ABC of Major Trauma

FOURTH EDITION

Edited by David V. Skinner and Peter A. Driscoll

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ABC of

Major Trauma

Fourth Edition

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Foreword

As a contributor and user of this book, I am delighted to see a fourth edition published. It represents a most useful core text for those seeking a contemporary practical guide to assess and deliver the best trauma care for those patients who are ''candidate major traumas''. All counties and healthcare systems are different and some changing, but the core principles of management are common. This text, through its breadth of expert contributors, succinctly describes these. Reading each chapter feels like you've just had a really good tutorial on the subject and represents a very efficient method of acquiring knowledge. I would certainly recommend you keep a copy of this publication close by whether preparing for your on-call day or a teaching session.

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Preface

This edition of the *ABC of Major Trauma* has had a long gestation, being 12 years since the third edition.

Trauma care continues to evolve and improve both in the 'front line' and nationally with the development of Trauma Centres and supporting networks. Prevention is also playing its part, with deaths on the roads continuing to fall.

There is, however, no room for complacency and we hope this fourth edition will remind our readership of the crucial importance of a thorough, stepwise assessment of the trauma patient and that attention to detail, not least in spinal care, can avoid the devastating consequences of the 'second' injury.

This edition sees extensive revision of all its chapters and the addition of further material. At the time of publishing all information is current.

The book is aimed at all clinicians involved in front line trauma care, paramedics, hospital doctors and nurses as well as those members of the 'team', crucial to optimal management, including radiographers, radiologists and laboratory staff.

Chapter 29 reminds us of the excellent facilities available to us in UK practice. However, this chapter also shows us that simple manoeuvres can be life saving in the Third World environment.

The continuing conflicts around the world involving UK armed forces has resulted in improved trauma management in these conflict zones. Lessons learnt and techniques developed have been shared with civilian clinicians to the benefit of patients. Many authors in this edition have put themselves in 'harms way' to manage victims of conflict. This edition is dedicated to them.

David V. Skinner

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David V. Skinner

List of Abbreviations

5-HT	5-hydroxytryptamine
ABC	airway, breathing, circulation
ACE	angiotensin-converting enzyme inhibitor
AIC	ambulance incident commander
AIS	Abbreviated Injury Scale
AP	anteroposterior
APLS	Advanced Paediatric Life Support
ARDS	acute respiratory distress syndrome
ASD	acute stress disorders
ATLS	Advanced Trauma Life Support
ATP	adenosine triphosphate
BATLS	Battlefield Advanced Trauma Life Support
BP	blood pressure
BVM	bag-valve-mask
CAT	computed axial tomography
CBF	cerebral blood flow
CBT	cognitive-behavioural therapy
CCS	casualty clearing station
CHaPD	Chemical Hazards and Poisons Division
COPD	chronic obstructive pulmonary disease
CPB	cardiopulmonary bypass
CPP	cerebral perfusion pressure
CPR	cardiopulmonary resuscitation
CRT	capillary refill time
CSF	cerebrospinal fluid
CT	computed tomography
CXR	chest X-ray
DCLHb	diaspirin cross-linked haemoglobin solution
DIC	disseminated intravascular coagulation
DPL	diagnostic peritoneal lavage
DVT	deep venous thrombosis
ECG	electrocardiogram
ECMO	extracorporeal membranous oxygenation
ED	emergency department
EEG	electroencephalogram
ET	endotracheal
ETA	expected time of arrival
$ETCO_2$	end-tidal carbon dioxide concentration
FAST	focused assessment with sonography in trauma
FBC	full blood count
FFP	fresh frozen plasma
FiO_2	fraction of inspired oxygen
FRC	functional residual capacity
GCS	Glasgow Coma Scale
GDP	Gross Domestic Product
GP	general practitioner
HART	hazardous area response team
HBOC	haemoglobin-based oxygen carrier
HCT	hospital co-ordination team
HCVR	hypercapnic ventilatory response
HPA	Health Protection Agency/hypothalamo-pituitary-adrenal
HR	heart rate
HVR	hypoxic ventilatory response
ICP	intracranial pressure
ICU	intensive care unit
I/E	inspiratory/expiratory
IED	improvised explosive device
IO	intraosseous
IPE	individual protective equipment
ISS	Injury Severity Score
ITU	intensive therapy unit
IV	intravenous
MAP	mean arterial pressure
MERIT	medical emergency incident response team
MIC	medical incident commander
MODS	multiorgan dysfunction syndrome
MRI	magnetic resonance imaging
NAI	non-accidental injury
NGT	nasogastric tube
NICE	National Institute for Health and Clinical Excellence
NPIS	National Poisons Information Service
NSAID	non-steroidal anti-inflammatory drug
PEEP	positive end-expiratory pressure
PPE	personal protective equipment
PPH	postpartum haemorrhage
PTA	post-traumatic amnesia
PTC	Primary Trauma Care
PTSD	post-traumatic stress disorder
RSI	rapid-sequence induction
RTA	road traffic accident
RTC	road traffic crash
RTS	Revised Trauma Score
SaO_2	oxygen saturation

SCIWORA	spinal cord injury without radiological abnormality
SHO	senior house officer
SIGN	Scottish Intercollegiate Guidelines Network
SIRS	systemic inflammatory response syndrome
SXR	plain radiograph of the skull
TARN	Trauma Audit and Research Network
TNF	tumour necrosis factor
US	ultrasound
USAR	urban search and rescue
WHO	World Health Organization
ZPP	zone of partial preservation

CHAPTER 1

Initial Assessment and Management: Primary Survey and Resuscitation

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OVERVIEW

- Initial management of trauma victims requires a team approach in which each member carries out a specific task. Collectively, the team should aim to treat all the immediately life-threatening conditions and identify the need for surgery early.
- The ABC (airway, breathing, circulation) approach provides an optimal system whereby urgent, potentially life-threatening conditions are dealt with first.
- The critically injured patient requires a calm rapid response to his/her injuries, in the field, resuscitation room and operating theatre. If prehospital personnel, the resuscitation room team and its leader, as well as the appropriate surgeons can deliver this, then lives will be saved and unnecessary deaths avoided. Any deaths that do occur will have been unavoidable. The team should also be aware of this and suitably debriefed.

Morbidity and mortality in seriously injured patients, managed in UK hospitals, remain higher than necessary. Recognition of this problem over the last 25 years has seen a variety of initiatives designed to improve the situation, including the introduction of Advanced Trauma Life Support (ATLS) to clinical practice, the widespread use of the auditing tool TARN (Trauma Audit and Research Network), and the deployment of multidisciplinary trauma teams to manage trauma victims in emergency department (ED) resuscitation rooms. Increasingly, consultant-delivered services, where available, will further enhance care.

For each individual patient, however, survival and reduction of long-term disability depend on the rapid deployment of skilled prehospital clinicians (paramedics and/or doctors), the skills and experience of the receiving clinicians (trauma team) and the human and other resources available round the clock to deal with patient injuries in a timely and effective fashion.

Most seriously injured patients seen in UK EDs have suffered blunt trauma. This, by its very nature, presents its own unique set of difficulties for the clinician, not least because serious life-threatening injuries may be initially covert, especially in the young. Prehospital clinicians may not recognise potential problems; this may be further compounded by a failure of recognition by the receiving hospital, leading to inappropriate triage. Lone junior doctors may then find themselves assessing a deteriorating trauma patient in an unmonitored area of the ED, leading to potential catastrophe.

All ED doctors should therefore be ATLS trained and encouraged to have a very low threshold for 'upgrading' such patients without delay to the resuscitation room for a team response. Such upgrade should include not only the deteriorating patient, but also those in whom the mechanism of injury suggests the possibility of serious problems. In the authors' experience, most problems arise from a failure to understand, or take note of, the mechanism's injurious potential, rather than poor management of an overtly seriously injured patient.

Comprehensive management protocols (usually ATLS) must be followed to the letter. Short cuts expose patients to risk which will lead some into difficulty. The 'experienced' clinician's personal opinion must be outweighed every time by the multitude of experienced clinicians who devised the protocol. Such protocols are frequently driven by the need to avoid the errors of the past.

The introduction of trauma centres will hopefully produce a further improvement in trauma care but in the end, individual clinicians, either working alone or as trauma team leaders, bear the responsibility for ensuring optimum care.

Effective ED care depends on the following.

- Safe, accurate receipt of prehospital information regarding the trauma victim or victims.
- Assembly of a competent trauma team, competently led, and dressed in protective clothing.
- The team's ability to identify immediately life-threatening problems and begin their correction.
- Limiting investigations and interventions to those crucial to addressing life-threatening problems.
- Ready availability of all investigation modalities, and a suitably urgent response by labs, radiology, intensive therapy units (ITU) and theatres.
- The additional ability to sensibly allocate resources when a multivictim response is needed.

Trauma centre 'feeder units' will not have the resources and manpower to provide a full trauma team response 24 hours a day,

ABC of Major Trauma, Fourth Edition. Edited by David V. Skinner and Peter A. Driscoll.

7 days a week. In spite of this and given the difficulty of complete triage accuracy in the prehospital field, seriously injured patients will continue to arrive at such feeder centres. It is crucial therefore that such patients are managed in a logical way, based on ATLS, before possible onward transfer to a trauma centre. The main difference will be that the resuscitation phase will take longer given the reduced numbers in the trauma team.

Where a trauma team can be made available round the clock then it is in the patient's interests that it should be deployed. The following text suggests one way in which such a team should be developed and deployed. Individual centres will decide on the exact composition of such teams and comparative national data will identify the optimum team size and composition.

The trauma team

Personnel

The trauma team (Figure 1.1) should initially comprise four doctors, five nurses and a radiographer. The medical team consists of a team leader, an 'airway' doctor and two 'circulation' doctors. The nursing team comprises a team leader, an 'airway' nurse, two 'circulation' nurses and a 'relatives' nurse.

Team members' roles

Examples of paired roles and tasks are given below but assignments may vary among units depending on the resources available. To avoid chaos, no more than six people should be touching the patient. The other team members must keep well back. The objectives of the trauma team are shown in Box 1.1.

Box 1.1 **Objectives of the trauma team**

- Identify and correct life-threatening injuries.
- Commence resuscitation.
- Determine the nature and extent of other injuries.
- Prioritise investigation/treatment needs.
- Prepare and transport the patient to a place of continuing care.

Figure 1.1 Trauma team in action.

Figure 1.2 The resuscitation room: preparing for the patient's arrival.

Before the patient arrives

All EDs should be warned by the ambulance service of the impending arrival of a seriously injured patient. This communication system can also provide the trauma team with helpful information about the patient's condition and the paramedics' prehospital interventions.

After the warning, the team should assemble in the resuscitation room (Figure 1.2) and put on protective clothing. A safe minimum would be rubber latex gloves, plastic aprons and eye protection because all blood and body fluids should be assumed to carry HIV and hepatitis viruses. Ideally, full protective clothing should be worn by each member of the team, and all must have been immunised against tetanus and the hepatitis B virus. Trauma patients often have sharp objects such as glass and other debris in their clothing and hair and on their skin, and therefore suitable precautions must be taken by all team members.

While protective clothing is being put on, the team leader should brief the team, allocating roles and responsibilities. A final check of the equipment by the appropriate team members can then be made. As the resuscitation room must be kept fully stocked and ready for use at any time, only minimum preparation should be necessary.

Roles of trauma team members

Medical and other staff

Team leader

- Co-ordinates the activities of the whole team.
- Performs a rapid initial primary survey to identify any immediately life-threatening problems.
- Ensures that airway and circulation team members are managing their roles rapidly.
- Allocates a suitably skilled team member to any task necessary, e.g. chest drain.
- Constantly prioritises patient's needs and team's activities.
- Ensures all information from prehospital team is noted.

- Ensures that other specialist clinicians are urgently alerted as soon as their need is identified.

Airway doctor

- Clears and secures the airway while taking appropriate cervical spine precautions.
- Inserts central and arterial lines if required.

Circulation doctors

- Assist in the removal of the patient's clothes.
- Establish peripheral intravenous infusions and take blood samples for investigations.
- Carry out other procedures depending on their skill level.

Radiographer

- Takes three standard X-ray films on all patients subjected to blunt trauma: chest, pelvis and lateral cervical spine.

Nursing staff

Team leader

- Co-ordinates the nursing team and liaises with the medical team leader.
- Records clinical findings, laboratory results, intravenous fluid and drug infusion, and the vital signs as called out by the circulation nurse.
- Prepares sterile packs for procedures.
- Assists the circulation nurses and brings extra equipment as necessary.

Airway nurse

- Assists in securing the airway and the cervical spine.
- Establishes a rapport with the patient in the resuscitation room. Ideally all information should be fed through this nurse to the patient.

Circulation nurses

- Assist in the removal of the patient's clothes.
- Assist with starting intravenous infusions, blood bottle labelling and other tasks allocated to the circulation doctor.
- Measure the vital signs and connect the patient to the monitors.

Relatives' nurse

- Cares for the patient's relatives.

Reception and transfer

The team leader should meet the patient and prehospital team in the ambulance bay and accompany them to the resuscitation room. The essential prehospital information required by the trauma team is shown in Box 1.2. The nursing team leader should start the stop clock so that accurate times can be recorded.

Box 1.2 **Essential prehospital information**

- Nature of the incident.
- Number, age and sex of the casualties.
- The patient's complaints, priorities and injuries.
- Airway, ventilatory and circulatory status.
- The conscious level and spinal status.
- Estimated time of arrival.

The transfer of the patient from stretcher to trolley must be co-ordinated to avoid rotation of the spinal column or exacerbation of pre-existing injuries (see Chapter 8). Team members should also check that lines and leads are free so that they do not become disconnected or snagged.

Primary survey and resuscitation

The objectives of this phase are to identify and treat any immediately life-threatening condition (Box 1.3). Each patient should be assessed in the same way, and the appropriate tasks performed automatically and simultaneously by the team. It is vital that problems are anticipated and prepared for, rather than reacted to. If the patient deteriorates at any stage, the medical team leader must reassess the patient, beginning again with the airway.

Box 1.3 **Objectives**

- **Primary survey and resuscitation**
  - Airway and cervical spine control
  - Breathing
  - Circulation and haemorrhage control
  - Dysfunction of the central nervous system
  - Exposure and environmental control
- **Secondary survey**
- **Definitive care**

As previously suggested, the team leader should perform a rapid primary survey to identify immediately life-threatening conditions. This should take no longer than 1–2 min. The management of individual problems identified in this rapid primary survey is detailed below. The tasks are allocated to team members and take place concurrently rather than in a stepwise approach as laid out below.

Airway management, with cervical spine protection

Assume that the cervical spine has been damaged if there is a history of a high-speed impact, head injury, neck pain or any positive neurology. If the ambulance service have immobilised then assume a C-spine injury until proven otherwise. The doctor dealing with the airway should talk to the patient with the neck immobile and if the patient replies appropriately with a normal voice, then

the airway is patent and the brain is being perfused adequately with oxygenated blood. If there is no reply, the patient's airway should be checked, cleared and managed appropriately. This is the first and pre-eminent priority.

The complications of alcohol ingestion and possible injuries to the chest and abdomen increase the chance of regurgitation. If the patient does vomit and is on a spinal board, the trolley should be tipped head down by 20° and the vomit sucked away with a rigid sucker as it appears in the mouth. If not on a spinal board then log roll the patient and suck out.

Progressively interventionist manoeuvres should be employed as necessary including chin lift/jaw thrust, Guedel airway (Figure 1.3) insertion (although these can precipitate vomiting) and deployment of a nasopharyngeal airway (Figure 1.4) which is preferred (less likely to cause vomiting) provided that there is no evidence of a base of skull fracture.

Apnoeic patients require ventilation with a bag-valve-mask device initially but this may lead to gastric distension with air and can induce vomiting, so early intubation should be considered. Orotracheal intubation with in-line stabilisation of the neck is recommended, rather than nasotracheal intubation. If this proves impossible (rarely) then a surgical airway must be provided.

Figure 1.3 Guedel airway.

Figure 1.4 Nasopharyngeal airway.

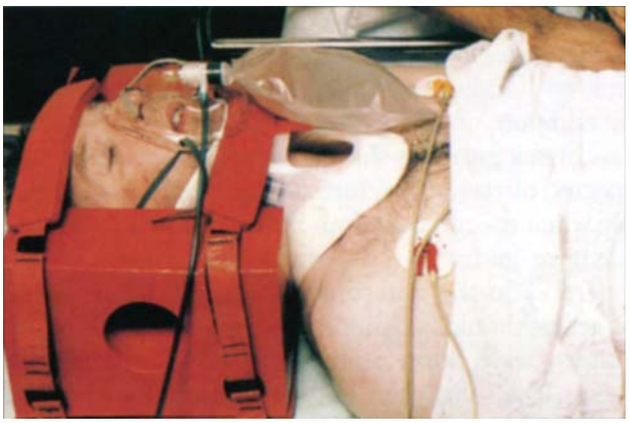

Figure 1.5 Patient with rigid collar in place.

Once the airway has been cleared and secured, every patient should receive 100% oxygen at a flow rate of 15 L/min. The neck must then be examined for wounds, tracheal position, venous distension, surgical emphysema and laryngeal crepitus. Confirmation of the security of the cervical spine, using a semi-rigid collar, sand bags and tape, is crucial. The only exception is the restless and thrashing patient. Here the cervical spine can be damaged by immobilising the head and neck while allowing the rest of the body to move. Suboptimal immobilisation with just a semi-rigid collar is therefore accepted (Figure 1.5).

Breathing

Listed in Box 1.4 are five immediately life-threatening thoracic conditions that must be urgently identified and treated during the primary survey and resuscitation phase (see Chapter 4).

Box 1.4 **Immediately life-threatening thoracic conditions**

- Tension pneumothorax.
- Cardiac tamponade.
- Open chest wound.
- Massive haemothorax.
- Flail chest.

All clothes covering the front and sides of the chest must be removed. The respiratory rate, effort and symmetry must be noted. These are sensitive indicators of underlying pulmonary contusion, haemothorax, pneumothorax and fractured ribs. The team leader must examine both sides of the chest for bruising, abrasions, open wounds and evidence of penetrating trauma. Cardiac tamponade after trauma is usually associated with a penetrating injury. The team leader should also remember that because of intercostal muscle spasm, paradoxical breathing is seen with a flail chest only if the segment is large or central, or when the patient's muscles become fatigued. The patient with a flail

chest usually has a rapid, shallow, symmetrical respiratory pattern initially.

After inspection, the chest should be auscultated and percussed to assess symmetry of ventilation and resonance. As listening over the anterior chest detects mainly air movement in the large airways, it is recommended that the medical team leader also listens over the axillae to gain a more accurate assessment of pulmonary ventilation. A tension pneumothorax or massive haemothorax can thus be identified. Early chest X-ray (CXR) is crucial: clinical examination in the context of major trauma is unreliable. Pneumothorax or haemothorax should be treated by inserting a chest drain with a gauge of >28 in the fifth intercostal space just anterior to the midaxillary line. This enables air and fluid to be drained but should always be preceded by intravenous lines. During examination of the chest, the patient should be attached to a pulse oximeter. Common causes of inadequate ventilation are shown in Box 1.5.

Box 1.5 **Common causes of inadequate ventilation**

- Bilateral
  - Obstruction of the upper respiratory tract
  - Leak between the face and mask
- Unilateral
  - Pneumothorax
  - Haemothorax
  - Intubation of the right main bronchus
  - Foreign body in a main bronchus, significant lung contusion

Circulation and haemorrhage control

The medical team leader will look for clinical signs of shock (see Chapter 5), apparent with tachycardia, poor capillary refill and peripheral perfusion. It is important to remember that up to 30% loss of blood volume produces tachycardia and reduces the pulse pressure, but the blood pressure may stay within normal limits (particularly in the young).

There is a consistent fall in the systolic blood pressure only when more than 30% of the blood volume has been lost.

The circulation doctor must control any major external haemorrhage by direct pressure. Tourniquets are usually only used when the affected limb is deemed unsalvageable.

A pelvic splint should be used when there is a suspected pelvic fracture and this may already have been applied by the prehospital team.

Concurrently with the above, two wide-bore (14–l6 gauge) peripheral lines must be inserted, preferably in the antecubital fossae. If this is impossible, venous access should be gained by a venous cutdown or by inserting a short, wide-bore central line into the femoral or subclavian vein. If a subclavian approach is used and a chest drain is already in place, the central line must be inserted on the same side. As central vein cannulation can cause serious injury, it should be carried out only by experienced personnel.

Once the first cannula is in position, 20 mL of blood should be drawn for group, type or full cross-match, full blood count, and measurement of urea and electrolyte concentrations. An arterial sample should also be taken for blood gas and pH analysis, but this can wait until the end of the primary survey. While venous access is being gained, a circulation nurse must measure the blood pressure and record the rate, volume and regularity of the pulse. An automatic blood pressure recorder and electrocardiogram (ECG) monitor should also be attached to the patient. In seriously ill patients, palpating femoral and carotid pulses is a quick and reliable method of establishing whether there is some cardiac output when no blood pressure can be recorded, either automatically or otherwise.

In the UK, the type of fluid initially given to injured patients to maintain fluid balance depends on departmental policy. Some start with colloid while others use crystalloid such as physiological saline. It is therefore important for team leaders to know the local policy. The aim of fluid management in a hypotensive resuscitation should be to restore critical organ perfusion until haemorrhage that is amenable to surgery is stemmed. Therefore the initial approach in a standard adult trauma victim is to give 1 L of warm colloid (or 2 L of crystalloid) and then reassess the patient. Remember that the best colloid is blood and, where necessary, this should be given as soon as possible. This underlines the importance of early cross-match and an effective chain between the resuscitation room, labs and back again!

When there is a limited response to the fluid bolus, or after a major injury, blood is urgently required. To reduce the incidence of hypothermia, all fluids must be warmed before use.

In reassessing the circulatory state one of three responses will be seen (Figure 1.6).

- The vital signs return to normal after infusion of less than 1 L of colloid solution (or 2 L of physiological saline). Such patients have lost less than 20% of their blood volume and are probably not actively bleeding.
- The vital signs initially improve with the infusion but then deteriorate. These patients are actively bleeding and have usually lost more than 20% of their blood volume. They require transfusion with typed blood and the source of the bleeding must be controlled. This often requires surgery.
- The vital signs do not improve at all. This suggests either that the shock has not been caused by hypovolaemia or that the patient is bleeding faster than blood is being infused. History, mechanism of injury and physical findings will help to distinguish between these possibilities.

Measurement of the central venous pressure and, in particular, its change after a fluid bolus may assist in diagnosis. There are a limited number of anatomical sites of bleeding: external, into the chest or abdomen, or around a fractured pelvis or long bones. Skilled FAST (focused assessment with sonography in trauma) ultrasound will confirm intra-abdominal blood and clinical examination and CXR will identify the others.