction, accessible haemorrhage and emergency amputations.
- *P2 - Delayed Treatment*. Those needing major surgery (after initial sustaining treatment such as intravenous fluids, antibiotics and splinting), or medical treatment, but where conditions permit delay without endangering life. Examples are open fractures of long bones, large joint dislocations and burns covering 15-30% BSA.
- *P3 - Minimal Treatment*. Those with relatively minor injuries who can effectively take care of themselves or be helped by untrained personnel. Examples are minor lacerations and uncomplicated fractures.

- *P1 Hold - Expectant Treatment*. Those with serious multiple injuries needing extensive treatment or with a poor chance of survival. These casualties receive appropriate supportive treatment compatible with resources, for example, analgesia. Examples are severe head and spinal injuries, extensive burns and large doses of radiation.

0310. The T (Treatment) System of triage, is an alternative to the P System and is routinely used by the RN, the RAF,

NATO allies, the International Committee of the Red Cross, civilian ambulance services and in civilian disaster programmes.

0311. The relationship between the two systems is as follows;

- **P1** is equivalent to **T1**
- **P2** is equivalent to **T2**
- **P3** is equivalent to **T3**
- **P1 Hold** is equivalent to **T4**
- **Dead** is still **Dead**.

Triage for Treatment

0312 A simple, safe, rapid and reproducible system is required that can be applied by any Serviceman with appropriate medical training. Physiological systems that look at the consequences of injury (a change in the vital signs: *Respiratory Rate*, *Pulse Rate* and *Capillary Refill Time [CRT]* are more reliable than anatomical systems (which require extensive clinical knowledge and a need to undress the casualty).

0313. A widely accepted physiological method of triage for treatment is the *Triage Sieve*. This involves an assessment of the casualty's mobility, then an assessment of

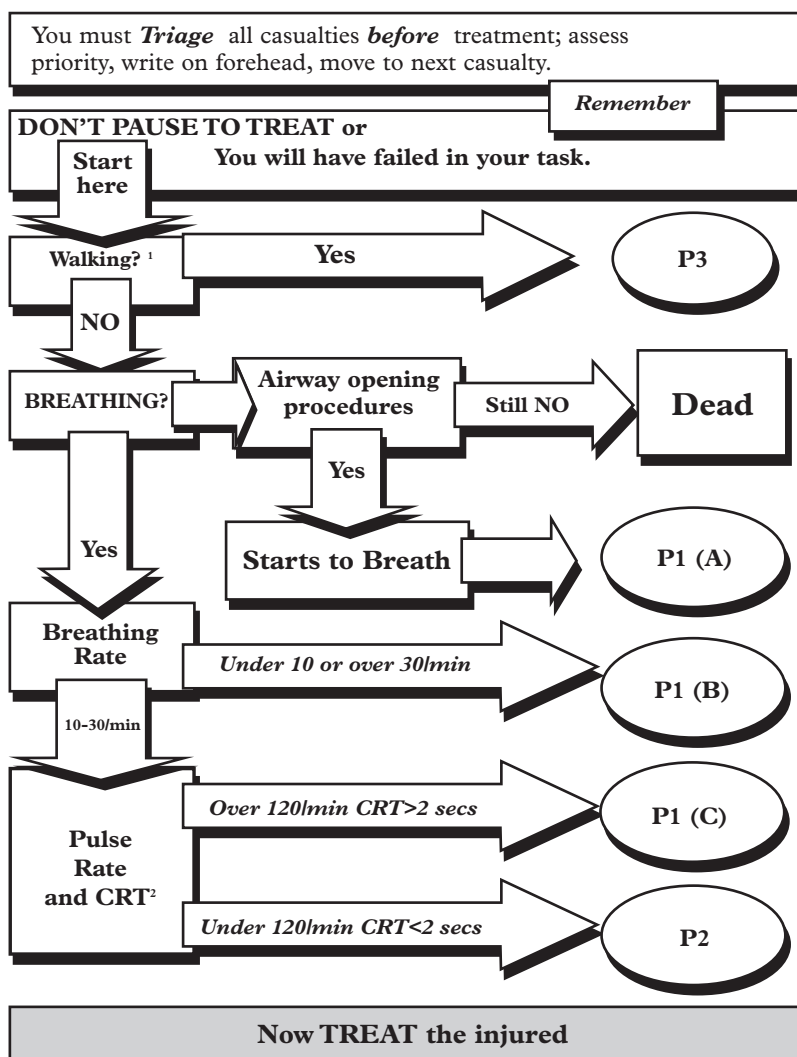
the airway, breathing and circulation (see Table 3.1).

0314. Triage is only a 'snapshot' of how the casualty is at the time of assessment. In order to identify changes in the casualty's condition, the triage sieve **must** be repeated at each link of the evacuation chain. It is important initially **not** to try to predict how a casualty may deteriorate, this will lead to over-triage (a higher than necessary triage category) and can overwhelm the system with P1 and P2 casualties.

Triage for Evacuation

0315. Limited time and personnel resources may prohibit a more detailed triage assessment other than that given by the triage sieve. When possible, the *Triage Sort* can be used to refine triage sieve decisions. Triage sort uses the respiratory rate, systolic blood pressure and Glasgow Coma Scale, to numerically score the casualty from 0 to 12 and give an indication of priority for evacuation and/or the need for further intervention. This score has a proven direct relationship to outcome from severe injury.

Table 3.1 The triage sieve



¹ It must also be realised that some in this group, despite being ambulatory, may have injuries of sufficient magnitude to cause a clinical deterioration requiring a change in priority. ² Is unreliable in the cold or dark.

Table 3.2 Triage sort coded values

Physiological variable	Measured value	Score
Respiratory rate	10-30	4
	>30	3
	6-9	2
	1-5	1
	0	0
Systolic blood pressure	>90	4
	89-76	3
	75-50	2
	<49	1
	0	0
Glasgow Coma Scale	15-13	4
	12-9	3
	8-6	2
	5-4	1
	3	0

0316. Priorities are assigned as follows:

- **P1 (T1)** 1-10³
- **P2 (T2)** 11
- **P3 (T3)** 12
- **P1 Hold (T4)** 1-3³
- **Dead** 0

0317. The coded values for the Triage Sort are given in Table 3.2. After coding each of the three parameters, add them together to give a score ranging from 0 (dead) to 12 (physiologically normal).

0318. Evacuation will be delayed when the number of casualties outstrips available transport. In this situation, the greater time spent with the casualty will allow additional anatomical assessment of injuries. Where the priority determined by physiology does not match the anatomical severity of injuries, the priority can be upgraded.

Example: A soldier loses his left leg in a landmine incident. Immediate first aid is effective in stopping haemorrhage. He is

³ The overlap in scores allows for the seriously injured to be placed in either category, depending on number of casualties and resources available for evacuation.

transported to the RAP. He cannot walk, his respiratory rate is 22 and his pulse is 110/minute. He is triaged P2 for treatment (Triage Sieve). He then receives intravenous fluids and analgesia. His systolic BP is 115 mmHg, his respiratory rate is 20, he is fully alert, with a GCS of 15. He scores 12 on his Triage Sort, which is P3 for evacuation. Clearly, he requires early surgical treatment and the RMO upgrades his priority to P2 for evacuation to the field hospital.

0319. To help understand priority allocations for evacuation, it is appropriate to consider the standard casualty evacuation chain which is usually through the logistical Lines of Support. These lines of support relate to the Combat Services Support (CSS) provided at levels of operational deployment, that is, First Line at unit level, Second Line at brigade or divisional level, Third Line between the divisional rear boundary and point of entry, and Fourth Line at the base⁴. These should not be confused with Roles of Medical Support which is the term used throughout NATO to define the levels of medical capability⁵.

- **Role 1** Treatment to restore and stabilise vital functions. (Regimental Aid Post/Medical Section(s)).
- **Role 2** Resuscitation and stabilising treatment - may include stabilising (Damage Control) surgery (Dressing Station).
- **Role 3** Hospitalisation and life-saving surgery, definitive surgery (Field Hospital).
- **Role 4** Time consuming specialist and long term treatment (NHS Hospital).

0320. It should be assumed that early surgery takes place at the field hospital, with subsequent care taking place back in the United Kingdom, within the National Health Service. There will be occasions when surgery, through a field surgical team being attached, is available forward of field hospitals. This will be the norm in airborne and airmobile operations and when FIRST⁶ teams are attached to Close Support Squadrons of Medical Regiments. Specialist teams, such as burns teams and head and neck teams, can be allocated to selected field hospitals: this will influence the disposal and transfer of candidate casualties.

0321. United Kingdom military operations are increasingly Joint Service in nature, for example, surgical support at Role Three may be found from the RN in the form of a Primary Casualty Receiving Ship (PCRS). An intermediate hospital may be set up, at a convenient location on either the tactical or strategic LOCs.

Application at Role One and Role Two

0322. For the regimental medical officer (RMO) and the dressing station medical officer, casualties are likely to be graded for treatment and/or evacuation as follows:

• P1

Airway: Obstruction including that due to maxillofacial injury. Airway burns with the potential for obstruction.

Breathing: Tension pneumothorax - open chest wound - flail chest/pulmonary contusion. Respiratory rate <10>30. Triage Sort Score 1-10.

Circulation: Major haemorrhage - external or internal - compressible or non compressible. CRT >2S. Pulse rate >120/mm. Massive muscle injuries. Multiple fractures and/or multiple wounds. Burns between 15 and 30% Body Surface Area (BSA).

• P2

Lesser visceral injuries. Vascular injuries not having features of P1. Cerebral injuries that are deteriorating (See table 8.2). Burns of less than 15% BSA involving face, eyelids, hands, perineum and across joints (see paragraph 1222). Large joint dislocations.

• P3

Lesser fractures and dislocations. Lesser soft tissue injuries ultimately requiring surgery. Maxillofacial injuries with no airway problems. Eye injuries. Other burns less than 15% BSA.

0323. Expectant (P1 Hold [T4]) cases would include, for example, burns of greater than 30% BSA, gunshot wounds to the brain and other injuries with a poor prognosis.

0324. Medical cases are categorised in exactly the same way in relation to their need for resuscitation and timely intervention by a physician. Psychiatric cases invariably tend to fit into the P3 bracket, with the particular caveat they should be treated as far forward as possible; this approach will result in the maximum number being rendered fit and returned to duty. The further rearward a psychiatric case is evacuated, the less likely this is to happen.

Application at Role Three

0325. The critical decision at the field hospital is whether the casualty needs resuscitation and surgery now, or whether

4. See Army Doctrinal Publication Vol 3 Logistics (Army Code 71566). 5. For example, there will be Role 1 and Role 2 medical units at Third Line. 6. Forward Immediate Resuscitation and Surgery Teams.

he can withstand further delay. The identification of casualties requiring expert treatment by specialist teams must also be considered.

0326. At this level, in the presence of mass casualties, the P1 Hold (T4) category will represent:

- Cases whose survival is uncertain.
- Cases who require prolonged surgery, who must wait until time and facilities are available.
- Major burns cases who are kept for 48 hours prior to transfer to a specialist burns team.

0327. When there are many casualties, the expedient of the greatest good of the greatest number must prevail.

Summary

- Triage is the sorting of casualties into orders of priority for treatment and evacuation. The triage process is dynamic and needs reassessment throughout the casualty evacuation chain. It will be coloured by doctrinal and organisational factors which affect time between and location of, medical echelons in the chain. Even when faced with large numbers of casualties, the A B C routine must be followed in order to identify life-threatening problems and indicate priorities.
- The principles of management of the injured remain as primary survey, resuscitation, secondary survey and definitive care, albeit that the last two may be carried out at a more rearward echelon. The philosophy of treatment for large numbers of casualties is:
- To evacuate rearwards all those who can withstand the journey.
- To address the medical resources towards those who have the best chance of survival.

This is achieved through effective and efficient triage.

CHAPTER 4 AIRWAY MANAGEMENT AND VENTILATION

Aim

0401. On successfully completing this topic you will be able to:

- Recognize those conditions causing airway and breathing difficulty in the battlefield casualty.
- Discuss the principles of airway and ventilatory management.
- Demonstrate basic and advanced methods of airway management.

Anatomy and Physiology of the Airway

0402. The upper airway consists of the nose, mouth and pharynx. The lower airway

consists of the larynx, trachea and lungs. An open airway allows air (containing oxygen) to enter the lungs, oxygenate the blood, which is then carried to the tissues. A reduction in oxygen levels in the blood or tissues, is termed hypoxia. Tissue hypoxia causes cell damage and, if prolonged, can lead to organ failure and death. Some organs are more sensitive to hypoxia than others. For example, cerebral hypoxia even for a short period of time will cause agitation, then a decreased level of consciousness and eventually, irreversible or fatal brain damage.

0403. Carbon dioxide is produced by cellular metabolism and carried in the blood to the lungs; it is then exhaled. If there is airway obstruction, there is a build up of carbon dioxide in the blood (hypercarbia). This causes drowsiness.

Supplementary oxygen must be administered to all seriously injured battle casualties as early as possible in the evacuation chain.

0404. Obstruction to either the upper or lower airway can compromise ventilation of the lungs and quickly result in cerebral hypoxia. *Management of the upper and lower airway is the first concern in any battlefield casualty.*

The airway must be opened, maintained and protected, with ventilatory support provided if necessary.

Airway and Breathing

0405. Early preventable deaths from airway problems after injury are frequently due to:

- Failure to recognize the urgent need for intervention in casualties with a compromised airway.
- Limited experience in airway clearing skills.
- Faulty judgement in selecting the correct airway manoeuvre.
- Failure to secure the airway prior to evacuation.
- Becoming distracted by less urgent problems.

Awareness

0406. Particular problems that will endanger the airway:

- Head injury with decreased level of consciousness (see paragraph 0822).
- Other causes of decreased level of consciousness (poisoning, alcohol, low oxygen, carbon monoxide).
- Maxillofacial injuries:
 - Mid face fractures can move backwards and block the airway.
 - Mandible fractures can allow the tongue to fall backwards.
 - Bleeding and secretions caused by these injuries can block the airway.
- Injuries to the neck:

- Direct trauma to the larynx and supporting structures.
- Bleeding inside the neck compressing the hypopharynx or trachea.
- Burns to the face and neck:
 - Swelling of the upper and lower airway due to direct burns or inhaling hot smoke, gases or steam, will cause airway obstruction.

0407. Airway problems may be:

- *Immediate* (block the airway quickly) or,
- *Delayed* (come on after a time delay - minutes or hours) or,
- *Deteriorate with time*; this is often insidious because of its slow progression and is easily overlooked.

0408. An airway that has been cleared may obstruct again if the casualty's level of consciousness decreases, there is further bleeding into the airway or there is increasing swelling in or around the airway.

Recognition

0409. **Talk** to the casualty! Failure to respond implies an altered level of consciousness with the potential for airway compromise. A positive appropriate reply in a normal voice indicates that the airway is patent, breathing normal and brain perfusion adequate. Any inappropriate or incomprehensible response may suggest airway or breathing compromise, or both.

0410. **Look** to see if the casualty is agitated, drowsy or cyanosed. The absence of cyanosis does not mean the casualty is adequately oxygenated.

Remember that a casualty who refuses to lie down quietly may be trying to sit up in an attempt to keep his airway open and/or his breathing adequate.

0411. **Listen** for abnormal sounds. Snoring, gurgling and gargling sounds are associated with partial obstruction of the pharynx. Hoarseness implies laryngeal injury. The abusive casualty may be hypoxic and should not be presumed to be merely insubordinate or intoxicated. **Total obstruction equals total silence!**

0412. **Feel** for air movement on expiration and check if the trachea is in the midline.

Management

0413. Management comprises:

- Clearing the obstructed airway.
- Maintaining the intact airway.
- Protecting the airway at risk.

0414. Techniques for clearing, maintaining and protecting the airway need to be modified in the trauma casualty when cervical spine injury is suspected or present. Cervical spine injury is suspected:

- In falls from a height.
- In vehicle collisions.

- When pedestrians have been hit by a vehicle.
- Where casualties have been thrown by explosions.
- In the unconscious casualty (especially where there is blunt injury above the clavicle).
- In the conscious casualty complaining of neck pain or loss of sensation or motor function in one or both arms. (see paragraph 1002-1006).

0415. Moving a casualty with bony spinal injury risks damaging the spinal cord. Ideally, these casualties should only be moved when the appropriate spinal immobilization devices are in place. (see paragraph 1007).

In situations where there is danger to the casualty or rescuer, rapid extraction of the casualty using improvised immobilisation or none at all, will be needed.

Priority is CLEAR THE AIRWAY but stay safe.

0416. Penetrating missile neck wounds that directly involve the bony cervical spine or spinal cord carry a 95% mortality. They can be ignored in terms of cervical spine protection; *get on and manage the airway!* A combination of blunt and penetrating neck injuries should be managed as for blunt injury.

Clearing the airway

0417. In the casualty with suspected cervical spine injury, manual inline immobilization of the cervical spine and airway clearance are carried out together. In a casualty with an altered level of consciousness, the tongue falls backwards and obstructs the hypopharynx. This obstruction can be readily corrected by the *jaw-thrust* or *chin-lift* manoeuvres. Blood and debris can be cleared by suction and finger sweeps.

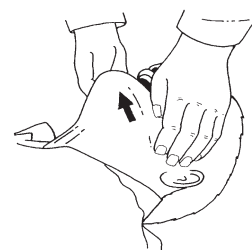


Fig 4.1 Jaw-thrust

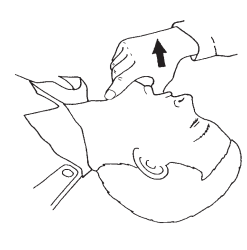


Fig 4.2 Chin-lift

0418. **Jaw-thrust.** Grasp the angles of the mandible, one hand on each side and move the mandible forward. The jaw-thrust is used for the injured casualty because it does not destabilise a possible cervical spine fracture and risk converting a fracture without spinal cord injury to one with spinal cord injury. This manoeuvre will open 95%

of obstructed upper airways. The jaw-thrust is illustrated at Fig 4.1.

0419. *Chin-lift*. Place the fingers of one hand under the chin and gently lift it upwards to bring the chin anteriorly. To open the mouth, use the thumb of the same hand to depress the lower lip slightly. The thumb may also be placed behind the lower incisors and, simultaneously, the chin gently lifted. This will open the upper airway in 70–80% of casualties. The chin-lift is illustrated at Fig 4.2.

Make sure you do not hyperextend the neck.

0420. *Suction*. Remove blood and secretions from the oropharynx with a rigid suction device (for example, a *Yankauer* sucker). If there is bleeding at the external nares clear this with suction. A casualty with facial injuries may also have a cribriform plate fracture; this means that suction catheters should not be inserted through the nose as they could enter the skull and injure the brain.

0421. *Finger sweeps*. Finger sweeps into the back of the mouth and pharynx may be useful for dislodging foreign bodies, particularly if no suction device is available.

Make sure that your fingers do not inadvertently push foreign bodies further into the airway.

0422. *Displacement of fractured maxilla or mandible*. Where airway obstruction results from a fractured maxilla, insert the index or middle finger or both, through the mouth behind the hard palate and pull it forward to disimpact the displaced bone. When an anterior mandibular fracture allows the tongue to fall back into the hypopharynx you may have to pull the mandible forward manually.

Maintaining the airway

0423. How to maintain the casualty's airway will depend on:

- The casualty's injuries.
- The casualty's level of consciousness.
- The equipment available.

0424. Clearing the casualty's airway may result in his level of consciousness improving and being able to maintain his own airway.

0425. If the casualty cannot maintain his own airway you (or an assistant) need to

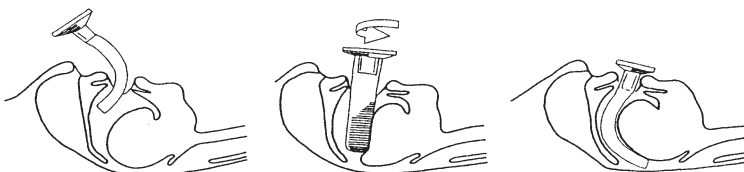


Fig 4.3 Nasopharyngeal airway

continue with the jaw-thrust or chin-lift or try using an oropharyngeal airway or nasopharyngeal airway.

0426. *Oropharyngeal airway*. The oropharyngeal airway (Guedel type) is inserted into the casualty's mouth over the tongue. It stops the tongue falling back and provides a clear passage for air flow. The preferred method is to insert the airway concavity upwards until the tip reaches the soft palate and then rotate it 180°, slipping it into place over the tongue (see Fig 4.3).

Make sure that the airway does not push the tongue backwards as this will block rather than open the airway.

0427. A casualty with a gag reflex may reject the oral airway. If so, move on to the nasopharyngeal airway.

0428. *Nasopharyngeal airway*. A nasopharyngeal airway can be used when

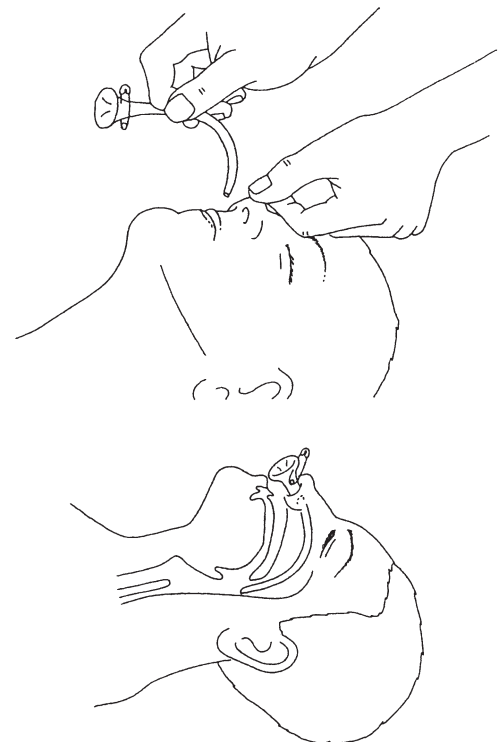


Fig 4.4 Nasopharyngeal airway

there is oral injury, a fractured mandible or masseter spasm. It is better tolerated than the Guedel by the more responsive casualty and is less likely to be dislodged during evacuation (see Fig 4.4). A suspected fractured base of skull is not a contraindication for use of this airway if an oropharyngeal airway cannot be inserted.

0429. Lubricate the airway and insert it through either nostril, straight backwards - not upwards - so that its tip enters the hypopharynx. A safety pin should be applied across the proximal end before insertion to prevent the tube disappearing into the casualty's airway. If this happens it could compromise rather than maintain the airway. A complication of inserting the

nasopharyngeal airway is bleeding from the nose. Gentle insertion, good lubrication and using an airway that passes easily into the nose will decrease the incidence of bleeding.

The oropharyngeal and nasopharyngeal devices MAINTAIN the airway but do not protect it from aspiration.

0430. A casualty whose airway has been cleared and maintained by the techniques described above may need help with their breathing if this is depressed due to injuries or toxic agents.

0431. Ventilation is covered at paragraphs 0446-0451 and is practised in Skill Station 1.

Protecting the airway at risk - advanced airway techniques

0432. Advanced airway techniques include:

- Surgical cricothyroidotomy.
- Surgical tracheostomy.
- Endotracheal intubation.

0433. Indications for performing advanced airway techniques are:-

- Inability to clear or maintain an airway using simple manoeuvres and airways in, for example:
 - Injury around the face.
 - Face and airway burns (causing swelling of the airway, see paragraphs 0406 and 1213).
 - An obstruction in the upper airway that cannot be removed and needs to be by-passed.
 - Neck injury or swelling blocking

the lower airway.

- To protect the airway from:
 - Obstruction due to swelling.
 - Aspiration of gastric contents or other fluid. (Note: A cuffed endotracheal tube or cuffed surgical airway maintains a clear passage and the cuff provides a seal).
- To allow accurate control of oxygenation and ventilation.
- As part of head injury management by helping to control oxygen and carbon dioxide levels in cerebral blood flow (see Chapter 8):
- In the management of some chest injuries.
- In surgery and anaesthesia.

DEFINITIVE AIRWAY

This is a cuffed tube placed in the trachea by the surgical route or by endotracheal intubation.

SURGICAL AIRWAY

0434. A surgical airway is used when:

- A casualty needing a definitive airway for resuscitation or evacuation is too awake to tolerate endotracheal intubation without the use of anaesthetic drugs.
- Trauma to the face and neck make endotracheal intubation impossible.
- A casualty with face and neck burns requires airway protection to pre-empt delayed obstruction but expert anaesthetic help is unavailable to carry out endotracheal intubation.

Surgical cricothyroidotomy

9435. Surgical cricothyroidotomy places a tube into the trachea via the cricothyroid membrane (See fig 4.5). A small tracheostomy tube (5-7 mm) is suitable. This will be practised in skill station 2 and is illustrated in Fig 4.6. During the procedure, appropriate cervical spine protection must be maintained when indicated. There are also commercially available cricothyroidotomy sets in use with some NATO armies. A cricothyroidotomy can be replaced by a formal tracheostomy (if needed) at a later time.

Emergency tracheostomy

0436. A formal surgical tracheostomy takes longer and is more difficult, than a surgical cricothyroidotomy. Commercial sets are available for rapid tracheostomy using a Seldinger (guide wire) technique.

Endotracheal intubation

0437. This technique uses a laryngoscope to visualise the vocal cords. A cuffed endotracheal tube is placed through the vocal cords into the trachea. This skill is illustrated at Fig 4.7 [shown in Skill Station 2] and will be practised in the Skill Station.

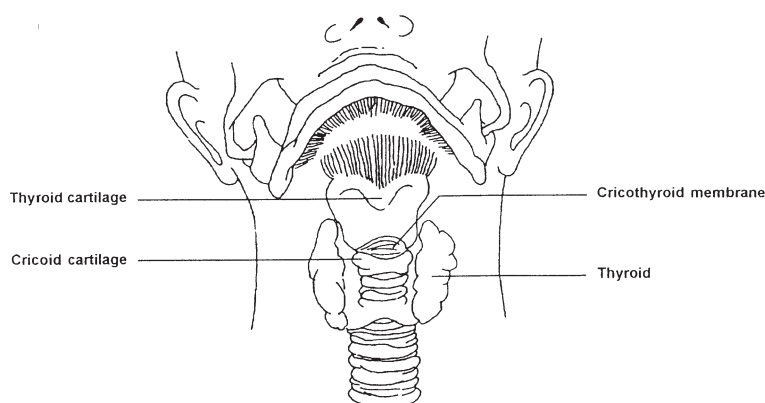


Fig 4.5 Cricothyroid membrane

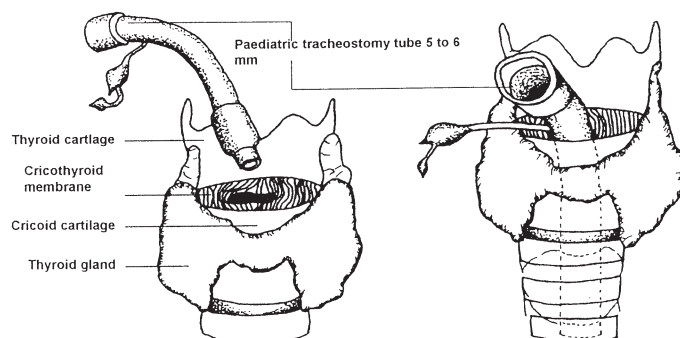


Fig 4.6 Insertion of tracheostomy tube

0438. At Role 1 and Role 2, in the absence of anaesthetic skills and drugs, endotracheal intubation will only be achieved in deeply unconscious casualties (GCS 4 or less). Attempting intubation in the semiconscious casualty will result in gagging on the laryngoscope and coughing on the endotracheal tube. In casualties with raised intracranial pressure this will increase the pressure even further and worsen the situation. If the casualty gags or coughs, *stop* and try another method of airway management.

Note: This presents a dilemma with head injuries in coma (GCS 8 or less). Ideally these casualties should be intubated and ventilated to prevent cerebral hypoxia and hypercapnia worsening. In many of them, attempting to do this without the aid of anaesthetic drugs worsens the situation by raising ICP. A surgical airway with ventilation and oxygenation may be required.

0439. In casualties who are not deeply unconscious, maintain the airway with simple techniques. If protection is necessary, insert a surgical cricothyroidotomy under local anaesthesia.

0440. Where anaesthetic skills and drugs are available or can be brought to the casualty by an Incident Response Team (IRT), endotracheal intubation can be achieved using:

- Rapid sequence induction of anaesthesia with:
- Application of cricoid pressure (Sellick's manoeuvre) and,
- Maintenance of cervical spine immobilisation when indicated.

0441. *Intermittent oxygenation during difficult intubation.* Intubation of the hypoventilating or apnoeic casualty may require several attempts and even then, may not be successful. If oxygen is available, you must avoid prolonged efforts to intubate without intermittently oxygenating and ventilating the casualty. You should practise taking a deep breath when starting an attempt at intubation; if you have to take further breath before successfully intubating the casualty, abort the attempt.

0442. Correct placement of the endotracheal tube is checked in Skill Station 2. The main points are:

- See if the endotracheal tube has passed between the vocal cords. Remember to maintain immobilisation of the cervical spine when indicated.
- Listen on both sides in the mid-axillary line for equal breath sounds.
- Listen over the stomach for gurgling sounds during assisted ventilation for evidence of oesophageal intubation.
- Feel and listen for air movement at the proximal end of the tube if the casualty is breathing spontaneously.
- Monitor end-tidal carbon dioxide levels if equipment is available.

- If in doubt about the position of the endotracheal tube, take it out and oxygenate the casualty by another method.

It is failure to oxygenate the casualty that kills, not inability to intubate.

If you need to take over care of an intubated casualty make sure the endotracheal tube is in the correct place and has not moved during evacuation or transfer of the casualty.

Note: Other methods for maintaining the airways. Both the laryngeal mask airway and combitubes have been used in civilian practice to manage the trauma casualty's airway. Their role in military trauma has still to be evaluated.

Oxygenation and Assisted Ventilation

Oxygenation

0443. The primary goal in providing supplementary oxygen is to maximise the delivery of oxygen to the cells. This is done by providing the highest possible oxygen concentration to the lungs using high flow oxygen at 10-15 litres per minute, as soon as oxygen is available. A disposable face mask without a reservoir bag can deliver 35-60% oxygen, depending on type of mask and oxygen flow. A face mask with an oxygen reservoir can be used to deliver up to 85% oxygen. A correctly fitting bag-valve-mask system with a reservoir, can be used to deliver up to 100% oxygen to the lungs.

Ventilation

0444. Spontaneous ventilation (self ventilation) means the same as breathing. Assisted (artificial) ventilation means the casualty is receiving help with breathing. The aim is to improve gaseous exchange in the lungs and to breathe for the casualty if spontaneous ventilation has stopped or is inadequate. Indications for assisted ventilation include:

- Head injury.
- Chest injury.
- Respiratory depression due to drugs (such as nerve agents and opiates).

0445. Assisted ventilation can be achieved by the following techniques:

- Mouth to mouth (or nose).
- Mouth to mask.
- Bag-valve-mask.
- Bag-valve-endotracheal tube or surgical airway.
- Automatic ventilation (used by specialist resuscitation teams in field hospitals for prolonged casualty ventilation).

0446. Assisted ventilation is described in Skill Station 1 and will be practiced there.

0447. *Mouth to mouth (one man) technique.* If a pocket mask with a one-way

valve and oxygen inlet is not available, you can give assisted ventilation by removing the mask from the bag-valve-mask device and blowing into the connecting port.

Note: Do not use the mouth to mask technique if there is a *chemical agent vapour hazard* either in the environment or on the casualty.

0448. *Bag-valve-mask.* This technique can be performed one or two handed and is best performed with an oral or nasal airway in place.

0449. *Bag-valve-endotracheal tube/surgical airway.* The technique you will use will depend on the circumstances and equipment available. If a manual bag-valve-endotracheal tube/surgical airway technique is used, the bag is squeezed to achieve obvious chest movement at a rate of approximately 12-15 breaths per minute, that is, one second squeeze - three to four seconds release. An oxygen source and a reservoir should be attached to the bag as soon as they are available.

Evacuation of Airway Compromised Casualties

0450. Casualties who have lost their normal protective airway reflexes are in danger of aspirating gastric contents, blood and debris and developing airway obstruction; they become hypoxic.

Caring for and monitoring a casualty in the back of military vehicles or helicopters can be difficult, especially in low light conditions. A balance has to be made between:

- The need to move the casualty.
- The safety of the casualty during evacuation.
- The resources available to move the casualty.
- Distance for evacuation.
- The tactical situation.

If available, seek specialist advice from hospital teams, aeromed teams or incident response teams.

The casualty with a definitive airway in place
0451. Best practice is that they are evacuated by trained personnel with appropriate anaesthetic and intensive care skills and electronic monitors. If there is concern about the ability to care for an intubated casualty (for example, replacing a displaced endotracheal tube) during evacuation, consider providing a definitive surgical airway. In casualties being evacuated by air, inflate the cuff with saline; air expands at altitude.

The casualty at risk from aspiration but a definitive airway cannot be provided

0452. Maintain the airway with a Guedel or nasopharyngeal airway and transfer the casualty in the lateral position with an escort who has oxygen, suction and can care for the casualty en route. Continue cervical

spine immobilization as can best be managed but airway management takes precedence.

Unconscious casualties without a definitive airway must not be transferred lying on their backs.

The casualty at risk from airway blocking during transfer.

0453. Where the casualty's airway is at risk from blocking during transfer, for example, airway burns:

- Get specialist advice.
- Consider providing a surgical airway, or endotracheal intubation if anaesthetic expertise is to hand.

Note: On balance, a surgical airway is the method of choice. It may be difficult in the extreme incising through burnt skin. Aim not to go through burnt skin but, your prime concern is to protect the airway during casualty transfer!

Summary

- Airway obstruction must be recognised and relieved quickly.
- Beware of cervical spine injury during airway management.
- Start with simple techniques such as jaw-thrust/chin-lift/oropharyngeal suction.
- Try Guedel or nasopharyngeal airways.
- Give high flow oxygen from a mask with a reservoir.
- Definitive airways protect against aspiration of gastric contents and blood.
- Definitive airways include:
 - Surgical cricothyroidotomy.
 - Endotracheal intubation.

Note: Choice of definitive airway will depend on skills and equipment available:

- Casualties with inadequate respiration will need assisted ventilation.
- This can be done by mouth, by bag and mask or by automatic ventilators.

SKILLS STATIONS:

1. Basic Airway Management and Ventilation
2. Advanced Airway Management: Adult Orotracheal Intubation

Aim

The aim of these skills stations is to demonstrate and practise basic and advanced airway management. You will also discuss the indications for oral endotracheal intubation and associated complications.

On successfully completing these stations, you will be proficient in:

- Basic airway clearing techniques.
- Oropharyngeal airway insertion.
- Nasopharyngeal airway insertion.
- Ventilation without intubation.
- Orotracheal intubation.

Equipment

Adult intubation manikins.
Adult endotracheal tubes size 7.0, 8.0 and 9.0.
Laryngoscope handles.
Laryngoscope blades, adult, curved.
Extra batteries for laryngoscope handles.
Extra laryngoscope bulbs.
Stethoscopes.
Lubricant (for example, silicone spray that accompanies intubation manikin).
Semi-rigid cervical collar applied to one adult intubation manikin, or sandbags.
Magill's forceps.
Malleable endotracheal introducers.
Oropharyngeal airways size 2, 3 and 4.
Nasopharyngeal airways size 6.0 and 7.0.
Bag-valve-mask devices.
Pocket face masks (with a one-way valve to prevent back-flow of air and secretions).
Rigid suction devices (Yankauer sucker).
Safety pins.
Scissors.
1" open weave cotton bandage.

SKILLS STATIONS 1 BASIC AIRWAY MANAGEMENT AND VENTILATION

Aim

This skill station allows you to practice basic airway techniques and develop a system for airway management.

The order for performing tasks will depend on the situation, the personnel available and their skills. Some tasks will be done simultaneously if more than one person is available.

This skill station assumes there is an assistant to help you.

Sequence of actions:

- Approach and reassure casualty.
React to the casualty's response.
- Provide manual inline immobilisation of the cervical spine when indicated.
- Hand over manual inline immobilisation to your assistant (get them to place their hands over yours then gently remove your hands as they apply immobilisation). If assistance is not available your sole aim is to *clear the airway*.
- Clear the airway using:
 - Finger sweeps to remove solid debris (if safe to do so).
 - Magill forceps to remove solid debris.
 - Yankauer sucker to remove blood and fluid from the oropharynx.
 - Jaw-thrust.
 - Chin-lift.
- Provide high flow oxygen from a mask with a reservoir bag.
- Decide if the casualty needs an oropharyngeal or nasopharyngeal airway.

Airway management in the casualty with a fractured maxilla.

- Using the Mr Hurt manikin with maxillary fractures, practice pulling the fracture forward to clear the airway.

Airway management in the casualty whose head is not in the neutral position.

- Gently move the casualty's head into the neutral position if the airway cannot be cleared and maintained in the non-neutral position.
- Stop moving the head if:
 - There is resistance to movement.
 - The casualty complains of pain.

Airway management in the combative casualty who will not accept sand bags and tape

- Compromise by using a semi-rigid cervical collar only.

Oropharyngeal Airway Insertion

- Select the correct sized airway. Place the airway against the casualty's face. The correct sized airway will extend from the centre of the casualty's mouth to the angle of the jaw.
- Open the casualty's mouth with the chin-lift manoeuvre.
- Insert the tip of the airway along the roof of the mouth to the soft palate (see fig 4.3).
- Rotate the airway 180°, directing the concavity of the airway towards the feet and slip the airway over the tongue.
- If necessary, ventilate the casualty with mouth-to-mask or bag-valve-mask technique.

Nasopharyngeal Airway Insertion

- Assess the nasal passages for any apparent obstruction (fractures, haemorrhage, polyps). Choose a nostril that is patent.
- Select the correct size airway. Size 7 for the adult female and size 8 for an adult male.
- Insert the safety pin across the nostril end of the airway.
- Lubricate the nasopharyngeal airway with a water-soluble lubricant or water.
- Insert the tip of the airway into the nostril and direct it posteriorly and towards the ear lobe.
- Gently slide the nasopharyngeal airway through the nostril into the hypopharynx with a slight rotating motion until the flange rests against the nostril.
- If an obstruction is encountered try the other nostril or try a smaller nasopharyngeal airway. *Trying to force the nasopharyngeal airway past an obstruction may cause severe bleeding.*
- If necessary, ventilate the casualty with mouth-to-mouth or bag-valve-mask technique.

Ventilation Without Intubation

Mouth-to-mask ventilation, adult (one man technique)

- Attach oxygen tubing to the Laerdal pocket mask.
- Adjust the oxygen flow rate to 10 litres per minute.
- If there is no oxygen inlet, place the oxygen tubing under the side of the mask.
- Insert an oropharyngeal airway.
- Apply the face mask to the casualty using both hands.
- Open the airway using the jaw-thrust manoeuvre, three fingers on the underside of the jaw.
- Take a deep breath and place your mouth over the mouth port and blow.
- Assess the ventilatory efforts by observing the casualty's chest movement.
- Ventilate the casualty in this manner every five seconds.

Bag-valve-mask ventilation, adult (two man technique)

- Select the correct sized mask to fit the casualty's face.
- Connect the oxygen tubing to the bag-valve device and adjust the flow of oxygen to 10 litres per minute.
- Ensure the patency of the casualty's airway.
- The first person applies the mask to the casualty's face, making a tight seal with both hands.
- The second person ventilates the casualty by squeezing the bag with both hands.
- Assess the adequacy of ventilation by observing the casualty's chest movement.
- Ventilate the casualty in this manner every five seconds.

Bag-valve-mask ventilation, adult (one man technique)

- Follow the first three steps for the two man technique.
- Use one hand to apply the mask to the casualty's face. Use the index finger and thumb to hold the mask in place and use the other fingers to perform a jaw-thrust. Squeeze the bag with the other hand and ventilate as before.

SKILLS STATIONS 2 ADVANCED AIRWAY MANAGEMENT ADULT OROTRACHEAL INTUBATION

Aim

This skill station allows you to practice adult orotracheal intubation (see Fig 4.7). It also helps you to develop systems to substitute manual immobilization by using a cervical collar, sandbags and tape, and check that the endotracheal tube is correctly placed.

Sequence of actions:

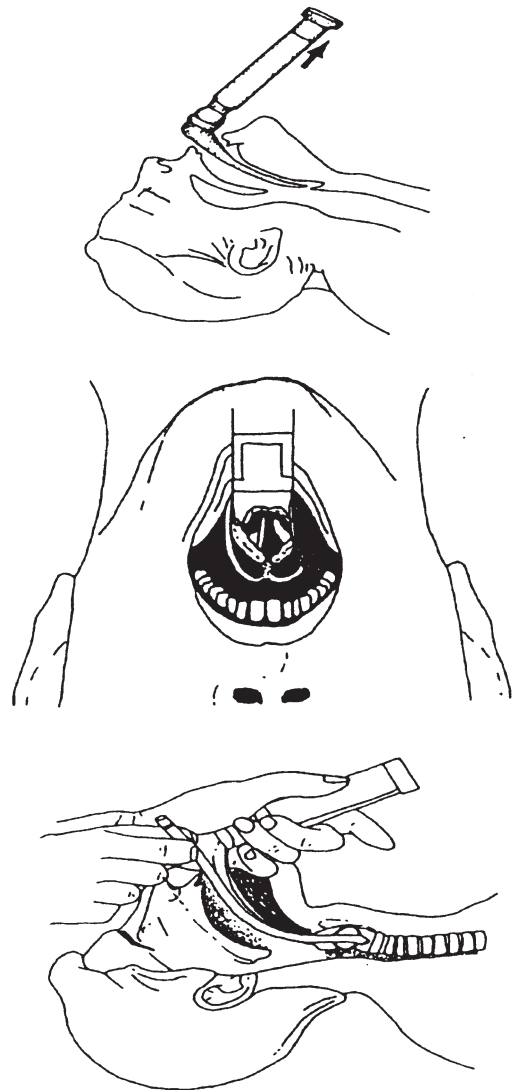


Fig 4.7 Endotracheal tube insertion.

- Ensure that adequate ventilation and oxygenation are in progress.
- Connect the laryngoscope blade and handle; check the bulb for brightness, also check both small and larger endotracheal tubes are to hand, their cuffs are working and the suction is working.
- If indicated, have an assistant manually immobilize the head and neck.
- If indicated, have an assistant apply cricoid pressure.
- Hold the laryngoscope in the left hand.
- Insert the laryngoscope into the right side of the casualty's mouth, displacing the tongue to the left.
- Look for the epiglottis and place the tip of the blade in the vallecula. Lift the epiglottis forward by pulling the handle of the laryngoscope forward and visualize the vocal cords.
- Gently insert the endotracheal tube into the trachea without applying pressure to the teeth or oral tissues.
- Check the placement of the endotracheal tube by bag-valve tube ventilation.
- Inflate the cuff with enough air to provide a gas-tight seal.

- Visually observe lung expansion with ventilation.
- Attach end-tidal CO₂ monitoring if available.
- Auscultate the chest with a stethoscope in both axillae and over the abdomen to check that the tube is not in a main bronchus (usually the right) or in the oesophagus.
- If endotracheal intubation requires several attempts, discontinue and ventilate the casualty between each attempt with a bag-valve-mask device. You should practice taking a deep breath when starting an attempt at intubation. If you have to take a further breath before intubation is achieved, abort the attempt (at intubation) and ventilate the casualty.
- Remember that the best way to ensure that the tube is not in the oesophagus is to see it lying between the vocal cords.
- Allow cricoid pressure to be released when correct endotracheal tube placement is confirmed and the cuff is inflated.
- Fix the tube in position by tying it with an open weave cotton bandage.
- Reapply cervical spine immobilisation.
- Consider placing a Geudel airway in the casualty's mouth next to the endotracheal tube to help stabilise the tube's position and to protect it by acting as a bite block.

Complications of orotracheal intubation

Hypoxia from:

- Prolonged attempts to intubate.
- Unrecognised oesophageal intubation.
- Aspiration of gastric contents during attempts to intubate.

Damage to the cervical spinal cord if the neck has not been immobilized when there is an unstable neck fracture.

Pushing the tube too far down into one of the main bronchi (usually the right).
The unintubated lung does not get ventilated and eventually collapses.

Rupture or leak of the endotracheal tube cuff, resulting in loss of seal during ventilation and necessitating re-intubation.

Airway haemorrhage secondary to injury.

Damage to the larynx.

Chipping or loosening of the teeth (caused by levering the laryngoscope blade against the teeth).

SKILLS STATIONS 3 SURGICAL AIRWAYS

Aim

The aim of this skills station is to give you the opportunity to practise and demonstrate the technique of surgical cricothyroidotomy on anatomical models.

The instructor will also demonstrate needle cricothyroidotomy and oxygen insufflation.

Equipment

Procedure gloves and disposable aprons.
Medicut IV cannulae 12 gauge.
Bag-valve-mask devices.
Oxygen tubing and Y-connector.
Full oxygen cylinders with flow meters.

Scalpel handle with blades.

Small artery forceps.

Tracheal dilating tongs.

Cuffed tracheostomy tubes size 6.0 with connector.

Lignocaine 1% (20 ml) with adrenaline.

Syringes 5 ml.

Blue needles 23 gauge.

Scissors.

Swabs.

Sharps disposable boxes.

Plastic rubbish bag.

Anatomical models.

Role of jet insufflation of oxygen via needle cricothyroidotomy

This technique has only very limited application on the battlefield but may have a role in the field hospital (see Fig 4.8). A 12 or 14 gauge cannula is inserted over a needle through the cricothyroid membrane (needle cricothyroidotomy) and oxygen insufflated into the lungs under pressure. This technique can be done without an insufflator by attaching the cannula to oxygen running at 15 litres per minute. A Y-connector or side hole is incorporated into the connector tubing. Occluding the open end of the Y-connector or side hole one second in every five, forces a stream of oxygen into the trachea. Without a proper insufflator, this technique will only be effective in casualties with normal pulmonary function in the absence of significant chest injury. A casualty with little or no ventilatory effort will not be adequately oxygenated using the Y-connector/side hole technique in the absence of an insufflator.

Because the chest wall in children is more elastic than in adults, a needle cricothyroidotomy attached to high flow oxygen is a useful technique to achieve oxygenation prior to tracheostomy in an emergency (See supplement No 1). The risks of barotrauma, including lung rupture and tension pneumothorax, are high if the technique is not applied with great care.

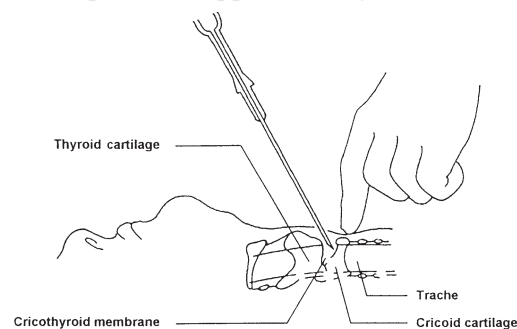


Fig 4.8 Needle cricothyroidotomy

Surgical Cricothyroidotomy

- Place the casualty supine with the neck in the neutral position. If not contraindicated, extend the neck and place a sandbag (or suitable alternative)

under the shoulders; this will bring the landmarks into more prominence. Palpate the thyroid notch and cartilage, cricothyroid membrane and cricoid cartilage.

- Clean the skin and infiltrate with local anaesthetic (unless the casualty is deeply unconscious). This is illustrated at Fig 4.9.

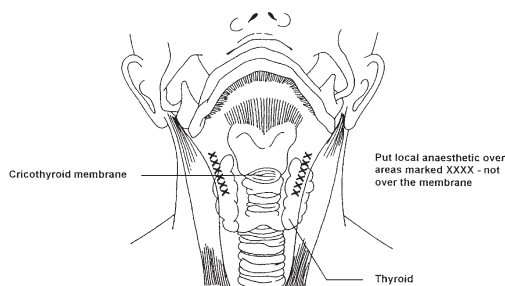


Fig 4.9 Surgical cricothyroidotomy

- Stabilise the thyroid cartilage with the left hand.
- Make a horizontal skin incision over the cricothyroid membrane.
- Carefully incise through the membrane horizontally.
- Insert the scalpel handle into the incision

and rotate it 90° to open the airway. (You can use artery forceps instead of the scalpel handle).

- Insert a 6 mm cuffed tracheostomy tube into the cricothyroid membrane incision, directing the tube distally into the trachea.
- Inflate the cuff.
- If spontaneous breathing does not occur, ventilate the casualty.
- Observe lung inflations and auscultate the chest for adequate ventilation.
- Secure the tube by stitch or tape, or both.

Complications of surgical cricothyroidotomy

Creation of a false passage into the tissues.

Asphyxia.

Aspiration (for example, blood).

Laceration of the trachea.

Laceration of the oesophagus.

Haemorrhage or haematoma formation.

Mediastinal emphysema.

Subglottic stenosis/oedema.

The Professor of Military Surgery wishes to thank the Technical Author for his assistance with this project.

BATLS

Battlefield Advanced Trauma Life Support (BATLS)

CHAPTER 5 SHOCK

AIM

0501. On successfully completing this topic you will be able to:

- Define shock.
- Identify clinical shock syndromes.
- Understand the difference between compressible and non-compressible haemorrhage.
- Relate the casualty's symptoms and signs to the underlying shock syndrome.
- Discuss the principles of treatment of hypovolaemic shock.
- Demonstrate techniques of fluid replacement.

Pathophysiology

0502. Shock is the general response of the body to inadequate tissue perfusion and oxygenation. This simple statement encompasses a complex pathophysiological process. If progressive and uncorrected, this process will lead to cell death, organ failure and the death of the casualty.

Shock is inadequate tissue perfusion.

Types of Shock

0503. Most cases will be caused by hypovolaemia, that is, a reduction of circulating volume due to haemorrhage or fluid loss in burns.

0504. Cardiogenic shock and neurogenic shock are both examples of hypoperfusion, when failure to maintain circulating volume is not due to blood loss. In cardiogenic shock the heart fails to pump blood around the body adequately. In neurogenic shock due to a spinal injury, blood vessels dilate causing pooling of blood and making the circulating blood volume inadequate. A similar situation arises in anaphylactic shock due to infection as a late complication of trauma. Both these mechanisms are related to the release of vasodilatory mediators.

TYPES OF SHOCK

- Hypovolaemic
- Cardiogenic
- Neurogenic
- Anaphylactic
- Septic

0505. *The treatment of shock is directed towards restoring cellular and organ perfusion with adequately oxygenated blood.* It bears repeating that inadequately treated tissue hypoperfusion causes cell damage and organ failure. Death inevitably follows.

The Pathological Mechanisms - Early

0506. Fluids in the body lie within cells (intracellular fluid), between the cells (intercellular fluid), and within the blood vessels. The intracellular and intercellular fluids form the *extravascular* compartment; fluid within the blood vessels forms the *intravascular* compartment.

0507. Loss of circulating fluid causes decreased venous return (preload) with subsequent decreased stretch of the muscle in the right and left ventricles of the heart. As a result of this, cardiac output is reduced resulting in hypotension and hypoperfusion (Starling's Law). The body's response to loss of tissue fluid or blood is directed at maintaining circulating volume. The principle corrective mechanisms involved in this process are:

- Fluid shifts from tissues into blood vessels, that is, from the extravascular to the intravascular compartment.
- The heart rate rises (tachycardia) due to increased sympathetic nervous system outflow and reduced vagus nerve inhibition.
- Constriction of blood vessels (vasoconstriction) in the splanchnic bed and limb peripheries, (the cold, pale extremities of shock).
- Fluid retention due to reduced urine output.

The Pathological Mechanisms - Late

0508. At the cellular level, hypoxic cells initially compensate by shifting to anaerobic metabolism. This results in the formation of lactic acid and the subsequent development of metabolic acidosis. If untreated, cells swell and burst producing marked tissue oedema and loss of function. These events compound the effects of hypovolaemia. Replacement of circulating volume is essential, as is adequate tissue oxygenation, in order to prevent further deterioration of this process of cell death.

Hypovolaemic Shock

0509. In the battlefield situation, hypovolaemic shock due to trauma or burns is by far the most common cause of the shock syndrome. It is also the most amenable to prompt management. Haemorrhage is the acute loss of circulating blood. In adults, 7% of body weight is circulating blood (approximately five litres in a 70 kg adult or 70 ml/kg of body weight). In children, circulating volume is calculated to be 8-9% of body weight (90 ml/kg of body weight).

0510. Blood loss in trauma may be into five sites (*'blood on the floor and four more'*):

- External ('on the floor').
- Chest.
- Abdomen.
- Pelvis and retroperitoneum.
- Around long bone fractures (especially the Femur).

Note: The presence of significant amount of blood in the chest will be identified during Breathing in the primary survey. Identification of other sites of bleeding is an essential element of Circulation.

You must be highly suspicious in all cases of blunt abdominal injuries; these can result in massive, concealed blood loss.

0511. Major soft tissue injuries and fractures compromise circulating volume in two ways:

- Blood lost at the site of the injury.
- Oedema. Soft tissue injuries result in obligatory oedema, the magnitude of which is related to the severity of the injury. Since plasma and extracellular fluid are in continuity, loss of extracellular fluid will inevitably affect circulating volume. Approximately 25% of post-trauma oedema will be derived from plasma.

0512. Some idea of blood volumes lost from different injuries can be seen from the following:

- | | |
|-------------------------------|-------------|
| • Closed femoral fracture | 1.5 litres |
| • Fractured pelvis | 3 litres |
| • Fractured ribs | 150 ml each |
| • One blood-filled hemithorax | 2 litres |

0513. The following may represent a loss of 500 ml:

- A closed tibial fracture
- An open wound the size of an adult hand.
- A clot the size of an adult fist.

0514. The elderly tolerate shock less well than the fit, young adult, and the very young in whom shock may not be clinically apparent until blood loss becomes quite severe.

Rapid Assessment of the Cardiovascular System

0515. *Mental state.* If the casualty is conscious and talking sensibly, he is not only breathing through an open airway, he is perfusing his cerebral cortex with sufficient oxygenated blood (50% of the normal cardiac output). Increasing hypovolaemia and subsequent cerebral hypoxia cause alterations in the level of consciousness. These alterations begin with anxiety and if untreated, proceed through confusion and aggressiveness to eventual unresponsiveness and death.

0516. *Colour.* Hypovolaemic casualties become pale, cold, sweaty and cyanosed.

0517. *Pulse.* The presence of a palpable radial pulse implies that the systolic blood pressure is at least 90 mmHg. Absent radial pulses, but a palpable femoral pulse, imply a systolic blood pressure between 80 and 90 mmHg; a palpable carotid pulse, in the absence of other pulses, indicates that the systolic pressure is at least 70 mmHg.

Radial pulse indicates blood pressure >90 mmHg.

Femoral pulse indicates blood pressure ≥80 mmHg.

Carotid pulse indicates blood pressure ≥70 mmHg.

0518. *Capillary refill.* This test is performed by compressing a fingernail for five seconds. The test is normal if colour returns within two seconds of releasing compression (the time taken to say the words '*capillary refill*'). Capillary refill is not effective as a measure of circulatory adequacy if the casualty is hypothermic or if it is dark!

Normal capillary refill takes two seconds.

0519. *Blood pressure.* This should be recorded during the primary survey and observations continued thereafter to ensure that the trend is towards normotension.

Classification of Circulating Volume Lost (See Table 5.1)

0520. *Class I.* Loss of less than 15% of circulating volume (up to 750 ml in a 70 kg adult). This is fully compensated by the diversion of blood from the splanchnic pool. There are no abnormal symptoms and signs other than minimal tachycardia.

0521. *Class II.* Loss of 15 - 30% of circulating volume (750 - 1500 ml in a 70 kg adult) requires peripheral vasoconstriction to maintain systolic blood pressure. The pulse pressure is narrowed because of raised diastolic blood pressure; this is a valuable indicator of Class II.

0522. *Class III.* Loss of 30-40% of circulating volume (1500-2000 ml in a 70 kg adult) causes a measurable fall in systolic blood pressure because peripheral

vasoconstriction fails to compensate for the increasing loss. *This manifests itself as the classical symptoms and signs of shock.*

0523. **Class IV.** Loss of more than 40% of circulating volume (over 2000 ml in a 70 kg adult) is immediately life-threatening. Effective and aggressive treatment must be initiated quickly. Loss of more than 50% circulating volume results in loss of consciousness.

This classification is the ultimate tennis match for survival:

Class I **0-15**
Class II **15-30**
Class III **30-40**
Class IV **40-game, set and exit tournament for good!**

Table 5.1 Vital signs

Class	I Up to 750 ml <15% lost	II 750-1500 ml 15-30% lost	III 1500-2000 ml 30-40% lost	IV >2000 ml >40% lost
Heart rate	<100/min	100-120/min	120-140/min	>140/min
Systolic BP	Normal	Normal	Decreased	Decreased/ unrecordable
Pulse pressure	Normal	Narrowed	Narrowed	Very narrow/absent
Capillary refill	Normal	Prolonged	Prolonged	Prolonged/absent
Respiratory rate	14-20/min	20-30/min	>30/min	>35/min
Urine output	>30ml/hr	20-30 ml/hr	5-20 ml/hr	Negligible
Cerebral function	Normal/ slightly anxious	Anxious/ frightened/ hostile	Anxious/ confused	Confused/ unresponsive

Initial Assessment and Management

0524. Obvious signs of shock are easy to recognise *but they do not usually appear until over 30% of circulating volume is lost.* The earliest signs are of peripheral vasoconstriction and tachycardia followed by narrowing of the pulse pressure. You must assume that any injured casualty with cold peripheries and a rapid heart rate is in shock, until proved otherwise. Remember, a pulse of 80 in a young, fit athletic soldier, whose normal resting pulse is 50, may represent a significant loss of circulating volume.

Principles of Management of Hypovolaemic Shock

0525. The principles of management are:

- To save life.
- To prevent deterioration.
- To promote recovery.

0526. Diagnosis of hypovolaemic shock must be promptly followed by appropriate treatment, directed at restoring effective tissue perfusion. Restoration of adequate circulating volume is not a substitute for definitive treatment (surgery). Remember: *circulation with haemorrhage control*; attempts should be made to treat, where possible, the cause of the shock; for example, application of pressure dressings and splinting of fractures. **Stop the bleeding!**

0527. Shock is defined as inadequate tissue perfusion. It is now accepted that the appropriate end point for the initial resuscitation of the shocked casualty is the achievement of a blood pressure sufficient to maintain tissue perfusion. This is generally accepted to be a systolic blood pressure of 90 mmHg, that is, a palpable radial pulse. Evidence suggests that a rapid return to normal blood pressure is associated with effects such as the displacement of blood clot and a dilution of clotting factors. Both of these effects may cause rebleeding and adversely affect outcome. The foregoing brings into question the traditional approach of giving *all* shocked casualties a standard intravenous fluid challenge of two or more litres in an uncontrolled way. This is especially the case when the haemorrhage is non-compressible (see paragraph 0530 and table 5.2).

Examination

0528. Physical examination is directed at the assessment of the **Airway, Breathing and Circulation**. Baseline recordings of vital signs (see Table 5.1) taken at this stage are important for subsequent decisions regarding treatment. Additionally, a rapid neurological survey (AVPU) will give important clues about cerebral perfusion. A more detailed secondary survey may offer information on the cause of the shock and on other conditions contributing to shock.

Resuscitation

0529. After establishing a clear airway (and protecting the cervical spine when appropriate) you should deliver oxygen, when available, at a high flow rate (10-15 litres per minute), through a bag-valve-mask reservoir system. After correcting any life-threatening breathing difficulties you must turn your attention to *stopping obvious haemorrhage*. This can be achieved by direct or indirect pressure, by wound packing and judicious and correct use of a tourniquet. You can minimise haemorrhage from limb fracture sites by reducing and immobilizing the fracture.

Haemorrhage

0530. When resuscitating the shocked casualty, you should consider haemorrhage to be of two types:

- Compressible haemorrhage.
- Non-compressible haemorrhage.

0531. Compressible haemorrhage is controllable by direct pressure, limb elevation, the application of a tourniquet or by splintage; All of which can be carried out by you.

0532. Non compressible haemorrhage is bleeding into a body cavity (chest, abdomen, pelvis or retroperitoneum) which can only be controlled by urgent surgery. This *cannot* be

carried out by you.

0533. In the case of pelvic fractures, although surgery may be needed, some control of bleeding may be achieved by splinting the pelvis using some form of pelvic splint as part of the resuscitation process.

0534. An algorithm for the management of shock is given at Table 5-2, this can be summarised as follows:

Fluid Resuscitation

Compressible haemorrhage	not shocked	No fluids
Compressible haemorrhage	shocked	IV fluids
Non compressible haemorrhage	evacuation available	No fluids
Non compressible haemorrhage	evacuation delayed	IV fluids

Table 5.2 Management of shock

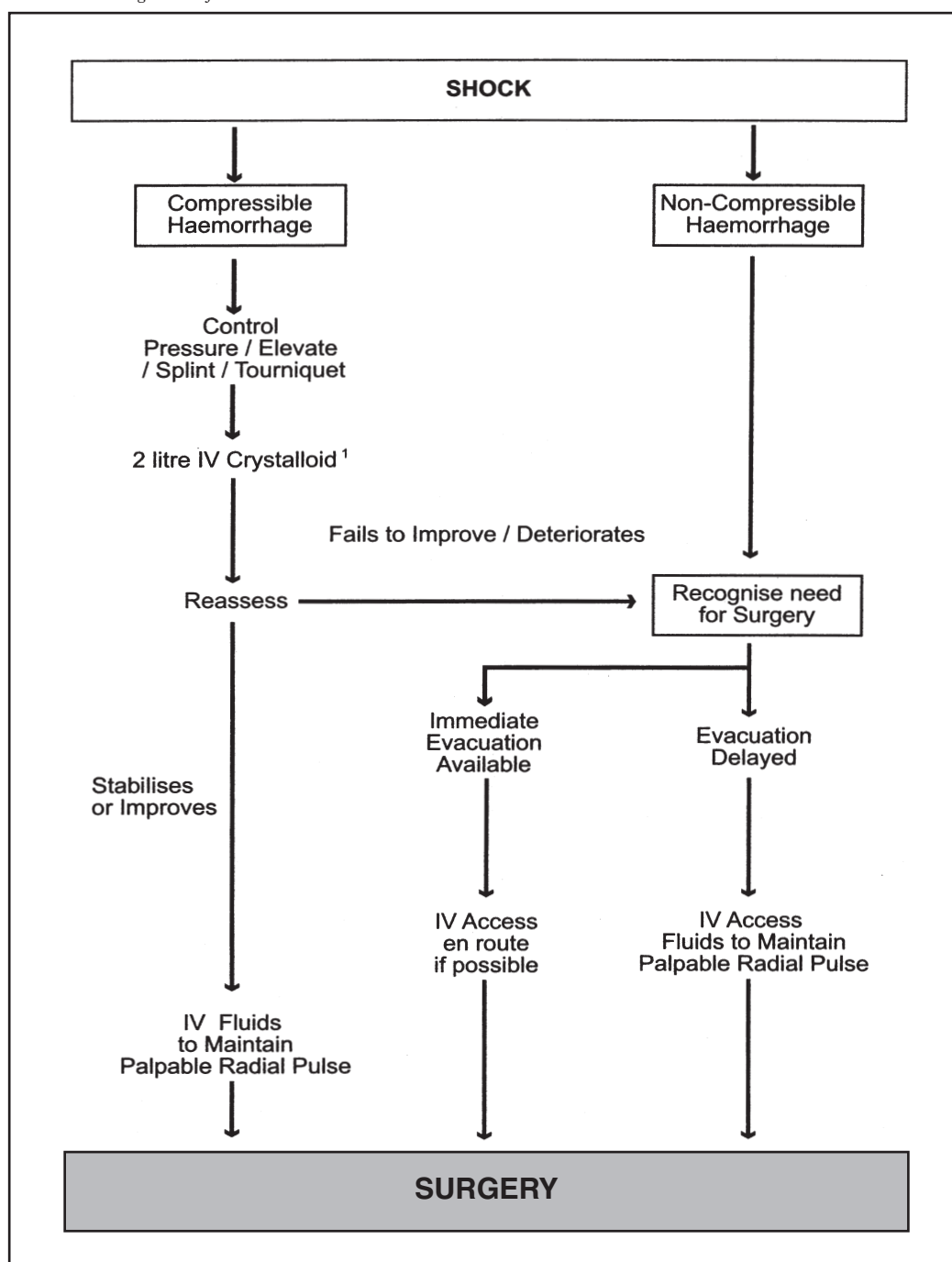
Replacement of Lost Volume

0535. Intravenous access is best achieved by inserting as large a cannula as possible into each antecubital fossa. If peripheral cannulation cannot be achieved consider:

- Femoral vein cannulation
- Intravenous cutdown

0536. Under no circumstances should attempts to obtain intravenous access delay casualty transfer to definitive care unless journey times are going to be prolonged.

0537. The choice of fluids is between crystalloid solutions and synthetic colloids; blood will be available at role 2 and 3 medical units.



¹ Never give cold fluids by rapid intravenous infusion. Ingenuity may be required to keep crystalloids and colloids warm. For example, never leave fluids in vehicles overnight in a cold environment. If necessary take them to bed with you! Carry packs of fluid under your smock close to your body, this will keep them warm, ready for immediate use. Blood taken straight from a refrigerator should be administered through a blood warmer.

Gaining intravenous access must not delay transfer to definitive care.

Crystalloids

0538. Crystalloids are physiological solutions which remain only temporarily in the circulation (about 30 minutes) before passing into the intercellular space. They are useful for the immediate replacement of lost volume, especially when evacuation times are short and definitive medical care is nearby. Initially, two litres of crystalloid (*Hartmann's Solution/Ringer's Lactate*) should be infused using wide-bore cannulae.

0539. The advantages of crystalloids are:

- They are inexpensive, plentiful and have a long shelf life.
- They have no allergenicity.
- They do not cause coagulation problems.
- There is no risk of transmitted infection.

0540. The disadvantages are:

- Three volumes are required for each volume of blood lost (the 3:1 rule).
- An overload may cause pulmonary and cerebral oedema.

Colloids

0541. Colloids are either *natural* (derived from blood products) for example plasma, or *synthetic* (derived from starches and gelatins) for example, polygeline (*Haemaccel*) which is a gelatin suspended in physiological solution, or *Gelofusine*.

0542. The advantages of colloids are:

- They are inexpensive, plentiful and have a long shelf life.
- They replace lost volume on a one-to-one basis.
- They remain in the circulation for long periods.
- There is no risk of transmitted infection.

0543. The disadvantages are:

- Occasionally (1:5000), they cause allergic reactions.
- When cold, they either become viscous or form a jelly.

Treatment regimen

0544. The response to resuscitation by intravenous fluids, and the need for further intravenous fluids and/or surgery, can be considered under four headings:

- *Type I response*. The pulse rate falls below 100, the systolic blood pressure rises above 100 and the pulse pressure widens; these signs remain stable. No further fluid challenge is required.
- *Type II response*. An initial fall of the pulse rate below 100, a rise of systolic blood pressure above 100 and widening of the pulse pressure, then a regression to abnormal levels of these vital signs. This means that either the fluid has been redistributed from the intravascular

compartment to the extravascular compartment, or blood loss continues. Give a further intravenous challenge of two units of colloid or whole blood if available. If the vital signs return to acceptable levels, the response was due to redistribution of fluid; if vital signs remain abnormal then this is a Type III response.

- *Type III response*. Continue intravenous colloid or whole blood at flow rates sufficient to sustain resuscitation (a palpable radial pulse). This casualty needs urgent surgery within the hour.
- *Type IV response*. No response to rapid intravenous infusion of crystalloid, colloid and/or blood. This casualty needs immediate damage control surgery (*to 'turn off the tap'*) if he is to survive.

0545. The above is a simple guide on how a casualty may respond to fluid resuscitation. More important is the question: has the casualty got non-compressible haemorrhage and can he be evacuated now? If the answer is 'yes' - **do it!**

0546. To resuscitate children, the initial bolus dose of crystalloid is 20 ml/kg of body weight. Further boluses will depend on the child's response. (see Supplement No 1).

Supplementary Treatments and Supportive Measures

0547. Protect casualties from the environment as hypothermia exacerbates shock. Administer oxygen at the highest possible percentage whenever it is available. Blood is indicated for casualties who have sustained a Class III or Class IV haemorrhage. Whenever possible use type specific blood although, in an emergency, uncrossmatched whole blood can be life-saving.

0548. Painful stimuli exacerbate shock. Use analgesia in responsive casualties; remember fracture stabilization and immobilization will minimise haemorrhage at the fracture site in addition to alleviating pain.

0549. Gastric dilation may occur despite the presence of a nasogastric tube. To avoid the risk of aspiration in unconscious casualties, the airway must be protected by a cuffed endotracheal tube, together with intermittent aspiration of the nasogastric tube.

Monitoring

0550. Once stabilized, the casualty must be continually monitored and reassessed to prevent deterioration and to ensure that all diagnoses have been made. Legible and accurate records are essential, noting the date and time of each intervention and observation. The variables that must be monitored are:

- Pulse (rate, rhythm and pressure).
- Capillary refill time.
- Respiration (rate, expansion and symmetry).

- Blood pressure
- Neurological state (AVPU).

0551. An additional guide to the response to resuscitation or casualty deterioration can be gained from:

- Pulse oximetry.
- Urine output (ideal: adults 50 ml/hr - children 1-2 ml/kg/hr).
- Blood gas analysis.

Management Problems

Continuing haemorrhage

0552. You must consider all potential sources of blood loss. Concealed haemorrhage is life-threatening and must be in the forefront of your mind in all hypovolaemic casualties who respond poorly or do not respond to treatment - Response types III and IV. Urgent surgery is required. You must also consider the possibility of dilution of clotting factors when large volumes of fluids have been infused. Remember that stored blood contains fewer clotting factors than fresh blood and fresh frozen plasma.

Fluid overload

0553. Fluid overload is unlikely to occur in severely injured, previously fit young men. Fluid replacement should be titrated against haemodynamic effects, especially when estimates of loss can be calculated from the mechanism of injury and the haemorrhage is compressible. If fluid overload does occur and pulmonary oedema is detected, the infusion should be slowed to maintain intravascular access and you should consider the use of intravenous diuretics and intravenous morphine.

Acid/base imbalance

0554. Initial respiratory alkalosis is due to tachypnoea. Metabolic acidosis may develop with severe or long-standing shock as a result of inadequate tissue perfusion and subsequent anaerobic metabolism. When arterial blood gas measurement is available and indicates the presence of metabolic acidosis, it should be treated with increasing intravenous fluids.

Other Types of Shock

0555. In the battlefield situation, most shocked casualties will have hypovolaemia. The differential diagnosis should also include cardiogenic, neurogenic, anaphylactic and septic shock. Clues can be gained from the history, careful secondary survey, selected additional tests and the response to treatment:

- *Cardiogenic shock.* Myocardial dysfunction may occur following cardiac tamponade, myocardial contusion, air embolus, pulmonary embolus, tension pneumothorax or myocardial infarction.

Ideally, all casualties with blunt thoracic injury should have constant ECG monitoring. Measuring cardiac enzymes will not alter the acute management of myocardial infarction and are poor indicators of myocardial contusion.

- *Neurogenic shock.* Damage to some parts of the brain stem or high thoracic/cervical spinal cord, produces hypotension due to interruption of the sympathetic chain, with subsequent loss of vessel tone. Sympathetic denervation also removes the cardiac response to hypotension, that is, tachycardia. The vagus is unopposed resulting in bradycardia which may worsen if the vagus nerve is stimulated, for example, by passing an endotracheal tube or nasogastric tube. The casualty with neurogenic shock demonstrates hypotension without tachycardia. The immediate treatment of symptomatic bradycardia in neurogenic shock is atropine 0.5 - 1 mg intravenously.
- *Anaphylactic shock.* You should suspect this uncommon mechanism of shock in any casualty who has recently received medication or who has been exposed to other allergens, especially when the history is not known. Signs of anaphylactic shock include peripheral vasodilatation, oedema, bronchospasm and urticaria. Attention to the airway is essential. The definitive treatment is adrenaline 1 mg as 1 ml of 1:1000 solution intramuscularly or, in life-threatening cases, 1 mg as 10 ml of 1:10000 solution intravenously *slowly*.
- *Septic shock.* Septic (toxic) shock may occur if evacuation is delayed for many hours. It is most likely to occur in casualties with penetrating abdominal injuries and in whom the peritoneal cavity has been contaminated by intestinal contents. The mechanism of shock is one of vasodilatation caused by bacterial toxins. If there has been no haemorrhage (or if haemorrhage has been adequately corrected) the casualty, although hypotensive, will have a tachycardia, warm pink skin and a wide pulse pressure (a full bounding pulse).

Summary

Hypovolaemia is the cause of shock in most battle casualties. A high index of suspicion is essential during assessment of the casualty. Management requires immediate control of haemorrhage either by direct compression, splintage, the application of a tourniquet or where necessary, by urgent surgery.

Skills Station 4 Peripheral Intravenous Cannulation

Aim

The aim of this skills station is to give you the opportunity to practise and demonstrate the technique of peripheral intravenous cannulation.

Equipment

Model arm or IV practice pads.
IV giving sets.
14 gauge cannulae.
Hartmann's Solution.
Haemaccel.
Micropore tape.
Adhesive tape 3 inch.
Alcohol sterets.
Blood sample bottles.
Venous tourniquet.
Surgical gloves.

Skills Procedures

- Run the intravenous solution through the giving set.
- Identify the vein to be cannulated (first choice is the antecubital fossa).
- Check there are no fractures proximal to the intended cannulation site.
- Apply a venous tourniquet proximal to the intended cannulation site.
- Prepare the skin with an alcohol steret.
- Insert the cannula into the vein; withdraw the trocher and feed the cannula further into the vein when blood is seen in the flash chamber.
- Draw 15 ml of blood for crossmatch, full blood count and haematocrit.
- Connect the giving set and commence flow at the required rate.
- Secure the cannula with Micropore tape.
- Cover the cannula site with adhesive tape.
- Secure the giving set tubing.
- If the casualty is going to be moved or evacuated ensure the taping of the cannula and giving set is robust enough to survive this; consider applying a POP backslab.

Skills Station 5 Peripheral Venous Cutdown / Femoral Access

Aim

The aim of this skills station is to give you the opportunity to practise and demonstrate the technique of peripheral venous cutdown.

Equipment

Animal model or IV practice pads.
IV giving sets.
14 gauge cannulae.
Hartmann's Solution.
Micropore tape.
Alcohol sterets.
Sutures (3-0).

Ties (3-0).
Scalpels (22 balde).
Small haemostat forceps.
Gauze swabs (4" x 4").
Venous tourniquet.
Surgical gloves.
Scissors.

Anatomical Considerations

- The primary site for cutdown is over the long saphenous vein above the ankle at a point approximately 2 cm anterior and 2 cm superior to the medial malleolus - but not if there is significant injury proximal to this site. (See Fig 5.1).
- The site of second choice is the median basilic vein, located 2.5 cm lateral to the medial epicondyle of the humerus in the antecubital fossa.

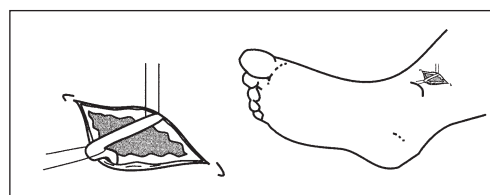


Fig 5.1 Cut down technique - long saphenous vein (right ankle).

Skills Procedures

- Run the intravenous solution through the giving set.
- Apply a venous tourniquet proximal to the intended cannulation site.
- Prepare the skin with an alcohol steret.
- Infiltrate the area with local anaesthetic.
- Make a full-thickness transverse incision through the skin.
- By blunt dissection, identify and display the vein.
- Free the vein from its bed and elevate a 2 cm length.
- Ligate the distal end, leaving the suture in place for traction.
- Pass a tie around the proximal end of the vein.
- Make a small transverse venotomy and gently dilate the opening with the tip of a closed haemostat.
- Introduced the plastic cannula (without trochar) through the venotomy and secure it in place by tying the proximal ligature.
- Attach the giving set and commence flow at the required rate.
- If possible, close the incision, otherwise apply a sterile dressing and secure the giving set tubing in place.

Complications

Haemorrhage or haematoma.
Perforation of the posterior wall of the vein.
Nerve transection.
Phlebitis.
Venous thrombosis.

Femoral access

The femoral vein lies medial to the femoral artery (see Fig 5.2). This anatomy can best be remembered by use of the mnemonic **NAVY** - **N**erve, **A**rtery, **V**ein, **Y**-front.

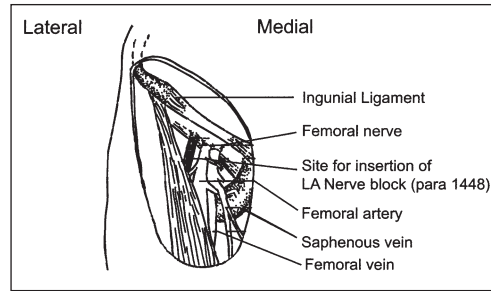


Fig 5.2 Anatomy of the femoral region.

Skills procedures

- Run the intravenous solution through the giving set.
- Place a 10 ml syringe onto a brown venflon.

- Prepare the skin with an alcohol steret and ensure that suitable fastening materials are available.
- Identify the femoral artery and place the middle and index finger of the left hand on the pulsation.
- Insert the cannula medial to the two finers advancing towards the head with the needle at 45° to the skin.
- Apply continuous moderate suction to the syringe by gently withdrawing the syringe plunger as you advance.
- When the vein is punctured blood will enter the syringe rapidly. Stop advancing the cannula, pause then gently advance the cannula into the vein while simultaneously withdrawing the needle.
- Suture or tape the cannula into place.
- Attach the giving set and commence flow at the required rate.
- Apply an appropriate dressing.

BATLS

Battlefield Advanced Trauma Life Support (BATLS)

CHAPTER 7 ABDOMINAL INJURIES

AIM

0701. On successfully completing this topic, you will be able to:

- Identify casualties who have sustained abdominal injuries.
- Recognise the differences in patterns of abdominal injury based on the history and mechanisms involved.
- Establish management priorities and institute appropriate treatment.

0702. Specifically, you will be able to:

- Describe the anatomical regions of the abdomen.
- Recognise abdominal injury.
- Recognise the difference in injury pattern between blunt and penetrating injury.
- Identify the signs indicative of intraperitoneal, retroperitoneal and pelvic injury.
- List the diagnostic procedures specific to a casualty with abdominal injury.
- Understand the use of diagnostic peritoneal lavage.

- Understand the role of Focused Abdominal Sonography for Trauma (FAST).

INTRODUCTION

0703. *You must correctly identify those casualties who have sustained abdominal injury and require surgery.* This requires a high index of suspicion. Unrecognised abdominal injury frequently results in death that could have been prevented, both in peace and war. In young athletic people, such as soldiers, there may be initially no apparent physical signs. As many as 50% casualties with significant intraperitoneal haemorrhage will have few or no signs when assessed at Role One. These casualties have non-compressible haemorrhage and require urgent surgical intervention.

The abdominal cavity is a silent reservoir for major blood loss.

0704. Casualties presenting with penetrating abdominal injury will pose little difficulty. Always assume that visceral injury has occurred. In casualties presenting with blunt injury, the history is often the most vital

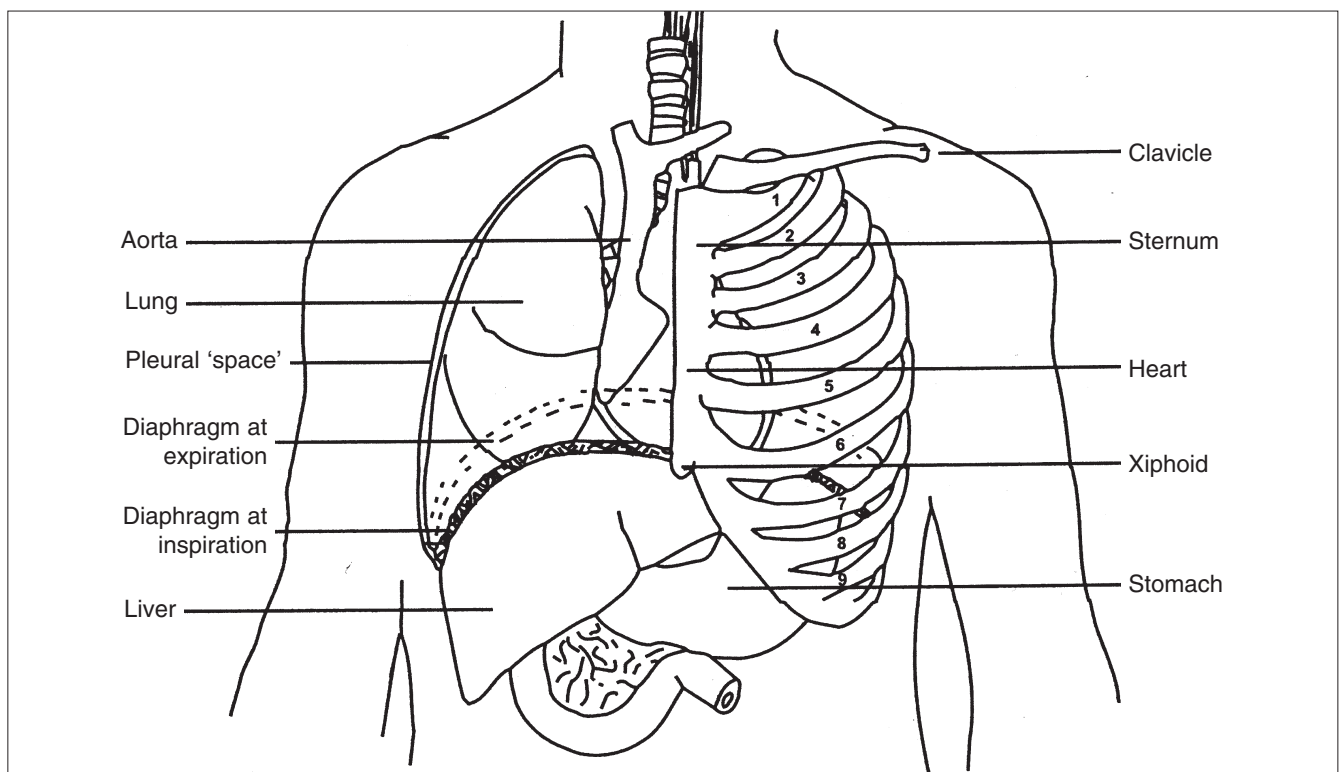


Fig 7-1 Change in position of diaphragm at inspiration/expiration.

indicator of abdominal trauma. *You must assume that the casualties who have sustained significant deceleration have suffered intra-abdominal trauma.*

Anatomy

0705. The abdomen has three distinct anatomical compartments - intraperitoneal, retroperitoneal and the pelvis. The intraperitoneal cavity can be further divided into intrathoracic and abdominal components. The intrathoracic abdomen is that portion protected by the lower rib cage and includes the diaphragm, liver, spleen, stomach and transverse colon. The diaphragm can rise to as high as the fourth intercostal space during full expiration (see Fig 7-1), putting these abdominal viscera at risk, particularly from thoracoabdominal penetrating injury. In blunt injuries resulting in lower rib fractures you should be suspicious of damage to the liver or spleen.

0706. The retroperitoneal component contains the aorta, inferior vena cava, kidneys, ureters, the ascending and descending colons, the duodenum and pancreas. Injury to these structures is frequently covert and you must have a high index of suspicion. You should note particularly that diagnostic peritoneal lavage may be misleading; it can fail to detect retroperitoneal haemorrhage.

Blunt versus Penetrating Injury

0707. The pattern following blunt injury is quite different from that of penetrating injury.

- *Blunt Injury*, particularly following road traffic accidents, falls, or due to a blast, results from rapid deceleration, deforming or crushing which can cause visceral disruption due to compression and shear forces. The structures most at risk are the liver, spleen, kidneys and retroperitoneal duodenum. Seat belt compression can result in injury to hollow viscera such as the small and large bowel; it can also result in spinal injury.
- *Penetrating injury* may have direct and indirect effects. Low energy-transfer missiles and stab wounds involve structures directly in their path and cause damage by direct laceration. High energy-transfer missiles usually cause considerably more damage, not only to organs in their path but also to adjacent viscera. This is particularly so if solid organs such as the liver, spleen and kidney are involved. Energy-transfer and cavitation is much greater in solid as opposed to hollow viscera (see paragraph 0114). The thoracolumbar spine is also at greater risk of injury from high energy-transfer, as opposed to low energy-transfer, missiles.

IMPORTANCE OF HISTORY

Blunt Injury

0708. Blunt injury may be overt or covert. Accurate initial assessment may depend on knowing the circumstances leading to the injury. Of particular importance are the time and mechanism of injury; the nature of impact particularly if a soft-skinned vehicle is involved; whether seat belts were worn; and the condition of other victims. Were any other occupants of the vehicle killed or thrown clear? If possible, get a description of the wrecked vehicle; for example, was the steering wheel buckled? This will point to possible chest or upper abdominal injury. In other words, *read the wreckage*. All these factors are important in assessing whether or not a high energy impact has occurred. Details of earlier life support measures are also important.

Penetrating Injuries

0709. While accepting as paramount the maxim, *treat the wound, not the weapon*, you should get as much valuable historical information as you can. This should include the time of injury; the weapon or other munitions involved; how many shots were fired; the casualty's location at the time of injury, for example, inside an armoured vehicle; and the position of the casualty when hit (crouching, prone and so on - these may give a pointer to the track of the missile). Any earlier life support measures carried out should also be determined.¹

PRIMARY SURVEY AND RESUSCITATION

0710. The primary survey and life-saving resuscitation, as with all casualties, take precedence. The secondary survey, the specific in-depth assessment of abdominal injuries, must not take place until completion of the primary survey and resuscitation phases.

Remember the A B C D E routine

0711. A confident clinical diagnosis of abdominal injury is difficult even under ideal conditions. It is even more difficult under austere field conditions. Further, medical attendants working at Role 1 will be junior and relatively inexperienced. In the primary survey, casualties with abdominal injuries will come to light during assessment of C in the A B C D E assessment. The problem facing the medical officer or Cbt Med Tech will be "*Where is the blood?*" In many cases there will be no hard physical signs on abdominal examination that will answer the question. The *possibility* of an abdominal injury should always be considered. Early evacuation on suspicion alone is totally appropriate. Delay until signs become

obvious will result in mortality rates over 90%: this must be avoided. Your task is to answer the question “*is the casualty bleeding within the abdomen?*”. Later, it is the surgeon’s task to answer “*what is bleeding?*”.

0712. Additional procedures in the resuscitation phase, depending on the role at which the casualty is treated, are:

- *Venous access.* Refer to the shock lecture for recommendations on the siting of venous access cannulae. Withdraw blood from one of the venous access cannulae and either send it with the casualty on evacuation or send it to the laboratory. Appropriate immediate tests include full blood count, haematocrit, group and crossmatch and amylase.
- *Fluid Resuscitation.* Refer to the algorithm on fluid resuscitation in the shock lecture (table 5-2). The overriding principle is to stop the bleeding by early evacuation to a surgical centre. Injudicious use of IV fluids in a casualty with non-compressible haemorrhage may result in exacerbation of existing bleeding or rebleeding. This is particularly true when managing a casualty in the pre-hospital setting.

SECONDARY SURVEY

0713. You have already made a rapid assessment of the abdomen during the primary survey, identifying and treating all life-threatening conditions. Now the cause of the threat to the casualty may become evident. Do the examination in a systematic fashion:

- *Inspection.* Whenever feasible, undress the casualty completely. Examine the front of the abdomen, the chest, pelvis and thighs. Turn the casualty fully, log-rolling if necessary, and examine the back. You are looking for open wounds, bruising and obviously swelling. Examine the perineum and do a rectal examination at the same time.
- *Palpation.* This can yield subjective as well as objective evidence of intra-abdominal injury. Early pain is visceral in origin and poorly localized. Later pain is somatic and leads to involuntary guarding with or without rigidity of the abdominal wall muscles. Rigidity provides unequivocal evidence of peritoneal irritation.
- *Percussion.* This can yield the earliest sign of peritoneal contamination by blood or faeces, by evincing pain when the abdomen is percussed.
- *Auscultation.* The presence or absence of bowel sounds may be difficult to determine because of extraneous noise. The presence of a bruit would suggest significant vascular injury, for example arteriovenous (AV) fistula.
- *Perineal and rectal examination.* This examination may draw attention to:

- Fractured pelvis.
- Ruptured urethra
- High riding prostate.
- Blood at the urinary meatus.
- Scrotal haematoma.
- *Vaginal examination.* Lacerations from blunt or penetrating wounds or bony spicules indicate serious injury.
- *Bladder Decompression.* Bladder catheterization, either through the urethra or suprapubic route is both diagnostic and therapeutic. The first aim is to provide a means of monitoring shock therapy by measuring urinary output. The presence of haematuria provides an important indicator of genitourinary injury. It is mandatory that a rectal examination must precede bladder decompression if urethral injury is a possibility.
- *Gastric tube.* Passing a gastric tube is both therapeutic and diagnostic. You must decompress the stomach by removing gastric contents, thereby reducing the risk of aspiration, this particularly applies during casualty evacuation when supervision may be less than ideal. The presence of blood in the aspirate suggests upper gastrointestinal injury; this finding may affect priority for evacuation or surgery.
- *Screening X-rays.* Assuming that facilities are available, the only X-rays indicated in the primary survey and resuscitation phases are cross table lateral cervical spine, together with PA of chest and pelvis. Further X-rays should be deferred until the definitive care phase. The taking of X-rays should not delay resuscitation.

Note: Rectal and vaginal examinations and urethral catheterisation should only be performed by an appropriately trained medical officer at a static, well equipped medical facility.

A positive abdominal examination points to further action although a negative examination does not preclude significant injury. Repeated assessments are typically required and medical officers in the forward areas may evacuate casualties on the basis of history alone or a high index of suspicion.

CRITICAL DECISION MAKING

Blunt Injuries

0714. In many cases, the decision to evacuate the casualty early will be self-evident, (a penetrating injury in a shocked casualty demands priority 1 evacuation). Other casualties with significant abdominal injury may not be so obvious. A finding of bruising of the abdominal wall, lower thoracic injury, obvious pelvic fracture or other positive physical findings may indicate the need for early evacuation.

0715. Within field surgical facilities, diagnostic peritoneal lavage (DPL) may yield valuable information particularly if the casualty has suffered severe multi-system injuries or is unconscious following blunt trauma and cannot give a history.

DPL is an operative procedure and should only be performed by the surgeon in charge of the casualty. Placement of a nasogastric tube and bladder catheter are mandatory before DPL.

0716. Diagnostic peritoneal lavage is contraindicated if there are obvious signs that indicate the need for laparotomy. Relative contraindicators include previous abdominal surgery, morbid obesity and advanced pregnancy. Cirrhosis or established pre-existing coagulopathy, possibly present if dealing with civilian casualties, are also relative contraindications.

0717. The indications for diagnostic peritoneal lavage are: history of severe blunt thoracoabdominal injury, altered pain response (that is, reduced level of consciousness), unexplained hypovolaemia, multiple injuries, or if a casualty is not available for reassessment of the abdomen - such as being under anaesthesia during prolonged orthopaedic or neurosurgical procedures.

0718. A positive diagnostic peritoneal lavage result is indicated by bloody aspirate, obvious faeces, bile or small bowel contents appearing in the catheter, or lavage fluid appearing through a chest drain or bladder catheter. A positive result is also indicated by laboratory findings that show greater than 100,000 rbc/mm³, greater than 500 wbc/mm³, amylase in excess of 175 IU in the aspirate, or the presence of vegetable fibres.

Penetrating Injuries

0719. Decision making in the forward areas is usually easy. On the battlefield there is no place for conservative management of penetrating wounds - all should be evacuated early with the highest priority.

- *Gunshot or fragment wounds.* Early laparotomy is mandatory even in an apparently stable casualty.
- *Stab wounds.* These are relatively uncommon on the battlefield. Whereas a conservative approach may be appropriate in peacetime, it is inappropriate in war. Early evacuation and exploration are mandatory.
- *Lower chest wounds.* The lower chest lies between the nipple line (fourth/fifth intercostal space) anteriorly, the tips of the scapulae posteriorly (seventh intercostal space), and the costal margin. Penetrating wounds to this region are likely to involve

abdominal viscera. The incidence of significant organ injury has been estimated as 15 to 25% after stab wounds and 45 to 50% after bullet or fragment wounds. On the battlefield, you should assume abdominal injury in all cases and evacuate to the nearest surgical facility.

- *Flank and back wounds.* Penetrating wounds in this region may involve the retroperitoneum and can be notoriously silent. A missed retroperitoneal wound to the colon or duodenum can be fatal. The incidence rates for visceral injuries are:
 - Back penetration: 5 to 15%
 - Flank penetration: 20 to 30%

GENITOURINARY TRACT INJURIES

0720. You should assume genitourinary injury in all casualties following blunt decelerating injury or penetrating wounds entering the peritoneal or pelvic cavities. *The absence of haematuria does not exclude injury to the genitourinary tract.* If the injury is obvious or the index of suspicion indicating genitourinary tract injury is high, early evacuation is necessary.

Blunt Injuries

0721. Back and loin contusions, haematomas or ecchymosis found during the secondary survey point to possible underlying renal injury; associated fractures of the lower ribs posteriorly increase the probability.

0722. Perineal haematomas and pelvic fractures indicate bladder or urethral injury until proved otherwise. Inability to void urine, or blood at the meatus is absolute evidence of injury. Anterior urethral injury is associated with straddle impact and is usually isolated to that part of the urethra.

Penetrating Injuries

0723. Penetrating injuries by bullets or fragments involving the back, loin or pelvis indicate a probability of urological injury. Do not rely on finding haematuria.

Aids to Diagnosis

0724. In the forward areas, a high index of suspicion is essential and casualties should be evacuated early. At role 3 it may be possible to perform a limited range of investigations if time and the casualty's condition permit.

- *Intravenous pyelography (IVP).* High dose intravenous bolus injection of a suitable contrast medium may give valuable information on renal anatomy and function. For example, unilateral non-function of a kidney implies serious disruption of the kidney or its blood supply. Delayed films may give additional information.
- *Abdominal ultrasound scanning.* This may reveal, for example, disruption of renal

substance, perinephric haematoma, retro-peritoneal haematoma and free intra-peritoneal fluid indicating the presence of urine or blood, or both.

- *Focused abdominal sonography for trauma (FAST)*. FAST is an emerging technology which may be performed as an adjunct to the primary survey in contradistinction to normal abdominal ultrasound scanning, which is a secondary survey activity taking place in the radiology department of a field hospital facility. It involves the use of a hand held scanning device and may be utilised at all roles of medical care, provided appropriately trained and skilled personnel are available. In trained hands, FAST may be used to detect blood in the pericardial sac, free blood or fluid in the peritoneal cavity, assess the integrity of solid organs such as liver, spleen or kidney and may also detect the presence of a disrupted bladder.

Note: The gold standard for detecting free blood in the peritoneal cavity remains diagnostic peritoneal lavage (DPL). The utility of FAST as an aid to diagnosis in the field has recently been trialled in Kosovo².

- *Urethrography*. This can be performed by securing a small (12 French gauge) urethral catheter in the meatal fossa and gently instilling contrast medium. Subsequent X-rays will reveal any urethral tear.
- *Computed tomography (CT)*. This investigation, when available, will play a significant role in planning definitive surgery following complex genito-urinary injury. Mobile CT scanners are planned for Role 3 facilities.

PELVIC INJURIES

0725. Pelvic fractures in war are commonly associated with high energy blunt trauma causing widespread disruption. Three mechanisms are recognised:

- *Anteroposterior compression*. This typically results from a pedestrian/vehicle impact, motorcycle accident or crush injury following a fall from a height of greater than 3.5 m. Disruption of the pelvis occurs at multiple sites, causing widening of the pelvic ring and may be associated with catastrophic haemorrhage.
- *Lateral compression*. This mechanism of injury is associated with motor vehicle side-impact crashes and motor cycle accidents. Injury is usually to one hemipelvis on the impact side, which is disrupted and internally rotated. Major bleeding is uncommon.
- *Vertical shear*. This mechanism is associated with falls from a height, including parachute accidents and results in shearing of the hemipelvis in the vertical plane. Widespread bony and soft tissue disruption is a feature resulting in major haemorrhage.

0726. Casualties with abdominal injuries associated with pelvic fractures have a high mortality rate and merit special attention. Major haemorrhage is usual in battlefield pelvic injuries. Such haemorrhage is difficult to control and is time consuming and resource intensive to manage. Mixed arterial and venous haemorrhage from large bones and bulky muscle is the underlying problem. Additionally, numerous large, thin-walled veins and major arteries lie within the pelvic cavity and are readily disrupted. Mortality rates associated with open pelvic fractures exceed 50% in peacetime and are significantly higher on the battlefield.

0727. Major pelvic injury is life-threatening and should be detected in the primary survey; its presence will be confirmed during the secondary survey. Key signs include open wounds in the pelvic region, bruising (particularly in the perineum), and pain or grating on gentle pelvic compression. (Do this only once! Done repeatedly it will increase blood loss). *Casualties with a major pelvic fracture are often in excruciating pain*. X-ray examination of the pelvis is one of the three radiological investigations allowed in the resuscitation phase of the BATLS programme.

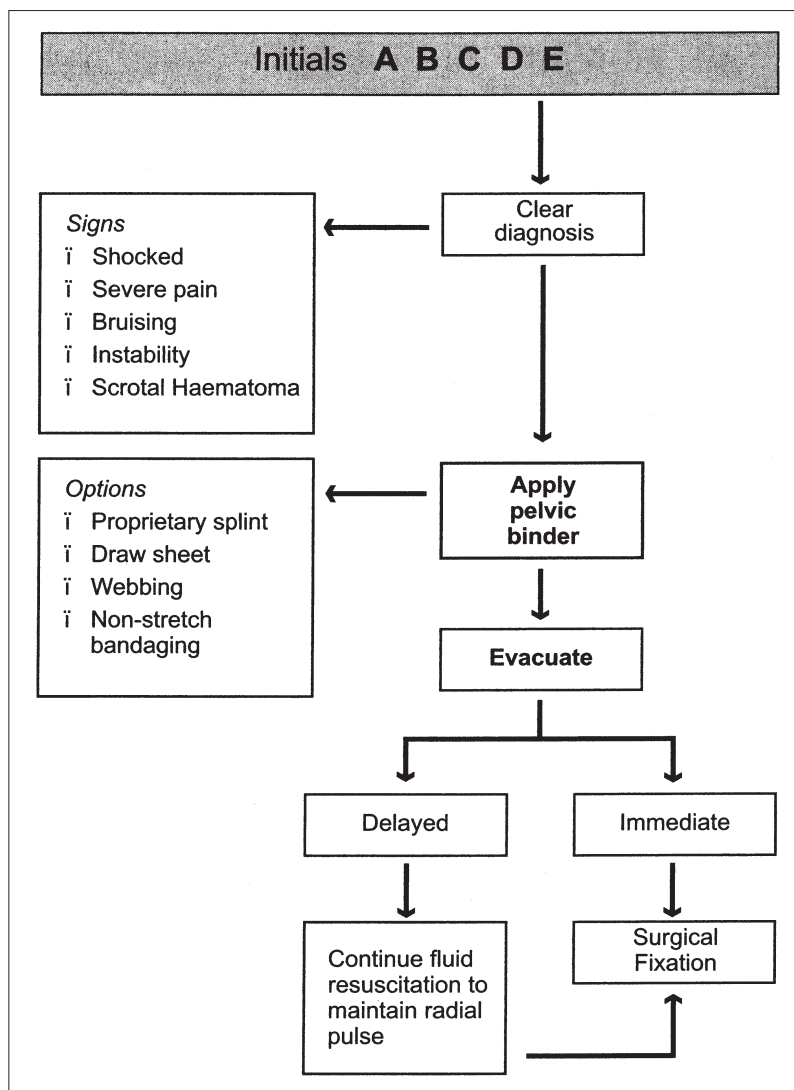
Initial Management

0728. This to some extent will be dictated by where the casualty is being managed. Adequate volume replacement is essential at all roles of care, bearing in mind haemorrhage is non-compressible or only partially compressible until pelvic fixation is applied. Class IV haemorrhage will be typical and fluid volumes given intravenously must be realistic. Careful monitoring of vital signs and urinary output after each bolus will aid calculation of further requirements. Following immediate resuscitation, a careful and full secondary evaluation must be performed to determine the presence of other injuries and other sources of blood loss. Pelvic binders should be used to support and compress the pelvic ring before the casualty is evacuated early to a surgical centre (see table 7-2)

Management at Role Three

0729. Early compression of mobile bony elements is the key to haemorrhage control. *External fixation is the method of choice and can be applied rapidly, if necessary by non-orthopaedic surgeons*. In hospital, immobilization should continue to be used if external fixation is not available. Civilian techniques such as arterial or venous emobilization are unavailable on the battlefield.

0730. Continuing shock, despite vigorous fluid therapy² and external fixation, should suggest an additional source of haemorrhage, usually intraperitoneal and diagnostic

Table 7-2 Management of unstable pelvic fractures in war².

peritoneal lavage by a surgeon should be considered. But there are hazards. Lavage should be performed well above the umbilicus to avoid disruption of a retroperitoneal haematoma. Such disruption may lead to catastrophic and uncontrollable haemorrhage. Whereas negative lavage

suggests contained retroperitoneal haemorrhage, a positive lavage needs to be evaluated with caution. In the absence of intraperitoneal haemorrhage, a laparotomy is best avoided as it may lead to uncontrollable haemorrhage by releasing abdominal wall tamponade.

SUMMARY

- Recognise the possibility of abdominal injury.
- Two major types of abdominal injury may be present in war, blunt and penetrating. In either case, early surgery is essential.
- With blunt injuries, a high index of suspicion is required. Diagnosis in the early stages may be very difficult. Serial examination is required; even then, evacuate early. Aids to diagnosis include: DPL, FAST, CT
- Casualties with penetrating injuries must be given the highest priority for evacuation and surgical evaluation. Penetrating injury to the loin, back, buttocks, lower chest and thighs, should raise suspicion of intra-abdominal injury.
- Management of abdominal injury follows normal BATLS protocol and includes:
- Primary survey: **Remember the A B C D E routine.**
- Resuscitation: This involves:
 - Continued oxygenation
 - Appropriate therapy for hypovolaemic shock (refer to Chapter 5)
 - Continued monitoring of response by assessment of vital signs, aided by additional parameters such as pulse oxymetry and blood gas analysis, when available.
 - Placement of nasogastric tube and bladder catheter.

Secondary survey: Following stabilization, but not before, you may proceed to full assessment of the mechanism and location of injury. This demands a full secondary survey and continued monitoring of the casualty.

1. Remember the mnemonic MIST. M = Mechanism of injury; I = Injuries found; S = Symptoms and signs; T = Treatment given.

2. High mortality (50%) and management difficult.

3. The dilemma of IV fluid resuscitation causing re-bleeding and dilution of clotting factors, is a difficult one. Adequate fluid resuscitation should complement attempts at temporary pelvic compression, with vigorous resuscitation complementing surgical stabilization of the pelvis and surgical control of other sources of blood loss (see table 7.2)

BATLS

Battlefield Advanced Trauma Life Support

CHAPTER 8 HEAD INJURIES

Aim

0801. On successfully completing this topic you will be able to:

- Discuss general management of the unconscious casualty with a head injury.
- Understand the anatomy and pathophysiology of head injury.
- Understand that an altered level of consciousness is the hallmark of brain injury.
- Demonstrate the initial assessment and management of a casualty with a head injury.
- Assess the criteria for neurosurgical referral in war.

Introduction

0802. Head injury is common: it carries a high mortality both in peacetime and on the battlefield. The aim of initial management of a casualty with a head injury is:

1. To prevent secondary brain injury due to cerebral hypoxia
2. To identify injuries needing urgent surgery.

0803. This is done by appropriate management of: Airway, Breathing, Circulation, and D - repeated assessment for neurological DEFICIT.

Anatomy and Pathophysiology

0804. The skull is a rigid box containing brain, cerebrospinal fluid (CSF) and blood vessels:

- The brain is surrounded by a series of membranes. The outer, thick membrane is called the *dura*. Beneath the *dura* is a more flimsy membrane called the *arachnoid*. The CSF flows in the space deep to the *arachnoid*. Bleeds are described as occurring outside or inside these membranes hence *extradural*, *subdural* and *subarachnoid*.
- Blood is supplied to the brain by the *internal carotid* and *vertebral arteries* and eventually drains via the *internal jugular veins*.
- The brain is very active and needs a lot of oxygen and substrate to survive. *Loss of oxygenated blood flow for more than three minutes will cause brain damage.*
- Intracranial pressure (ICP) is the pressure

inside the skull. Because the skull is a rigid box, an increase in the size of the brain, the volume of blood or amount of cerebrospinal fluid within it, will cause an increase in ICP. *Cerebral perfusion* refers to the supply of oxygenated blood to the brain.

- Cerebral perfusion pressure (CPP) depends on the blood pressure pushing blood into the brain and the resistance to this blood flow from the ICP. If the ICP rises then a higher blood pressure is needed to supply blood to the brain. In other words -

$$\text{CPP} = \text{MAP} - \text{ICP}$$

Note: MAP (Mean Arterial Pressure)¹. Normal value 70 to 90 mmHg.

Normal ICP 10 mmHg

If CPP is less than 50 mmHg, cerebral hypoxia will follow.

- Lack of oxygen (*hypoxia*) makes the brain swell. Raised carbon dioxide levels in the blood causes cerebral blood vessels to dilate which increases the volume of blood in the head and further raises ICP. This is why management of Airway and Breathing is essential.
- Raised ICP may also be due to obstruction of *venous drainage* from the head.

This may be due to:

- Pressure on the neck veins.
- Increased pressure inside the chest.

0805. Rising ICP, brain swelling or expanding haematomas inside the head can cause a variety of neurological signs:

- Pressure of the third cranial nerve (oculomotor) will result in a dilated pupil on the same side as the injury.
- Damage to the motor or sensory cortex (or tracts leading from them) will result in a motor or sensory DEFICIT on the contralateral side to the injury.
- A decrease in level of consciousness is *the* marker of brain injury. Generally, the more deeply unconscious a casualty becomes, the more serious is the injury. *Coma* is a term used for unconsciousness although to be accurate it should only be used for deeply unconscious casualties (see paragraph 0829).
- Pressure on the lower part of the brain (brain stem) where the respiratory and

1. This is not the same as the systolic pressure.

cardiovascular centres lie, produces respiratory or cardiovascular abnormalities (change in heart rate and blood pressure, change in breathing pattern and rate).

0806. It follows that preventing a rise in intracranial pressure or a fall in cerebral perfusion is vital in the overall management of head injury. ***This must never be forgotten.***

Brain Injury

0807. *Primary brain injury* is the neurological damage produced by the traumatic event, for example, a blow to the head or damage from a gunshot wound. *Secondary brain injury* is the neurological damage produced by what follows on from the traumatic event. Causes include: hypoxia, reduced cerebral perfusion, raised ICP, convulsions and infection.

Primary Brain Injury

0808. Primary brain injury may be *diffuse* or *focal*.

Diffuse Brain Injury

0809. Blunt injury to the brain may cause diffuse brain injury, particularly when rapid head motion (acceleration or deceleration) leads to widespread damage within the brain substance. Such injuries form a spectrum extending from mild confusion to severe injury.

Concussion

0810. Concussion is a brain injury accompanied by a brief loss of consciousness and, in its mildest form, may cause only temporary confusion or amnesia. With mild forms of concussion, most casualties will be slightly confused and may be able to describe how the injury occurred. They are likely to complain of mild headache, dizziness or nausea. The mini-neurological examination will not show localising signs. With more severe concussion there is a longer period of unconsciousness, longer amnesia (for time both before and after the injury) and there may be focal signs. The duration of amnesia needs to be recorded.

Diffuse axonal injuries

0811. At the other end of the spectrum from mild concussion, diffuse axonal injury is so severe as to cause a characteristically long coma, present in 44% of cases. The overall mortality rate is over 30%, rising to 50% in its most severe form. The treatment of such injury involves prolonged controlled ventilation in an intensive care unit, a facility that may not be available. Because the mortality is so high, these casualties have a low priority for evacuation.

Focal Brain Injuries

0812. Brain injuries that produce a contusion or haematoma in a relatively small area of the

brain are amenable to emergency surgery. These conditions must be diagnosed early as rapid evacuation to a surgical or neurosurgical unit for early surgery, greatly reduces the morbidity and mortality.

Contusions

0813. These are caused by blunt injury producing acceleration and deceleration forces on the brain tissue resulting in tearing of the small blood vessels inside the brain. Contusions can occur immediately beneath the area of impact when they are known as *coup* injuries, or at a point distant from the area of impact in the direction of the applied force when they are known as *contrecoup* injuries. If the contusion occurs near the sensory or motor areas of the brain, these casualties will present with a neurological deficit. Precise diagnosis requires appropriate imaging (CT scanning), consequently, the treatment is supportive, aimed at the avoidance of secondary brain injury.

Intracranial haemorrhage

0814. Haemorrhage may arise either from meningeal vessels or from vessels within the brain substance.

Extradural haemorrhage

0815. This is caused by a tear in a *dural artery*, most commonly the middle meningeal artery. This can be torn by a linear fracture crossing the temporal or parietal bone and injuring the artery lying in a groove on the deep aspect of the bone (see Fig 8.1). Isolated extradural haemorrhage is unusual, accounting for only 0.5% of all head injuries and less than 1% of injuries causing coma. The importance of early recognition of this injury lies in the fact that, when treated appropriately, the prognosis is good because of the lack of underlying serious injury to brain tissue. If missed, the rapidly expanding haematoma causes ICP to rise, reducing cerebral perfusion and leading to cerebral hypoxia, coma and death.

0816. The typical symptoms and signs of extradural haemorrhage are:

- Loss of consciousness followed by a lucid interval (which may not be a complete return to consciousness).
- Secondary depression of consciousness.
- Dilated pupil on the side of injury.
- Weakness of the arm and leg on the contralateral side to the injury.

Subdural haematoma

0817. This is more common than extradural haemorrhage and is found in 30% of all severe head injuries. The mortality rate is up to 60% because, in addition to the compression caused by the subdural clot, there is often major injury to the underlying brain tissue. The haematoma can arise from

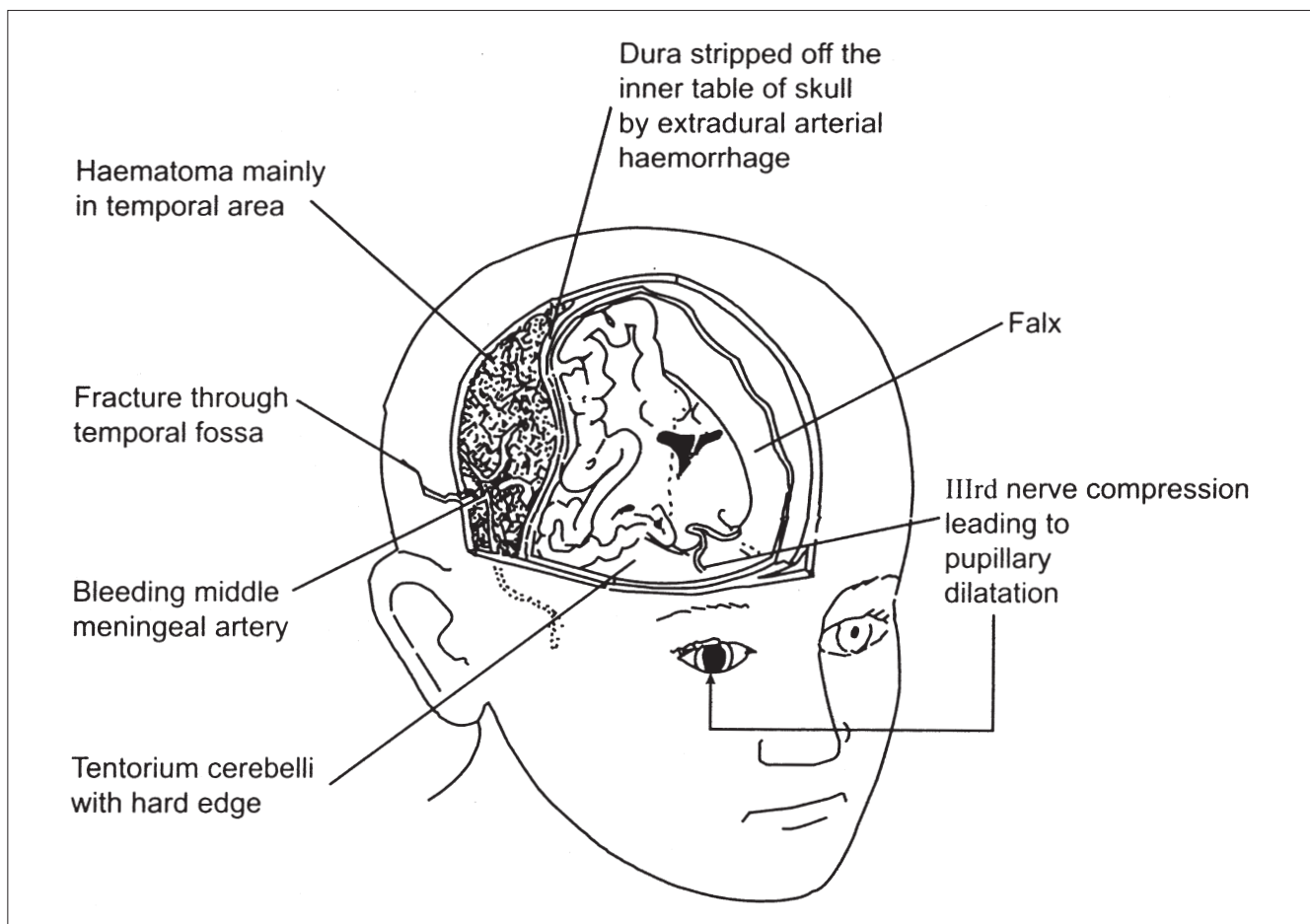


Fig 8.1 Acute extradural haematoma

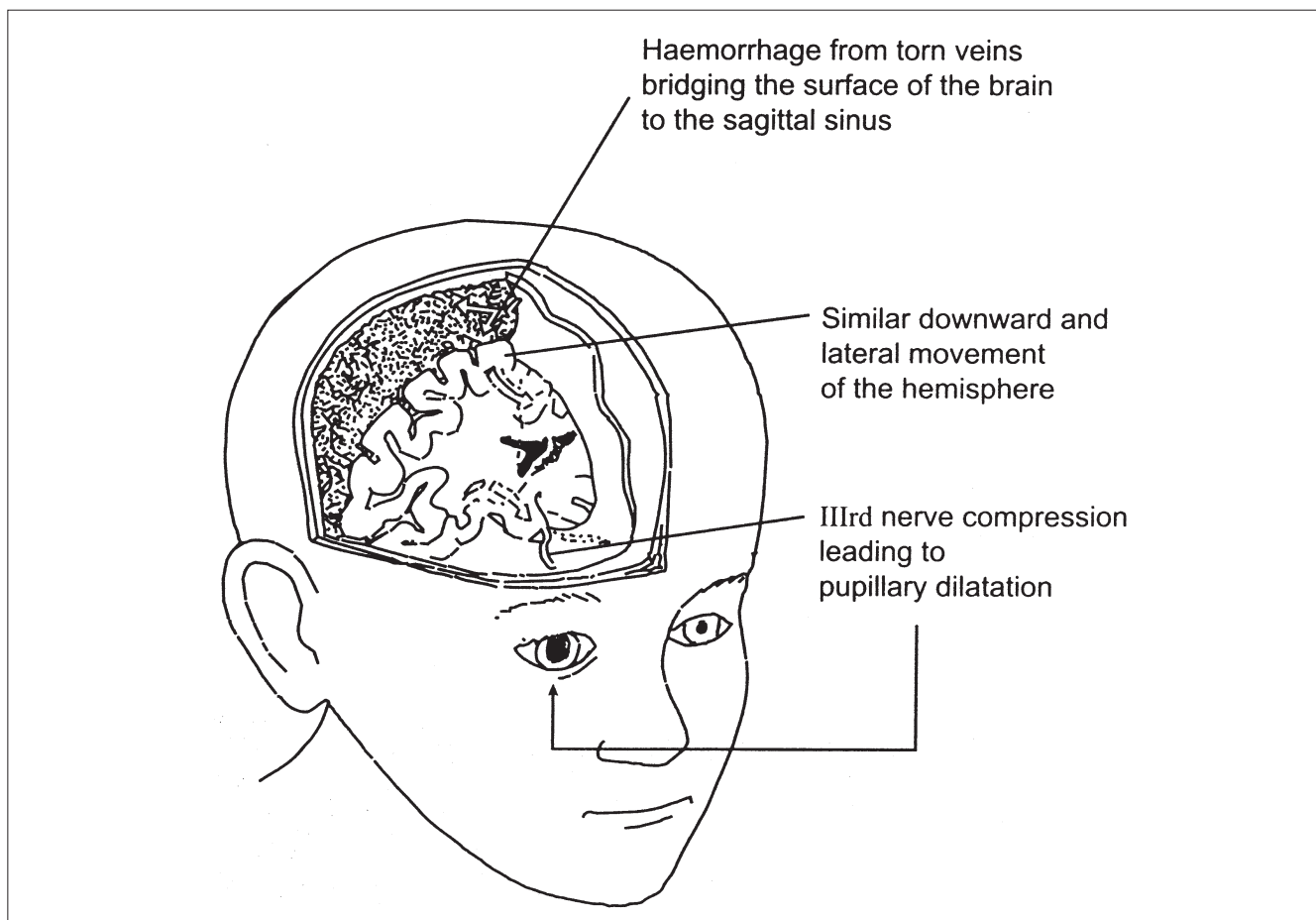


Fig 8.2 Subdural haematoma

tears in the bridging veins between the cortex and the dura or from laceration of the brain substance and the cortical arteries (see Fig 8.2). Levels of consciousness will vary depending on the underlying brain damage and rate of haematoma formation. The pupil on the affected side will become dilated together with contralateral limb weakness.

Subarachnoid haemorrhage

0818. Where haemorrhage has occurred into the subarachnoid space, the irritant effect of the bloody cerebrospinal fluid causes headache, photophobia and neck stiffness. On its own this is not serious, but prognosis is poor if associated with a more severe head injury.

Intracerebral laceration

0819. These can be caused by:

- *Impalement injury.* All foreign bodies found protruding from the skull must be left in place; these will be removed at the neurosurgical unit. Skull X-rays will show the angle and depth of penetration. Care must be taken during evacuation to ensure there is no further penetration.
- *Gunshot wounds and fragment wounds.* Prognosis is determined by the size of missile and energy transfer, the number of penetrating fragments and the length of the wound track. Casualties with these injuries who are in coma have a very high mortality rate. (See Table 8.1).

Table 8.1 Mortality rates - penetrating head injuries

Level of Consciousness	Percentage Mortality	Approximates to:
Alert	11.5	A
Drowsy	33.3	V
Reaction to pain	79.1	P
Coma	100	U

Note: Through-and-through injuries, side-to-side injuries and injuries in the lower region of the brain stem, all have a poor outcome. All these factors must be considered when deciding the priority for evacuation. Open brain injury in a conscious casualty carries a good prognosis if surgery is not delayed. Scalp haemorrhage should be stopped, entrance and exit wounds covered with sterile dressings and the casualty evacuated to a neurosurgical unit.

Assessment of Head Injury

History

0820. Knowing the mechanism of injury provides important information for both prognosis and early selection for evacuation to a neurosurgical unit. For example, a fall from a height, as opposed to involvement in a road traffic accident, quadruples the likelihood of an intracranial haematoma. With gunshot and fragment injuries to the head, the initial level of consciousness is related to mortality.

Primary Survey

0821. This follows the BATLS A B C D E protocols. For head injury understand:

A. Airway.

A casualty with a reduced level of consciousness is likely to have a compromised airway.

B. Breathing.

Good ventilation ensures the brain receives blood containing enough oxygen and not excess carbon dioxide.

Raised intrathoracic pressure (as happens in tension pneumothorax) will interfere with venous drainage from the head and raise ICP.

C. Circulation.

Never presume the brain injury is the cause of hypotension. Scalp lacerations may bleed profusely but hypotension secondary to an isolated brain injury is uncommon and usually fatal.

Always presume that hypotension is due to hypovolaemia not brain injury and look for a source of blood loss elsewhere.

Cushing's response (progressive hypertension, bradycardia and slowing of respiratory rate) is an acute and potentially lethal response to rapidly rising intracranial pressure. This usually indicates a need for immediate surgery or precedes death.

D. Disability.

A rapid assessment of conscious level is made in the primary survey using AVPU, that is, is the casualty **A**lert or responding to **V**oice or only responding to **P**ain or **U**nresponsive?

SECONDARY SURVEY

Mini-neurological examination

0822. In the secondary survey, the mini-neurological examination is carried out to:

- Identify neurological injuries.
- Establish anatomical diagnosis.
- Identify casualties needing early evacuation for surgery.

0823. The mini-neurological examination assesses:

- Pupillary Function.
- Lateralised limb weakness.
- Level of consciousness by the Glasgow Coma Scale.

0824. The mini-neurological examination serves to determine the severity of the brain injury. When applied repeatedly at various points in the evacuation chain, it can be used to determine objectively any neurological deterioration. Remember:

Alteration of the level of consciousness is the hallmark of brain injury.

Mini-neurological examination - pupils

0825. Evaluate the pupils for their equality and response to bright light. A difference in diameter of the pupils of more than 1 mm is abnormal, but remember that a local injury to the eye may be responsible for this abnormality. Normal reaction to a bright light is brisk constriction of the pupil; a more sluggish response may indicate brain injury. A dilated pupil on the same side as the injury indicates compression of the brain on that side.

Mini-neurological examination - extremity movement

0826. Observe the spontaneous limb movements for equality; if movement is negligible then you must assess the response to a painful stimulus¹. Any delay in onset of movement, or late realization of movement following a painful stimulus, is significant. Obvious limb weakness localized to one side suggests an intracranial injury causing brain compression on the opposite side.

Mini-neurological examination - Glasgow Coma Scale

0827. This provides a quantitative assessment of the level of consciousness. It is the sum of scores awarded for three types of response:

- Eye opening (E). The scoring of eye opening is not possible if the eyes are so swollen as to be permanently shut. This fact must be documented.

Spontaneous, that is, open with normal blinking.	4 points
Eye opening to speech on request.	3 points
Eye opening only to pain stimulus.	2 points
No eye opening despite stimulation.	1 point

- *Verbal response (V)*. The scoring of verbal response is not possible if the casualty cannot speak because of endotracheal intubation. This fact must be documented.

Orientated, spontaneous speech; knows name, age and so on.	5 points
Confused conversation but answers questions.	4 points
Inappropriate words, that is, garbled speech but with recognizable words.	3 points
Incomprehensible sounds or grunts.	2 points
No verbal response.	1 point

- *Motor response (M)*. The best response obtained for either of the upper extremities is recorded even though worse responses may be present in other extremities.

Obeys commands and moves limbs to command.	6 points
Localizes, for example, moves upper arm to pain stimulus on head.	5 points
Withdraws from painful stimulus on limb.	4 points
Abnormal flexion or decorticate posture.	3 points
Extensor response, decerebrate posture.	2 points
No movement to any stimulus.	1 point

The Glasgow Coma Scale is scored differently in children - See Supplement No 1.

0828. The Mini-neurological examination can thus be used to determine the severity of brain injury at a particular time. Subsequent reassessment can be used to detect any deterioration. For example, if the Glasgow Coma Scale has decreased by two points or more, deterioration has occurred. A decrease of three points or more is a bad prognostic indicator and demands immediate treatment. Dramatic changes in the Glasgow Coma Scale are often preceded by more subtle signs indicating deterioration, notably:

- A very severe headache or increase in the severity of headache.
- An increase in the size of one pupil or the development of unilateral limb weakness.

Changes in the casualty's neurological condition can be detected only if the mini-neurological examination is repeated and re-documented at various points along the evacuation chain.

All previous efforts will be wasted if the deterioration is not detected, recorded and acted upon.

Definition of Coma

0829. Coma can be defined as that state in which:

- There is no eye opening despite stimulus.
- The casualty does not follow commands.
- There is no verbalization.

0830. Consequently the objective Glasgow Coma Scale score that equates to coma is 8 or less. The scale gives some indication of the severity of brain injury as follows:

Score 8 or less	Severe
Score 9 to 12	Moderate
Score 13 to 15	Minor

0831. When dealing with a closed head injury you must never assume that coma is due to alcohol or sedative drugs, even if the casualty has had access to them. You must still consider the mechanism of injury in

1. Supraorbital nerve compression

addition to the possible pharmaceutical effects of alcohol and drugs.

**In BATLS,
The unconscious casualty who has
been drinking has a head injury
until proved otherwise.**

Secondary Survey - Specific Injuries

Scalp Wounds

0832. The scalp is arranged in layers. It is highly vascular and a laceration will often result in profuse haemorrhage. The bleeding point should be located and the haemorrhage arrested. This may include the use of haemostatic surgical clips and ligatures, particularly where the laceration is deep. Direct pressure may not be sufficient. The wound should be inspected carefully for signs of skull fracture and irrigated to remove debris and dirt.

0833. Gentle palpation of the scalp wound wearing a sterile glove may enable you to diagnose the presence of a skull fracture. If an open or depressed fracture is detected, close the wound with sutures, apply a dressing, give antibiotics and evacuate the casualty to a neurosurgical unit. Do not remove any bone fragments at this stage.

Skull Fractures

0834. Although skull fractures are common, many major brain injuries will occur without the skull being fractured and many skull fractures are not associated with severe brain injury. Where the mini-neurological examination identifies the presence of a severe brain injury, time taken to search for a skull fracture should never delay definitive management. The significance of a skull fracture is that *it identifies a casualty with a higher probability of having or developing an intracranial haematoma*. All casualties with skull fractures should be detained for observation.

- **Linear skull fractures.** These are particularly important when the fracture crosses the line of intracranial vessels indicating an increased risk of intracranial haemorrhage.
- **Depressed skull fractures.** All depressed skull fractures should be evacuated for neurosurgical unit assessment; they may be associated with underlying brain injury and require operative elevation to reduce the risk of infection.
- **Open skull fractures.** By definition, there is direct communication between the outside of the head and brain tissue because the dura covering the surface of the brain is torn. This can be diagnosed if brain tissue is visible on examination of the scalp wound or if cerebrospinal fluid is seen to

be leaking from the wound. These fractures all require operative intervention as the risk of infection is high. Give prophylactic antibiotics in accordance with Casualty Treatment Regimes.

- **Basal skull fractures.** The base of the skull does not run horizontally backwards but diagonally (See Fig 8.3); basal skull fractures will produce signs along this diagonal line. They can be diagnosed clinically in the presence of cerebrospinal fluid leaking from the ear (otorrhoea) or the nose (rhinorrhoea). When cerebrospinal fluid is mixed with blood it may be difficult to detect; the ring sign can be used to detect its presence. Allow a drop of the fluid to fall on a piece of absorbant material, such as filter paper; if cerebrospinal fluid is present the blood remains in the centre with one or more concentric rings of clearer fluid developing around it. Bruising in the mastoid region (*Battle's sign*) also indicates basal skull fracture, but the bruising usually takes 12 to 36 hours to develop. Blood seen behind the tympanic membrane (haemotympanum) may also indicate a basal skull fracture. Fractures through the cribriform plate are frequently associated with bilateral periorbital haematomas. Subconjunctival haematoma may occur from direct orbital roof fracture, in which case there is no posterior limit to the haematoma. All these signs may take several hours to develop and may not be present in a casualty seen immediately after injury. Basal fractures are very difficult to diagnose from plain X-ray films. If X-ray facilities are available you should look for the presence of intracranial air or bleeding into anatomically related air sinuses.

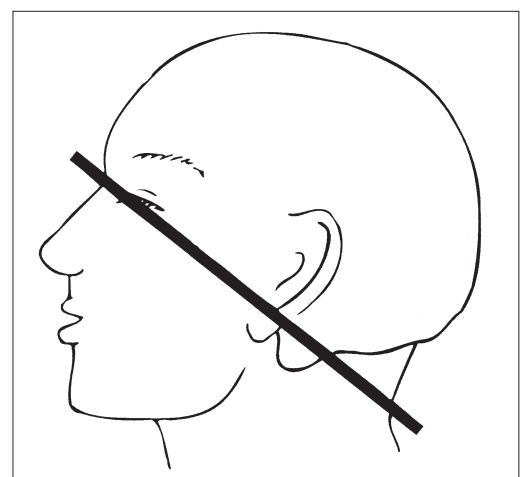


Fig 8.3 Diagonal line showing the level of the base of the skull.

Triage of Head Injuries

Which casualties should be evacuated?

0835. In peacetime practice, head injury management guidelines are usually agreed between local A&E and neurosurgical centres. In ideal circumstances:

- a. **Severe head injuries** need neurosurgical referral:
 - Coma score (GCS) less than 8.
 - Compound or depressed skull fracture.
 - Skull fracture with neurological signs.
 - Fractured base of skull.
- b. **Moderate head injuries** should be admitted to hospital for further investigation and observation including CT scanning:
 - Simple skull fracture.
 - Neurological signs (including confusion).
 - Casualty is difficult to assess because of drugs or alcohol.
- c. **Minor head injuries** following the loss of consciousness need 24 hours observation, done by designated personnel. These casualties are:
 - Fully orientated.
 - No skull fracture.
 - No neurological signs.
- d. Should the casualty develop any of the following, then they need to be assessed by a medical officer with a view to hospital admission:
 - Vomiting.
 - Drowsiness.
 - Fits.
 - Double/blurred vision.

0836. *In less than ideal circumstances* on the battlefield, the task is to identify those casualties who will benefit from evacuation to a neurosurgical unit and those whose outlook is so poor that they should not be put into the evacuation chain ahead of priority. This decision must be made on the basis of clinical findings. In short, casualties who require emergency surgery are those with depressed or open skull fractures and those with focal lesions causing symptoms of raised intracranial pressure. The head injury triage scheme at Table 8-2 is not foolproof but will act as a guide.

Summary

Remember the A B C D E routine.

- Prevent secondary injury by:
- Preventing hypoxia, hypercarbia and hypovolaemia.
- Giving oxygen if available and ensure a clear airway at all times.
- Treating fits with diazepam in appropriate doses.
- Establishing a working diagnosis.
- Searching for associated injuries.
- Constantly repeating the mini-neurological examination.
- Identifying and evacuating appropriate casualties to a neurosurgical unit.

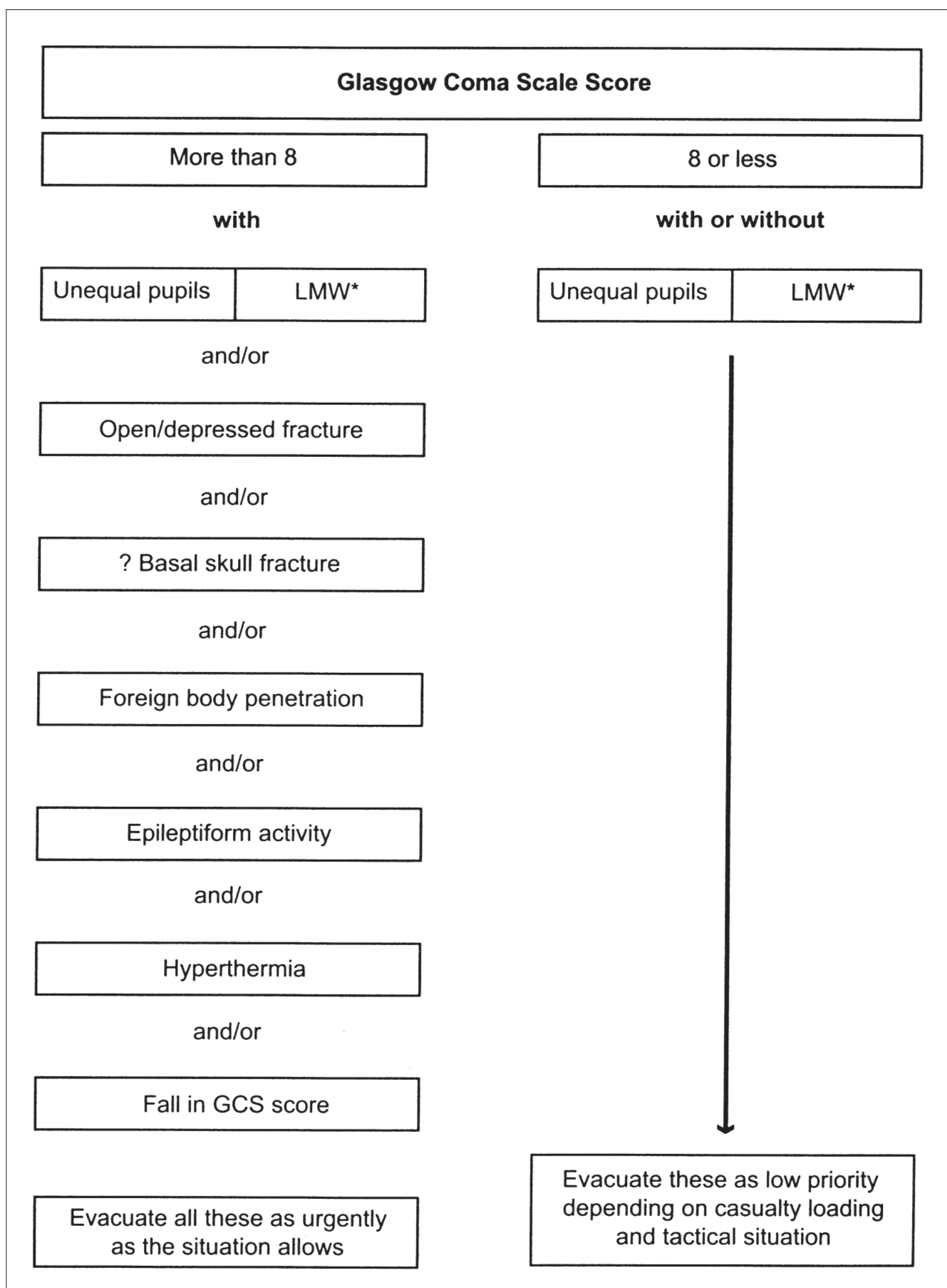


Table 8-2 head injury triage scheme

* Lateralised motor weakness

BATLS

Battlefield advanced trauma life support

Chapter 9 Maxillofacial Injuries

AIM

0901. On successfully completing this topic you will be able to demonstrate the techniques of assessing and managing battlefield maxillofacial injuries. Specifically you will be able to:

- Discuss the general management of unconscious, facially injured casualties.
- Discuss the anatomy and physiology of specific facial injuries.
- Identify the criteria for stabilisation and evacuation.
- Demonstrate your ability to assess specific injuries using a head injury manikin.

INCIDENCE

0902. On the battlefield, between 10 to 15% of casualties who reach role one care have maxillofacial injuries. Approximately 50% of jaw injuries on the battlefield are of the blunt, civilian type. With penetrating injuries, more are caused by fragments than by gunshot.

ANATOMY

0903. The face is of crucial importance because it encompasses the airway and is in close proximity to the brain and the spinal cord. The face is usually divided into three parts - the mandible, the middle-third and the upper-third (see Fig 9.1). The upper-third forms part of the cranium; injuries in this region are covered in Chapter 8.

The Mandible

0904. This is a single bone to which numerous muscles are attached, notably the muscles of the tongue. Certain types of mandibular injury will prejudice the airway by allowing the tongue to fall backwards, or by causing gross swelling of the tissues around the upper airway.

Middle-third

0905. The middle-third of the face is composed of many relatively thin plates of bone, particularly those related to the orbits, nasal cavity and paranasal sinuses. Fractures of this area may involve the base of the skull. Obstruction of the airway may occur and

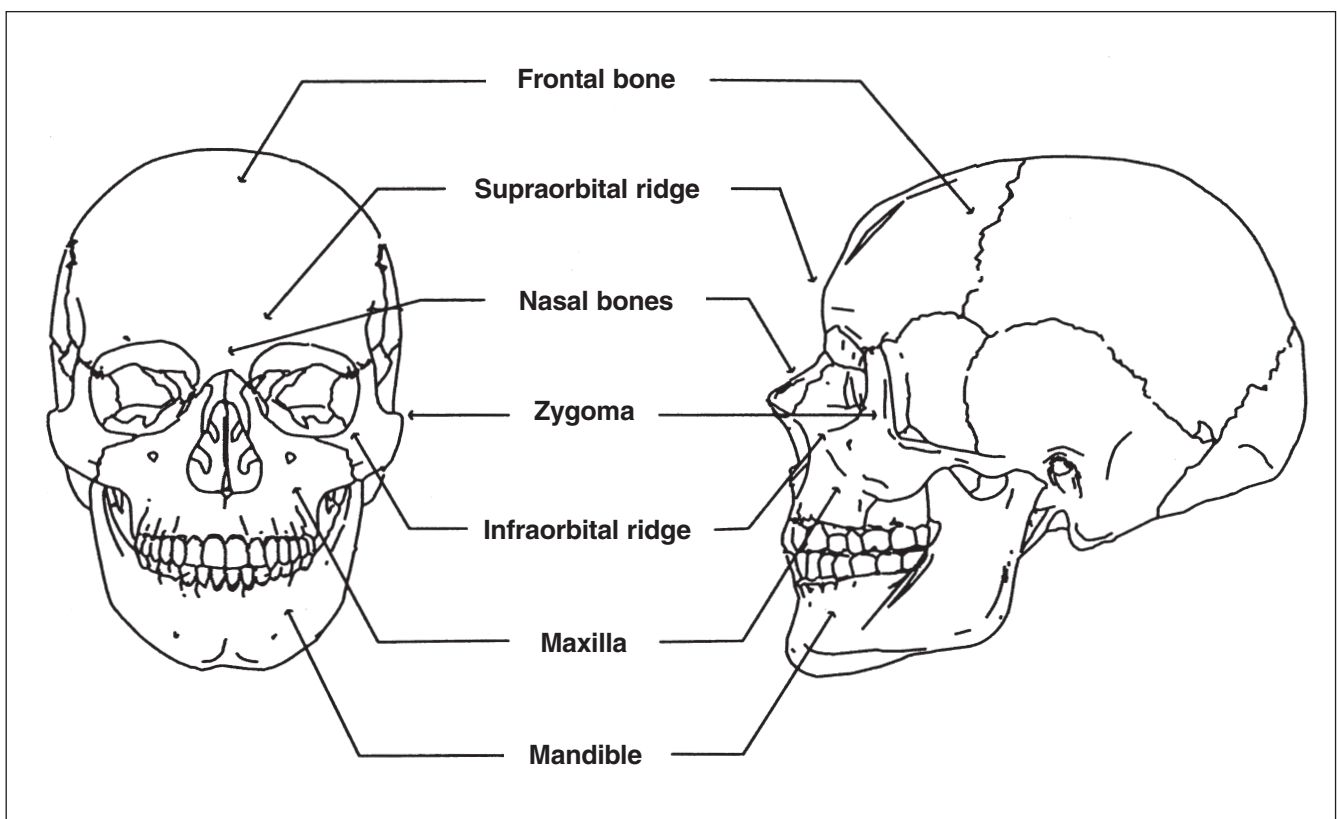


Fig 9.1 Anatomy of the facial skeleton.

haemorrhage from branches of the maxillary artery may require internal packing.

INITIAL ASSESSMENT AND MANAGEMENT

0906. The aims of all primary treatment on the battlefield are:

- To preserve life.
- To prepare the casualty for evacuation.

Remember the four phases of management:
Primary survey, Resuscitation,
Secondary survey, Definitive care.
 (see Chapter 2).

PRIMARY SURVEY AND RESUSCITATION

In maxillofacial injuries the airway is at risk and there is an increased risk of damage to the Cervical spine and brain. Remember the A B C D E routine.

0907. The majority of maxillofacial injuries will be found during the secondary survey. Of prime importance are injuries to the lower face resulting in bleeding and soft tissue swelling, or both. These can cause immediate or delayed airway obstruction (see paragraph 0407). Albeit they may also produce haemorrhagic shock. These problems need to be detected and dealt with in the primary survey.

Airway

0908. Identify and remove or bypass, all causes of obstruction. These may include blood, vomit, fragments of bone or teeth as well as post-traumatic swelling of the adjacent tissues.

0909. Carry out airway management in accordance with the principles of BATLS. In some instances, placing the casualty in the correct position (in this case the three-quarter prone position) will allow them to maintain their own airway. Failing this, the jaw-thrust or chin-lift manoeuvre may be required and the airway maintained with an oral, nasal or endotracheal tube. Take extra care in placing tubes in casualties with facial injuries, particularly when there is the possibility of a fracture involving the base of the skull. (See Chapter 8). In the early stages, the importance of correct positioning to maintain the life of the casualty cannot be over-emphasized. Too many maxillofacial casualties die unnecessarily by being left unattended in the supine position.

No severe maxillofacial casualty should be left unattended in the supine position.

Breathing

0910. It is not enough merely to clear the airway. You must ensure that the casualty is ventilating adequately. This is covered in Chapter 4.

Circulation

0911. Unless very severe, facial injuries are rarely a cause of hypovolaemic shock. If a casualty exhibits signs of shock out of proportion to his facial injuries, you must consider the possibility of covert bleeding elsewhere.

0912. External bleeding from the head and neck can be controlled with pressure dressings - taking care with vital structures such as the airway and eyes. Bleeding from the mid-face may require a post nasal pack applied in the standard manner. As an emergency measure, two *Foley* (urinary) catheters (12 or 14 French gauge) can be passed through the anterior nares to the back of the nose, the bulbs inflated and the catheters then pulled gently forwards - anterior nasal packs can then be inserted.

Disability

0913. Assessment of the pupils is difficult in orbital injuries because of bleeding or oedema. Take care to avoid aggravating ocular damage.

SECONDARY SURVEY

0914. The head, face and neck are fully examined and assessed as part of the secondary survey. This examination takes time and must be carried out in good light. Comprehensive records are essential. Thoroughly check for, and record, the following:

- Lacerations.
- Bruising, for example mastoid and periorbital - indicating basal skull fracture - the neck and the floor of the mouth.
- Cerebrospinal fluid/bleeding from the ears, nose or mouth.
- Tenderness, depression or deformity of bones.
- Malocclusion.
- Proptosis, enophthalmus, restriction of eye movement.
- Visual acuity (mid-face injury may lead to blindness).
- Facial muscle weakness, for example upper, mid- or lower face.
- Sensory loss, for example cheek or lower lip.

Beware of airway compromise caused by continuing haemorrhage and soft-tissue swelling.

Evacuation

0915. When preliminary treatment has been completed, evacuate the casualty to a specialist unit for definitive treatment. Casualties without a definitive airway should be evacuated in the three-quarter prone position and must be carefully supervised. Attendants travelling with maxillofacial cases must be instructed in the dangers and management of respiratory obstruction.

The priorities for evacuation of maxillofacial casualties are:

- P1 Airway problems.
- P2 Multiple facial injuries without airway compromise.
- P3 Uncomplicated maxillofacial injuries.

Pain Control

0916. For most facial injuries, no immediate splinting is required, but mobile painful fractures can be gently supported using two crepe bandages; one being placed vertically and the second horizontally (around the forehead) - and the two anchored together with safety pins. Analgesia may be given but care must be taken to avoid respiratory depression.

Fluid Replacement

0917. Replace fluids orally or intravenously as indicated (see Chapter 5).

SUMMARY

- In maxillofacial injuries, the airway is most at risk.

Do not let the casualty die for want of an airway.

- Look for associated injuries, such as basal skull fractures, provide simple splintage for mandibular fractures and adequate analgesia. Evacuate most casualties in the three-quarter prone position and ensure adequate supervision.

Skills Station 7 Maxillofacial Injuries

AIM

The aim of this skills station is to give you the opportunity to:

- Demonstrate skills in examining maxillofacial injuries
- Perform primary and secondary surveys of the middle-third and lower-third of the head.
- Discuss priorities of management of casualties with maxillofacial injuries.

EQUIPMENT

Mr Hurt (head injury manikin).
A skull.

SKILLS PROCEDURES

Primary Survey

Remember the A B C D E routine.

- Examine for cervical spine injury and immobilise if necessary.
- Check pupillary size and response to light.
- Check:

Alert

Voice responsive

Pain

Unresponsive.

Secondary Survey

(to determine the extent of the injuries).

External

- *Visual.* Carry out a visual inspection of all surfaces of the head and face. Note asymmetry and alterations in normal proportions:
 - Swelling and bruising.
 - Lacerations.
 - Bleeding from nose or ears, with or without cerebrospinal fluid leakage.
- *Palpation.* Carry out a systematic bilateral bimanual examination of bony surfaces and margins to detect breaks in continuity:
 - Cranium.
 - Orbital rims.
 - Nose.
 - Zygomas and zygomatic arches.
 - Condyles.
 - Posterior border of the ramus and the lower border of the mandible.

Internal

- *Visual.* Note the following:
 - Broken, missing or displaced teeth.
 - Alteration in alignment of teeth.
 - Failure of the teeth to meet correctly (malocclusion).
 - Limitation of mandibular movement and/or asymmetrical opening.
 - Haematomas.
- *Palpation.* Palpate the teeth, dental arches and palate to detect abnormal mobility.

Detailed Examination

- Carry out a more detailed examination of positive findings.
- Perform mini-neurological survey (Glasgow Coma Scale):
 - Eye-opening response.
 - Verbal response.
 - Best limb motor response.
- *Scalp laceration.* Palpate for extent of possible bone injury and presence of foreign bodies.

- *Eyes.*
- Check pupillary size and response to light again.
- Check for exophthalmus (proptosis) or enophthalmus.
- Check subconjunctival haematoma or hyphaema (blood behind cornea).
- If conscious, check visual acuity, eye movement and diplopia.
- *Ears.* Check for haemotympanum (blood behind the eardrum).

- *Mandible.* Check for normal mandibular movement.

General Assessment

- Carry out a general assessment of the whole casualty for additional injuries.

Continuing Re-assessment

- Continually re-assess the casualty for signs of deterioration.

BATLS

Battlefield Advanced Trauma Life Support

Chapter 10 Spine and Spinal Cord Injuries

AIM

1001. On successfully completing this topic you will be able to:

- Assess spinal injury.
- Apply immobilisation techniques.
- Apply the principles of the management of casualties with spinal injury.

PRINCIPLES OF EVALUATION AND TREATMENT

1002. In the context of this publication, spinal injuries refer to injuries to the bony spinal column or to the spinal cord, or to both. The principles involved in the evaluation and treatment of spinal injuries are:

- There can be an injury to the bony spine without injury to the spinal cord, *but the potential for spinal cord injury is always present.*
- Undue manipulation or movement can cause additional spinal cord injury and worsen the prognosis.
- *Careful handling of the casualty is essential.* When the mechanism of injury dictates, always assume a spinal injury and keep the spine immobilised *until* you have excluded injury by examination and X-ray.

1003. With all spinal injuries or suspected spinal injuries the aim is:

- To immobilise and protect the spine and the spinal cord.
- To prevent neurological deterioration due to hypoxia, underperfusion or movement of the spinal cord.
- To prevent complications of paralysis.

HISTORY

1004. The mechanism of injury, the casualty's neurological status, other pertinent physical signs and the potential for further injury, must be recorded at each role of medical care. This will allow recognition of any deterioration or improvement in the casualty's condition at each stage of the evacuation chain.

Mechanism Of Injury

1005. Is is a blunt injury or a penetrating injury?

- A blunt injury could be due to, for example, deceleration in a road traffic accident, injury to crew in a disabled armoured vehicle, blast, trench cave-in or a parachuting accident.
- A penetrating injury could be due to gunshot, fragments or stabbing. These carry a high mortality especially when caused by high energy-transfer (see paragraph 0416).

Neurological Status

1006. This will be important in the management of the injury at later roles of medical care. You must always be highly suspicious of a possible cervical spine injury in an unconscious casualty.

EXAMINATION AND ASSESSMENT

1007. Ideally, before the start to examine and assess casualties with suspected spinal injuries you must immobilize the whole spine in the neutral position. This is the *gold standard* in peacetime and should remain so whenever possible in wartime, although it may be necessary to compromise on this standard because of the tactical or physical situation on the battlefield. For example, it may be necessary to extract a casualty hurriedly from a vehicle that is ablaze or under attack. It is also difficult to achieve the ideal when dealing with a casualty single-handed.

1008. There are three groups to consider:

- *The conscious casualty without paralysis.* You must assume that a casualty with a blunt injury above the clavicle has a spinal injury.
- *The conscious casualty with paralysis.* This casualty can localize pain, identify sensory loss and demonstrate motor weakness. Be aware that paralysis and sensory loss may mask intra-abdominal or lower limb injuries.
- *The unconscious casualty.* About 15%¹ of unconscious casualties have some form of neck injury. Clinical findings that suggest *spinal cord injury* include:
 - Flaccid areflexia of limbs.
 - A lax anal sphincter.
 - Diaphragmatic breathing.
 - Response to pain above the clavicle – but not below.
 - Flexion – but no extension – at the elbow.

¹ Approximately 25% of spinal injury casualties have some degree of head injury.

- Hypotension and bradycardia without hypovolaemia.
- Prispism (unopposed parasympathic drive).

Spinal Assessment

1009. Carefully palpate the spine for localised tenderness, a palpable gap between the spinous processes and localised swelling. At some stage during the examination, you must perform a careful log-roll to look for bruising and deformity.

Neurological Assessment

1010. Examine the casualty for motor strength and weakness, sensory changes and altered reflexes:

- *Autonomic nervous system.* You will recognise autonomic dysfunction by loss of bladder and anal sphincter control and the presence of priapism. Bradycardia and hypotension may be present.
- *Incomplete neurological damage.* This may present in a variety of ways. Whichever way it presents, there is always evidence of motor or sensory function below the level of injury. In such cases, there may be sparing of sensation in the sacral area and the anal sphincter tone can be normal. Neurological recovery is likely in such cases.
- *Complete cord lesion.* There is no evidence of neurological function below the level of injury; the prognosis is poor.

Neurogenic shock

1011. This is the term for hypotension with high thoracic or cervical cord injuries. Hypotension results from destruction of the sympathetic pathways with loss of vasomotor tone and loss of sympathetic drive to the heart. There can also be bradycardia because of the unopposed parasympathetic (vagal) effect on the heart.

Spinal shock

1012. This is a neurological condition occurring shortly after a spinal cord injury. It results in limb flaccidity and areflexia, a flaccid bladder and loss of drive by the sympathetic nervous system. The condition is variable but normally lasts about six weeks.

Assessment Of Other Systems

Cardiovascular

1013. *Central.* Asystole can occur from stimulation of the unopposed action of the vagus, for example, by pharyngeal suction and nasogastric or endotracheal intubation. It is prevented by giving atropine 0.5 mg intravenously. A bradycardia of 60/min is usual in the high, isolated cord injury.

1014. *Peripheral.* Paralysis of the sympathetic system results in hypotension (see paragraph 1011). The casualty feels

warm and well perfused due to peripheral vasodilatation. Do not forget that the most common cause of hypotension is due to blood loss and hypovolaemia often co-exists with spinal injury. Always assess and treat for hypovolaemic shock first.

Respiratory

1015. If the injury is above the fourth vertebra there is no respiration. With injuries between the fourth cervical and the twelfth thoracic vertebrae there will be intercostal paralysis and, depending on the level, there may be only diaphragmatic breathing.

1016. Complicating factors are rib fractures, flail chest, pulmonary contusion, haemo-pneumothorax and aspiration pneumonitis. You must vigorously address these problems by providing ventilatory support, chest drainage and, if the casualty can feel pain, analgesia.

Abdomen

1017. Inability to feel pain may mask serious intra-abdominal injury. The only symptom pointing to an intra-abdominal problem may be referred shoulder-tip pain. Ileus is usual in a paralysed casualty; you should decompress the stomach with a nasogastric tube. This will also minimise dangerous silent regurgitation and aspiration of gastric contents.

Locomotor

1018. Pelvic injuries may be masked by a spinal cord injury and, if present, may merit a higher priority in the management of the casualty.

1019. Lower limb injuries are easily missed in the absence of sensation. Remember that early and correct management of upper limbs injuries may have a profound effect on the eventual mobility of a quadriplegic.

Skin

1020. In a high cord lesion, temperature control function is lost and the casualty may become hypothermic or hyperthermic.

Bladder

1021. Casualties with spinal cord injury and urinary retention need continuous catheter drainage. The recording of urinary output is a good monitor of response to resuscitation if there are other injuries requiring treatment by intravenous fluid administration.

Treatment

Follow the primary survey: the A B C D E routine

1022. Treat as follows:

- *All casualties:*
 - Ensure in-line immobilization of the whole spine by any means available, a combination of semi-rigid collar, sandbags and tape and backboards, is ideal.
 - Correct any life-threatening conditions found in the primary survey.
 - Continue immobilisation until you are certain there is no spinal injury.

- *Conscious casualties with paralysis:*
 - Maintain mean arterial pressure at 90 mmHg (a systolic pressure of 120 mmHg), with intravenous infusion if necessary. If not contraindicated by the presence of a head injury, a head down position will aid venous return.
 - Insert a nasogastric tube under cover of intravenous atrophine (see paragraph 1013).
 - Insert a urinary catheter and put this on continuous drainage.
 - Remove all hard objects and *ensure the backboard or stretcher is well padded.*
- *Unconscious casualties:*
 - Keep the back and neck straight.
 - In order to protect the airway it may be appropriate to evacuate the casualty in the three-quarter prone position. If this is done, a supporting pillow or blanket under the head will reduce the risk of lateral neck flexion.
 - Maintain three-point stability at the pelvis, knee and shoulder.
 - Keep one hemidiaphragm clear of the ground.
 - If anaesthetic support is available, intubation and ventilation is preferred and should be established before the casualty is transferred.
 - Remember: although good spinal immobilization is ensured by using back-boards, they are not a good carrying device as the casualty is balanced on seven bony points – the occiput, scapulae, ischial tuberosities and the calcanei. These bony points are vulnerable to pressure sores if evacuation time is protracted.

EVACUATION

1023. Before evacuation ensure that:

- The airway is secured, the casualty is ventilating with or without support and well oxygenated.
- The casualty is adequately immobilized and secured, is well padded and not in any danger from hard objects. Do not use halter traction.
- Sufficient drugs, such as atrophine, are available for the journey.

1024. During evacuation ensure that:

- Ventilation and oxygenation remain adequate.
- Immobilisation is maintained.
- Intravenous infusion lines, urinary catheters and nasogastric tubes remain secure.
- In-transit escorts are capable of managing the casualty.

SUMMARY

- Deal with life-threatening conditions but avoid any movement of the spinal column.
- Establish adequate immobilisation and maintain it until you are certain there is no spinal injury.

- Record history and clinical findings as a base-line for changes in the neurological status.
- Obtain X-rays when facilities are available.
- Evacuate.

Chapter 11 Limb Injuries

AIM

1101. On successfully completing this topic you will be able to:

- Identify life-threatening limb injuries
- Identify limb-threatening injuries
- Outline priorities in the management of limb injury at different roles of medical care.

PRINCIPLES OF MANAGEMENT

Primary Survey And Resuscitation

Remember the A B C D E routine

1102. The main considerations in the primary survey of limb injury are:

- Control of bleeding, usually by direct pressure or application of a tourniquet.
- Recognition of long-bone fractures and their immediate management – the application of splintage or traction.
- Recognition of covert vascular injury.

1103. The aim is obvious: look for life-threatening or potentially life-threatening blood loss and *stop it.*

Secondary Survey

1104. You must examine the limbs in detail and evaluate all limb injuries. In examination you must:

- Record the presence of wounds, swelling or limb deformity.
- Assess limb circulation; note perfusion by checking capillary return. This should not exceed two seconds; note the colour and temperature of the skin and presence of peripheral pulses (absent in 70% of vascular injuries).
- Record any neurological disability following nerve damage.

Definitive Care

1105. Clean and dress wounds with firm sterile dressings. Continue to control haemorrhage. Correct deformities to relieve pain and to protect the circulation. Splint and immobilise fractures. Application of a traction splint has the following effects:

- Reduction of haemorrhage (see Fig. 11.1).
- Reduction of pain
- Prevention of further soft tissue injury
- Reduces the incidence of fat embolism.

ASSESSMENT OF LIMB INJURIES

History

1106. An accurate picture of the

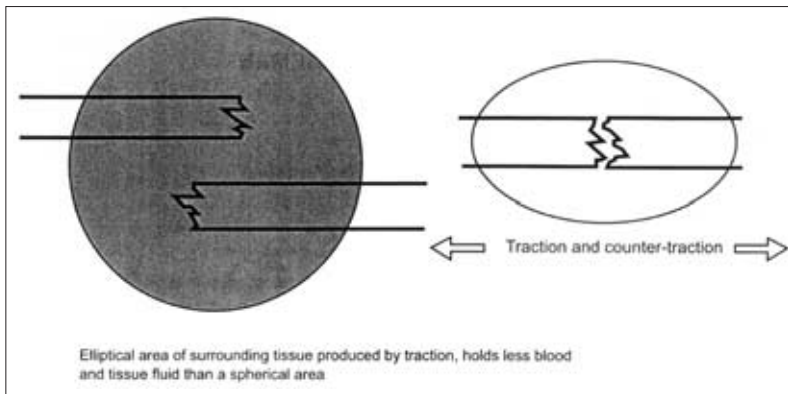


Fig. 11.1 Traction

circumstances resulting in injuries sustained in the military environment is very important and should be recorded briefly on F Med 826 by those giving initial treatment. The casualty may pass through several roles of medical care and be seen by several people before receiving definitive treatment. When you take over care of a casualty establish the **Mechanism of injury, Injuries found, Symptoms and signs and Treatment**. The mnemonic is **MIST** (see footnote page 7-3).

Examination

- **Look.** Examine the limbs for obvious deformity and the presence of any swelling. Note the colour and compare it with the contralateral limb. Note the perfusion of the limb and describe it in the notes - record perfusion return time. Describe the wounds (with a sketch if appropriate) and their relationship to any fracture. This will avoid the need for repeated disturbance of the dressings. Note any skin loss especially over fractures.
- **Feel.** Palpate for tenderness or crepitus which will reveal the presence of a fracture. Assess in each limb the temperature, the capillary refill time, sensation and the peripheral pulses. Is there loss of sensation to touch? If so, record where, draw a picture or use the body outline on the F Med 826.
- **Move.** Check all the limbs for active movements where possible. With an unconscious casualty, test each limb passively for range of movements.
- **Fracture assessment.** Is the fracture open or closed? Any fracture with a wound adjacent to it must be assumed to be an open fracture. Note any bone protrusion - remember that reduction of potentially contaminated protruding bone is likely when splints are applied. Surgical toilet of the bone may be required later.

Life Threatening Limb Injuries

1107. Life-threatening injuries include:

- Complete or incomplete traumatic amputations.
- Multiple long bone fractures.
- Major pelvic injuries.

1108. The threat to life is caused by blood loss; this threat is even greater if there are a

number of severe limb injuries, or injuries in other areas contributing to blood loss. It is on record that up to 10% of battlefield casualties with limb injuries bleed to death unnecessarily. *Do not let this happen.* Remember, the majority of haemorrhage from limb injuries is compressible or, controllable by correct use of a tourniquet. To a lesser extent, haemorrhage from pelvic fractures is also compressible.

Limb Threatening Injuries

1109. Most limb-threatening injuries are related to vascular injury, particularly if the injury is proximal to the knee or elbow. Fractures or fracture-dislocations around the knee or elbow are commonly associated with injury to the popliteal and brachial artery respectively. Crush injuries may result in later amputation, because of cell damage. An unrecognised *compartment syndrome* will result in permanent disability. Open fractures will lead to severe complications if ignored.

Associated Injuries

1110. It is important to realize that the casualty may have multiple injuries. Knowledge of the cause of the injury is important: for example, a fall from a height can result in vertebral fractures or fractures of the calcanei as well as long bone fractures. Some fractures are not easy to detect and are found only after repeated examination. *Do not forget the possibility of a cervical spine injury in falls from a height.*

Assessment Of Blood Loss

1111. Limb injuries play an important role when estimating blood loss. With open wounds the loss may be evident. Equally, the overall condition of the casualty may be the clue to covert haemorrhage. A closed fracture of the femoral shaft may easily result in the loss of two litres into the surrounding tissues. The summation of the effect of a number of such injuries is evident when the signs of hypovolaemic shock are detected.

Remember the four areas for occult blood loss

- Chest
- Abdomen
- Pelvis and retroperitoneum
- Long-bone fractures

Assessment Of Dislocations

1112. Dislocations and fracture-dislocations are difficult to distinguish without X-rays. Dislocations are extremely painful when attempts are made to move the joint and this helps early recognition. Such early recognition can allow prompt reduction especially if there is altered blood supply to the limb, for example in posterior dislocation of the knee occluding the popliteal artery.

Assessment Of Vascular Injury

1113. A major vascular injury may be suggested by:

- Obvious arterial or venous haemorrhage from the wound.
- An expanding haematoma.
- Absent distal pulses (70%).
- Delayed capillary return.
- Differing skin colour and temperature compared with the contralateral limb.
- Increasing pain at the site of the injury.
- Decreasing sensation.

Repeated assessment of the circulation is necessary especially when the casualty arrives at a new role of medical care.

Assessment Of Nerve Injury

1114. Some injuries are often associated with neurological damage, for example a dislocated hip and sciatic nerve injury, or a dislocated elbow and median nerve injury. Confirmation can be obtained by the presence of alteration of sensation or motor power, or both. If you detect an inappropriate nerve injury, you must consider the possibility of a cerebral or spinal injury.

Compartment Syndrome

1115. Untreated, this will lead to rapid loss of a limb or permanent disability. Prompt recognition and emergency surgery are needed. Causes include crush injuries or prolonged limb compression, open or closed fractures, the restoration of circulation to an ischaemic limb and tight plasters or dressings. Compartment syndrome occurs when the interstitial pressure in a fascial compartment exceeds the capillary pressure as a result of haemorrhage or oedema within the involved compartment. Initially, venous flow stops and as the pressure increases the arterial supply also stops. Ischaemia of nerves and muscles occurs with rapid and irreversible damage. *The distal pulses may be present throughout.* The compartments most commonly affected are the anterior tibial compartment and the flexor compartment of the forearm. The main presenting symptom is severe pain in an injured limb that is adequately immobilised. The pain is aggravated by passive stretching of the muscles in the involved compartment. Active movements are absent. The compartments are swollen, tense, tender and the distal sensation may be altered.

The presence of a distal pulse does not exclude a compartment syndrome.

Crush Syndrome

1116. This causes damage to muscle cells releasing potassium and myoglobin into the circulation. High levels of potassium in the blood can cause cardiac arrest. Myoglobin blocks renal tubules, leading to renal failure. Before releasing a trapped injured limb you must give intravenous crystalloid in large volumes. To avoid renal failure, intravenous fluids should be given in sufficient volume to produce a minimum of 100 ml of urine per hour. An ECG monitor, if available, may give warning of hyperkalaemia (broad bizarre complexes; tented T-wave)¹.

MANAGEMENT OF LIMB INJURIES

Fractures

1117. With an open fracture, control haemorrhage by direct pressure, firm compression, bandaging and elevation of the limb. This will cope with most bleeding. Pressure points, which are difficult to compress, are rarely used. Remove gross contamination, such as earth and bits of clothing and clean the wound with copious irrigation before applying a dry sterile compression dressing. Splint severe soft tissue wounds to relieve pain and to control haemorrhage. Describe the wound in the notes to avoid repeated disturbance of the dressing before definitive treatment. Repeated wound inspection increases the risk of infection. The fracture should then be treated as for any other fracture. Protruding bone should be carefully reduced back into the wound, usually by the application of traction.

Emergency Amputations

1118. A mangled limb with no prospect of reconstruction should be removed. Such a limb will usually be attached only by a few remnants of skin or other soft tissues. To leave it, especially in the presence of other injuries, may endanger the casualty's life. In removing the limb, preserve as much healthy skin, fascia and muscle as possible. You can amputate through the fracture site. Transfix the major blood vessels and ligate them with strong suture material. Divide nerves and allow them to retract. Leave flaps open, firmly bandage the stump and apply a plaster splint. The use of a tourniquet may be considered to reduce blood loss during the procedure. Skin from the amputated part may subsequently be used for grafting. If the part is not too mangled and the casualty evacuation is not delayed, send it with the casualty to the surgeon.

1. Treat Hyperkalaemia initially with 20 soluble insulin plus 50 ml of 50% dextrose given intravenously.

Dislocations

1119. Reduce all dislocations at the earliest opportunity. They are often relatively easy to reduce soon after injury. Remember that they are painful injuries. Reduction under *Entonox*, when available, avoids the need for continued monitoring after sedation. Ketamine in analgesic doses provides excellent analgesia for five to ten minutes and will not depress respiration like morphine. Immobilise the joint after reduction *but* check the distal circulation before you do so.

Vascular Injuries

1120. If you suspect a major vessel injury you must control haemorrhage from the wound, dress the wound and splint the limb. Early evacuation for further investigation and definitive treatment is necessary if the limb is to be saved.

Compartment Syndrome

1121. If you suspect this condition and the limb is in plaster or has circumferential dressings, split them completely down to the skin and open them widely. If symptoms do not improve within 15 minutes, any dressings overlying open wounds should be removed and the underlying muscle examined. Its colour should look like raw, red meat; if it does not, suspect compartment syndrome. Such a limb requires urgent fasciotomy.

Do not hesitate to remove plaster casts and circumferential dressings.

Immobilisation

1122. Adequate splintage will relieve pain and help to control haemorrhage. The circulation and soft tissues will also be protected.

Splinting Limbs

1123. Support the hand with a wool and crêpe bandage. Immobilise injuries of the forearm or upper arm with padded splints or plaster, together with a broad arm sling. Keep the elbow at a right angle. If only one leg is injured, splint it to the good limb, together with padded external splints and bandages. A traction splint should be used for fractures of the femur, but not if there is an ankle fracture on the same side. Obvious deformity and rotation of long bones should be corrected before splinting - this relieves pain, protects the circulation and makes splinting easier.

The Tourniquet

1124. The *Samway* anchor tourniquet is available at all roles of medical care but should only be used when other measures fail or compression is difficult. For example, it will be more appropriate to immediately apply a tourniquet to a trapped limb when access for adequate compression is

impossible. A tourniquet may also be necessary when completing a traumatic amputation. A tourniquet must be applied effectively above the level of haemorrhage to stop arterial flow; it should be released as soon as possible. But, remember *you have applied the tourniquet to save the casualty's life*. Ischaemic damage to a limb is rare if a tourniquet is left for up to one hour. If it is feasible to control haemorrhage by direct compression, release the tourniquet. If haemorrhage is not controlled, or not controllable, by compression, re-apply the tourniquet. If transfer of the casualty is delayed, repeat this process every hour and discard the use of the tourniquet as soon as haemorrhage is controlled by compression. 1125. Incorrectly applied, the tourniquet will increase venous pressure and aggravate, rather than control, haemorrhage. Keep at the forefront of your mind the fact that, inappropriate or incorrect use of a tourniquet, may result in unnecessary limb loss. A tourniquet, used correctly and for the right reasons, will save a life.

SUMMARY

- Manage life-threatening injuries first.
- Dress wounds, align fractures and immobilise.
- Record details.
- Determine priority and evacuate.

Skills Station 8 Limb Splintage

AIM

The aim of this skills station is to give you the opportunity to practice and demonstrate the proper techniques for immobilising limbs. On completion of this station you will be able to:

- Demonstrate the steps in the control of haemorrhage and the initial management of wounds.
- Demonstrate the application of splints to upper and lower limbs.
- Demonstrate the application of a traction splint to a lower limb.
- Discuss the advantages and dangers in the use of a tourniquet.

EQUIPMENT

Padded wood and <i>Kramer</i> wire splints.
Broad arm bandages.
Traction splint.
Plaster of Paris, wool and gauze.
Plaster cutters.
Stretcher.
Basin and cleaning materials.
<i>Samway</i> anchor tourniquet.

BATLS

Battlefield Advanced Trauma Life Support

Chapter 12 Burns

AIM

1201. On successfully completing this topic you will be able to:

- Identify the methods used to assess the size and severity of burns.
- Outline the measures used to stabilize, treat and evacuate casualties with burn injuries.

INTRODUCTION

1202. The incidence of burn injury in battle casualties has increased steadily throughout the last century. An analysis of recent conflicts suggests that, in the modern armoured battle, 10-30% of all battle casualties will have sustained burns¹. Of these, approximately half will also have other physical injuries.

1203. Burns can be caused by the high temperature combustion from modern explosives as well as by secondary ignition of fuel and lubricants. In addition, specific types of weapons are designed to inflict burn injury, for example flame-throwers and napalm munitions.

ASSESSMENT

1204. Successful management of burns depends on the ability to assess the severity of the injury accurately and early. The severity depends on:

- The area of the body burnt - Body Surface Area (BSA) burnt.
- The depth of the burn.
- The presence or absence of respiratory tract thermal injury.

Assessing The Body Surface Area

1205. The BSA can be assessed by the *Rule Of Nines*:

- Head and neck = 9%
- Each upper limb = 9%
- Front of trunk = 18%
- Back of trunk = 18%
- Each lower limb = 18%
- Perineum = 1%

Remember that the area of the casualty's palm is approximately 1% of the body surface area. In children below 30kg weight (about 12 years old and under) the

proportions are different; the head represents 18% of the body surface area and the lower limbs only 14% each.

Estimating The Depth Of Burn

1206. Burns can be either:

- Partial-thickness - confined to the epidermis.
- Full-thickness - complete destruction of the epidermis.

1207. Partial-thickness can vary from superficial, with some erythema and pain (as in sunburn), to deep partial-thickness. The latter involves destruction of the whole epidermis at various points but the depth of burn spares sweat glands and hair follicles. Pain is a feature of all these and sensitivity to needle prick is retained.

1208. With full-thickness burns there is total loss of the whole epidermis together with a variable degree of tissue beneath. Destruction of superficial nerve endings render the burnt area insensitive to pain. The affected area (the eschar) may look dirty-white, brown or black and sometimes has an almost transparent, leather like appearance, through which coagulated blood in the blood vessels can be seen.

Full-thickness versus partial-thickness burns.

A simple test is to pull a hair with forceps if it comes out easily the burn is full-thickness.

RECOGNIZING RESPIRATORY INJURY

1209. Many cases are complicated by concomitant injury of the respiratory tract caused by inhalation of the products of combustion. These can cause one or more of the following:

- *Considerable swelling of the upper respiratory tract leading to airway obstruction.* The upper respiratory tract is a very good heat exchanger. Heat damage to the lower respiratory tract is seldom seen except when super-heated steam is inhaled; this can occur, for example, when boilers and pipes in ships' engine rooms fracture.
- *Chemical damage to upper and lower respiratory tracts.* Many products of combustion form gases that are highly irritant, particularly to the lower

¹ This figure can be considerably higher on ships.

respiratory tract; this can lead progressive respiratory failure.

- **General toxicity.** Some products of combustion, which may or may not be locally irritant to the lungs, can be absorbed into the circulation and prove highly toxic. For example, many plastics and modern materials give off cyanide gas which is one of the most common causes of death in fires.

1210. The most common poison in a fire is carbon monoxide. In addition, fire rapidly consumes oxygen in the atmosphere surrounding a victim so that the whole problem is compounded by anoxia. On the battlefield, various nitrate products from explosions are likewise extremely toxic. Inhalation injury is one of the major causes of mortality in burns. Initially, after exposure, a casualty may not demonstrate any adverse effects and a high index of suspicion should be used when assessing a casualty with burns.

1211. On the battlefield, two or more of the following features should be considered sufficient to diagnose inhalation injury:

- A fire in an enclosed space such as a bunker or armoured vehicle.
- Carbonaceous sputum.
- Impaired level of consciousness or mental confusion.
- Burns on the face, lips, nose and mouth - look for singeing of the hairs in the nares and oedema of the uvula.
- Signs of respiratory distress such as increased respiratory rate or shortness of breath.
- Stridor or any abnormal signs in the lung fields such as rhonchi or crepitations.
- Hoarseness or loss of voice.

MANAGEMENT

Remember the A B C D E routine

1212. Immediate first aid is:

- Extinguish the flames on the casualty or clothing by wrapping the casualty in a blanket or laying the affected part on the ground.
- Small burns may be cooled by applying clean cold water. *But remember that liberal application of cold water following extensive burns will produce a hypothermic casualty.*
- Cover all burns except the face with *cling-film*.
- Provide pain relief, ideally, IV morphine (some casualties with severe burns suffer little initial pain).
- Elevate burnt limbs. Burnt hands can be placed in polythene bags to facilitate finger movement.
- Protect from the elements but do not over-warm.

Airway

1213. With casualties who have, or are likely to develop inhalation injury, you must

suspect airway compromise and give it a high priority. If necessary, you must secure the airway either by endotracheal intubation or cricothyroidotomy. Control of the airway is best established before major symptoms of obstruction become apparent and, under field conditions, a surgical airway may be preferable to an endotracheal tube.

Local Management Of Burn Wounds

1214. Burning often sterilizes the skin at the time of injury. At the same time, burnt skin instantly loses its ability to resist invasion by bacteria; you must cover the burns with appropriate dressings as soon as possible. Cover the burns with cling-film. Ensure that the film is laid in strips and stuck to each other along the limb - rather than wrapped around the limb like a bandage as this may cause constriction.

1215. Put the casualty's hands and feet in polythene bags secured at the wrist or ankle and encourage movement of the fingers and toes inside the bags. If available, you may put a small quantity of antiseptic such as flamazine cream on the hands and feet. Treat burns of the face and head by exposure; warn the casualty that gross swelling of the eyelids may occur - reassure him that this is temporary and that he is not losing his sight.

Escharotomy

1216. The dead tissue caused by full-thickness burning (the eschar), if circumferential in any part of the body, will constrict as it is formed. This may have dire consequences. For example, in a limb it will obstruct the bloody supply, around the chest it may restrict respiratory excursion and around the neck it may produce respiratory obstruction. Division of the eschar (escharotomy) may be a life- or limb-saving procedure that should be performed as soon as a circumferential full-thickness burn is diagnosed.

1217. The procedure is to incise the eschar down to the deep tissues with any form of sharp blade. Since the burn is full-thickness, no form of anaesthesia is required. Make a cut starting at the centre of the eschar and passing longitudinally up and down the limb until sensitive tissue is reached. For circumferential, full-thickness burns on the trunk, it may be necessary to incise both vertically and horizontally. Gauge the depth by finding the level at which the eschar splits open. Haemorrhage may be significant and may require a pressure dressing. *Do not allow this dressing, in turn, to cause constriction.*

Fluid Replacement

1218. Due to excessive capillary permeability, there is a loss of protein-rich fluid from the burn surface, as well as significant interstitial oedema in the area. In

full-thickness burns there is direct destruction of blood within burnt vessels. Replacement of fluid loss as early as possible is one of the most important aspects of treatment to prevent the development of hypovolaemic shock. In burns up to 15% BSA in adults (10% in children), rehydration can be achieved by the oral route using *Moyer's* electrolyte solution. This is made up by adding one sachet of the solution to a casualty's standard-issue water bottle full of water¹. This solution is not particularly palatable - adding orange juice or something similar improves the taste.

1219. Burns over 15% BSA in adults require intravenous fluid. There are many different formulae used to determine the approximate amount of fluid needed; most depend on knowing the casualty's body weight. In forward areas this is impractical and the British Army formula is based on the body surface area burnt. The total amount of fluid needed is 120ml of colloid per 1% of BSA burnt, administered over 48 hours. Half of this should be administered in the first eight hours *from the time of burning*. (In another words, if six hours has elapsed before intravenous resuscitation has started, the first half of the calculated fluid volume should be given in two hours). A quarter of the calculated volume is given in the next 16 hours and the final quarter given during the second 24 hours. In addition, 100ml of fluid per hour is required for normal metabolic purposes. If the casualty can swallow, it should be given orally, if not, as IV crystalloid.

1220. This formula is only a rough guide and it should be monitored by means of:

- Pulse rate.
- Peripheral perfusion.
- Minimum urinary output of at least 50ml per hour (catheter required).
- A falling haematocrit, measured hourly.

Surgical Treatment

1221. This will depend on facilities available, the nature of the burn and the number of casualties to be treated. Certain full-thickness burns require urgent surgery, particularly those involving the eyelids, dorsal surfaces of hands and flexion aspects of joints.

1222. Triage Priorities

- *Priority 1:* Burns between 15 and 30% BSA, casualties with respiratory compromise and electrical burns.
- *Priority 2:* Burns of less than 15% BSA involving face, eyelids, hands, perineum and across joints.
- *Priority 3:* All remaining burns cases.

1223. In civilian life, the dividing line between adults requiring life-saving emergency treatment and those who do not

is considered to be burns of 20% BSA or more. In the military setting, 15% is selected because of the likelihood of multiple casualties, delays in the evacuation chain and the high incidence of other concomitant physical injuries.

1224. Priority 1 cases will normally be evacuated as soon as possible to a field hospital with a specialist burns team. Casualties with burns of more than 30% BSA should normally be held as P1 hold at a Role 3 facility until they have survived the 48 hour shock phase.

SPECIAL BURNS

Phosphorus Burns

1225. Phosphorus combusts spontaneously on contact with air and consequently contamination of clothing, skin or flesh with particles of phosphorus produces deep burns. Such burns, extremely rare in civilian life, are common on the battlefield. This is because many munitions designed to produce smoke screens rely on the widespread scattering of phosphorus pellets.

Immediate treatment is as follows:

- Douse the flames and keep covered with water or some other solution such as saline.
- If possible, remove with forceps any large fragments of visible phosphorus that are not adherent.
- Apply moist dressings and keep them wet.
- Continue with standard burn therapy.
- Avoid contaminating yourself with particles of phosphorus.

1226. At Role 3, phosphorus burns may be treated as follows, usually under general anaesthetic:

- Irrigate the wound with 1% copper sulphate solution. This combines with the phosphorus to neutralise it, and turns the fragments black allowing easy identification for removal.
- You must then flush the copper sulphate from the wound with saline.

Copper sulphate is highly toxic if absorbed and must never be left on a wound as a dressing

Electrical Burns

1227. Electric currents passing through the body generate heat deep in the tissues and many produce serious burns. Much of the heat damage is to deep tissues and visible burns on the skin may be small. These burns are always far more extensive than initially apparent. The burns may cause massive breakdown of muscle tissue giving rise to:

- Renal failure (due to myoglobinuria).
- Metabolic acidosis.

¹ The standard Service issue sachet contained 4.5g each of sodium chloride and sodium bicarbonate.

1228. The general effects of electrocution may also produce cardiac or respiratory arrest, or cardiac arrhythmias. Intravenous fluids should be given in sufficient volume to produce a minimum of 100ml of urine per hour to try to prevent renal failure and to combat metabolic acidosis. In order to monitor this the casualty should be catheterized. Such casualties should be evacuated to a special burns unit as Priority 1.

SUMMARY

- Remember the **A B C D E** routine with special emphasis on A in known or suspected burns of the airway - thermal or chemical.
- Calculate BSA burnt, give intravenous fluid according to the British Army formula to burns of more than 15% BSA and monitor effectiveness. Adjust the volume of intravenous fluid to maintain effective resuscitation.
- Cover with cling-film, use polythene bags on hands and feet.
- Do not hesitate to do escharotomies for circumferential full-thickness burns.
- Evacuate as appropriate to a specialist burns unit.

Chapter 13 Ophthalmic Injuries

AIM

1301. On successfully completing this topic you will be able to:

- Take an ophthalmic history.
- Examine the globe and orbit.
- Identify conditions requiring expert ophthalmic surgery.
- Give treatment prior to evacuation.
- Treat conditions that do not require evacuation.

1302. About 10% of battle casualties have an eye injury. Of these, 15% are bilateral. Hysterical bilateral blindness is an important symptom of battleshock.

ASSESSMENT

Remember the A B C D E routine History

1303. Ascertain as far as possible the details and circumstances of the injury:

- Activity of the casualty, such as hammering metal or a laser strike.
- Is the injury due to blunt or penetrating trauma?
- If a chemical injury, record whether acid, alkali or NBC agent (note swelling of lids or clouding of the cornea).
- *Drops.* Is the casualty on eye medication or has he been given miotics/mydriatics?
- *Eyewear.* Was the casualty wearing goggles, spectacles, anti-laser protection or contact lenses?

- *Foreign Body.* Do you suspect a foreign body in the eye? If so, is there a sample?

Examination

1304. Check the casualty for the following:

- *Visual acuity.* Can he read normal text or headlines? Can he count fingers? Can he detect hand movements? Has he any perception of light?

Perception of light can still be tested with the eyes closed - by shining a torch through the eyelid.

- *Conjunctiva and cornea.* Look for corneal abrasions, ideally using fluorescein and a blue light. Look for superficial foreign bodies, blood inside the eye, perforations of the iris, clouding of the cornea and corneal perforations.
- *Soft eye.* This will indicate a posterior perforation of the globe.

Do not press on a soft eye.

TREATMENT

1305. Treat the casualty as follows:

- Wash out chemicals and foreign bodies with saline or *Hartmann's Solution* immediately and continue for 15 minutes holding the lids open.
- Use chloramphenicol ointment liberally on the lids and in the conjunctival sac.

It is better to use chloramphenicol drops every hour if a perforation is seen.

- Apply one drop of 1% atropine.
- Apply pad and bandage firmly (unless the globe is soft in which case do not apply pressure to the eye but protect it with a plastic shield).
- With a large penetrating foreign body, pad both eyes to prevent further injury due to concomitant eye movements.
- Remember tetanus toxoid and systemic antibiotics.

PRIORITIES AND EVACUATION

1306. All casualties with loss of visual acuity will need to be seen by an ophthalmic surgeon, preferably within 24 hours. An intraocular foreign body, if metallic, will cause blindness within ten days unless removed. Perforations of the globe are usually blinding to that eye; they require to be seen urgently by an ophthalmic surgeon. Remember perforations of one eye may blind the other eye by sympathetic ophthalmia unless treated within a few days. All eye injuries, except simple abrasions, are

P2 and require early evacuation to a specialist eye unit. A high priority should be given to intraocular foreign bodies from anti-laser goggles; such fragments cause an intense retinitis. Ideally most casualties should be evacuated by *air*.

SUMMARY

- All but the most simple of eye injuries will require expert ophthalmological opinion. This is particularly so with all actual or suspected penetrating injuries.
- Rest the *part*, that is atropine to the affected eye and pad both eyes (if circumstances allow).
- Rest the *whole*, that is evacuate P2 as a stretcher case.

BATLS

Battlefield Advanced Training Life Support

Chapter 14 Analgesia

AIM

1401. On successfully completing this topic you will:

- Understand how pain is caused.
- Understand how drugs that treat pain work.
- Have a system for managing the casualty in pain.
- Be able to use a simple scheme for using morphine on the battlefield.

INTRODUCTION

1402. Pain affects people in different ways. Some people seem able to tolerate pain while others cannot. This may be influenced by a person's emotional state (including their expectation of the consequences of injury), by alcohol and by other drugs. A person's culture and their society's expectations of behaviour also influence the way they show their response to pain.

Pathophysiology

1403. Trauma causes tissue damage. Damaged tissue releases chemicals and these stimulate the nerves that sense pain (different types of nerves respond to different stimuli; some respond to pain, other to light touch and temperature). Stimuli pass along nerves to the spinal cord. The spinal cord acts like a junction box deciding which signals continue on upwards to the brain and which do not. In the brain, signals from pain nerves are felt as pain. The process from the point of injury to the brain is called the *pain pathway*.

1404. Nerves can also be damaged directly by trauma. A nerve close to a fracture site may be stretched and damaged by bone movement, causing pain.

1405. Damage to the spinal cord may prevent pain stimuli being transmitted to the brain. The casualty will be unable to feel pain below the level of the spinal damage. Injuries below this level may not be noticed by the casualty (or by the person examining the casualty, a point that can lead to further damage to the injured part).

1406. The casualty distressed by pain produces extra stress chemicals (catecholamines) such as adrenaline. Catecholamines cause tachycardia, peripheral vasoconstriction, poor tissue perfusion and a rise in

intracranial pressure. The cumulative effect is to exaggerate the detrimental features of clinical shock.

1407. Hypoxia and hypercarbia also worsen the pain threshold.

Initial assessment and management

1408. *Reassure the casualty.* Explain what is happening now and what is going to happen. Ask yourself, *is the casualty distressed due to hypoxia, shock, pain or all of these.*

1409. Management of Airway, Breathing and Circulation comes first. Correcting hypoxia, hypercarbia and hypovolaemia helps to relieve the pathophysiology of uncontrolled pain.

1410. Simple measures to treat pain should be tried first:

- Splinting fractures. (See paragraph 1123).
- Cooling burns. (See paragraph 1212).

1411. Use of pain relieving drugs will depend on:

- What drugs are available.
- What other equipment (such as syringes and needles) is available.
- Contraindications to a drug's use such as allergy or pregnancy.
- The clinical condition of the casualty.
- How many casualties there are.
- What monitoring and nursing care can be given to them.
- The skill, experience and training of the person administering the drug.
- The legal entitlement of the medical or nursing personnel to use a particular drug.
- Whether the casualty is about to receive general anaesthesia and surgery.

Drug action

1412. A drug usually causes its effect by working at a site of action. Once a drug has been absorbed into the blood stream, it travels all over the body. At certain places in the body it meets a site of action; this could be a specialised area on the surface of a cell (a receptor). The interaction between the drug and the receptor causes chemical changes inside the cell which, in turn, produce an effect. Pain control is one such effect.

1413. Because the drug travels all over the body it interacts with receptors all over the body. Different receptors produce different effects, some wanted and some unwanted. For example, the wanted effect of morphine

is pain control. Unwanted effects include respiratory depression, constipation and constriction in the pupil of the eye.

1414. Different drugs work at different sites along the pain pathway. Morphine influences pain transmission to the spinal cord and perception in the brain. Local anaesthetic drugs temporarily stop transmission of pain impulses in nerves. Non-steroidal anti-inflammatory drugs act on the pain chemicals released at the site of the injury.

1415. Pain control may involve a combination of simple measures and different drugs.

Routes of administration

1416. A drug swallowed as a tablet has to be broken up into very small pieces in the gut before being absorbed across the wall of the gut and into the blood stream. This will depend on the blood supply to the gut and also on gut motility, which moves food and gut contents along within the gut. Motility is important as food or drugs may have to reach particular places within the gut before being absorbed. The whole process – motility and absorption – is delayed by injury and shock.

1417. A drug injected into a muscle (intramuscular) or under the skin (subcutaneous) needs to travel from the muscle or skin by blood flow and then on the site of action.

1418. In shock, where blood supply to skin and muscle is reduced, it takes much longer for the drug to be absorbed and reach the site of action. A return of blood supply to skin and muscle during resuscitation can wash the drug out rapidly into the blood and produce a relative overdose. This needs to be anticipated and watched for during resuscitation.

1419. A drug given directly into a vein (intravenous) is rapidly carried to the site of action and causes its effects. Intravenous drugs are best given in a series of small doses, assessing the casualty's response between each dose.

1420. Drugs can also be inhaled, for example, Entonox (50% oxygen and 50% nitrous oxide). This goes into the lungs, crosses into the blood and is taken to sites all over the body. The proportion that crosses into the brain gives an analgesic effect.

1421. Local anaesthetic drugs (for example, lignocaine) may be used to temporarily block pain impulses in nerves and the spinal cord. The local anaesthetic is injected close to the appropriate nerve. This requires a good knowledge of anatomy.

The ideal analgesic

1422. The ideal analgesic should have:

- A predictable action.
- No side effects.
- A long duration of action.
- A readily available antidote.

And be:

- Easily administered.
- Easily stored and transported.

1423. None of our currently available drugs meet all these criteria. Choice of drug will be influenced by the factors listed in paragraph 1411. The following is a practical guide to using analgesic drugs in the battle casualty.

MINOR INJURY

Musculo-skeletal pain, for example, sprains, fractures and minor fragment injury

1424. Consider paracetamol and Non Steroidal Anti-Inflammatory Drugs (NSAIDs). Use doses and routes as given in CTRs. A range of NSAIDs are available but differ in terms of recommended dosage, dosage interval, licensed route of administration and severity of side effects. Some have been associated with an increase in pre operative bleeding during surgery and with post operative wound haemorrhage.

The surgical team need to know the casualty has received NSAIDs.

1425. NSAIDs can cause acute renal failure, particularly in casualties with diminished renal perfusion.

This means that they should not be used in cases of major injury associated with haemorrhage and shock.

1426. NSAIDs can also exacerbate asthma, cause gastric irritation and should not be used in aspirin sensitive casualties.

1427. Other drug options include: codeine phosphate and combinations of paracetamol with codeine, dihydrocodeine or dextropropoxyphene (See CTRs).

MODERATE TO SEVERE INJURY

1428. If the above are insufficient or not available, use morphine. Morphine is a powerful analgesic. Morphine is the standard battlefield analgesic used by the British Army. It is supplied to soldiers as a Medimech Auto Injector containing 10 mg of morphine sulphate. This allows self administration or buddy administration of the morphine by intramuscular injection. The limitations of intramuscular drug administration have been outlined in paragraph 1417 and 1418 but on the battlefield this may be the only practical option.

1429. Side effects of morphine include:

- Drowsiness.
- Nausea and vomiting
- Respiratory depression.

1430. Table 14-1 gives practical guidelines to using morphine as a battlefield analgesic.

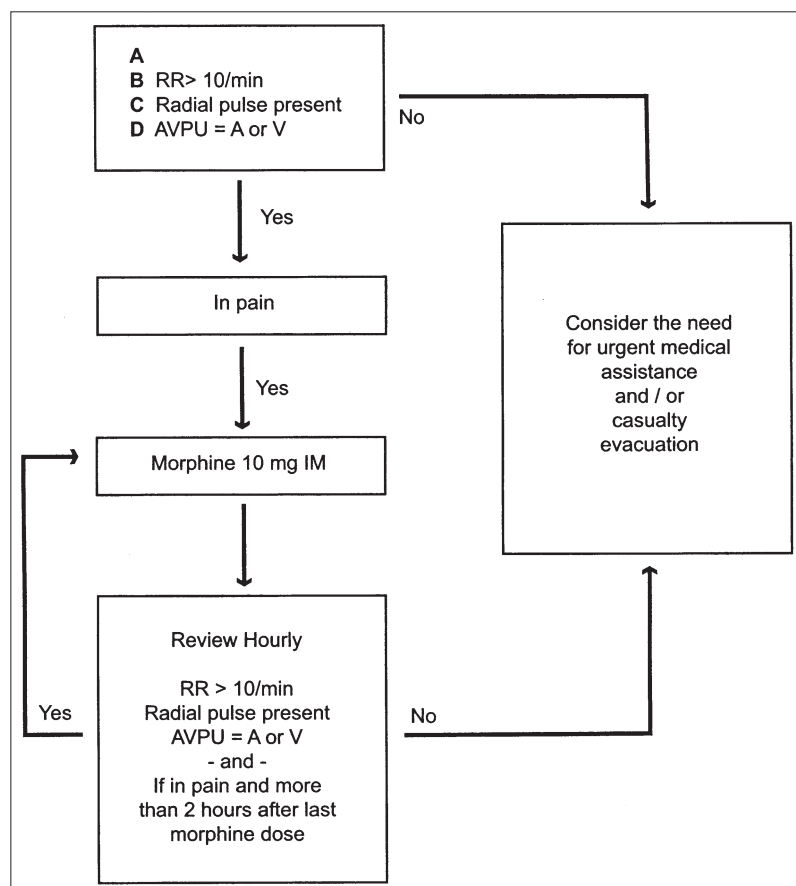
1431. A good clinical predictor of effective morphine requirement is age. The average 24 hour morphine requirement for casualties over 20 years of age is 100 mg minus the age in years. The approximate needs of a 20 year old soldier would be 100 mg minus 20 = 80 mg of morphine in 24 hours.

1432. In field hospitals with surgical teams and when other specialist teams, for example IRTs are present, morphine will be available for intravenous administration to casualties. In the resuscitated adult give an initial slow intravenous injection of 5 mg of morphine followed by boluses of 1 to 2 mg according to pain control achieved, heart rate and blood pressure.

Cardio-respiratory deterioration after analgesia requires careful reassessment of the casualty to ensure that an unrecognised or inadequately resuscitated injury is not the cause.

1433. Antiemetics will frequently be necessary when morphine has been used, particularly when the casualty is being transported, as the incidence of vomiting during casualty evacuation is significant. The phenothiazines and metoclopramide are effective in treating nausea and vomiting caused by drugs but ineffective in motion sickness. Motion sickness is treated with drugs such as hyoscine or the antihi-

Table 14-1. Basic approach to battlefield analgesia.



stamines (for example, cyclizine).

1434. In field hospitals, pain control may be achieved by a combination of NSAIDs or paracetamol, morphine and local anaesthetic blocks.

Opioid reversal

1435. Naloxone antagonises the effects of morphine. Available as a 100 micrograms/ml concentration intravenous injection, initial doses are 100-200 micrograms, with increments of 100 micrograms every two minutes. Its action is specific but short lived and the reappearance of respiratory depression after 1 hour is a possibility. The duration of action of naloxone can be prolonged by giving additional doses intramuscularly. Side effects include nausea, tachycardia and hypotension. Analgesia will also usually be reversed.

SEVERE INJURY

Rescue of a trapped casualty and emergency surgical procedures

1436. Ketamine is a powerful analgesic and anaesthetic drug that can be used in the above circumstances. It can be given both intravenously and intramuscularly.

Ketamine should only be used by personnel with appropriate training. As with any drug capable of producing sedation and general anaesthesia, administration should be confined to personnel capable of and equipped for, advanced airway management.

1437. Airway reflexes are better maintained with ketamine than with other sedative drugs but airway competence and protection is not guaranteed:

- Salivation increases after ketamine and suction may be required.
- Respiratory depression does not usually happen but may if morphine or other sedative drugs have been given.
- Blood pressure is usually maintained although worsening hypotension may occur in shocked casualties.

1438. Ketamine can cause increases in intracranial pressure (ICP) in spontaneously breathing casualties with intracranial pathology but, in ventilated casualties where blood carbon dioxide levels can be controlled, this is less of a problem.

1439. Ketamine given intravenously (1-2 mg/kg of body weight over 60 seconds) normally produces some 10 minutes of anaesthesia. An intramuscular dose of 10 mg/kg of body weight should, after five to ten minutes, produce 12 - 25 minutes of surgical anaesthesia.

1440. Recovery from Ketamine anaesthesia is associated with hallucinations. These can

be prevented or decreased with small doses of short acting intravenous benzodiazepines. *Use of benzodiazepines increases the risk of airway compromise.*

OTHER METHODS

Inhalation analgesia: Entonox

1441. Entonox is available in military hospitals and on some military ambulances. The mixture is provided from on demand, valved cylinders and administered via a mask mouth piece. Its use as a patient controlled, demand system, means that the casualty is unlikely to overdose himself. If they become drowsy they allow the mask or mouth piece to drop, stop inhaling the mixture, exhale the gas they have received and their level of unconsciousness recovers. Size D cylinders allow 20 - 30 minutes continuous use, the efficiency of which is improved by locating the demand valve at the patient's mouth piece.

Analgesia will peak some two to five minutes after starting inhalation and this fact needs to be respected when entonox is used to assist procedures such as casualty extraction.

1442. During storage, care must be taken to ensure that the temperature of the gas is not allowed to fall below minus 7°C. At this point, separation of the gases can permit delivery of a hypoxic mixture. Manufacturers recommendations are that such a cylinder should be rewarmed at 10°C for two hours then completely inverted three times (to mix the gases) or rapidly rewarmed by immersion in water at 37°C for five minutes then inverted three times. A practical solution to prevent this is to use a cylinder kept warm in a vehicle cabin (with the engine kept running periodically so as not to allow the cabin to cool overnight in a cold environment).

1443. **Contraindications.** Entonox should not be used:

- In decompression illness.
- In the presence of a pneumothorax unless there is a functioning chest drain in situ.

1444. The reason is that nitrous oxide is able to diffuse out of the blood stream into gas filled cavities (and bubbles) faster than nitrogen can be removed, causing increases in pressure and volume within these cavities and bubbles. Use in head injuries is discussed in paragraph 1454.

Local anaesthesia.

1445. Local anaesthetic blocks can provide safe and effective analgesia in acute trauma. There are a number of limitations in field conditions:

- Personnel with the appropriate anatomical knowledge and training may be not be available.
- Preparation of both casualty and materials is usually less than ideal in respect of access, positioning, fluid resuscitation and sterility.
- There may be insufficient time to perform and wait for the technique to work.
- Inadvertent toxic problems will be difficult to manage on scene.

Safety

1446. Safety is maximised by ensuring that an intravenous cannula has been sited in the casualty (to allow fluid resuscitation and treatment of allergic and toxic reactions to the local anaesthetics), that accidental intravascular injection of local anaesthetic does not occur and the recommended maximum safe doses (MSD) relevant to nerve block and infiltration techniques, are not exceeded).

1447. Lignocaine is a rapid acting local anaesthetic available in 0.5 l, or 2% concentrations with or without adrenaline. The MSD is 4 mg/kg of body weight without adrenaline and 6mg/kg of body weight with. 1% solutions are suitable for most infiltration and nerve block techniques. Use of solutions containing adrenaline are best avoided in the field, complications from systemic absorption of the adrenaline or incorrect injection to areas of vascular compromise, are then avoided.

1448. Specific blocks

- *Femoral nerve block.* Inject 10 to 15 ml of 1% lignocaine just below the inguinal ligament at a site 1.5 cm deep and 1.5 cm lateral to the femoral artery. Aspirate the syringe to check the artery has not been punctured. The block will onset in 5 to 15 minutes and last about an hour. It provides good analgesia for femoral shaft fractures allowing them to be reduced and splinted.
- *Haematoma block for reduction of closed wrist fractures.* This is useful when dealing with a large number of casualties. Attention to sterile technique is important to avoid introducing infection in the haematoma. *Adrenaline containing solutions should be avoided.* Inject 15 ml of 1% lignocaine into the fracture haematoma. The block will onset in about 5 minutes and last about one hour.
- *Intercostal nerve blocks* are used in hospitals to treat the pain from fractured ribs. They are also useful when placing chest drains in alert casualties. The practical danger when performing intercostal blocks is the risk of pneumothorax and short, small gauge needles must be employed.

Palpate the rib to be blocked in the posterior axillary line. **If the rib cannot be palpated – do not attempt the block.** Insert the needle through the skin until it hits bone close to the lower margin of the rib. When the needle contacts bone, slowly move it downwards until it just slips under the lower margin of the rib. Aspirate the syringe and check that there is no air or blood obtained. Inject 5 ml or 1% lignocaine. Good analgesia will usually require additional blocks at 1 or 2 levels above and below the fractures.

CLINICAL PROBLEMS

1449. *Analgesia for head injured battle casualties.* The initial management of head injuries should be carried out as described in Chapter 8, treating problems with **Airway, Breathing and Circulation**. Untreated pain may cause a rise in intracranial pressure which in turn, can worsen a developing brain injury. Excess use of morphine will cause respiratory depression (with hypoxia and hypercapnia) and pupillary assessment during neurological examination may become more difficult.

1450. Pain management in the head injured military casualty is a balance between treating the pain but not masking signs and symptoms of an injury needing neurosurgical attention. In other words: judicious use of analgesics, especially morphine.

1451. The casualty in coma (see paragraphs 0828-0831) after resuscitation is assumed not to be feeling pain.

1452. *Headache* in the casualty with minor and moderate head injury is treated with either paracetamol, NSAIDs or codeine phosphate. Severe headache associated with vomiting or neurological symptoms and signs may indicate an intracranial haematoma. The management of the casualty with an intracranial haematoma is described in Chapter 8.

1453. *Pain due to other injuries.* This is treated with a combination of nerve blocks, paracetamol and NSAIDs. Morphine is used as outlined in Table 14.1. Ideally, morphine if needed, is given as incremental intravenous doses but, if this is not possible, use IM as shown in the table. Level of consciousness and cardiorespiratory state need careful monitoring after using morphine.

1454. *Entonox and head injury.* In a casualty with a fractured skull, the nitrous oxide in entonox could increase the size of intracranial air collections. Practically, casualties with significant head injury are unlikely to be able to self administer entonox. In the casualty with mild concussion and pain from other injuries, entonox should be safe, particularly as the entonox is likely to be given over a short period of time.

Analgesia for battle casualties with chest injury

1455. Fractured ribs and other chest injuries are very painful. The act of breathing moves the broken ribs and makes the pain worse. The casualty is reluctant to take effective breathes resulting in retained secretions in the underlying lung, atelectasis, decreasing oxygenation and decreased carbon dioxide removal. Infection and respiratory failure may follow.

1456. The initial management of chest injuries should be carried out as described in Chapter 6, treating problems with **Airway, Breathing and Circulation**. These casualties need supplemental oxygen.

1457. After resuscitation, the pain of chest injury is treated with a combination of intercostal blocks, paracetamol or NSAIDs and incremental intravenous opiates. The hospital management will include physiotherapy and may also involve specialised analgesic techniques such as epidural or intrapleural blocks.

1458. The casualty presenting in respiratory failure needs initial ventilatory support as described in Chapter 4 and will need subsequent management in an intensive care unit.

1459. Entonox and chest injury. In a casualty with a pneumothorax the nitrous oxide in entonox could increase the size of the air collection and may even cause it to tension. A chest drain needs to be placed before entonox is used.

Mass casualties

1460. The provision of effective analgesia for mass casualties needs to be simple in its scope and application, supporting the principle of providing the greatest good for the greatest number. Following triage and resuscitation, intramuscular administration of analgesics is likely to be the most practical solution, particularly if personnel lack cannulation skills, resources are limited or casualties present in large numbers with minor injuries. The monitoring of such casualties may need to rely on minimally trained personnel using simple clinical parameters.

United Kingdom prescribing restrictions

1461. The Medicines Act (1968) and its secondary legislation provides a regulatory scheme of licences, registrations and exemptions which control all aspects of the production and distribution of all medicinal products.

1462. It classifies drugs as:

- General Sales List (GSL) medicines, suitable for unsupervised sale in shops or supermarkets.
- Pharmacy (P) only medicines, which can only be sold or supplied in a pharmacy under the direct supervision of a pharmacist.

- Prescription Only Medicines (POM), which can only be sold or supplied in accordance with a prescription issued by a fully registered medical practitioner.
1463. The Misuse of Drugs Act (1971) provides the basis of control for certain drugs. Drugs are placed into Class A, B or C based on the harmfulness attributable to a drug when it is misused. The penalties for unlawful possession of the more harmful drugs are more severe than for those considered less harmful.
1464. The Misuse of Drugs Act (1985) divides drugs into five schedules which define the classes of person authorised to supply and possess controlled drugs while acting in their professional capacities. Also covered are regulations for prescribing and record keeping.
1465. The Safe Custody Regulations (1973) define the type of cabinet or safe that should be used to store controlled drugs securely. These regulations refer to Schedule 2 and 3 drugs although many Schedule 3 drugs are exempted.

1466. Medical officers, nurses and medical personnel involved in aeromedical transport must be aware of potential legal difficulties imposed by crossing international borders. Most countries prohibit the import and export of medicines (including non-controlled drugs). For non-domestic flights, prior approval and certification from the Department of Health and the Home Office is advised.

SUMMARY

- Resuscitation using the BATLS method comes first.
- Effective analgesia is an essential part of casualty management.
- Methods used depend on your training, the number of casualties, the resources available and the injuries to be managed.
- Start simple, for example, splint limbs and cool burns.
- Effective analgesia may need a combination of techniques and drugs.
- If unsure, get help.

BATLS

Battlefield Advanced Trauma Life Support (BATLS)

SUPPLEMENT NO 1 PAEDIATRIC TRAUMA

Aim

1. On successfully completing this topic you will understand:

- The important differences in the anatomy and physiology of a child that affect trauma management.
- The similarities between children and

adults in the assessment and management of trauma.

Introduction

2. In terms of assessment and management following injury, children cannot simply be regarded as small adults. There are important anatomical, physiological, and psychological differences that must be considered in the **A B C D E** routine during the primary survey and resuscitation phases.

Anatomical differences

Airway

Differences	Associated problems
<ul style="list-style-type: none"> ● A large tongue in babies and small children. ● A relatively high anterior larynx. ● A large floppy leaf-shaped epiglottis. ● Poor support for the upper trachea other than the cricoid ring. 	<ul style="list-style-type: none"> ● Airway obstruction from the tongue. ● Difficulty in visualising the vocal cords. ● Need to modify tracheal intubation technique. ● Contraindication to surgical cricothyroidotomy under 12 years old.

Breathing

An elastic chest wall.	A tendency to underestimate severity of internal injuries in the absence of chest wall injury, particularly following blunt injury.
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Circulation

Difficult intravenous access.	Peripheral venous access can be particularly difficult in tiny children, or in any child if there is peripheral shut down. The intraosseous needle technique is a rapid, safe and effective alternative, or peripheral venous cut-down may be used.
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Disability

Difference	Associated problems
Under 4 years old, inability to speak fluently.	The Glasgow Coma Scale score cannot be used. The Paediatric Coma Scale score must be used instead. (See paragraph 15 of this Supplement).

Physiological differences

Airway

Difference	Associated problems
Small children are obligate nasal breathers.	Nasal obstruction is poorly tolerated.

Breathing

The respiratory rate and tidal volume vary with age.	An adult ventilation bag can be used, but with only enough tidal volume to make the chest rise. An adult face mask can also be used, but often gives a better seal if rotated through 180°.
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Circulation

The pulse rate and systolic blood pressure vary with age. As a rule, the normal systolic blood pressure for a child is $\text{systolic BP} = 80 + (\text{age} \times 2) \text{ mmHg}$. The normal ranges of childhood pulse rate, blood pressure and respiratory rates are shown opposite:	Age (yrs)	Pulse	Systolic BP	Respiration
	<1	110-160	70-90	30-40
	2-5	95-140	80-100	20-30
	5-12	80-120	90-110	15-20
	>12	60-100	100-120	12-15
The circulating blood volume in a child is relatively large than in an adult – 80-90 ml/kg.	A child can lose up to 40% of circulating blood volume before the blood pressure falls. Do not be caught out by an injured child who is normotensive.			

Psychological differences

Difference	Associated problems
Soldiers injured in battle can be remarkably ambivalent towards their injuries. This has something to do with their inherent camaraderie and concern for each other, and perhaps because injury heralds a temporary respite from the continual exposure to the stress of war.	An innocent child injured in conflict is unlikely to have this perception and will be in pain, frightened by his injuries and anxious about separation from a parent.

Primary Survey and Resuscitation

3. The primary survey and resuscitation follows the same systematic approach as in adults, the A B C D E routine.

Airway

4. The airway in children is opened by the chin-lift or jaw-thrust manoeuvre. A blind finger sweep should not be attempted, as the delicate tissues of the oropharynx can be damaged and the foreign body further impacted in the upper airway. To clear the airway use an oropharyngeal (*Guedel*) airway, *but this must be correctly sized*; if it is too large the glottis will be stimulated causing retching (with a rise in intracranial pressure), vomiting and aspiration. In children, the airway is inserted the *right-way-up*, not *upside-down* and rotated by 180°, as in adults. A nasopharyngeal airway can be improvised by cutting a tracheal tube to the appropriate length (from the nostril to the angle of the jaw). *The correct size of nasopharyngeal airway is one that just fits inside the nostril without causing blanching of the nasal skin.* Care must be taken not to cause bleeding from the nose.

5. Tracheal intubation remains the *gold standard* for securing a child's airway. The correct tube size is calculated by the formula: $(\text{age in years} \div 4) + 4 = \text{internal diameter in millimetres}$. *The correct internal diameter for the tracheal tube is the one that will just accept the child's little finger.* The tube length is important; the tracheal tube should be passed just below the vocal cords but no further. The short trachea makes endobronchial intubation likely. The position of the tracheal tube should be carefully checked by auscultating in both axillae. An *uncuffed* tracheal tube must be used in all children under the age of puberty.

6. Surgical cricothyroidotomy is contraindicated in children under 12 years old. A needle cricothyroidotomy, using an 18 gauge cannula, may be performed on a child under 12 years old for immediate resuscitation prior to tracheostomy (see page 4-25).

Breathing

7. All children who have been seriously injured require oxygen. A high flow rate and non-rebreathing reservoir mask should be used when available. Gastric distension is common with high flow oxygen, this distension may promote gastric regurgitation and aspiration and splint the diaphragm. A nasogastric or orogastric tube should be considered early in resuscitation. Chest trauma has the same spectrum of injuries and is managed in exactly the same way as for adults, using appropriately sized equipment.

Circulation

8. Fluid resuscitation is in millilitres per kilogram. This dosage begs the question *How do you work out the weight of a child?* There are four simple methods when scales are not available:

- Ask the parent.
- Use the formula $(\text{age in years} + 4) \times 2 = \text{weight in kilograms}$ (accurate up to ten years old).
- Use a resuscitation guide such as a modified *Oakley* Paediatric Resuscitation chart.
- Use a *Broselow* tape (this correlates the length of a child with a list of appropriate drug doses and tube sizes).

9. The following fluid resuscitation protocol is recommended for a child:

- 20 ml/kg crystalloid, as a bolus, reassess; then if no response

- 20 ml/kg colloid, as a bolus, reassess; then if no response
- 10ml/kg blood

Consider surgery, especially if the vital signs – pulse rate and blood pressure – do not improve after fluid therapy. All fluid should be warmed. Children have a larger surface area-to-volume ratio than adults and will cool more quickly when exposed. Hypothermia is a real threat and will be made worse by the use of cold resuscitation fluids.

10. Peripheral venous access can be attempted first but, if this is unsuccessful, move rapidly on to the intraosseous route. This is a rapid, safe and effective alternative for children under seven years old. A 16 gauge cannula is preferable, or a special intraosseous needle. The primary site is 1 to 2 cm below and medial to the tibial tuberosity. Any drug can be given by this route; remember that fluids must be syringed in, not just left to drip in. The needle can be stabilised by packing dental swabs between the skin and the flange and by supporting the limb in a splint. The intraosseous route is regarded as a resuscitation procedure and should be replaced by peripheral or central venous access for ongoing intravenous fluid. Osteomyelitis is rare (less than 0.5%).

Disability

11. The disability assessment in the primary survey is the same as in adults. Ask yourself – is the child;

- Alert?
- Voice – responding to?
- Pain – responding to?
- Unresponsive?

Assess the:

- Pupils for size and inequality.
- Posture for signs of severe brain injury (decorticate or decerebrate) which may present intermittently following painful stimuli.

Exposure

12. Exposure is necessary to make a complete examination (secondary survey), but remember that hypothermia is a real risk; consider exposing the child in stages. The head is an important site of heat loss.

13. It is worth including an additional step in the primary survey for children – this is *blood glucose* estimation. A stick test from a heel or finger prick is adequate. Children have small glycogen stores that are rapidly metabolised following the stress of an injury. A reduced level of response or consciousness may simply be due to hypoglycaemia, which is readily reversible with 2 ml/kg 10% dextrose, intravenously.

Secondary Survey and Definitive Treatment

14. A head-to-toe examination is essential to identify all injuries. These injuries are then sorted into priorities for definitive treatment. The examination, injuries and priorities are as in adults with some important differences described below.

Head injury

15. Head injury is the most common cause of death from blunt trauma in children surviving to reach hospital. Scalp lacerations can bleed profusely and, unlike the general rule for adults, haemorrhage may be sufficient to produce hypotension. The Glasgow Coma Scale cannot be applied to children under four years old; the Paediatric Coma Scale, which has a modified verbal response component, must be used in this age group:

- 5 points = Smiling.
- 4 points = Crying but consolable.
- 3 points = Crying and intermittently consolable (moaning).
- 2 points = Crying and inconsolable (irritable).
- 1 point = No response.

Abdominal injury

16. Isolated visceral abdominal injuries are sometimes managed conservatively in children. This is only possible when an accurate diagnosis can be made (for example with ultrasound or CT scanning) and the surgeon is experienced. There needs to be an adequate monitoring and round-the-clock surgical support. Diagnostic peritoneal lavage is not appropriate if the intention is to manage these injuries conservatively, as the presence of blood alone will not be an indication for surgery.

Spinal injury

17. Spinal injuries are uncommon in children and spinal immobilisation in an anxious child is often difficult. Adequate spinal immobilisation is still important until the injury has been excluded clinically and, where necessary, radiologically. If the child is very agitated it is better just to apply a semi-rigid collar and not tie the head down with tape and sand bags, as the rest of the body will continue to thrash about causing rotational stresses to the cervical spine. Pseudosubluxation of C2 on C3 is noted in 9% of X-rays of children under eight years old, with up to 40% of these showing tendencies towards this X-ray finding. If in doubt, the spine should be immobilised until the cervical spine X-ray has been assessed by a suitably qualified doctor.

Pain relief

18. Pain relief should be considered early once the primary survey has been carried out and resuscitation has been performed. The

following can be used:

- **Reassurance.** This costs nothing. A parent in the room can be as useful as any analgesic drug.
- **Splintage.** Fractured limbs should be splinted.
- **Entonox.** A 50:50 mixture of oxygen and nitrous oxide that is inhaled. This is useful for short painful procedures if the child will co-operate.
- **Morphine.** The dose in children is 0.1 to 0.2 mg/kg titrated slowly intravenously according to response. Intramuscular morphine should be avoided in the presence of shock.
- **Ketamine.** This is a useful analgesic for short, painful procedures, such as emergency manipulation of fractures or dislocations to restore a distal pulse. The analgesic dose is 0.5 to 1 mg/kg intravenously and up to 5 ml/kg intramuscularly. The onset of effect is five to ten minutes after intravenous administration and longer after intramuscular administration, so wait for an effect before you perform any painful procedure.

Ketamine is contraindicated in head injuries. In larger doses it is an anaesthetic and should only be used by experienced doctors with appropriate facilities available.

Summary

- The principles of trauma management in children and adults are the same although there are important anatomical, physiological and psychological differences between children and adults.

- Remember the **A B C D E** routine.

SUPPLEMENT NO 2 HELICOPTER EVACUATION

Introduction

1. After initial BATLS resuscitation, casualties requiring surgery have to be moved out from the RAP to a forward surgical team or a field hospital. After initial surgery has been performed at these facilities, casualties may need to be moved again for further surgery. These transfers may involve military helicopters. Aeromed trained personnel of the RAF normally evacuate casualties, but operational situations may preclude the use of these escorts and untrained personnel may have to be utilised in the best interest of the casualty.

2. It is strongly advised that if untrained personnel are utilised for the transportation of casualties by helicopter, the organising medical officer contacts the Aeromedical Evacuation Co-ordinating Officer (AECO) or the Aeromedical Evacuation Liaison Officer (AELO) for advice. In normal circumstances a field hospital will have an AELO, who will be responsible for co-ordinating casualty pre-

paration and evacuation.

3. Aim to become confident and proficient about working around and with helicopters before you have to prepare a casualty for flight, escort a casualty in flight or work with aircraft in an emergency.

Golden rules to be observed when working with helicopters

Approaching the helicopter

- Do not approach within 30 metres (100 feet) of a helicopter, or leave the aircraft without a clear signal from the aircrew to do so. A *thumbs up* by day, *one flash of light* (by torch) by night.
- Always approach the aircraft from the correct direction. In general, this is the 2-3 o'clock position, except for the Chinook, which is approached from the 4-5 o'clock or 7-8 o'clock position.
- Particular care is to be taken when working on sloping or uneven ground. Remember, on an uphill slope the rotor blades will be nearer the ground.
- Casualties may have to be loaded while the rotor blades are still turning. Because of the downwash created by the rotor blades, all headgear is to be removed and loose articles secured, before approaching the aircraft.

General safety

- No smoking inside or within 15 metres (50 feet) of the aircraft.
- Personal belongings must be kept to a minimum.
- All personal weapons should be unloaded and the magazine removed before approaching the aircraft.
- Do not enter the inside of the cabin unless instructed to do so.
- Do not touch anything while inside the cabin unless instructed to do so.

Be particularly careful of those areas painted with black and yellow stripes. These are emergency controls.

- All helicopters are extremely noisy aircraft. This noise is to be considered a hazard and hearing protection is to be worn when in their vicinity (including casualties).
- Do not move about the aircraft during flight, especially the Puma and Wessex without first informing the crew.

Casualty considerations

- The aircrew must be informed of any flying restrictions imposed by the casualty's clinical condition prior to the flight.
- Casualties on stretchers are to be brought to the aircraft feet first, except for the Chinook, when casualties are to be brought to the aircraft head first.

Emergency procedures

4. Obey all orders given by the aircrew. In an emergency situation the instructions of the

aircrew *must always* be carried out *immediately*.

5. In the event of an emergency, the aircrew will brief you. Ensure that you are strapped in correctly (your casualties should be strapped in at all times). Brace yourself in readiness for impact and above all *keep calm*. On landing, wait until the rotors have stopped, unfasten casualties and make good your's and the casualty's escape.

6. In a ditching situation (emergency landing on water) remain calm, fit your life jacket (do not inflate until you have completely exited the aircraft). Brief conscious casualties on how and when to release their harness. Identify the nearest exit. Following impact with the water, the helicopter may begin to tumble. Hold your breath and wait for the aircraft to come to rest, then vacate through the exit and rise to the surface. If the airframe remains afloat, follow the instructions of the aircrew.

Military Helicopters

7. Military helicopters have two methods of carrying casualties in the Air Ambulance role:

- Rapid reaction (hot extraction).
- Multi-stretcher fit (aeromedical transportation).

8. As the aeromedical evacuation squadron will always undertake the aeromedical transportation, this section will concentrate on the rapid reaction method of transportation, where in unusual circumstances it may become necessary for untrained personnel to escort casualties.

The Puma

9. The Puma is a single main rotor, twin engine helicopter. Its main role is to provide tactical support but is often used in a casevac role. This extremely versatile aircraft, when conditions dictate, can accommodate usually two stretchers (but can take three) or six walking casualties (or a combination between the two maximums) in the rapid reaction role (see Fig Suppl 2.1).

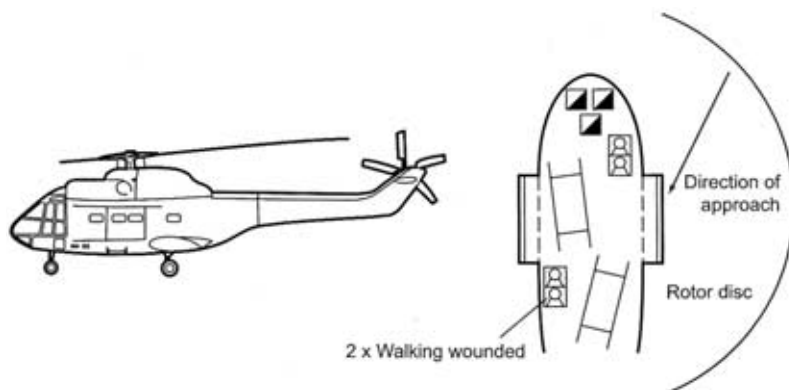


Fig Suppl 2.1 Puma helicopter.

Danger points

10. *Main rotor*. The main rotor is 15.8 metres (49.5 feet) in diameter and drops to a low point of 3.65 metres (12 feet) approximately on level ground.

11. *Tail rotor*. The tail rotor is 3.05 metres (10 feet) in diameter and reaches a low point of 2.05 metres (6.75 feet) on level ground.

12. *Fragile windows and doors*. The main cabin doors, the cockpit access door and the co-pilot's jettisonable panel are all made of light-alloy and transparent materials. Use care when operating the cabin door and stay well clear of these areas when in flight.

Loading sequence

13. The *ready position* is 30 metres (100 feet) out from the helicopter at the 2 o'clock position.

14. *Emplaning*. Approach the helicopter only when signalled to do so by the aircrew. The approach is from the ready position to the starboard cabin door. Casualties are loaded feet first and are secured with their heads forward (except when contraindicated by the casualty's injuries, particularly those with head injuries who, whenever possible, should not fly in a head-down position).

15. The stretchers are loaded in the following sequence.

- Port rear.
- Starboard rear.
- Port centre.

16. Unloading is the reverse of loading.

The Chinook

17. The chinook is a tandem rotor, medium lift helicopter designed to operate in all weather conditions. It is designed for trooping, tactical support, internal/external freight carrying, parachuting, rescue and aeromedical roles. In tactical conditions, up to ten stretchers cases can be secured directly to the helicopter floor, the extra space required to achieve this is obtained by detaching the seating from floor points and folding them back (see Fig Suppl 2.2).

Danger points

18. *Twin rotors*. The twin rotors are 18.3 metres (60 feet) in diameter and the forward rotor can drop to a low point of 1.34 metres (4.5 feet) on level ground.

19. *Engine and auxillary power unit (APU) exhaust*. The exhaust gases from the engines and APU are blown to the rear of the aircraft. These gases are extremely hot and care must be taken when emplaning.

20. *Engine noise*. The Chinook is an extremely noisy aircraft and it is essential that hearing protection be worn in and around

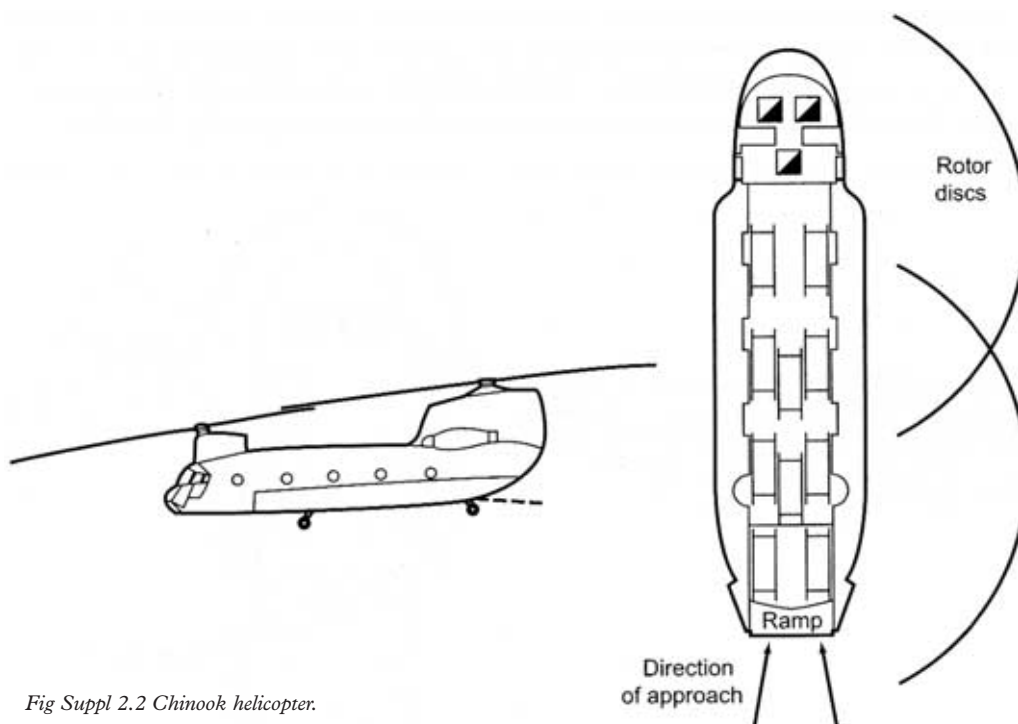


Fig Suppl 2.2 Chinook helicopter.

this aircraft. Failure to do so is likely to cause permanent hearing damage.

Loading sequence

21. The *ready position* is 30 metres (100 feet) out from the helicopter between the 4/5 o'clock and 7/8 o'clock positions.

22. *Emplaning.* The approach to the aircraft is from the ready position to the edge of the ramp (when loading and unloading casualties, only the ramp is to be used). Casualties are to be carried headfirst onto the aircraft and positioned with their heads forward, this includes those with head injuries. A member of the aircrew will control the loading and securing of the casualties.

The Sea King

23. The Sea King is a single main rotoed, twin engined, all weather tactical support helicopter. This aircraft is extremely versatile but is primarily used for troop transport, carriage of underslung loads and search and rescue. In the rapid reaction role, up to six stretchers can be secured to the floor. This layout is heavily dependent on the aircraft's configuration and the theatre of operation. In a combat zone, it will be more likely to carry four stretchers (see Fig Suppl 2.3).

Danger points

24. *Main rotor.* The main rotor is 21.34 metres (70 feet) in diameter and drops low as the blades slow to a halt. **Do not enter the disc area during engine shut down.**

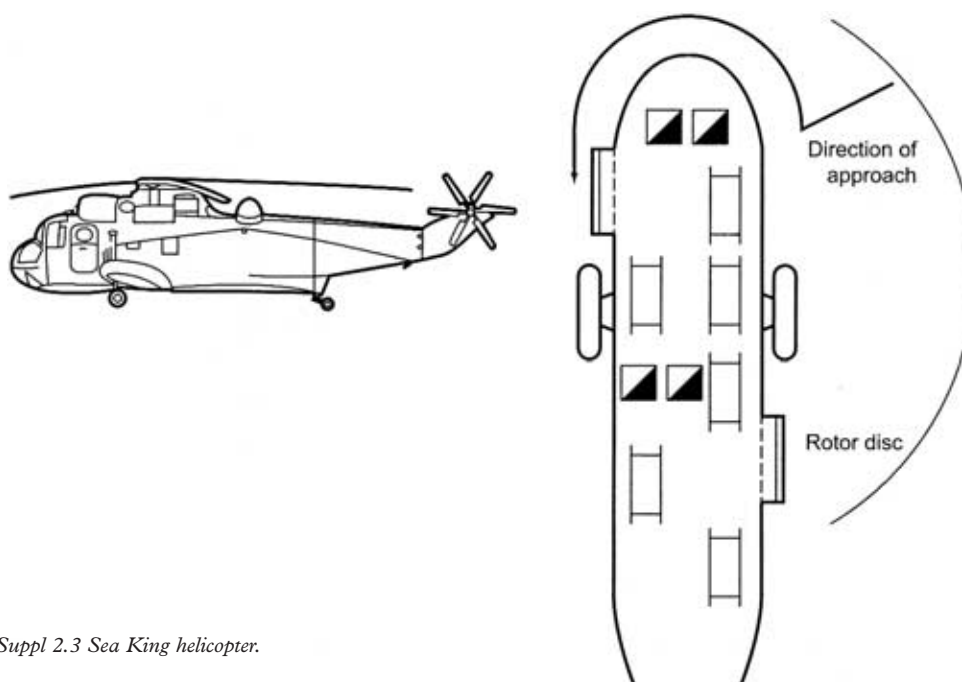


Fig Suppl 2.3 Sea King helicopter.

25. *Engine intakes and exhausts.* The engine intakes are situated above the cockpit and the exhaust gases are blown to the side and may radiate up to 8 metres from the main rotor assembly.

26. *Tail rotor.* The tail rotor is 3.96 metres (13 feet) in diameter and reaches a low point of 2.74 metres (9 feet) on level ground.

27. *Other danger areas* include the Flootation Bag Canister covers (can travel up to 60 metres (200 feet) when operated), the high frequency aerial and General Purpose Machine Gun (GPMG) where fitted. There is also an Ice Accretion Indicator at eye level on the forward port side.

Loading sequence

28. The *ready position* is 30 metres (100 feet) out from the aircraft at the 2 o'clock position.

29. *Emplaning.* The approach is from the ready position to the main starboard side door. The casualties are loaded headfirst into the cabin and positioned with their head forward, the exception again being those with head injuries.

The Wessex

30. The Wessex is a single rotored, twin engined, extremely versatile utility helicopter. In the rapid reaction role this aircraft can accommodate two stretcher casualties secured directly to the floor and up to three walking casualties. This configuration allows for a minimal amount of time spent on the ground (see Fig Suppl 2.4).

Danger points

31. *Main rotor.* The main rotor is 17.06 metres (56 feet) in diameter and drops to a low point of 2.59 metres (8.5 feet) on level ground.

32. *Engine intakes and exhausts.* The main engine intake is located in the nose of the aircraft. There are two exhaust pipes on either side of the aircraft situated just below the

cockpit side windows.

33. *Tail rotor.* The tail rotor is 2.89 metres (9.5 feet) in diameter and has a maximum ground clearance of 2 metres (6.75 feet) on level ground.

Loading sequence

34. The *ready position* is 30 metres (100 feet) out from the aircraft at the 2 o'clock position.

35. *Emplaning.* The approach is from the ready position to the starboard cabin door. Stretcher cases are loaded in the following sequence.

- Port centre.
- Starboard rear.

36. Casualties are loaded into the cabin feet first and secured with their heads forward, except head injuries.

Universal hazards

37. Personnel on the ground should avoid looking at the IR Jammers fitted to the fuselage, eye damage may be sustained if viewed at a distance closer than 4.5 metres (15 feet). There may be chaff and flare dispensers fitted to the aircraft and close proximity to these must be avoided. HF aerial antennae must also be avoided.

Clinical criteria

General

38. In a *hot extraction* situation, particularly when there is extreme danger to the aircraft (a soft-skinned vehicle!) and personnel, a 'scoop and scoot' approach may be necessary. This will move you, the casualty and the aircraft to a safer environment *but* will almost certainly mean little by way of clinical intervention, other than clearing and maintaining an airway, can be carried out.

39. Whenever feasible, the casualty should be as stable as possible before casevac, with a secure airway and other life-saving procedures, such as chest drain insertion carried out *before* emplaning. Remember, once airborne it is extremely difficult verging on

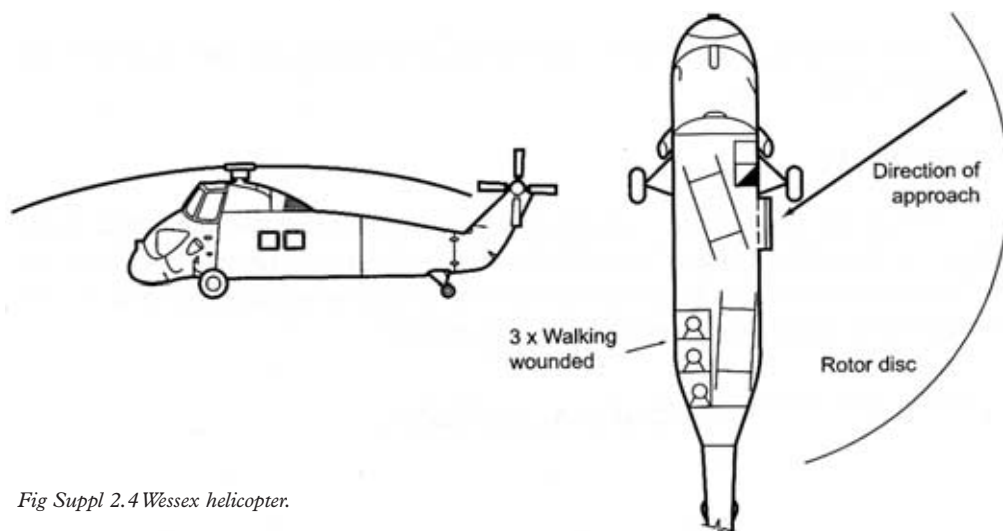


Fig Suppl 2.4 Wessex helicopter.

the impossible, to carry out these procedures. Even palpating a pulse at the carotid may be rendered impossible due to aircraft vibration. If portable electronic monitoring aids are available, use them!

40. Although most of the following clinical criteria apply more to evacuation by fixed-wing aircraft in the aeromed role, they should still be borne in mind when helicopter evacuation is employed.

41. The medical employment of Air Transport in the Forward Area is governed by NATO Standardisation Agreement (STANAG) No 2087. This agreement defines who, how, when and where casualties can be evacuated from the battlefield.

42. The remainder of this supplement gives some broad guidance to medical personnel for the transportation of the more common battlefield injuries/conditions. There are no absolute medical contraindications to air movement, but some precautions are required with certain clinical conditions.

Surgery

43. Significant gastrointestinal dilation may occur due to gas expansion at altitude; any casualty who has undergone a laparotomy should not normally be emplaned within ten days of the operation. This interval should be extended to 21 days in the case of a thoracotomy. In an emergency, these casualties can be flown providing a sea level cabin altitude is maintained.

Head trauma/neurosurgery

44. *Raised Intracranial Pressure (ICP)*. Any casualty who presents with clinical signs of raised ICP will require a medical escort with easy access to resuscitation equipment. There is no requirement for any altitude restriction, as the altitudes at which military helicopters fly do not lead to any significant rise in ICP.

45. *Subarachnoid haemorrhage (SAH)*. Ideally, casualties should only be evacuated when their condition is stable and accompanied by a medical officer. No altitude restrictions apply but evacuation should be direct to a pre-arranged neurosurgical centre.

46. *Intracranial haematoma/Intracerebral haemorrhage*. The haemorrhage/haematoma should be evacuated prior to the casualty being transferred, but if this is not possible they should be accompanied by medically trained personnel with appropriate resuscitation equipment and flown in a head-up position.

47. *Fractured skull*. A casualty who has sustained a fractured skull, particularly open fractures complicated by intracranial air, should be evacuated at sea level.

Chest trauma

48. *Pneumothorax/Tension pneumothorax*. Any casualty who has sustained a pneumothorax/tension pneumothorax or has air in the pleura cannot be evacuated by helicopter unless a chest drain is in situ, attached to either a Heimlich valve or closed chest drain bag.

Orthopaedics

49. *Fractures*. Limbs may swell under fracture immobilisation casts, it is important to follow the appropriate guidelines:

- *Plaster of Paris (POP)*. A recently applied POP (less than 72 hours) must be bi-valved prior to evacuation. Older POP casts may be left, but the casualty must be escorted, with plaster shears available, to bi-valve the cast if required.

- *Synthetic casts*. Synthetic casts are virtually impossible to cut in-flight. More caution must be exercised before emplaning a casualty with such a cast. Synthetic casts must be bi-valved if the cast has been applied for less than 10 days.

Maxillofacial trauma

50. All casualties with maxillofacial trauma must have a secured airway prior to evacuation. Casualties who have had external fixation of the jaw must be accompanied by an escort who has the means of releasing the fixation (wire cutters) immediately available. (Motion sickness may cause the casualty to vomit in-flight).

Ophthalmic trauma

51. A casualty who has a penetrating eye injury or suspected penetrating eye injury is to have two sterile pads applied to the injured eye and systemic antibiotic therapy commenced prior to evacuation. The casualty may travel sitting and no altitude restrictions are required: ideally, space permitting, they should travel as a stretcher case.

52. Any ophthalmic case which has been operated on and in which the surgeon has injected air can be evacuated as a sitting case but cabin altitude must be restricted to 600 metres (2000 feet).

Summary

Preparation of casualties for flight

The vast majority of casualties will only require a *common sense* approach to their preparation for evacuation, by asking simple questions, most problems can be identified and resolved prior to the evacuation.

Ask?

- Are aeromed teams available to undertake this task? (Contact them).
- If aeromed teams are unavailable but can offer advice, talk to them.
- Where is the onward destination and are they expecting the casualty. (Check).
- Is the destination suitable for the casualty

and the aircraft type? (Check).

- What level of training is required to transfer the casualty? (Cbt Med Tech/RGN/ MO).

- Are the appropriate aeromed stretchers and harnesses available? (If not get them).

- Are all the casualty's documentation and X-rays available for transportation with the casualty? (Check).

- Does the casualty require a secure airway, intravenous access or fluid resuscitation prior to or during flight? (Ideally, the casualty must be as stable as possible prior to flight).

- Are all IV lines taped and secure. (Check them).

- Is there sufficient oxygen supply on board for the casualty's(ies) needs to complete the journey and cope with delays? This especially applies if the ventilator is air or oxygen driven.

- Has the electrical medical equipment required for transportation been cleared for use on the aircraft? (Talk to the aircrew). This equipment may be necessary for in-flight

monitoring. Even simple tasks such as counting a pulse rate using the carotid artery, may be impossible in a vibrating airframe.

- How is the casualty going to be positioned on board the aircraft and does the escort have access? (Find out).

- If the flight is tactical and at night, the aircrew may be using night vision goggles, can any light be used in the cabin? (On chinooks the crew may be able to provide a blacked out area; in other aircraft torches with green filters will have to be used and monitoring undertaken by touch. Check the situation with the crew and be prepared to adapt).

- It is very difficult to care for a casualty in the air, particularly on a helicopter. It is extremely important to prepare the casualty properly prior to the flight. A few extra minutes on the ground preparing the casualty may ultimately save their life. However, the tactical situation or the condition of the casualty may dictate the *scoop and scoot* approach, rather than *stay and play*.