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Initial Management of the Severely Injured Patient Clinical Guidelines

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Clinical Guidelines

Royal College of Surgeons in Ireland
November 2003

Clinical Guidelines Committee

Royal College of Surgeons in Ireland

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FOREWORD

The publication of Guidelines on the Initial Management of the Severely Injured Patient represents an important demonstration of the continuing commitment of the Royal College of Surgeons in Ireland to develop and improve standards of care for patients in this country.

Guidelines on this issue are difficult to prepare because of the large number of factors relevant to a discussion of this critical matter. That these guidelines are comprehensive in scope, explicit in detail and both expert and up-to-date in recommendations is due to the great energy, ability and commitment of Dr. Chris Luke who was the Chairman of the Working Party which prepared this report. All of the members of the Working Party deserve the gratitude of everyone involved in the management of the injured including medical and paramedical staff, hospital managers and health planners. A wide-ranging document has been produced. It describes best practice, not only in treatment of specific injuries but also in the organisation and systems which should be in place if trauma patients are to be resuscitated and treated safely and well. Arrangements and systems are currently suboptimal. These guidelines draw attention to these deficiencies but also provide clear guidance as to how improvements can be achieved.

The Royal College of Surgeons in Ireland is proud of its record in training medical personnel to deal competently with patients in the early phase following injury. Since the Advanced Trauma Life Support programme was introduced into Ireland in 1991, more than 1200 doctors have participated in the 90 courses which have been organised by the R.C.S.I. It is certain that these course have raised standards of emergency care and have saved lives.

These guidelines also provide advice about the management of major incidents and describe the logistical arrangements needed for the best outcomes. In an innovative addition, the authors have devoted a section to Cochrane Library Reviews on particular issues concerned with acute trauma care.

As well as the members of the Working Party, very many other experts were involved in the preparation of this informative booklet. Their names appear on Page 3 and their work is acknowledged and deeply appreciated.

The publication of these guidelines may signal an opportune time for the Royal College of Surgeons in Ireland to enter further dialogue with health care planners in continuing efforts to improve the care of injured patients.

November 2003
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Introduction

Injury or trauma is one of the leading causes of death and disability in the Republic of Ireland (as it is all over the world) but it has remained relatively neglected as a subject of medical or surgical research in this country. Moreover, it is widely recognised that medical training here in the care of severely injured patients is also deficient. Such relative neglect and deficiency have become increasingly problematic in Irish healthcare and have been highlighted in recent years as the profile of both unintentional and intentional injury has grown.

Recently, for example, popular dismay has been expressed at the disturbing number of deaths and injuries caused by road traffic collisions on Ireland's roads. Industrial action over the past few years has also drawn attention to the daunting scale of accidental injury and death associated with the construction industry. Additionally, gun-related and other gangland violence in the Republic has escalated dramatically.

The Royal College of Surgeons in Ireland, with others, has carefully considered the issue of trauma care and for over a decade has been instrumental in enhancing the training of surgeons in initial care of the injured through, for instance, the globally recognised *Advanced Trauma Life Support* [ATLS] and the *Care of the Critically Injured Surgical Patient* [CCrISP] training courses. It has also sought to encourage debate through colloquia and journals.

In its determination to improve the quality of care provided within the Irish healthcare setting, the College has concluded that a clear set of Clinical Guidelines should be issued for those dealing with severely injured patients, particularly those who may have little experience of major trauma cases. These guidelines deliberately concentrate on the initial care of severely injured patients as this is the area where experience has shown both the greatest *deficiency* and the greatest *opportunity* in trauma care. Where possible, the guidelines have been referenced with an emphasis on evidence-based medicine and/or authoritative sourcing (e.g. the Trauma Committee of the American College of Surgeons).

The additional aims of this document are to explain the rationale behind the development of the guidelines, to briefly outline the College's aspirations for trauma care in Ireland over the coming decade and to provide for quick reference (in the appendices) advice with regard to certain troublesome aspects of trauma care (such as prevention of transmissible infections or management of haemorrhage in those who may decline blood transfusion). A limited but wide-ranging further reading section is also included for those who wish to advance their understanding of recent developments in trauma care both in this country and abroad.

Finally, it is recognised that healthcare throughout Ireland has a proud tradition of local innovation, great dedication and often heroic work by surgeons and their many colleagues. This document has been compiled with those factors clearly in mind. It is hoped that the guidelines, accompanying recommendations and references will be of practical assistance to those initially dealing with severely injured patients as well as to those planning improvements in the resources for such care. It is to the patients and the staff looking after them that this document is dedicated.

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TRAUMA: DEFINITIONS

It is essential to define what "trauma" is in order to describe and discuss its management. Several definitions are available but it is important not to be too prescriptive or dogmatic if distracting controversy is to be avoided. Perhaps the most useful definition of trauma is that it is *the derangement or "injury" which results from the transfer of energy.* This derangement can be anatomical and/or physiological (so the terminology allows for both organ damage and the aberrations of vital signs which may accompany it) while the energy may be of different categories (e.g. thermal, kinetic).

"Initial" or "early" care can be equally simply defined as that treatment which is rendered within a few hours of the occurrence of injury. For comparative epidemiological purposes, some refinement of definition is required but as long as this is done explicitly there should be no difficulty in accepting the validity or relevance of different systems of trauma audit (and the understanding drawn from such analysis).

Trauma (Injury): the derangement – anatomical and physiological – which follows the transfer of energy

Early Trauma Care: management in the first few hours after injury

Major Trauma: ISS >15, hospitalisation >3 days, lethal or permanently disabling

In Advanced Trauma Life Support (ATLS)[1] parlance, the "golden hour" represents a metaphorical maximum opportunity for optimal care by emphasising the need to swiftly transport severely injured to definitive care (e.g. from the scene of injury to the operating theatre or Intensive Care Unit). However, there is no real evidence base to say that the opportunity for good care declines abruptly after 60 minutes. What matters is that care must be urgent, while allowing for patient comfort, safety, assessment, and transfer arrangements.

"Severe" trauma should not be a subjective description, for instance, merely reflecting inexperience on the part of clinicians or reflecting a deficiency of resources required to deal with the injury. "Severe" trauma can be relatively consistently defined according to internationally recognised measurement scales, e.g. an injured patient who scores 15 or more on the *Injury Severity Score* (ISS)[2], who requires more than three days' hospitalisation or who dies or is chronically or permanently disabled by their injury.[3] The ISS has been developed over recent decades to stratify and render comparable data on trauma epidemiology and treatment, in Europe and North America.

It would seem reasonable to employ similar systems in Ireland and, in fact, a number of hospitals here already subscribe to the UK Trauma Audit and Research Network (TARN).[3] TARN collates data from many hospitals throughout these islands, which may in due course permit assessment of quality and other aspects of trauma care.

[1] ATLS Student Course Manual, 1997. Course Overview, p 9,10.
[2] Baker SP, O'Neill B, Haddon W, Long WB. The injury severity score: a method for describing patients with multiple injuries and evaluating emergency care. **J Trauma 1974;14:187-96.**
[3] UK Trauma Audit and Research Network; uktrauma@fsl.ho.man.ac.uk

TRAUMA CARE IN IRELAND

There is a relative paucity of literature regarding the medical aspects of trauma (and its management) in Ireland. Nonetheless, such literature as exists in the Irish medical journals succinctly replicates the extent of understanding of the trauma problem and the process of responding to it which has occurred in most developed countries over the past two decades.[1, 2, 3]

The statistics relating to trauma and trauma management in Ireland are inadequate but where they are available they tend to parallel the findings in the UK and the USA where advanced systems of trauma epidemiology have been in place for years. The major sources of injury data in the state are the Central Statistics Office, the National Roads Authority[4], and the European Home and Leisure Accident Surveillance System[5] (EHLASS), which is supported by the Department of Health and Children along with notable voluntary or semi-voluntary agencies (e.g. the National Suicide Registry). Recent figures for trauma occurrence in Ireland are shown in the box.

Trauma = leading cause of morbidity / mortality in Ireland in those <45 years.

1993: In-patient hospital care for trauma costs in Ireland were Ir£55m.

1995: 1050 accidental deaths in Ireland (41% on roads, 24% in falls).

1998: 46,030 injured patients hospitalised (>10% admissions in Ireland).

2000: There were 415 fatalities in 362 accidents on Irish roads.

The road traffic crash death rate in Ireland exceeds the European average (121 -v- 119 per million population or c. 11.0 per 100,000 population).

Ireland has the (joint) 7th highest road fatality rate of the 15 EU states.

While quantitative analysis of trauma and its management in Ireland is sub-optimal, qualitative medical research is even more wanting. However, it seems reasonable to extrapolate from North American and British medical science and the understanding garnered in those countries to the broad description of injury patterns in Ireland. For instance, the "trimodal distribution" of mortality after trauma[6] seems to be reproduced in Irish clinical practice:

(i) death after injury occurs within minutes in the case of massive injury to brain, heart or spinal cord;

(ii) within an hour or so [the so-called "golden hour"] if reversible conditions like airway obstruction or hypovolaemia are not promptly redressed; or

(iii) within weeks if poorly understood conditions such as poly-organ failure or sepsis syndromes set in.

Extrapolation from international trauma science aside, there are circumstances that are peculiar to Ireland (such as the relatively poor condition of the national road network, the large proportion of unqualified drivers, the under-developed culture of "health and safety" observance in the construction and marine industries and the high rate of young male suicide). Additionally, the dramatic socio-economic changes affecting the country over the past decade, the strong cultural ties with North America and the growing number of European Union directives (e.g. those affecting medical training and hours of work) have important consequences for trauma prevention and management.

[1] Rowley DI. Trauma care in the UK – the debate must continue. **J R Coll Surg Edinb 1992;37:127.**
[2] Gleeson A. Major trauma – major problem. **J Irish Coll Physicians Surgeons 2000;29(2):69-71.**
[3] Laffoy M. Prevention of unintentional injury. **J Irish Coll Phys Surg 1999;28(2):73-5.**
[4] National Road Authority, Dublin 4, August 2001. Road Accident Facts Ireland 2000.
[5] Department of Health and Children, Dublin: EHLASS Report for Ireland 1998.
[6] **ATLS Student Course Manual, 1997.** Course Overview, p 11-12.

TRAUMA CARE IN IRELAND

A few papers in recent Irish journals have hinted at the sub-optimal provision of trauma care in Ireland, at least in terms of resources.[1] They cite cases of extradural haematoma which were transferred to a neurosurgical unit, for instance, and the authors recommend that surgeons at "peripheral" or "county" hospitals maintain their skills in undertaking burr-hole evacuation of imminently life-threatening intra-cranial haemorrhage. Although this is consistent with Advanced Trauma Life Support (ATLS) guidelines, the latter suggest that such a scenario should be "very exceptional" and emphasise the need to involve a neurosurgeon in any such decision and – ideally – in any such treatment.[2]

Other papers have begun the process of describing the reality of trauma care in Ireland. One study,[3] for instance, revealed that a "peripheral" country hospital was able to manage nearly 80% of the trauma case load resulting from road crashes in its catchment area in one year (1996): approximately 18.5% of the 963 cases were admitted to the county hospital (of whom 12% had surgery there) while 20% of the patients needed to be transferred to the regional "trauma centre" (a tertiary teaching hospital). Equally interesting was the significant under-reporting by the "statutory" authority of the scale of accidents in the hospital's catchment area at the same time.

Another paper[4] reviewed the care of 70 patients admitted to a different county hospital with severe trauma over a two-year period after the establishment of a trauma team and the adoption of ATLS protocols by the hospital. The patients were predominantly male (aged 15-35 years); 21 cases were treated entirely in the county hospital, with a mortality rate of 24%, while 49 patients were transferred to other institutions after initial stabilisation, with a mortality rate of 14.3%.

The overall mortality rate was 17%. The figures in these papers reflect international experience in that the serious trauma described mainly affects young males, has an appreciable mortality and entails substantial challenges for the hospital and rescue services.

Other papers from Ireland have also touched upon significant themes in trauma care which have emerged elsewhere. A study of elderly Irish trauma victims[5], for instance, found that they were likely to have a relatively higher Injury Severity Score, to have pre-existing medical conditions, to be injured between the hours of 9am and 5pm, to have more complications, a greater length of stay and less likely to be discharged directly home after admission.

Preventability is a hallmark of many trauma cases: the landmark Report on the Management of Patients with Major Injuries by the Royal College of Surgeons of England in 1988[6] suggested that as many as one third of fatalities from trauma were avoidable (in theory, at least) through better care. The first Irish studies[7] into preventability of death after injury have yielded similar disturbing figures, and for the same sort of reasons postulated by the 1988 report (under-resourcing in terms of training, manpower and funding of trauma systems is familiar to all working in the Irish Healthcare service).

[1] O'Brien DP, Phillips JP. Head injuries in the Republic of Ireland: a neurosurgical audit. **Ir Med J 1996 Nov/Dec; 89(6): 216-8**
[2] **ATLS Student Course Manual, 1997. Chapter 6: Head Trauma, p 204.**
[3] Street JT, Winter D, Buckley S, Nicholson P, Twomey A. Trauma on rural roads: the role of a peripheral hospital. **Injury 1999 Jun; 30(5): 337-40.**
[4] Calleary JG, El-Nazir AK, El-Sadig O, Carolan PE, Joyce WP. Advanced Trauma and Life Support principles: an audit of their application in a rural trauma centre. **Ir J Med Sci 1999 Apr/May/Jun 168(2):93-98.**
[5] Cunningham CJ, Howard D, Walsh JB, Coakley D, O'Neill D. The effects of age on accident severity and outcome in Irish road traffic accident patients. **Ir Med J 2001 Jun;94(6):169-71.**
[6] Royal College of Surgeons of England. Commission on the provision of surgical services. Report of the Working Party. The management of patients with major injuries **RCS, London, 1988.**
[7] Caldwell MTP, McGovern EM. Fatal trauma: a five-year review in a Dublin hospital. **Ir J Med Sci 1993 Aug; 162(8): 309-12.**

Trauma Care: International Experience

TRAUMA CARE IN IRELAND

Even if patients survive after major trauma, they may still have to contend with enduring *disability*. An important recent Irish study revealed that 37% of 61 patients admitted to an orthopaedic surgical unit remained disabled despite a year or more of recuperation and even those who managed to return to work experienced difficulties of some kind in a quarter of cases. A further insight into the "cost" of trauma care is offered by the study, which found that the average length of hospitalisation for these 61 cases was 17 days. This problem is further compounded by a lack of long-term care facilities for the critically-injured young patient[1]. The dismal problem of inter-personal *violence* in Ireland was highlighted by a study[2] in 1993 which revealed that over a quarter of 332 cases of facial fracture were the result of assault.

There is some cause for optimism, nevertheless. A retrospective study[3] of 1564 head injuries presenting to a regional hospital in Ireland, over twelve months, found that 1% died, 12% were admitted and the remainder discharged after initial assessment. Forty three patients (22%) had a computed tomographic (CT) brain scan performed and 18 of these were abnormal. These scans were transmitted electronically to a specialist neurosurgical unit (SNU) and, based on this, just 6 patients needed to be transferred. The authors concluded that 96% of those with a head injury severe enough to warrant hospitalisation can be safely managed in a non-specialist unit with access to CT facilities and image link transmission to a SNU. Similarly *"telemedicine"* is likely to be a major opportunity for improved trauma care in Ireland over the next decade.

TRAUMA CARE: INTERNATIONAL EXPERIENCE

A review of the international medical literature relating to severe trauma reveals a relatively consistent evolutionary process of *recognition* that major trauma is a significant problem for a particular jurisdiction, *description* of the scale and profile of the challenge and then a systematic *response*.

A search for optimal management of serious trauma reveals certain key characteristics in effective trauma care. These include the respective importance of a *planned* trauma system (for instance, that described by Trunkey and others in California in the early 1980s[4]), adequate *resourcing* (under-pinning well-known trauma facilities in Northern Europe and North America[5]), *standardisation* (for instance, adherence to the ATLS system[6]), *collaboration* (for example, in the state-wide network of personnel and institutions seen in Oregon) and meticulous review of practice and *audit* (perhaps most relevantly exemplified by the UK Trauma Audit Regional Network or TARN [formerly known as the major trauma outcome study or MTOS]), already mentioned.

Planned (e.g. Orange County)
Resourced (e.g. Leuven, Mainz, Washington)
Standardised (e.g. ATLS)
Collaborative (e.g. Oregon)
Audited (e.g. UK TARN)

However, experience also suggests that enthusiasm for trauma systems may be impermanent: many North American Trauma Centers established in the late 1980s or early 1990s have closed because their "funding mechanisms have been unstable", their data systems are in disarray or they have inadequate external "advocacy".[7]

[1] Delargy M. Seminar for Rehabilitation after Brain Injury (6/6/2003). Medicine Weekly 7 (23): 3.
[2] Eguare E, Tierney S, Barry MC, Grace PA. Management of head injury in a regional hospital. **Ir J Med Sci 2000 Apr-Jun; 169(2): 103-6.**
[3] Carroll SM, O'Connor TPF. Trends in the aetiology of facial fractures in the south of Ireland (1975-1993). **Ir Med J 1996 Sep-Oct; 89(5): 188-9.**
[4] Cales RH. Trauma mortality in Orange County: the effect of implementation of a regional trauma system. **Ann Emergency Med 1984;13:1-10.**
[5] American College of Surgeons Committee on Trauma. Resources for optimal care of the injured patient. **Chicago: American College of Surgeons, 1990.**
[6] American College of Surgeons Committee on Trauma: Advanced Trauma Life Support for Doctors, **Student Course Manual, 1997.**
[7] San Francisco EMS Trauma Plan. City and County of San Francisco Trauma Care System Plan 2001.

Trauma Care: International Experience

Measurement of trauma care may be susceptible to similar surprising fluctuation, sometimes because of the labour-intensive process involved in collecting trauma data, sometimes because data may be difficult to obtain (e.g. respiratory rate is important to trauma scoring but is universally poorly recorded) and sometimes because the methodology may be challenged.[1] Even the pivotal ATLS guidelines have seen substantial changes over the two decades or so since their inception, largely driven by the vogue for evidence-based medicine.[2]

Looking to our nearest international neighbours, it would seem prudent to learn from the United Kingdom (UK) experience over the past 15 years. The history of modern British trauma care reflects military tradition, features interesting but ultimately disappointing experiments (like the Birmingham Accident Hospital and the North Staffordshire Trauma Centre) and has been dominated by recent NHS reforms.

If there have been sustained trends in the evolution of trauma care in the UK, however, they are the recognition that high-quality *data* remain crucial to planning[3], *training* is essential to effective care and an *integrated* systematic response to care of the victim of trauma (whether within or between hospitals) is paramount.

In terms of clinical preparation in the UK, the ATLS course has perhaps been the greatest reformation and it has become essential to the training of many doctors-in-training, from Accident and Emergency Medicine to Anaesthesia, as well as being a fundamental part of every surgeon's education (as it is in Ireland). At the same time, evidence-based medicine – or the requirement for proof that a procedure or principle is sound - has become part of the everyday language of UK (and Irish) medicine.

This has led to a growing scrutiny of trauma care, both as practiced and as preached. The ATLS educational methodology is widely regarded as the key to its success, for instance, but much of the original – and some of the present – dogma has either been rebutted for want of supportive evidence (e.g. the spinal board or hard neck collar in lucid patients without good clinical evidence of spinal injury,[4, 5] the intubation of patients with traumatic pulmonary contusion according to arterial blood gas figures,[6] the use of pulses to predict systolic blood pressure[7] or the "harmlessness" of hyperoxia[8]) or is being sceptically re-examined (e.g. the lateral decubitus position recommended in the pregnant victim of trauma).

Notwithstanding this healthy scrutiny, ATLS remains indisputably the educational gold standard for clinical care in trauma. In the UK, it has been joined by other important standards set out by the Royal Colleges and others.[9,10] Such standards are designed to enhance the quality of trauma systems (e.g. through co-ordination, audit and outcome targets) but may take years to achieve fruition. Perhaps the most important recent advance in UK trauma care has been a more realistic appreciation that there are *limitations* to what can be achieved. Trauma systems, scoring and teams have been tried enthusiastically but a study of their impact suggests that a "plateau" in the quality of patient outcome was reached in about 1994 (at about the same time as the enthusiasm for trauma care peaked).[10] This is worth bearing in mind in any reconfiguration of trauma care in this country.

[1] Zoltie N, de Dombal FT. The hit and miss of ISS and TRISS. **BMJ 1993;307:906-9.**
[2] Luke LC. ATLS : Has the end become the means? **CPD Anaesthesia 1999; 1(2):94-96.**
[3] Yates DW et al. Trauma audit – closing the loop. **Injury 1994;25:511-4.**
[4] Vickery D. The use of the spinal board after the pre-hospital phase of trauma management. **EMJ 2001;18:51-54.**
[5] Papadopoulos MC, Chakraborty A, Waldron G, Bell BA. Lesson of the week: Exacerbating cervical spine injury by applying a hard collar. **BMJ 1999; 319: 171-172.**
[6] Vidhani K, Kause J, Parr M. Should we follow the ATLS guidelines for the management of traumatic pulmonary contusion: the role of non-invasive ventilatory support. **Resuscitation 2002;52:263-8.**
[7] **Deakin CD, Low J L** Accuracy of the advanced trauma life support guidelines for predicting systolic blood pressure using carotid, femoral, and radial pulses: observational study. **BMJ 2000;321:673-674.**
[8] Thomson AJ, Webb DJ, Maxwell SRJ, Grant IS. Oxygen therapy in acute medical care. **BMJ 2002;324:1406-1407.**
[9] Oakley PA. Setting and living up to national standards for the care of the injured. Injury **1994;25:595-604.**
[10] Lecky FE, Woodford M, Bouamra O, Yates DW. Lack of change in trauma care in England and Wales since 1994. **Emerg Med J. 2002 Nov;19(6):520-3.**

TRAUMA CARE IN IRELAND: ACHIEVING BEST PRACTICE

In a small country such as Ireland, where there exists a peculiar combination of highly trained clinical staff and chronic under-resourcing of public hospitals, it would seem appropriate to reproduce best practice (as identified above) primarily by better *organisation* of the response to trauma. It is the view of the Working Party that such organisation might be overseen by a Trauma Liaison Group (for instance, based at the Royal College of Surgeons in Ireland (RCSI) and involving representatives from relevant hospital disciplines, pre-hospital and public health specialists, the Department of Health and Children and other parties, like the National Roads Authority, the Pre-Hospital Emergency Care Council (PHECC) and the Irish Association for Emergency Medicine (IAEM). Important *standards* documents relevant to organised trauma care have recently been produced by the latter and other Irish organisations[1 2 3] and these will be important in planning any developments.

Clearly, improved *resourcing* is required although not as much as some might suggest. In fact, much of the required additional resourcing has been quietly progressing over the past few years in terms of imaging facilities, manpower and peri-operative and emergency departments. The *system* which might best enhance trauma care would necessarily reflect the particular demographic and socio-economic features of this country, it would evolve organically (i.e. in an incremental manner mirroring the strengths of existing institutions and professionals) and it would involve a quantum leap in the culture of care for trauma victims in Ireland.

Such a culture would be predicated on continual *collaboration* between all those interested in the management and prevention of trauma and would entail frequent collaborative processes and events such as the North-South Trauma Forum held in Beaumont Hospital in Dublin in 1999. All of the above would require high-quality data and feedback, and a national trauma database would seem essential in the near future, although some hospitals may continue usefully to contribute to the UK TARN in the interim and perhaps beyond.

Plan (e.g. Trauma Liaison Group @ RCSI / DoHC)

Resource (e.g. new emergency departments, surgical and imaging facilities)

Standardise (e.g. a "greened" ATLS; IAEM 2001; PHECC)

Collaborate (e.g. Trauma Forum @ Belfast/Dublin; RAMI*)

Audit (e.g. UK TARN @ Waterford; Cork Emergency Medicine Forum)

All of the above notwithstanding, the foremost element of any proposed system, in the view of the College Working Group, is a standardised clinical approach to the injured patient. Clearly, the ATLS system represents the most suitable basis for Clinical Guidelines, albeit with allowances for the limitations of the Irish healthcare system and recognition of the evolving evidence base in clinical trauma care. These guidelines are included in the next section.

*Royal Academy of Medicine in Ireland.

[1] Irish Association for Emergency Medicine. Emergency Medicine Services in Ireland. Standards Document. Dublin, March 2001.
[2] Irish Society for Quality in Healthcare. Accident and Emergency Department Assessment Standard. Dublin January 2000.
[3] National Blood Users' Group. A Guideline for the Use of Blood and Blood Components in the management of Massive haemorrhage. Dublin, November 2002.

OVERVIEW OF THE INITIAL MANAGEMENT OF SEVERE TRAUMA

Trauma = *the derangement — anatomical or physiological — caused by the transfer of energy.* The extent of trauma or injury reflects the amount of energy (e.g. distance travelled or heat absorbed) and the vulnerability of the victim involved (e.g. whether young, old, sick or intoxicated).

Proper care of the seriously injured patient requires organisation

A systematic approach is recommended, especially for the inexperienced, and the most widely accepted system is that recommended in the American College of Surgeons' Advanced Trauma Life Support (ATLS) course. The key elements of this approach are the **primary survey/resuscitation** phase, the **secondary survey** and the rapid implementation of **definitive treatment,** which may involve early surgery. The objective is to detect life-threatening conditions as quickly as possible, to stabilise the patient and to start definitive treatment as early as possible, in a prioritised fashion. All of these may be telescoped into one process with the severely injured and unstable victim.

When a seriously injured patient is expected or has just arrived

Call for Help: get the level of assistance that will be *immediately* required and notify other personnel of the potential for their early involvement;

Summon Key Personnel who will be required from the outset (e.g. the Trauma Team if one exists or the most senior available emergency physician and nurse, surgeon, anaesthetist and radiologist in the hospital);

Identify a Leader: experience, local knowledge and training are the main considerations.

Triage: the following criteria suggest severe injury and urgency in care

Revised Trauma Score[1]	Injury Pattern	Injury Mechanism
Glasgow Coma Score <13	Penetrating injury to head, neck chest, abdomen or groin	Fall >6 metres (c. 20 feet)
Systolic Blood Pressure (sBP) <90 mmHg	Two or more proximal long bone fractures	Ejection of patient from a vehicle
Respiratory Rate (RR) <12 or >29 bpm	Flail chest	Roll-over of vehicle
	Burn >15% TBSA* or facial, airway or chest involvement	Death of occupant in same car
	Victim = pedestrian or motorcyclist	Rearward displacement of front axle
	History of ingestion of alcohol or drugs	Passenger compartment intrusion

Patients aged <5 or >55 and those with known cardiorespiratory disease are especially vulnerable after trauma.
*TSBA - Total Body Surface Area

[1] Champion HR, Sacco WJ, Copes WS et al. A revision of the Trauma Score. **J Trauma 1989; 29**(5):624.

OVERVIEW OF THE INITIAL MANAGEMENT OF SEVERE TRAUMA

The Primary Survey and Resuscitation proceed in parallel

A — Clear the Airway. Use chin-lift or jaw-thrust. Immobilise the cervical spine with collars, bags and tape until cleared;

B — Check Ventilation. Administer oxygen at 15 litres per minute with tight-fitting mask with reservoir or use bag, valve and mask;

C — Check for pulses, skin perfusion and consciousness. Identify obvious sources of blood loss;

D — Assess the level of consciousness with A.V.P.U.: A (alert); V (responds to verbal communication); P (responds only to pain); U (unconscious);

E — Expose and examine the patient thoroughly.

Search for Life-Threatening Injuries and Treat Them Urgently

Airway	Breathing	Circulation	Disability	Exposure
Is the **airway** compromised? Consider **oro-pharyngeal** or **naso-pharyngeal airway.** If ineffective, intubate with **endotracheal** or **naso-tracheal** technique. If unable, consider **crico-thyroidotomy.**	**Ventilate** by bag and mask or tube, with **oxygen.** Perform a **needle thoracostomy** (2nd L. ICS-MCL)* for a tension pneumothorax. Seal open pneumothorax. Identify **flail chest.** Insert chest **drain** for massive haemo-pneumo-thorax. The **oximetry** reading should be 95% or greater, on supplemental oxygen.	Arrest obvious bleeding. Pre-empt shock with **2 large bore i.v. cannulae.** Infuse **2000 mls** (20ml/kg in children) of **crystalloid** before transfusion of warmed blood (O-neg., type-specific or fully cross-matched). Drain any **significant haemo-pericardium.** Use **cutdown** or **intraosseous** lines if necessary.	Assess level of **consciousness** with **AVPU** (see D. above) Look at the **pupils.** Can the patient move **all 4 limbs?** Is there evidence of peripheral nerve disruption or upper motor neurone/intra-cranial injury (e.g. asymmetry of movement or up going plantar – Babinski or thumb – Hoffman -reflexes).	**Undress** completely. Avoid hypothermia. Attach **ECG** monitor. Insert **NG tube** and **urinary catheter.** Beware of contra-indications! **Blood specimens:** plasma chemistry, arterial blood gases, FBC, and cross-match. Get a urine sample (for urinalysis and toxicology etc).

Imaging in the Resuscitation Room: Get 3 immediate X-rays in the Resuscitation Room: cervical spine (with shoulder traction to see C7 - T1), chest and pelvis. CT or Ultrasonsography or Angiography may be required, but are usually undertaken in the main x-ray department when the patient is sufficiently stable.

Is the Patient's *Haemorrhagic* Shock Unresponsive to Treatment? If so, transfer patient to the Operating Theatre with senior surgical and anaesthetic input, immediately.

*2nd left intercostal space – mid-clavicular line.

OVERVIEW OF THE INITIAL MANAGEMENT OF SEVERE TRAUMA

The Secondary Survey

Recheck A, B, C and D. Proceed to next stage if the patient is stable and analgesia has been effective. The secondary survey is a head-to-toe examination of the patient's body.

A.M.P.L.E. - a simple mnemonic for key information

A: allergies (e.g. penicillin or aspirin)

M: medication (e.g. a beta-blocker or warfarin)

P: previous medical history (e.g. previous surgery or anaesthetic mishap)

L: last mealtime (i.e. drink versus major meal)

E: events surrounding the incident (e.g. fell 5 metres with immediate loss of consciousness)

Examine each body region meticulously

Head	Face	Neck	Chest
Assess for wounds and fractures. Examine the **eyes,** and check for **basal skull fracture.**	Examine the **mouth,** mandible, zygoma, nose and ears. **Exclude mid-facial fracture** or **airway obstruction.**	**Assume initially that a fracture – dislocation exists.** Use collar – tape – sandbag neck immobilisation and palpate the spine. Wounds deeper than the platysma need formal surgical exploration.	Look, listen and feel: inspect the **chest X-ray.** Exclude lung and cardiac contusion, aortic rupture, diaphragmatic hernia, tracheal, bronchial or oesophageal injury. Look for **haemo-pneumothorax.**

Neurological	Abdomen	Orthopaedic
Estimate GCS* repeatedly (e.g. every 15 minutes). Perform a full CNS examination, in the co-operative patient. Evidence of paralysis or sensory deficit requires full spinal immobilisation. **Falling GCS levels** require urgent CT scan and neurosurgical consultation.	Peritoneal and retro-peritoneal injuries may present with normal signs. **Rectal and perineal examination** is essential. **CT,** ultrasonsography or occasionally diagnostic peritoneal lavage may help in excluding abdominal injury.	Check for limb or spinal malalignment, crepitus, and tenderness. **Examine the back.** Assess **neuro-vascular** and tendon function. **Logroll** the patient to assess thoraco-lumbar injury. Search for minor fractures, dislocations, glass or other foreign bodies.

*Glasgow Coma Score.

OVERVIEW OF THE INITIAL MANAGEMENT OF SEVERE TRAUMA

Definitive Care

Definitive Management is in the Operating Theatre, Intensive Care Unit or Rehabilitation Facility.

Get senior help to define treatment objectives and formulate a plan of action; this may include further resuscitation, investigation, and/or getting the patient to the operating theatre or transferred to a specialist centre.

Analgesia

Effective pain relief is paramount in the management of the seriously injured (semi) conscious patient. This usually requires an opioid like **Morphine:** 0.1 - 0.2 mg / kg IV in diluted incremental doses every 3 minutes as it takes this long for the opiate to penetrate the blood-brain-barrier. There is probably no good pharmacological reason to routinely or pre-emptively provide anti-emetic medication (e.g. prochlorperazine or cyclizine).

Transferring Patients between Departments and Institutions

- Stabilise the patient as far as possible before transfer
- Send an experienced anaesthetist
- Secure a patent airway before transfer: intubate if necessary
- Life saving surgery (i.e. splenectomy) may be needed occasionally before transfer to regional trauma unit

Remember

- The order of priority of treatment is A→B→C→D→E
- Do not waste time: aim to get the patient from ambulance to definitive care within 1 hour
- Document everything meticulously, including *consent* where practicable
- Ensure adequate tetanus prophylaxis and or other communicable disease precautions
- Give antibiotics where clearly indicated (e.g. open fractures, abdominal or facial injuries)
- Communicate information to relatives/partners in a kindly and timely fashion

Sources

American College of Surgeons Committee on Trauma, *Advanced Trauma Life Support for Doctors,* Student Course Manual, 1997;

BAEM Academic Committee Guidelines: *The Management of Major Trauma* British Association for Accident and Emergency Medicine, 1999.

Immediate Assessment

IMMEDIATE ASSESSMENT

- **Trauma =** the physiological and physical *derangement* which follows the transfer of *energy* (in any form); generally described as "injury", the greater the transfer of energy (e.g. kinetic, thermal, chemical), the greater the likelihood of severe resulting trauma or injury.

- To best manage the trauma victim, *preparation* must be adequate in both the pre-and in-hospital phases and staff should wear suitable protective gear.

- *Triage*[1] of patients should always be performed when there are multiple casualties.

- *Primary Survey* is the core practice of ATLS[2] with initial priority of care and assessment following a hierarchy (the A.B.C.D.E. approach):
  1. **A**irway with Cervical Spine protection
  2. **B**reathing / Ventilation
  3. **C**irculation / Haemorrhage
  4. **D**isability / Dysfunction
  5. **E**nvironmental Control / Exposure

- *Management* is initially directed at identifying and treating those injuries that first interfere with critical biological functions, supporting the airway, providing adequate ventilation and replacing lost fluids through 2 large bore intravenous (IV) cannulae (14 - 16 G), while giving effective analgesia promptly as required.

- *Adjuncts* to the Primary Survey include blood samples for full blood count (FBC), coagulation studies, plasma chemistry (urea and electrolytes, and sometimes toxicology or other case-specific indices), transfusion screening (group and cross-match etc.), 12-lead electrocardiography/ ECG monitoring, naso-, oro-gastric and urinary catheterisation and the standard *Trauma Series* of 3 X-rays: cervical spine, chest and pelvis (AP). A *diagnostic peritoneal lavage* (DPL) may be carried out at this stage, if non-invasive abdominal imaging (i.e. computed tomographic [CT] scanning or ultrasonography) is not readily available.

- *Secondary Survey* begins after the patient has been initially stabilised: **A.M.P.L.E.** is the mnemonic for brief screening of the patient (allergies or current medication, previous relevant medical history, the time of their last meal, and the details of the events leading to the patient's injury/ies);

  Focused *systematic examination:* "head-to-toe" including "log-roll" aiming to detect other injuries (often occult), with assessment of Glasgow Coma Score (GCS) and pupillary status (including the response to light).

- Adjuncts to the secondary survey are mainly radiological.

- *Constantly re-evaluate* the patient's progress and if deterioration occurs, start assessment again according to the Primary Survey hierarchy (A.B.C.D.E. approach).

- Arrange appropriate *referral* (to an operating theatre, intensive therapy unit or specialist surgical team, within the receiving hospital or in a referral unit).

[1] Manchester Triage Group. Emergency Triage. **BMJ Publishing Group; 1996.**
[2] American College of Surgeons Committee on Trauma: Advanced Trauma Life Support for Doctors, **Student Course Manual, 1997.**

AIRWAY AND VENTILATORY MANAGEMENT

- Adequate *oxygenation* of the blood is critical to survival after trauma[1]. Such oxygenation can be compromised however in a variety of ways. The maintenance of adequate levels of oxygen in the bloodstream is a paramount objective in the management of severe trauma.

- *Hypoxia* may occur as a result of multiple injuries, haemorrhage or depressed respiration and it may occur acutely or insidiously. However, obstruction of the airway is one of the commonest life-threatening causes of insufficient oxygenation and its reversal is regarded as fundamental in any approach to the severely injured patient.

- The severely injured patient may have difficulty maintaining his/her own airway especially with the following injuries:
  1. *Maxillo-facial trauma:* this may be exacerbated by lying the patient supine (in an effort to protect a potential cervical spine injury). Particular manoeuvres may be required (such as passing a large suture through the tongue and exerting traction away from the posterior pharynx) but urgent maxillofacial and/or anaesthetic assistance should always be obtained.
  2. *Neck trauma:* haemorrhage or penetrating trauma can occlude the airway;
  3. *Laryngeal trauma:* this may be associated with a palpable fracture, subcutaneous emphysema, and/or hoarseness.

- Continue the **A.B.C.D.E.** approach *look-listen-and-feel* approach to airway/ventilation management should be followed with each patient.

- Adequate suction and *100% oxygen* must be available in the pre-hospital and emergency department settings, along with other appropriate airway equipment and drugs.

- A conventional step-wise approach to airway management should be adopted: basic airway techniques of *chin-lift* and *jaw-thrust* may be followed by *oro- or naso-pharyngeal airway intubation and, ultimately, endotracheal intubation.*

- A *nasogastric tube* should be inserted when a patient is being ventilated by bag-valve-mask as it will prevent vomiting and regurgitation.

- The need for expert anaesthetic or critical care assistance should be anticipated if possible; for instance, from radio communication from an incoming ambulance.

- Occasionally, rapid sequence induction (RSI) may be required in the severely injured patient.

- Surgical airways (e.g. crico-thyroidotomy) are reserved for those rare situations where an endotracheal or other per-oral or per-nasal airway cannot be achieved.

[1] Walls RM, Luten RC, Murphy MF, Schneider RE. Manual of Emergency Airway Care. Lippincot-Willaims; May 2000.

Shock

SHOCK

- *Shock* = (potentially lethal) inadequate organ perfusion and tissue oxygenation.

- It is categorised broadly as *hypovolaemic, cardiogenic, neurogenic or septic.*

- Clinical assessment requires evaluation for tachycardia, vasoconstriction, tachypnoea, end-organ (dys)function and finally hypotension (this latter finding suggests a total circulating blood volume loss in excess of 30%).

- Treat initially for *haemorrhagic shock:*

  1. Adhere to the **A.B.C.D.E.** approach
  2. Give a 2 - 4 litre bolus of warmed crystalloid solution (e.g. normal saline although not dextrose which is poorly metabolised in trauma victims).
  3. Control obvious haemorrhage with direct pressure. Tourniquets are hazardous.

- Assess the patient's response:
  1. *"Rapid responders":* continue maintenance fluids and have cross-matched blood ready.
  2. *"Transient responders:* such patients have either continuing losses or have received inadequate fluid replenishment. They require more fluid intravenously, type-specific blood and surgical review.
  3. *"Non-responders":* continue fluid resuscitation, administer *O-negative blood* and obtain urgent surgical intervention.

- *Coagulopathy* is a rare complication in the first hour after trauma but undertake a baseline assessment of coagulation (full blood count, coagulation studies etc). Hypothermia should be avoided as it may contribute to coagulopathy.

There is no good evidence that one colloid solution is better than any other (large trials are needed)[1] or that resuscitation with colloids reduces the risk of death compared with crystalloids in trauma[2] or that earlier or larger volumes of IV fluid administration in uncontrolled haemorrhage are better than delayed or smaller volumes.[3] The limited published evidence supports the use of "restrictive" transfusion triggers in patients who are free of serious cardiac disease;[4] there is no good evidence that albumin administration reduces the risk of death in critically ill patients with hypovolaemia, and a strong suggestion that it may actually increase it.[5] There are not enough good data to support the use of hypertonic crystalloid rather than isotonic crystalloid in trauma resuscitation;[6] finally, there is no evidence to suggest that Military Anti-Shock Trousers (MAST) / Pneumatic Anti-Shock Garments (PASG) application reduces mortality, length of hospitalisation or ICU stay in trauma patients and it may actually increase these.[7]

- If treatment for hypovolaemic shock fails, consideration should be given to addressing *non-haemorrhagic* causes of shock, including: tension pneumothorax, neurogenic shock, cardiogenic shock or septic shock.

[1] Bunn F et al. *Colloid solutions for fluid resuscitation (Cochrane Review).* **In: The Cochrane Library, Issue 4, 2001. Oxford: Update Software.**
[2] Alderson P et al. *Colloids versus crystalloids solutions for fluid resuscitation in critically ill patients (Cochrane Review).* **In: The Cochrane Library, Issue 4, 2001. Oxford: Update Software.**
[3] Kwan I et al. *Timing and volume of fluid administration for patients with bleeding following trauma.* (Cochrane Review). **In: The Cochrane Library, Issue 4, 2001. Oxford: Update Software.**
[4] Hill SR et al. Transfusion thresholds and other strategies for guiding allogenic red blood cell transfusion. (Cochrane Review). **In: The Cochrane Library, Issue 4, 2001. Oxford: Update Software.**
[5] Roberts I et al. Human albumin solution for resuscitation and volume expansion in critically ill patients. (Cochrane Review). **In: The Cochrane Library, Issue 4, 2001. Oxford: Update Software.**
[6] Bunn F et al. Hypertonic versus isotonic crystalloid for fluid resuscitation in critically ill patients. (Cochrane Review). **In: The Cochrane Library, Issue 4, 2001. Oxford: Update Software.**
[7] *Use of military antishock trousers (MAST) in the treatment of traumatic hypovolaemic shock.* (Cochrane Review). **In: The Cochrane Library, Issue 4, 2001. Oxford: Update Software.**

Thoracic Trauma

THORACIC TRAUMA

- Serious chest (thoracic) injury carries a *mortality of 10%*, mainly due to tension pneumothorax, open pneumothorax, flail chest, airway obstruction, cardiac tamponade, or massive haemothorax.

- Victims of thoracic trauma must be managed by the A.B.C.D.E. approach.

- *Primary survey* should aim to identify and treat the following 5 injuries rapidly:
  1. *Tension pneumothorax:* this is often caused by mechanical ventilation. Treatment is by needle decompression at the second intercostal space mid-clavicular line (2nd ICS-MCL) with subsequent chest drainage (thoracostomy);
  2. *Open pneumothorax:* if the chest wall defect is more than two-thirds of the diameter of the trachea, air will be drawn preferentially through the defect. The treatment is to seal the defect with a flutter valve dressing and undertake thoracostomy;
  3. *Flail chest:* i.e. where there are fractures of 2 or more ribs in 2 or more places. The underlying lung contusion is the most important aspect of the injury. Avoid both shock and over-rehydration and ventilate in order to alleviate respiratory distress and/or hypoxia;
  4. *Massive haemothorax* (i.e. there is over 1.5 litres of free blood in the chest cavity). Decompression should be matched to fluid input. Thoracotomy should be performed if over 1500 mls of blood are initially drained or there is over 200 mls / hr blood loss through the thoracostomy tube over the 2 - 4 hrs following chest drainage.
  5. *Cardiac tamponade:* this is traditionally characterised by "Beck's triad" of reduced jugular venous pressure, muffled heart sounds and low blood pressure, but in practice these may be very difficult to assess in the resuscitation room. Treatment is by sub-xiphoid pericardiocentesis (which should be performed if at all possible by a thoracic surgeon or at least by ultrasonographic guidance).

- *If sternal, scapular, first or second rib fractures* are found, internal injury is more likely. However, suspected myocardial contusion should be treated only as is clinically indicated (e.g. dysrhythmias). Patients with sternal fractures do not need admission routinely for observation of *possible underlying cardiac contusion.*[1,2]

- Secondary survey in the context of severe thoracic injury requires chest x-ray (CXR) arterial blood gas sampling (ABGs) and ECG. Identify and treat:
  1. *Simple pneumothorax:* consider thoracostomy
  2. *Haemothorax:* thoracostomy and consider surgical repair.
  3. *Tracheo-bronchial injury:* this usually requires urgent surgical repair.
  4. *Cardiac injury:* contusion may cause arrhythmias or even cardiac rupture.
  5. *Aortic rupture:* if not quickly fatal, requires CXR, angiography and urgent surgery.
  6. *Diaphragmatic rupture:* this occurs more commonly on the left than on the right. Diagnosis may be suggested by a displaced NG tube or gastric bubble on CXR.
  7. *Traversing wounds:* these require unilateral or bilateral drains and mandatory exploration.

[1] Chiu WC, D'Amelio LF, Hammond JS. *Sternal fractures in blunt chest trauma: a practical algorithm for management.* **Am J Emerg Med. 1997 May;15(3):252-5.**
[2] Sadaba JR, Oswal D, Munsch CM. *Management of isolated sternal fractures: determining the risk of blunt cardiac injury.* **Ann R Coll Surg Engl. 2000 May;82(3):162-6.**

Abdominal Trauma

ABDOMINAL TRAUMA

- A *"surgical abdomen"* may not always be present in a patient with significant intra-abdominal trauma so clues to potential injury need to be derived from the history, mechanism of injury and examination.

- As with the other body systems, abdominal trauma is managed according to the **A.B.C.D.E.** approach.

- Management of the patient with suspected or evident abdominal trauma may require the introduction of oro- and/or naso-gastric tubes, along with urinary catheterisation while pelvic X-ray and resuscitation are undertaken simultaneously.

- It should be quickly established if any intra-abdominal haemorrhage is present. A number of investigations complement physical examination for this purpose:

(1) **Computerised Tomography (CT):** this may be rapidly and specifically diagnostic and is becoming an invaluable element in the approach to the injured patient but it should only be performed in haemodynamically stable patients.

(2) **Ultrasonography (US):** where available and in experienced hands is as useful as DPL and may be more quickly performed;

(3) **Diagnostic Peritoneal Lavage (DPL):** although less popular nowadays (with the advent of a more conservative approach to solid organ injuries) DPL remains a useful and rapid investigation with a 98% sensitivity for use in the unstable patient with altered consciousness, sensation, equivocal clinical findings, adjacent rib/pelvis injuries causing haemorrhage or where the patient is to be anaesthetised for other procedures;

- Pancreatic and diaphragmatic injuries are often missed by all methods.

- Penetrating injuries to the abdomen may require surgical exploration. Where the patient is haemodynamically stable, serial examination is as sensitive as either DPL or CT when a decision to proceed to surgical intervention is being made.

- **Indications for laparotomy may include:**
  1. "Positive" findings on CT, US or DPL.
  2. Blunt abdominal trauma with hypotension and failure to respond to fluid resuscitation.
  3. Peritonitis.
  4. Penetrating trauma with substantial bleeding and/or hypotension.
  5. Gunshot wounds (GSW).
  6. Evisceration.

Pelvic fractures cause marked blood loss and shock and should be aggressively managed with splintage, analgesia and urgent orthopaedic or radiological intervention (e.g. fixation, therapeutic embolisation). The possibility of posterior urethral disruption must always be considered in such patients and in those with perineal haematoma, meatal blood and an elevated prostate on rectal examination. Retrograde urethrography must precede any attempt at urethral catheterisation in these patients.

HEAD TRAUMA / TRAUMATIC BRAIN INJURY

- Traumatic Brain Injury (TBI) is classified according to aetiology (blunt or penetrating trauma), severity (mild, moderate or severe) and "morphology", e.g.

  1. *Skull fracture* (whether present or not);
  2. *Focal brain lesion* (e.g. extradural, subdural or intracerebral haematoma);
  3. *Diffuse lesion* (e.g. "concussion" without loss of consciousness [LOC])
  4. *Classic cerebral "concussion"* (i.e. minor traumatic brain injury)
  5. *Diffuse axonal injury* (e.g. prolonged coma without mass lesion or ischaemic insult)

- Assessment of the head injured patient requires adherence to the **A.B.C.D.E.** approach, with evaluation of the *Glasgow Coma Score* (GCS) the *pupillary status* (each side) and response to light and "lateralising" signs, e.g. weakness on one side, upgoing plantar reflexes or Hoffman's thumb response.

- The radiological investigation of choice in TBI is **CT** scanning (plain radiography may occasionally be useful, e.g. in depressed and/or open skull fractures, pneumocephalus or with retained foreign bodies or weapons). However, "normal" CT appearances by no means excludes significant brain injury.

- When treating a severely head injured patient (especially if there are other injuries), it is important to remember the *Monroe-Kelly Doctrine:* CPP (cerebral perfusion pressure) = MABP (mean arterial blood pressure) - ICP (intra-cranial pressure). This signifies that mean arterial blood pressure must be maintained to ensure oxygenation of the brain (by IV fluids or urgent treatment of other injuries if necessary). Thus, hypotension and hypoxia due to other injuries must be minimised in order to minimise secondary brain injury.

- Options in management of the head injured patient may include IV crystalloid (e.g. normal saline); hyperventilation (e.g. in a patient with raised ICP, pCO2 is maintained at 3.3 - 4.0 kPa, although this is less popular nowadays); mannitol: e.g. 1 mg / kg of 20% (which may aggravate hypotension); frusemide may be used to lower ICP in the ICU).

Routine intra-cranial pressure monitoring in TBI is not supported by randomised controlled trials (RCTs);[1] there is no evidence to support therapeutic hypothermia;[2] there are insufficient data to recommend one form of mannitol infusion over another;[3] RCTs are required to assess the effectiveness of hyperventilation,[4] and steroid therapy.[5] Barbiturates provoke dangerous hypotension and – like anti-convulsants – have no recognised role in *early* TBI care.

- Urgent neurosurgical expertise and input should be sought as soon as possible in all cases of (suspected) severe traumatic brain injury, and appropriate transfer to definitive neurosurgical care arranged.

[1] Forsyth R et al. *Routine intra-cranial pressure monitoring in acute coma.* (Cochrane Review). ***In:*** **The Cochrane Library, Issue 4, 2001. Oxford: Update Software.**
[2] Gadkary CS et al. *Therapeutic hypothermia for head injury.* (Cochrane Review). ***In:*** **The Cochrane Library, Issue 4, 2001. Oxford: Update Software.**
[3] Schierhout G et al. *Mannitol for acute traumatic brain injury.* (Cochrane Review). ***In:*** **The Cochrane Library, Issue 4, 2001. Oxford: Update Software.**
[4] Schierhout G et al. *Hyperventilation for acute traumatic brain injury.* (Cochrane Review). ***In:*** **The Cochrane Library, Issue 4, 2001. Oxford: Update Software.**
[5] Alderson P et al. *Corticosteroids for acute traumatic brain injury.* (Cochrane Review). ***In:*** **The Cochrane Library, Issue 4, 2001. Oxford: Update Software.**

Spine and Spinal Cord Trauma

SPINE AND SPINAL CORD TRAUMA

- All victims of severe or multiple trauma are presumed to have a spinal cord injury until proven otherwise although patients who are awake, alert, sober, neurologically normal, with no back pain or other painful distracting injury are unlikely to have spinal injury.[1]

- Conversely, a patient who is comatose, has altered consciousness or is unable to identify his injuries for any reason (e.g. age, intoxication or head injury) should be comfortably immobilised until spinal injury can be ruled out. Protracted immobilisation is hazardous and painful and is of uncertain value.[2]

- Assess each patient for *bony tenderness,* a *"sensory level"* and the presence of *complete or incomplete cord injury.* Spinal cord injury may reduce a patient's ability to perceive pain (there may be a paradoxically reduced requirement for analgesia early on).

- Exclusion of injury requires a working knowledge of anatomy and neurology.

- **Spinal Anatomy:** corticospinal tract (postero-lateral) = ipsilateral power; spinothalamic tracts (antero-lateral and contra-lateral) = pain and temperature sensation; posterior columns = proprioception and temperature sensation. Check dermatomal sensation and reflexes.

- Management of suspected injury requires cautious "log-rolling" and full spinal examination with digital rectal examination.

- Radiographs of the areas of suspicion should be undertaken followed by computerised tomography (CT) if the diagnosis remains uncertain.

- In-line immobilisation must be maintained even if this involves sedating and paralysing a restless patient until injury is excluded.

- Maintenance fluids are given and vasopressors may need to be given to reverse severe neurogenic shock (obtain local Critical Care / Spinal Specialist Advice).

- Methylprednisolone sodium succinate has been shown to improve neurological outcome if given in the first 8 hours of the injury (i.e. a bolus of 30 mgs / kg over 15 mins and then 5.4 mgs / kg IV over 23 hours).[3]

- Early transfer to a specialist spinal unit should be arranged if necessary.

Classification of spinal cord injury can be along several lines:

Level: quadriplegia (injury at T1 or below) or paraplegia (injury at C1-C7);

Severity: complete or incomplete;

Central Cord Syndrome: in hyperextension injury with relatively greater paralysis in upper limbs (this has a relatively benign prognosis);

Anterior Cord Syndrome: paraplegia and reduced temperature and pain sensation (this has a grim prognosis);

Brown-Séquard Syndrome:(cord hemisection with ipsilateral weakness and contralateral sensory loss) this is very rare;

*(**SCIWORA:** spinal cord injury without radiological abnormality)*

[1] Vickery D. The use of the spinal board after the pre-hospital phase of trauma management. **EMJ 2001;18:51-54.**
[2] Kwan I et al. WHO Pre-Hospital Trauma Care Steering Committee on Spinal Immobilisation for Trauma Patients. (Cochrane Review). ***In:*** **The Cochrane Library, Issue 4, 2001. Oxford: Update Software.**
[3] Bracken MB. Steroids for acute spinal injury. (Cochrane Review). ***In:*** **The Cochrane Library, Issue 4, 2001. Oxford: Update Software.**

Musculoskeletal Trauma

MUSCULOSKELETAL TRAUMA

- Musculoskeletal trauma should be managed within the A.B.C.D.E. approach with attention to specific injuries (e.g. diaphyseal fractures) as part of the *Secondary Survey.*

- Musculoskeletal injuries may contribute to the severity of trauma through haemorrhage, contamination (open fractures) and ischaemia-reperfusion injury (with massive rhabdomyolysis).

Life-threatening musculoskeletal injuries include:

- *Pelvic ring disruption* causing massive haemorrhage;
- Arterial *haemorrhage* (which should be controlled by direct pressure, rather than blind clamping);
- Long bone *fractures* with haemorrhage especially from the femoral diaphysis.

Limb-threatening injuries include:

Open fractures/dislocations: these should be **photographed, swabbed** for microbiological screening, wound **lavage** should be performed to reduce the bacterial load, displacement should be anatomically **reduced** and appropriate **antibiotic and tetanus prophylaxis** should be provided, as necessary.

- *Neurovascular injuries and amputation:* require urgent referral to appropriate teams, including vascular and/or plastics opinion. The **Mangled Extremity Severity Score**[2] (MESS) may assist in decision making.

- *Compartment syndrome:* can occur in any site where muscle is contained in a closed fascial space. Consider when pain in an extremity is more than expected: one sign is severe pain on passive stretch of involved muscle. Early referral is essential.

The aims of fracture management are to control haemorrhage (by direct pressure and immobilisation), control contamination, remove dead tissue, relieve pain with intravenous analgesia and comfortable splintage and to prevent further soft tissue injury. The importance of the **Secondary Survey** is underlined by the fact that the most frequently overlooked injuries in patients with severe polytrauma are musculoskeletal (e.g. calcaneal or tibial plateau fractures are often only appreciated days or even weeks after initial resuscitation).

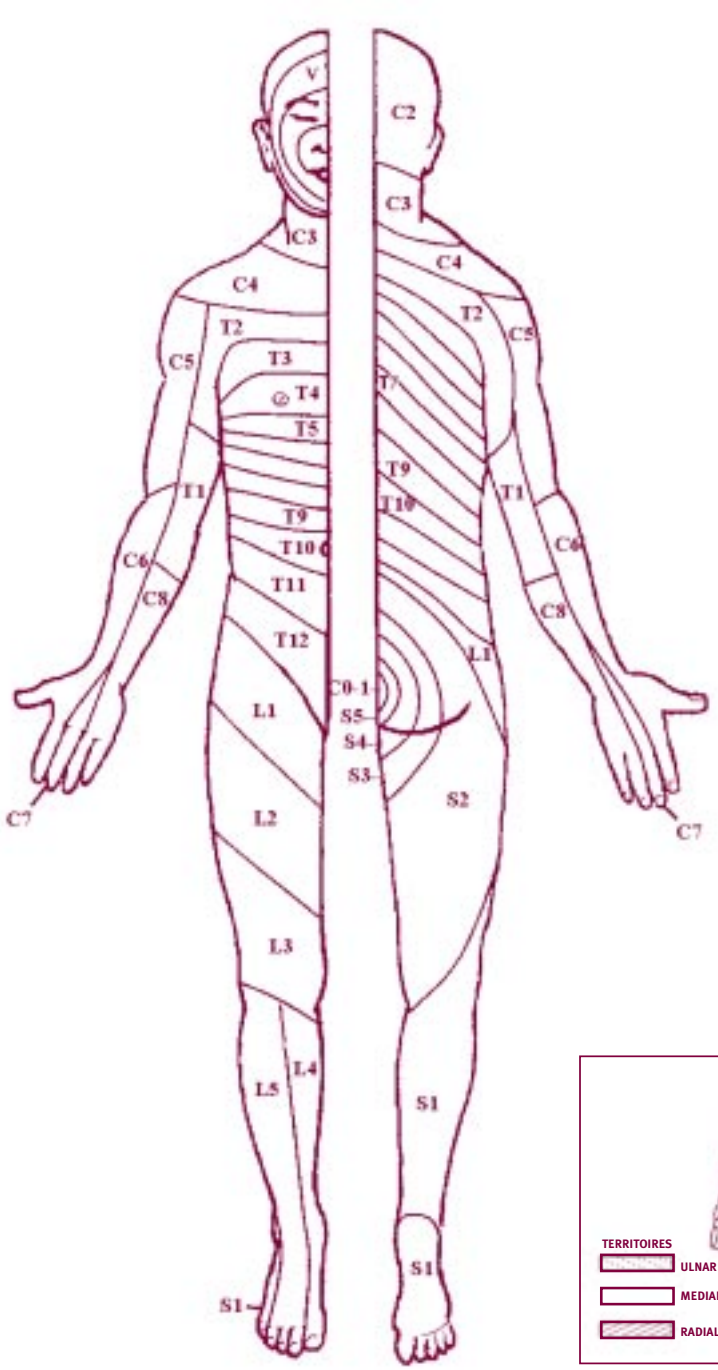
Open fractures have been classified by Gustillo[1]:

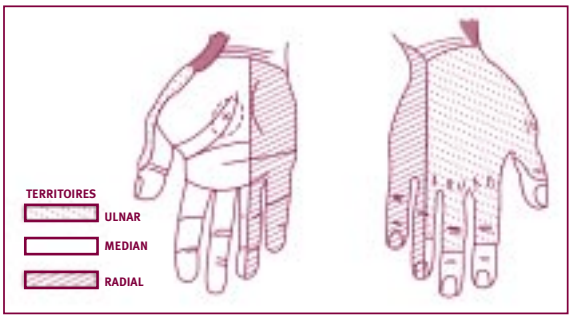
Type I:	an open fracture with a wound less than 1cm and "clean";
Type II:	an open fracture with a wound more than 1cm and which is not associated with extensive soft tissue damage, avulsions or flaps;
Type IIIA:	an open fracture where there is adequate soft tissue coverage of bone despite extensive soft tissue damage, or where a high energy trauma has been sustained irrespective of the wound;
Type IIIB:	an open fracture with extensive soft tissue loss, periosteal stripping and bone exposure;
Type IIIC:	an open fracture with arterial injury requiring repair.

[1] Gustillo RB et al. *Prevention of infection in the treatment of 1,025 open fractures of long bones.* **J Bone Joint Surg America 1976;584:45328.**
[2] Johnsen K et al. *Objective criteria accurately predict amputation following lower extremity trauma.* **J Trauma 1990; 30: ed 5; 568-72.**

8. MUSCULOSKELETAL TRAUMA

Nerve roots supplying dermatomal regions





Trauma due to burns

TRAUMA DUE TO BURNS

- In severe burns cases, as with all other injuries, follow the **A.B.C.D.E.** approach.
- In all burns suspect an airway injury which may result in compromise.
- Suspicion is increased with facial burns, inflamed oropharynx, carbonaceous sputum, altered cognition, COHb >10%, or explosion with upper body burns.
- Intubate early if in doubt and obtain IV access at the scene of the burn if needed.
- For severe burns (>15% total body surface area [TBSA] in adults, or >10%. TBSA in children), give crystalloid (e.g. normal saline) at 2 - 4mls / kg / % TBSA. Give half in the first 8 hours and half in the next 16 hours. Aim to keep the urine output over 30-50 mls / hour in adults or over 1ml / kg / hr in children under 30 kgs.
- Stop the burning process by removing all clothing/chemicals and if possible irrigate burns with cold running water for 20 minutes (except with burns caused by elemental Group 1 metal, i.e. lithium, sodium, potassium, caesium).
- Avoid chemical neutralising agents as these can generate exothermic reactions.
- Ascertain the history, surface area and depth of the burn (use a Lund and Browder body map or "Rule of 9s").
- Give effective (e.g. IV opioid) analgesia bearing in mind that requirements will be increased if hypoxia and hypovolaemia are not corrected.
- Antibiotics are not indicated in the early stages of the management of burns.
- Alkali burns need to be irrigated for longer as they penetrate more deeply and cause greater damage.
- Electrical burns may lead to acute renal failure due to rhabdomyolysis. This may be managed (or prevented) with IV mannitol, keeping the urine output over 100 mls / hr while alkalinising the urine to increase the solubility of the myoglobin.
- Additionally, significant myocardial dysfunction and dysrhythmias may occur, particularly with high voltage shocks, although most revert spontaneously.[2]

Superficial Burns are erythematous, painful and blanch on touch with good capillary refill.

Partial Thickness Burns are divided into superficial dermal and deep dermal sub-types, and have good skin sensation.

Superficial Dermal Burns are characterised by blistering, blanching, good capillary return and good skin sensation.

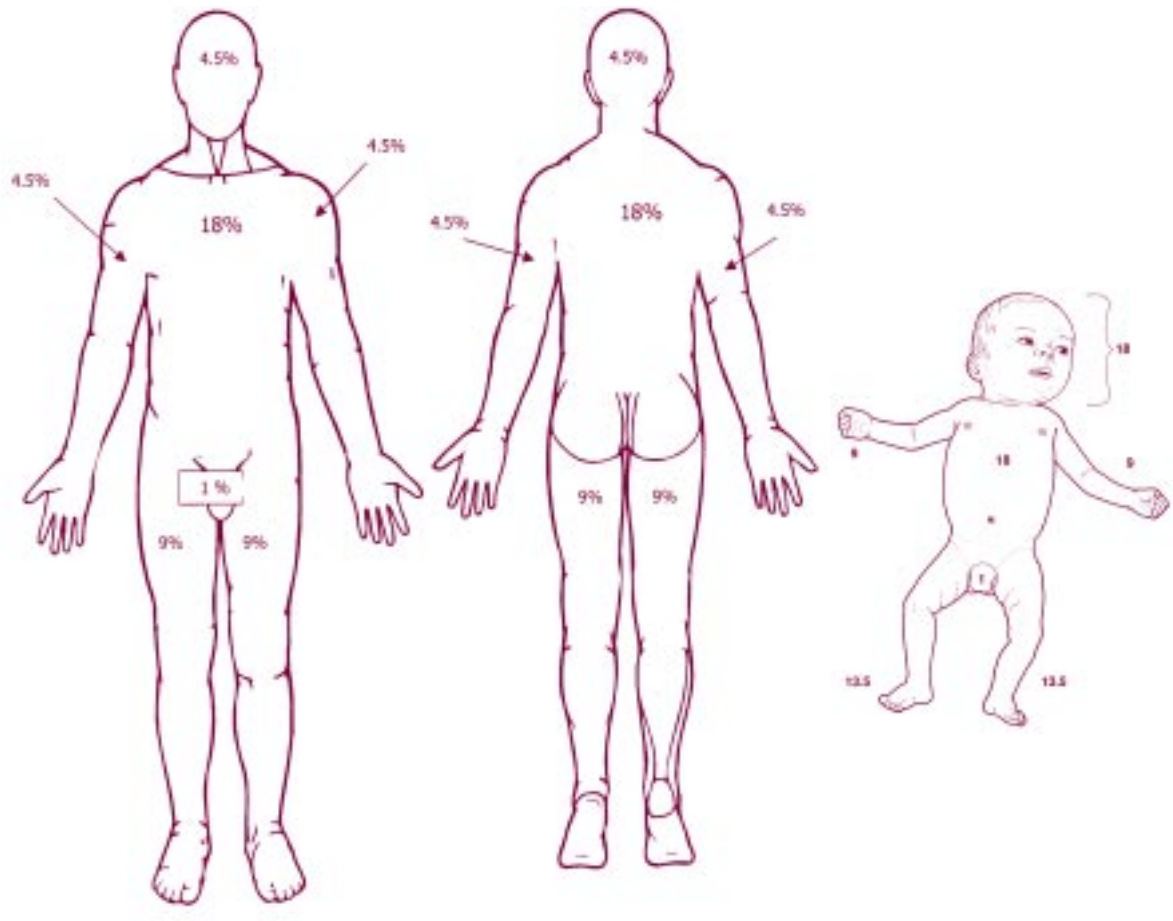
Deep Dermal Burns are mottled, with poor blanching and capillary return. Sensation may be impaired.

Full Thickness Burns are white, leathery or charred, with no blanching or capillary return. The skin is insensate.

Criteria for Transfer to a Specialist Burns Unit[1] are as follows:

Burns >5% TBSA if under 10, or >10% TBSA in adults
Full thickness burns >5% TBSA or circumferential burns of limbs or chest
Partial / Full thickness burns of face, eyes, extremities, genitalia
Significant electrical or chemical burns or involving inhalational injury
Suspected non-accidental injury or severe co-morbidity
Other injuries may need to be treated before transfer

Estimation of surface area of burn injury: Rule of Nines



A: Anterior view. **B: Posterior view.**[3]

[1] British Burn Association. *Emergency Management of Severe Burns* (EMSB). **UK Course Manual, 1996.**
[2] O'Connor CE. *Management of electrical injury.* **IMJ 2003; 96(5): 133-134.**
[3] from Dains JE: *Integumentary system.* In Thompson JM et al: *Mosby's Clinical Nursing,* 3rd Ed., **St Louis, 1993, Mosby-Year Book.**

Trauma due to Cold

TRAUMA DUE TO COLD

- Three types of injury are encountered:

- *Frostnip* is characterised by initial pain, pallor and numbness and is reversible without adverse effects.

- *Frostbite* is due to freezing and ice crystal formation within microvessels which results in anoxia. There are four degrees of injury:
  1. Hyperaemia and oedema without skin necrosis;
  2. Large clear vesicles and partial thickness skin necrosis;
  3. Full thickness and subcutaneous skin necrosis and haemorrhagic vesicles;
  4. Full thickness skin necrosis including muscle and bone.

- *Non-freezing injury* results from endothelial damage, stasis, and vascular occlusion. Prolonged immersion at above freezing. Initially have vasospasm and then painful vasodilation.

- The above injuries are all managed by rewarming of the affected part in water of 40˚C with adequate analgesia.

- A final assessment of these injuries can only be made when full *demarcation* of the wound has occurred and surgery should be reserved until then. This process may take weeks.

- **Hypothermia** is defined as a core temperature of <35˚C. Where there are no other injuries the following classification can be used:
  1. Mild: 35˚C - 32˚C
  2. Moderate: 32˚C - 30˚C
  3. Severe: <30˚C

- In the trauma patient hypothermia is any temperature <32˚C.

- Hypothermia is usually manifest as confusion, with grey cyanotic skin.

- Hypothermia should be managed along the **A.B.C.D.E.** approach and resuscitation should be continued until the temperature is returned to normal.

- Rewarming of mild and moderate cases can be done externally while severe degrees will need active core rewarming methods.

- Ventricular fibrillation is more likely when the temperature falls below 33˚C and should be treated with drugs and defibrillation. These modalities are ineffective below 28˚C.

Paedriatric Trauma

Paediatric Trauma[1]

- Trauma is the commonest cause of death and disability in the paediatric age group. The most important consideration is that the kinetic energy involved in paediatric trauma is absorbed by a smaller body, resulting in greater injury proportionately.

- The child has greater physiologic reserves than an adult so signs of shock are often delayed and the presence of hypotension indicates profound shock. An airway should be rapidly established, as hypoxia is the commonest cause of cardiac arrest.

- A maximum of 3 attempts or a period of 90 seconds at most should be spent gaining IV access before intra-osseous access is attempted.

- If fluid is required, give 3 boluses of crystalloid (e.g. normal saline) 20 mls / kg promptly. Reassess clinically for a response after each bolus. Blood (10 mls/kg) will be required if there is no response to fluid boluses. A urine output of 2mls / kg / hr should be achieved.

- Beware the lack of "obvious" external injury as this does not exclude serious internal injury, especially in chest trauma. Children's flexible ribs rarely fracture.

- Bowel and bladder perforation is more common than in the adult and enteric injury is very likely in the presence of a "Chance fracture" (i.e. a splitting injury of a vertebra or intervertebral disc, e.g. due to seat-belt injury as the spine is flexed and distracted)[2].

- A relatively large head: body mass ratio in children causes increased hyperflexion injury while SCIWORA (spinal cord injury without radiological abnormality) is more common than in adults.

- **Non-Accidental Injury (NAI):** this should be suspected where the clinical findings do not correspond with the history given, where there is delayed presentation, repeated attendances or an inappropriate attitude is shown by parents/carers.

- The following raise suspicions of **NAI:**
  1. Multiple subdural haematomata without fresh skull fractures
  2. Retinal haemorrhage
  3. Peri-oral injuries
  4. Ruptured viscera without history of major blunt trauma
  5. Perineal or genital trauma
  6. Bizarre, frequent or repeated injury (e.g. old fractures on x-rays)
  7. Long-bone fractures if victim <3 years of age
  8. Sharply demarcated partial / thickness deep burns in unusual areas

[1] Paediatric Advanced Life Support Course Manual.
[2] Walsh A, Sheehan E, Walsh MG. Lumbar Chance fracture associated with use of the lap belt restraint in an adolescent. IMJ 2003; 96 (5): 148-149.

Trauma in Pregnant Women

TRAUMA IN PREGNANT WOMEN

- Trauma in pregnancy requires attention to the welfare of two patients, and an understanding of the important and predictable anatomical and physiological changes that occur during pregnancy. These may significantly influence the evaluation and treatment of the injured pregnant patient.

- As pregnancy advances, the foetus becomes more vulnerable: the uterus is intra-pelvic until 12 weeks' gestation, reaches the umbilicus at 20 weeks and ribs by 36 weeks.

Physiological Characteristics of the Pregnant Woman

Intravascular volume is increased and cardiac output rises by 1 – 1.5 Litres / minute;

Heart rate rises by 10 – 15 beats / minute, while *blood pressure* drops by 5 – 15 mm Hg;

Oxygen consumption is increased; *haematocrit* and *plasma bicarbonate* are reduced;

Inferior vena cava (IVC) compression may diminish cardiac output (CO) by 30% if the patient is supine;

The placenta and uterus receive 20% of CO towards term;

Gastric emptying is slowed (the stomach should be assumed to be full);

Shock causes *uterine vasoconstriction* and *foetal hypoxia;* at the same time such shock may be insidious or occult because of the circulatory changes above;

Peculiar hazards of pregnancy include *amniotic fluid embolus* (which may cause disseminated intra-vascular coagulation [DIC]), *rhesus iso-immunisation, premature rupture of the membranes, abruptio placentae* and *domestic violence.*[1]

- **Management** otherwise follows similar priorities as for the non-pregnant patient, but a senior surgeon, obstetrician and neonatologist must be involved as soon as possible. Vaginal examination should be performed to assess for bleeding or early labour. Beware of introducing infection in the event of premature rupture of membranes. Keep a low threshold for admission: the foetus may be in jeopardy even with apparently minor maternal trauma.

- Irradiation of a foetus should be avoided whenever possible.[2]

- Check blood group and Rhesus Factor: consider giving Rhesus Immunoglobulin therapy (Anti-D) in all Rhesus-negative women unless the injury is remote from the uterus.

- If spinal injury is suspected, the pregnant victim should be nursed semi-recumbent with the right hip elevated; otherwise, the optimal position is with the patient turned on her left side to keep the gravid uterus away from the inferior vena cava.

- Seat belts may injure both foetus and mother.

- Particularly life-threatening injuries to foetus and/or mother include: *uterine rupture, abruptio placentae and pelvic fractures*

- Urgent caesarean section may be required if there is a poor foetal heart rate (120 – 160 *bpm* is normal), frequent decelerations and reduced beat-to-beat variability but peri-mortem caesarean section has little evidence of success to recommend it.

[1] Johnson JK, Haider F, Ellis K, Hay DM, Lindow SW. *The prevalence of domestic violence in pregnant women.* **BJOG. 2003;110(3):272-5.**
[2] UK Royal College of Radiologists. *Making the best use of a Department of Clinical Radiology.* **1998.**

Imaging in Severe Trauma

Imaging in Severe Trauma

Traditional recommendations (e.g. ATLS) for imaging in major trauma are that the severely (or multiply) injured patient should routinely undergo plain radiography of the cervical spine, chest and pelvis. However, the Working Party is of the opinion that imaging decisions in major trauma should be individualised. Careful and early consultation between clinical and radiological colleagues is recommended in order to reduce unnecessary irradiation.

Table: Recommendations for radiological imaging in the traumatised patient[1]

Clinical Problem	Investigation	Recommendation
HEAD INJURY: POSSIBLE INTRACRANIAL INJURY		
Low risk head injury Fully oriented; no amnesia or neurological signs; no serious scalp laceration or haematoma.	Skull X-ray/CT	Not indicated routinely.
Medium-risk head injury Loss of consciousness or amnesia; violent mechanism of injury; scalp bruise; swelling or laceration down to bone or >5cm; neurological symptoms or signs (eg. headache, vomiting twice or more, return visit); inadequate history or examination; child <5yrs: suspected NAI*, fall >60 cm or on to hard surface.	Skull X-ray/CT	Indicated: CT is increasingly being used as a first and only investigation in order to screen patients who may be discharged. If unavailable, patients should be admitted for a 24 hour period and undergo frequent neuro-observations.
High-risk head injury Suspected foreign body or penetrating injury; disoriented or impaired consciousness; focal neurological symptoms or signs; skull fracture or diastasis; nasal CSF leak or aural CSF/blood; unstable systemic state precluding transfer to neurosurgical unit; diagnosis uncertain.	CT	Indicated: CT should be done within 4 hours in all patients with a skull fracture.
Very high-risk head injury Deteriorating consciousness or neurological signs; confusion or coma; tense fontanelle or sutural diastasis; open or penetrating injury; depressed or compound fracture; fracture of skull base.	CT	Indicated: urgent neurosurgical and anaesthetic referral should not be delayed by imaging.
SPINAL TRAUMA		
Cervical spine Conscious patient with head and/or face injury	X-ray cervical spine	Not routinely indicated in those who are: fully conscious; not intoxicated; no abnormal neurological findings; no neck pain or tenderness.
Unconscious head injury	X-ray cervical spine	Indicated.
Neck injury (with pain) or neurological deficit	X-ray cervical spine	Indicated: radiology must show C7/T1 junction; should show odontoid peg. Special views/CT/MRI may clarify. MRI best if neurological signs.

*NAI: non-accidental injury.

[1] Radiation Protection 118 (2000): *Referral guidelines for imaging*. **Adapted by experts representing European radiology and nuclear medicine in conjunction with the UK Royal College of Radiologists.**

Table: Recommendations for radiological imaging in the traumatised patient contd.

Clinical Problem	Investigation	Recommendation
SPINAL TRAUMA CONTD.		
Thoracic and Lumbar Trauma: no neurological deficit	X-ray	Not routinely indicated if pain free as physical examination is reliable in the awake patient. Low threshold to XR when there is pain/tenderness, a significant fall, high impact RTA, other spinal fracture present, or impossible to evaluate.
Trauma with neurological deficit	X-ray/MRI	Indicated: MRI best (see neck injury with neuro.)
Pelvis and sacrum Fall with inability to bear weight	X-ray pelvis and lateral X-ray hip	Indicated: check especially for femoral neck fractures.
Urethral bleeding + pelvic injury	Urethrogram	Indicated: cystogram if normal urethra but bladder leak suspected.
Upper and lower limb Shoulder injury	X-ray shoulder	Indicated: some dislocations are subtle, US/CT/MRI for soft tissue injury.
Elbow injury	X-ray elbow	Indicated: performed to show effusion.
Wrist injury	X-ray wrist/MRI	Indicated: scaphoid fractures can be invisible at presentation. MRI/CT more sensitive.
Knee injury (fall/blunt trauma)		Not routinely indicated when physical findings are minimal. Inability to bear weight or marked bony tenderness (particularly at patella and fibular head) merit XR. CT/MRI may also help.
Ankle/foot injury	X-ray ankle/foot	Not routinely indicated: justified in elderly patients, malleolar tenderness, inability to bear weight, marked soft tissue swelling.
Chest and abdomen Minor chest trauma	Chest X-ray	Not routinely indicated: demonstration of rib fracture does not alter management.
Moderate chest trauma	Chest X-ray	Indicated: frontal CXR for pneumothorax, fluid or lung contusion. Normal CXR does not exclude aortic injury- consider arteriography/CT/MRI.
Stab Injury	Chest X-ray	Indicated: PA +/- other views to show pneumothorax, lung injury, fluid. US also helpful.
Sternal fracture	Chest X-ray and X-ray lateral sternum	Indicated: consider thoracic spinal and aortic injuries.
Blunt or Stab injury	Erect Chest X-ray	Indicated: US and CT also helpful.
Renal trauma	Imaging	Indicated: while US suffices for minor injury, dynamic contrast studies are required for moderate trauma, suspected renal artery injuries and to ensure normality of contralateral kidney.
MAJOR TRAUMA		
Unconscious patient	C-spine X-ray, Chest X-ray, Pelvis X-ray	CT head indicated: priority is stabilization.
Major torso trauma	Chest X-ray, Pelvis XR CT trunk	Indicated: CT is sensitive and specific but time consuming. Use of emergency room US increasing. Low threshold to arteriography if mediastinal haemorrhage suspected.

Transfer for Definitive Care

TRANSFER FOR DEFINITIVE CARE[1]

The following observation and suggestions are derived from recently published guidance by the Intensive Care Society in the United Kingdom (ICS-UK).[1] Although there are organisational, cultural and social differences between the UK and Ireland, much of what the ICS-UK recommends is worth considering in relation to the severely injured patient in this country.

- There is evidence that the outcome of the critically ill or injured patient is improved by the use of dedicated (inter-hospital and in-hospital) transport teams. Such teams should probably be trained and equipped on a regional or province-wide basis.

- All acute hospitals should retain the ability to resuscitate, stabilise and transport critically ill patients. In-hospital transport teams should be appropriately trained, resourced and supervised, and a senior clinician and nurse within each hospital should be responsible for their organisation and development.

- Each hospital should have a designated consultant available 24 hours a day to organise, supervise and, where necessary, undertake all inter-hospital transfers.

- Consideration should be given to the question of providing appropriately equipped ambulances to facilitate the transport of critically ill or injured patients, designed with the needs of both patients and staff in mind.

- Each critical care area (e.g. resuscitation room, ICU) should have access to a dedicated suitably equipped transport trolley, compatible with local ambulance mounting systems.

- Appropriate transport equipment, including monitors, ventilators and syringe pumps, must be available. All such equipment should be standardised across a region (or nationally) to enable the seamless transfer of patients between hospitals without interruption of drug therapy or monitoring.

- Critically ill or severely injured patients should be accompanied by at least two suitably experienced attendants, one of which should be a medical practitioner with appropriate training in intensive care medicine, anaesthesia, or other acute speciality.

- The decision to transfer a patient to another hospital is always a balance of the associated benefits and risk and must be made by an appropriate consultant (e.g. Consultant Surgeon, Consultant in Emergency Medicine or Consultant Intensivist), in consultation with consultant colleagues in the referring and receiving units. *The final decision to accept a patient lies with the specialist consultant in the receiving unit (e.g. neurosurgical or spinal injuries unit) although the Working Party recommends that National and/or Regional units should make every effort to assist referring units.*

- The most appropriate mode of transport will be influenced by factors such as medical urgency, distance, weather conditions, and availability. Transport by road is easier, cheaper and more familiar to staff. Helicopters should be considered for longer journeys or where road access is difficult.[2] Fixed wing aircraft should be considered for journeys over 150 miles.

[1] The Intensive Care Society (UK). ***Guidelines for the transport of the critically adult (Standards and Guidelines).*** **Intensive Care Society,** London, 2002.
[2] Dardis R, Roberts G, Philips J. *A cost-benefit evaluation of helicopters to the Beaumont neurosurgical unit.* **Ir Med J 2000; 93 (2): 50-51.**

TRANSFER FOR DEFINITIVE CARE

- Patients should generally be meticulously resuscitated and stabilised before transport. Patients with penetrating trauma may be the exceptions to such a "rule".

- The minimum standards for monitoring during transport include continuous presence of appropriately trained staff, ECG, non-invasive blood pressure, oxygen saturation, carbon dioxide and temperature monitoring. Invasive blood pressure measurement through an indwelling arterial cannula should be used in most cases.

- In mechanically ventilated patients the oxygen supply, inspired oxygen concentration, ventilator setting and airway pressure, should also be monitored.

- Safety is paramount. The patient should be secured in the transport trolley by means of a harness, and all equipment fastened to the trolley or securely stowed in lockers. Unnecessary high-speed transfer should be avoided. Staff should remain seated at all times.

- Transport of patients by air presents escorting staff with many problems relating to the unfamiliar environment, noise, vibration, poor access and visibility, and the effects of altitude. Staff should not undertake aero-medical transport without appropriate training.

- On arrival at the receiving unit, there should be a verbal and written handover to the receiving medical and nursing team.

- Clear notes must be maintained at all stages. Standard transfer documentation should be developed for use across regions (or nationally).

- Consideration should be given to developing regional/national comprehensive quality assurance programmes, involving audit and critical incident reporting. The clinician in each hospital responsible for the organisation of hospital transport teams should ensure that all patient movements within a hospital are subject to similar scrutiny.

- All individuals involved in the transport of severely injured patients should be suitably trained and experienced. Competency based training and assessment should be developed.

- Despite precautions, there is always a possibility of an ambulance being involved in an accident. The insurance situation in these circumstances is complex and staff should ensure that they have appropriate insurance cover.[1]

Appendix 1

A TRAUMA SYSTEM FOR IRELAND?

It has only relatively recently been appreciated that the care of most trauma patients has been sub-optimal and that it could be substantially improved by the establishment of trauma centres and systems.[1,2] The Royal College of Surgeons of England has concurred that there were significant deficiencies in the management of seriously injured patients because of inadequate staffing and facilities and a lack of senior supervision and specialist interest.[3] They proposed that up to one third of trauma deaths were potentially preventable by improving the training of all involved staff and in particular those involved with the prehospital care, by upgrading methods of transport to established specialist centres and by investing in trauma research, audit and outcome studies.[4]

This view was reinforced by the British Orthopedic Association who especially recommended concentrating services and expanding the consultant staffing of emergency departments.[5] In 1992, this society established protocols and standards for hospitals.[6] Rather than the American "level 1 trauma centre system"[7], it was suggested that while the majority of patients will still be treated locally in District Hospitals a "hub and spoke" model should pertain.[8] Several other reports echo these recommendations while recognising that there are considerable resource implications implicit in their implementation.[9,10,11,12,13]

Comprehensive and comparable information on the work of Emergency Departments in Ireland is extremely limited. In general, there is a greater dependence on nurses and junior medical staff to provide emergency services and poorer interaction with primary care. Additionally, many hospitals do not use formal triage systems while there are also problems accessing radiology and pathology services and difficulties accessing inpatient beds as well as inappropriate reassessment of admissions by less experienced doctors.

Moreover, there are serious concerns regarding excessive waiting times and overcrowding in Emergency Departments. Many of these issues reflect system-wide conditions such as the demands imposed on each hospital, the resources available to it, as well as the structure, organisation and staffing profile of the hospital.

It has been proposed[14] that the principles underpinning the future structure of emergency services should be as follows:

1. **Patients should be admitted directly to the hospital most capable of providing appropriate care by a consultant-delivered service.**
2. Primary and prehospital care are integrated with emergency transport and hospital services.
3. Distinct care pathways, prioritised for acuity, exist within hospitals and are managed as a single, integrated and comprehensive unit.
4. New hospital systems (previously Health Boards) form a network of resources to provide comprehensive care.
5. Agreed guideline standards and, where appropriate protocols underpinned by data systems for planning, audit, and evaluation, are created to guide all emergency staff.

1 Cales RH, Trunkey DD. *Preventable trauma deaths.* **JAMA 1985; 254: 1059-1063.**
2 Nicholl J, Turner J. *Effectiveness of a regional trauma system in reducing mortality from major trauma: before and after study.* **BMJ 1997; 315: 1349-1354.**
3 Commission on the Provision of Surgical Services. *The management of patients with major injuries.* **The Royal College of Surgeons of England. 1988.**
4 Anderson ID, Woodford M, Dombal FT, Irving M. *Retrospective study of 1000 deaths from Injury in England and Wales.* **BMJ 1989; 296: 1305-1308.**
5 British Orthopaedic Association. *The management of trauma in the United Kingdom.* **1989.**
6 British Orthopaedic Association. *The management of skeletal trauma in the United Kingdom.* **1992.**
7 American College of Emergency Physicians. *Trauma care systems development and evaluation.* **Ann Emerg Med 1998; 32: 528-529.**
8 British Orthopaedic Association. *The care of severely injured patients in the United Kingdom.* **1997.**
9 The Royal College of Surgeons in England. *The provision of emergency surgical services- an organizational framework.* **1997.**
10 British Medical Association. Leaner and fitter. *What future model for acute hospital services.* **1997.**
11 Standing Medical Advisory Committee of CMO. *Future patterns of medical care. Department of Health.* **1997.**
12 BMA, Royal College of Physicians of London, The Royal College of Surgeons in England. *Provision of acute general hospital services-* Consultation document. **1998.**
13 The Royal College of Surgeons in England, British Orthopaedic Association. *Better care for the severely injured.* **2000.**
14 Comhairle na nOspideal. *Report of the Committee on Accident and Emergency Services.* **February 2002.**

A TRAUMA SYSTEM FOR IRELAND?

In order to facilitate this, it is recommended that a three-tier emergency department system be adopted nationally comprising:

(1) *Regional emergency departments* located in major hospitals with a catchment population of 250,000 providing resuscitation, stabilisation and initial treatment for all emergencies and acting as a referral source and retrieval service for other centres.

(2) *Hospital emergency departments with access to some on-site surgical and medical specialties that* are linked to the regional emergency department for subspecialty services.

(3) *Hospital emergency departments with access to off-site specialist services* that act as centres for minor injury care and resuscitation and limited stabilisation before referral.

Appendix 2

Current Trauma Care Organisation in Ireland

Prehospital Care and Emergency Transport Services

The Prehospital Emergency Care Council (PHECC) replaced the National Ambulance Advisory Council (NAAC) in 2000. Its functions include the assessment and approval of training institutions, the development, conduct and award of a national qualification, maintenance of a register of qualified Emergency Medical Technicians (EMTs) and recommendation and assessment of standard operational procedures and protocols for prehospital care of the traumatised patient.

An EMT-A (Advanced EMT) programme has been launched by the Minister of Health and Children allowing such qualified personnel to prescribe and administer drugs independently of medical supervision. A helicopter emergency medical service consultancy group has been established and is due to report to the Department of Health.

The Distribution of Acute Hospitals in Ireland

Acute hospitals dealing with trauma patients are distributed throughout the country and differ in the degree of on-site surgical sub-specialisation available as well as the amount of facilities for care of the injured patient (e.g. whether there is 24 hour availability of CT and interventional radiological expertise). While, in general, a single hospital in any region functions as a regional resource centre with networks to other hospitals in that area, no one hospital in the country approaches the American College of Surgeons definition of a Level One Trauma Centre (i.e. an institution that admits at least 1,200 trauma patients yearly of which 20% will have an Injury Severity Score (ISS) of 15 or greater or where there are 35 patients per surgeon with an ISS of 15 or greater and in which there is an annual review of each surgeon's performance in the centre's trauma programme. Furthermore, to be considered as a Level One facility, there must be a full range of surgical specialties – including neurological, cardiothoracic, microvascular/replant and oral/maxillofacial services – promptly available on-site 24 hours a day, as well as an immediately available, fully-staffed, dedicated trauma operating theatre).[1]

Patient Flow through Emergency Departments in Ireland

Nationally, 17% of all patients arrive at Irish Emergency Departments by ambulance or other emergency service, about 75% attend between 8 am and 8 pm, 15 % between 8 pm and midnight and 10% between midnight and 8 am. Some 24% of all attenders are subsequently admitted into hospital, while 3% are transferred to another hospital. In Ireland, as in other countries, there is a disproportionately high number of young males and children attending Emergency Departments compared with other demographic groups. Finally, the situation in this country is likely to reflect the international experience in that some Emergency Department attendances are for non-urgent reasons and are sometimes deemed "inappropriate".[2]

[1] Committee on Trauma. *American College of Surgeons. Resources for Optimal Care of the Injured Patient.* **Department of Health and Children, Dublin, 1999.**
[2] Gill J, Riley A. *Non-urgent use of hospital emergency departments: urgency from patients perspectives.* **Journal of Family Practice 1996; 42: 491-496.**

Appendix 2

Emergency Department (ED) Attendances / Estimated Catchment Populations (1996 census).[1]

Hospital	New ED attendances	% National Attendances	Estimated Catchment Population	% National Population
Cork City (3 EDs)	88,651	8.9	330,000	9.1
Tallaght, Dublin; Naas, Kildare	84,274	8.5	260,000	7.2
Limerick City (2 EDs)	66,304	6.7	210,000	5.8
UCH Galway	51,589	5.2	140,000	3.9
Mater, Dublin	50,952	5.1	150,000	4.1
St. Vincent's and St. Michael's	50,422	5.1	200,000	5.0
Waterford Regional	46,624	4.7	120,000	3.3
Beaumont, Dublin	46,554	4.7	150,000	4.1
St. Jame's, Dublin	44,698	4.5	180,000	5.0
Temple Street, Dublin	41,256	3.4	100,000	2.8
Crumlin, Dublin	28,375	2.9	100,000	2.8
Drogheda, Louth	27,420	2.8	100,000	2.8
Blanchardstown, Dublin	24,556	2.5	75,000	2.0
Tralee, Kerry	23,775	2.4	125,000	3.3
Letterkenny, Donegal	23,476	2.4	120,000	3.3
Mayo	23,320	2.3	110,000	3.1
Sligo	23,238	2.4	90,000	2.5
Loughlinstown, Dublin	22,593	2.3	80,000	2.2
Mullingar, Westmeath	22,492	2.3	90,000	2.5
Tullamore, Offaly	21,282	2.1	65,000	1.8
Wexford	20,562	2.1	100,000	2.8
Cashel and Clonmel, Tipperary	20,030	2.0	75,000	2.0
Dundalk, Louth	18,975	1.9	50,000	1.4
Kilkenny	16,798	1.7	100,000	2.8
Portiuncula, Galway	16,207	1.6	60,000	1.8
Cavan	15,906	1.6	60,000	1.4
Port Laoise, Laois	15,252	1.5	50,000	1.4
Ennis, Clare	15,249	1.5	60,000	1.8
Navan, Meath	14,656	1.5	50,000	1.5
Mallow, Cork	9908	1.0	50,000	1.4
Roscommon	8935	0.9	40,000	1.4
Nenagh, Tipperary	7414	0.7	50,000	1.4
Bantry, Cork	5285	0.5	40,000	1.4
Monaghan	3228	0.3	40,000	1.4
Total	**1,000,255**	**100**	**362,6000**	**100**

[1] Comhairle na nOspideal. *Report of the Committee on Accident and Emergency Services*. 2002.

TRAUMA CARE ORGANISATION IN IRELAND

Consultant staffing[1,2,3]

Nationally, there are 31 permanent consultant posts in Emergency Medicine approved by Comhairle na nOspideal (approximately 0.5/100,000 population although there is considerable variation among the Health Boards *(see Table)*, of which 22 are currently filled (90% of the posts are Category 1. The 10% that are Category 2 are all located within the ERHA area). Seventeen of the total number of posts were approved between 1997 and 2002 representing a growth of 121% in consultant numbers since 1997. At present, 30% of the working time of a Consultant in Emergency Medicine is spent in direct patient care, the rest is spent in administrative matters.

Table: Emergency Medicine Consultant Staffing/Population comparison.

Health Board	Population	% of population	Consultant number	% of consultant number	Population per consultant	Base Hospital
ERHA East Coast	333,458	8.51	3	9.68	111,153	St Vincent's
ERHA Northern	486,305	12.41	7	22.58	69,472	Beaumont Mater Blanchardstown Temple St
ERHA South-Western	581,551	14.85	7	22.58	83,079	St James' Tallaght Crumlin
Mid-Western	339,930	8.68	1	3.23	339,930	Limerick
Midland	225,588	5.76	0	0	n/a	Tullamore
North-Eastern	344,926	8.81	1	3.23	344,926	Drogheda
North-Western	221,376	5.65	2	6.45	110,688	Sligo Letterkenny
South-Eastern	423,540	10.81	1	3.23	423,540	Waterford
Southern	580,605	14.82	6	19.35	96,768	Cork University
Western	380,057	9.70	3	9.68	126,686	Galway
Totals	3,917,336	100	31	100	119,089	–

[1] Report of the Forum on Medical Manpower. **January 2001.**
[2] Comhairle na nOspideal. *Consultant Staffing*. **January 2003.**
[3] Comhairle na nOspideal. *Report of the Committee on Accident and Emergency Services*. **February 2002.**

TRAUMA CARE ORGANISATION IN IRELAND

Non-Consultant Hospital Doctors (NCHD)[1]

Currently, the Consultant: NCHD ratio in Emergency Medicine stands at 1:9. There has been a fourfold increase in the numbers of NCHDs working in Emergency Medicine over the past two decades and there are now approximately 4.2 NCHDs per 100,000 population.

The Irish Association for Emergency Medicine recognised in 1999[2] that *"the majority of front-line Accident and Emergency (A&E) work is carried out by Senior House Officers (SHOs) (while) in the smaller hospitals SHOs in medicine or surgery who are "on-call" perform these tasks in the absence of A&E SHOs) under a degree of Consultant supervision"*. Furthermore, many of the NCHDs working in Emergency Departments are not registered on formal or recognised training programmes. This situation is currently being addressed by the Royal College of Surgeons in Ireland, the Royal College of Physicians in Ireland and the Irish College of General Practitioners, with the stipulation that SHOs receiving Basic Surgical Training (BST) should deal with 1,750 new patients during a six month rotation through an Emergency Department and by then matching the number of SHOs receiving BST to major teaching hospitals' new patient attendances. Additionally, the establishment of an inter-collegiate body to accredit, recognise and inspect training posts was discussed.

Finally, concern has been raised that, given the relative rarity of serious trauma, it is difficult for any one trainee to gain experience in the management of a sufficient number of such patients in order to achieve and maintain appropriate skill levels leading to the possibility of mandatory rotation through major international trauma centres for all Emergency Medicine and Surgical trainees.

NURSES[3]

Statistics for the number of nurses working in Emergency Departments (EDs) are not currently available. However, nurses play a central role in the multi-disciplinary team management of injured patients and are crucially engaged in triage of ED patients. Most departments have a core of permanent nursing staff, with supplementary cover being provided by other departments.

The role of nurses in Ireland's EDs has expanded in recent years, allowing for the creation of Advanced Nurse Practitioner posts in certain departments who are able to request X-rays, supply medicines, suture and take blood samples.

NCHDs in Emergency Medicine in Ireland

NCHD	1984	1994	2000
House Officer	42	100	138
Registrars	5	26	68
Specialist Registrar	-	-	2
Total	47	126	208

[1] Postgraduate Medical and Dental Board. *NCHD Staffing Survey of October 2000.*
[2] Irish Association for Emergency Medicine. *Staffing Pressures in Irish Accident and Emergency Departments.* **2000.**
[3] Comhairle na nOspideal. *Report of the Committee on Accident and Emergency Services.* **February 2002.**

Availability of 24 hr CT Scanning with Reference to Neurosurgical Indications.[1,2]

Hospital	CT	24 hr CT	Image-link facility*	Km from nearest neurosurgical unit
Mercy University Hospital, Cork	+	-	-	3
South Infirmary-Victoria Hospital, Cork	-	N/A	N/A	5
Temple St., Dublin (Paediatric)	-	N/A	N/A	5
Mater Hospital, Dublin	+	+	-	5
St. James', Dublin	+	+	-	8
Crumlin, Dublin (Paediatric)	+	-	+	11
St. Vincent's, Dublin	+	+	-	12
Blanchardstown, Dublin	+	-	-	12
St Michael's, Dublin	-	N/A	N/A	18
Loughlinstown, Dublin	-	N/A	N/A	23
Tallaght, Dublin (Adult and Paediatric)	+	+	-	25
Mallow, Cork	-	N/A	N/A	30
Naas, Kildare	-	N/A	N/A	35
Drogheda, Louth	+	-	N/A	40
Navan, Meath	-	N/A	N/A	48
Dundalk, Louth	-	N/A	N/A	65
Mullingar, Westmeath	+	-	-	87
Portloaise, Laois	-	N/A	N/A	90
Tullamore, Offaly	+	-	+	95
Clonmel, Tipperary	-	N/A	N/A	97
Bantry, Cork	-	N/A	N/A	105
Limerick	+	+	+	105
Cavan	+	-	-	115
Kilkenny	-	N/A	N/A	117
Tralee, Kerry	+	-	-	119
Monaghan	-	N/A	N/A	125
Ennis, Clare	-	N/A	N/A	137
Wexford	-	N/A	N/A	142
Roscommon	-	N/A	N/A	146
Nenagh, Tipperary	-	N/A	N/A	147
Ballinasloe, Galway	+	-	-	151
Waterford	+	+	+	163
Sligo	+	+	+	217
Galway	+	-	-	219
Mayo	-	N/A	N/A	226
Letterkenny, Donegal	+	-	-	237

[1] Caird J, Philips J. *Optimal management of extradural haematoma.* **Ir J Med Sci 1999; 92 (6): 388-389.**
[2] Updated by personal communication from NEHB (via Comhairle na nOspideal).

Appendix 3

THE USE OF BLOOD COMPONENTS IN MASSIVE HAEMORRHAGE[1 2 3]

A key aim of resuscitation in trauma is to maintain the patient's tissue oxygenation at a level that will avoid critical ischaemic damage and irreversible organ failure. Optimal care involves practiced teamwork adhering to a planned protocol: this will allow urgent interventions to be performed in parallel, with early involvement of senior personnel and laboratory support.

The maintenance of adequate ventilation and oxygenation while restoring the circulating blood volume is essential. Blood components should be transfused early if indicated and normothermia maintained (hypothermia less than 35°C constitutes an extremely important reversible haemostatic defect).

Early and frequent monitoring of haematological parameters (Hb, Hct, platelets, INR, APTT and fibrinogen) should be performed and if massive haemorrhage occurs, impending haemostatic defects should be anticipated and treated pre-emptively. Patients should be transferred urgently to an area where definitive intervention in terms of diagnosis and treatment can occur (e.g. the Intensive Care Unit).

Massive Haemorrhage is said to be present when there is:

1. an ongoing transfusion requirement of over 150 ml/min (adult).
2. replacement of over 50% of the patient's blood volume within 3 hours.
3. replacement of blood volume or transfusion of over 10 units of red cell concentrate within 24 hrs.

Red Cell Concentrates (RCC): Full cross-match is preferable to ABO Group-specific but takes longer to do. If needed immediately, "emergency stock" RCC (Group O, Rhesus D-negative in pre-menopausal females or Group O, Rhesus D-positive in older females and males) can be used. After replacement of one blood volume, cross-matching is no longer necessary and Group-compatible blood can be used. Red cell salvage systems can provide RCC with a haematocrit of 55-75% and should be used if available.

Fresh Frozen Plasma (FFP) and Cryoprecipitate: FFP (150 mls/u) contains all coagulation factors while cryoprecipitate (15 mls/pack) contains fibrinogen, Factor VIII and Von Willebrand Factor alone (5 units of FFP contains the same amount of fibrinogen as 10 packs of cryoprecipitate). While early use of FFP may thus avoid the need for cryoprecipitate, the latter should be used when fibrinogen levels are less than1g/l (1 pack/10kg; 1 pk contains 0.15-0.3g of fibrinogen). Initial transfusion comprises either one unit FFP/3 units RCC administered or 15 ml/kg FFP after more than one blood volume has been lost, with further FFP being given to keep the INR less than 1.5.

[1] National Blood Users Group. *A guideline for the use of blood and blood components in the management of massive haemorrhage.* **November 2002 (Dublin).**
[2] National Blood Users Group. *A guideline for transfusion of red blood cells in surgical patients. January 2001 (Dublin).*
[3] McClelland DBL. *Handbook of Transfusion Medicine*- **Republic of Ireland Edition, 1999 (? Publisher).**

THE USE OF BLOOD COMPONENTS IN MASSIVE HAEMORRHAGE

Platelets: These should be administered to maintain a plasma platelet count above 50 x 10^9/L (or above 100 x 10^9/L in patients with high-energy or intracranial trauma). A count below 50 x 10^9/L can be anticipated when approximately 2 blood volumes have been replaced, but considerable inter-individual variation occurs. Platelet transfusion should also be considered in bleeding patients on anti-platelet therapy or after cardiopulmonary bypass. Platelets are now issued in Ireland in packs containing a single adult dose of 2.4 x 1011 platelets suspended in 250 mls of plasma – one pack should increase the platelet count by 20 x 10^9/L

Management of Disseminated Intravascular Coagulation (DIC): DIC is manifest as microvascular bleeding during operation and oozing from vene-puncture sites and mucous membranes. It is particularly likely to occur in those with prolonged hypovolaemia or tissue hypoxia or where extensive tissue damage has occurred. Its presence should be suspected when either the INR exceeds 1.8, the fibrinogen level is less than 0.8 g/L or when significant thrombocytopaenia (< 50 x 10^9/L) occurs. Aggressive treatment is warranted with FFP (4-6 U), cryoprecipitate (10 U) and platelets (1 pack).

Glossary

Hb = Haemoglobin

Hct = Haematocrit

Plts = Platelets

INR = International Normalised Ratio

APTT = Activate Partial Thromboplastin Time

Appendix 4

CARE OF PATIENTS WHO REFUSE TRANSFUSION[1 2]

Every injured patient must be treated with respect and staff should be sensitive to their individual needs, values, beliefs and cultural background, even when these may pose a therapeutic difficulty. For instance, patients who are Jehovah's Witnesses are not permitted by their religion to receive allogenic blood or blood products (i.e. red cells, white cells, platelets and plasma). This is a deeply held core value. However, the decision to receive *fractions* of these primary blood components (e.g. albumin, immuno-globulins and clotting factors) is left up to the Witness's own conscience.

So-called *"disfellowship"* from the church only occurs if a Witness's action becomes known through self-disclosure or is substantiated by evidence of the offence. Hence, an individual's decision to accept transfusion must be treated with in the strictest confidence. Autologous blood transfusion and blood salvage systems may be acceptable provided a *continuous closed circuit,* maintaining a constant link to the patient's circulation, is employed.

Where possible, the views held by any trauma victim should be established with respect to blood products. Helpfully, the majority of Jehovah's Witnesses carry a signed and witnessed *advance directive card* refusing blood and releasing the clinician from any liability arising from this refusal. Non-consensual transfusion is considered an act of physical violation and may lead to criminal and/or civil proceedings.

In cases of severe trauma, where the patient may be unable to give informed consent and friends/relations or the Jehovah's Witness liaison committee are unable to produce evidence as to the Jehovah's Witness status of the patient, the clinical judgement of the treating doctor takes precedence over the opinion of relatives and associates. In the case of minors who refuse transfusions, the best interest of the child takes precedence and, while a court order may be pursued, it should not delay essential treatment. In such cases, it is important that two doctors of consultant status should state in the clinical record that *blood transfusion is essential,* or likely to become so, to save life or prevent serious permanent harm before making an application to the High Court.

When significant haemorrhage occurs in such patients, clear communication becomes paramount, both in understanding the patient's viewpoint and in co-ordinating the best approach (e.g. in decisions regarding the timing of operative intervention and whether they will undergo a single or staged procedure).

Particular attention should also be given to careful patient positioning during surgery, the use of hypotensive anaesthesia, tourniquets, meticulous haemostasis and the appropriate use of vasoconstrictors, anti-fibrinolytic agents (e.g. *tranexamic acid*) and haemodilution as well as early and frequent administration of recombinant erythropoietin.

[1] National Blood Users Group. *A guideline for the use of blood and blood components in the management of massive haemorrhage.* **November 2002.**

[2] Murphy D, McDonnell TJ, McElwain JP, O'Donnell T. *Treatment of anaemia in the polytrauma Jehovah's Witness* **IMJ 2003; 96 (1).**

Appendix 5

IMMUNISATION GUIDELINES[1]

Immunisation denotes the induction or provision of immunity artificially and may be either *active* (the administration of a vaccine or toxoid in order to stimulate the production of immune responses) or *passive* (the administration of preformed antibodies to confer temporary immunity). A vaccine is a suspension of live attenuated micro-organisms or their fractions while a toxoid is a modified bacterial toxin that, although non-toxic, stimulates the formation of antitoxin. Human immunoglobulin is that fraction of blood plasma which contains antibodies against infectious agents.

Tetanus: Tetanus is an acute neurological disease characterised by muscular rigidity with superimposed contractions. It is caused by the neurotoxin produced by *Clostridium tetani,* which is spore-forming and grows anaerobically in a contaminated wound. This ubiquitous organism may be introduced into the body during injury, often through a puncture wound but also through burns or trivial wounds.

Tetanus Prophylaxis: Tetanus Toxoid (e.g. *Diftavax* 0.5 ml, which also contains diphtheria vaccine) should be administered as a single booster dose to those previously immunised who have not received a booster dose within the preceding ten years, while a full course of immunisation (3 doses at monthly intervals) should be given to those not previously immunised. Additionally, Tetanus Immunoglobulin (e.g. *Tetabulin* 250 I.U., intramuscularly) should be given to those with impaired immunity or *Tetanus-prone wounds* (i.e. those that are contaminated with dirt, faeces, soil and saliva as well as puncture wounds, avulsions, wounds resulting from crushing, burns, frostbite and missiles) or those who have not received at least three doses of Tetanus Toxoid in the previous ten years. This single dose should be doubled (500 I.U.) for patients weighing more that 90 kg or those with wounds that are older than 24 hours, heavily contaminated, infected or involve a fracture.

Blood-borne infectious agents[2]: Healthcare workers may be exposed to blood-borne virus infections either from direct contact with body fluids or, in particular, from needle-stick injuries. It is imperative that they protect themselves adequately through hand-washing, universal precautions and by immunisation.

Hepatitis B (HBV): HBV infection can result in both acute illness (ranging from occult infection to fulminant liver failure) as well as a chronic "carrier" condition, which represents a continuous contagious risk and may lead to hepatitis, cirrhosis and hepatocellular carcinoma. Ideally, immunisation should be performed before any exposure (three doses of vaccine at day one, one month and six months) it may also follow exposure by non-immunised persons (e.g. specific HBV immunoglobulin, 6-10 I.U. / kg IM within 48 hrs of exposure). To date, there is no evidence to support the use of booster doses of HBV in immuno-competent individuals who have responded to a primary course (as determined by post-vaccination testing).

[1] National Immunisation Advisory Committee, Royal College of Physicians of Ireland. *Immunisation Guidelines for Ireland*. **Department of Health Publication 2002.**
[2] Devlin J. *Prevention of transmission of blood-borne diseases in the health-care setting*. **Department of Health and Children, Dublin 1999.**

IMMUNISATION GUIDELINES[1]

Human immunodeficiency virus (HIV):

HIV infection leads to the development of Acquired Immune Deficiency Syndrome (AIDS). Post-exposure prophylaxis (PEP) with anti-viral therapy should be considered urgently, but as these regimens change regularly it is not possible to give specific details here. Local advice should always be sought (e.g. from a Consultant Microbiologist or Consultant in Infectious Disease).

Asplenic patients[2]: All patients who have had splenectomy are at risk of serious infection, especially with encapsulated gram-positive organisms and therefore require vaccination against *Pneumococcus, Haemophilus influenza B* and *Meningococcus* and lifelong prophylactic treatment with *Penicillin* (333 mg PO b.d.) or Erythromycin (250 mg PO b.d).

While patients undergoing elective splenectomy should receive these vaccinations at least two weeks pre-operatively, those requiring emergency splenectomy should be vaccinated two weeks after surgery in order to obtain a maximal immunological response.[3]

[1] National Immunisation Advisory Committee, Royal College of Physicians of Ireland. *Immunisation Guidelines for Ireland.* **Department of Health Publication 2002.**
[2] Irish Haematological Society. *Recommendations for prevention of overwhelming post-splenectomy infections - Recommendations for Doctors.* **January 2000.**
[3] Shatz DV, Romero-Steiner S, Elie CM, Holder PF, Carlone GM. *Antibody responses in post-splenectomy trauma patients receiving the 23-valent pneumococcal polysaccharide vaccine at 14 versus 28 days postoperatively.* **J Trauma 2002 Dec;53(6):1037-42.**

Appendix 6

ANTIBIOTIC PROPHYLAXIS IN SEVERE TRAUMA

While the value of antibiotic prophylaxis in both elective and emergency surgical procedures is well validated, the purpose and optimal duration of antibiotic use in injured patients is less clear because there is no opportunity to administer the agent before bacterial contamination occurs. Although giving antibiotics in these circumstances constitutes early "presumptive" therapy rather than *true prophylaxis,* the goal of reducing infectious complications is similar. Additionally, the primary benefit must be significant because of the risk of emergent resistant organisms that is associated with excessive empirical use of antibiotics. In general, the choice of antibiotic used is based on assumptions regarding the likely micro-organisms contaminating the site of interest and the intravenous route is preferred to oral or intramuscular administration. Finally, where possible, specimens should be sent for culture and sensitivity prior to commencement of anti-microbial therapy.

Penetrating Abdominal Trauma:

If prophylactic antibiotics are utilised early, the post-operative infection rate following penetrating abdominal trauma is between 7 and 16%.[1] It is directly related to the presence of hollow viscus injury as well as the organ injured (being particularly high if the colon is perforated), the presence and degree of intestinal contamination, patient age, transfusion requirement and shock. Antibiotic administration should therefore be commenced in all patients with this injury as soon as possible after wounding and be continued for 24 hours after definitive surgery is preformed is performed. The antibiotics used should be directed against the flora of the gastro-intestinal tract (including streptococcus, enterococcus, clostridium, enterobacteriae, bacteroides and peptostreptococcus), and a suggested regimen is as follows:

Co-Amoxiclav 1.2g tds IV with *Metronidazole* 500mg tds IV.

Blunt Abdominal Trauma:

Unless signs of hollow viscus perforation are present or suspected, prophylactic antibiotics are not routinely indicated. If leakage of gastrointestinal contents is a concern, antibiotics should be administered as for penetrating abdominal trauma.

Mammalian Bites:

Bites by mammals are a common problem and they account for up to 1% of all visits to hospital Emergency Departments (ED). Dog and cat bites are the commonest and people are usually bitten by their own pets or by an animal known to them. School-age children account for about half of those bitten. While prevention of tetanus is the main priority for ED staff, antibiotics are used to reduce the risk of developing a wound infection, although the evidence-base for this is not conclusive.[2]

Suggested antibiotic regimens for mammalian bites:

Human: *Co-Amoxiclav* (or *Erythromycin* 500 mg q.i.d. PO if allergic to Penicillin).

Animal: *Benzylpenicillin* 1.2g IV q.i.d. or *Co-Amoxiclav* 375mg t.i.d. PO for outpatients.

[1] Fullen WD, Hunt J, Altemeier WA. *Prophylactic antibiotics in penetrating wounds of the abdomen.* **J Trauma 1972; 12: 282-289.**
[2] Medeiros I, Saconato H. *Antibiotic prophylaxis for mammalian bites (Cochrane Review).* **In: The Cochrane Library, Issue 1, 2003. Oxford: Update Software.**

FRACTURES:

When extremity fractures (especially those involving the tibia) occur in combination with an overlying cutaneous wound, prevention of wound sepsis is the primary objective in the management of the soft tissue. Initial treatment should include coverage with sterile dressings with splinting, as necessary, tetanus prophylaxis and immediate parenteral antibiotic coverage.[1] As local factors are the key determinants of subsequent infectious risk,[2] wound irrigation and debridement of devitalised muscle, fascia, subcutaneous tissue, skin, bone and all foreign material, along with fracture stabilisation, should be performed under regional or general anaesthetic as soon as the patient is stabilised, preferably within six hours of the injury (after which time the infection rate increases markedly). Wounds associated with open fractures are classified by severity according to Gustillo (p.23).[3]

Prophylactic antibiotics for coverage of gram-positive organisms should be given to all patients with open fractures, while for those with Grade III fractures, cover should be extended to include gram negative organisms. High dose penicillin (*Benzylpenicillin* 2.4g q.i.d.) and *Metronidazole* (500 mg/t.i.d.) should be included if there is a concern for faecal/*Clostridium contamination* (e.g. farm-related injuries). Antibiotics should be continued for no longer than 72 hours after the time of the injury or for 24 hours after soft tissue coverage of the wound is achieved (whichever occurs first).

Suggested antibiotic regimens for patients with open fracture are:

Grade I/II–1.2g *Benzylpenicillin* q.i.d. + 1gm *Flucloxacillin* q.i.d.

Grade III–as above but with *Gentamicin,* or alternatively, *Cefuroxime* IV 1.5mgs stat, then 750mg bd.

Prophylactic antibiotics should also be administered when a closed fracture requiring operative repair is present.[4 5]

[1] Dellinger EP. *Antibiotic prophylaxis in trauma: penetrating abdominal injuries and open fracture.* **Rev Infect Dis 1991; 13: S847-857.**
[2] Dellinger EP, Miller SD, Wertz MJ, Grypma M, Droppert B, Anderson PA. *Risk of infection after open fracture of the arm or leg.* **Arch Surg 1988; 123; 1320-1327.**
[3] Gustillo RB, Anderson JT. *Prevention of infection in the treatment of one thousand and twenty-five open fractures of long bones: retrospective and prospective analysis.* **J Bone Joint Surg 1976; 58A: 453-458.**
[4] Norden CW. *A critical review of antibiotic prophylaxis and orthopaedic surgery.* **Rev Infect Dis 1983; 5: 928-932.**
[5] Gillespie WJ, Walenkamp G *Antibiotic prophylaxis for surgery for proximal femoral and other closed long bone fractures (Cochrane Review).* **In: The Cochrane Library, Issue 1, 2003. Oxford: Update Software.**

Antibiotic Prophylaxis in Severe Trauma

Grade	Description of soft tissue wound associated with open fracture	Infection risk
I	Clean skin wound <1cm	<5%
II	Laceration >1cm without extensive soft tissue skin injury, flap or avulsion	<5%
III	Extensive soft tissue damage including traumatic amputation or segmental fracture	24%
(a)	Adequate soft tissue coverage covers fracture despite extensive tissue loss, or high energy trauma irrespective of size of wound	4%
(b)	Extensive tissue loss with periosteal stripping and bone exposure	52%
(c)	Open fracture associated with arterial injury requiring repair	42%

OPEN SKULL FRACTURES

In general, the routine use of antibiotics is not indicated for patients with open skull fractures, even in the presence of an apparent CSF leak.

Patients requiring Tube Thoracostomy:

The rationale for antibiotics in this situation is primarily to reduce the risk of empyema (most likely from contaminating gram-positive organisms such as staphylococcus and streptococcus) with a secondary aim of minimising the development of subsequent pneumonia (same organisms). While the literature is weak and even contradictory in some instances on this topic, there is level III evidence that administration of a second generation antibiotic for twenty-four hours only can reduce the risk of pneumonia but not empyema.[1]

Patients with heart valvular abnormalities, in situ synthetic heart valves/vascular grafts and mechanical joint replacements

These patients, require appropriate antibiotic cover prior to instrumentation (e.g. urethral catheterisation or in-dwelling central venous catheters) being preformed in order to prevent the risk of endocarditis or bacterial seeding on to the synthetic graft. Additionally, antibiotics are indicated in these individuals in case of any traumatic breach of an epithelial surface. Furthermore, any patient likely to undergo an operation for a traumatic injury that may entail the use of synthetic graft material should also receive preoperative intravenous antibiotic cover.

Suggested Antibiotic Regimen:

Central line insertion:
1.2 g *Benzylpenicillin* + 1gm *Flucloxacillin* stat.

Urethral urinary catheter:
240 mg *Gentamicin* IV stat.

[1] Luchette FA, Barie PS, Oswanski MF, Spain DA, Mullins CD, Palumbo F, Pasquale MD. *Practice management guidelines for prophylactic antibiotic use in tube thoracostomy for traumatic haemopneumothorax*. **EAST Practice Management Guidelines Work Group.**

Appendix 7

MANAGEMENT OF VASCULAR TRAUMA[1]

Vascular injury occurs in approximately 3% of all injuries requiring hospital admissions involving multiple extremities in between 27-87% of these. Following initial resuscitation, every seriously injured patient needs to be thoroughly and repeatedly examined for vascular injury, as this can be subtle or, indeed, occult (initial examination is normal in up to 15% of cases with significant vascular injury).

"Hard signs" of vascular injury (e.g. active arterial haemorrhage, large expanding haematoma and/or distal ischaemia) warrant urgent surgical exploration. Contrast angiography is useful in such cases in determining the level and extent of arterial injury. Even if such signs are absent, significant injury may be present. Thus, a high level of suspicion is necessary in dealing with high-risk injuries, e.g. knee dislocation, fracture of the distal femur or proximal tibia and penetrating injuries of the postero-medial thigh. Physical examination is especially unreliable in cases of "proximity injury" (i.e. injury in the immediate vicinity of a major vessel but without evidence of arterial disruption); in particular, reliance cannot be placed on using distal pulses as evidence of normality of the proximal arterial tree. Conversely, pulses that are present can be rendered impalpable in an injury by concomitant oedema, haematoma and dressings. "Soft signs" of a vascular injury include such "proximity wounds" as well as non-pulsatile haematoma, skin mottling, impalpable pulses, delayed capillary refill, temperature gradient, and paraesthesia.

While a complete neurological examination is also essential, it can be difficult to determine the relative contributions of direct nerve trauma and impaired limb perfusion to the impairment of limb function. While Doppler studies and ankle-brachial index measurements can be reassuring (particularly if repeatedly normal), they can be misleading in cases of extensive limb injury, haemodynamically unstable patients and when there is either venous or iliac and sub-clavian arterial injuries. Contrast angiography, while remaining the gold standard investigation, is not indicated as an exclusion procedure in cases without signs of a vascular injury. Abnormalities identified in this way behave predominantly in a benign fashion – the one exception to this rule being in patients with posterior dislocations of the knee.

The decision to amputate a limb must be individualised (predictive scoring systems based on injury severity are unreliable). In cases of isolated vascular injury, however, it should only be considered if repeated attempts to revascularise the limb are unsuccessful. The biggest factor in determining the ultimate fate of the limb with vascular compromise is duration of ischaemia, with amputation rates increasing markedly if a period of six hours is exceeded before revascularisation occurs. Four-compartment fasciotomy is mandatory where revascularisation follows prolonged ischaemia, due to the high risk of ischaemia-reperfusion injury. If all efforts fail and amputation is to be considered, careful written recording of the rationale for amputation should be documented by two surgeons.

[1] O'Sullivan ST, O'Hehir DJ. *Diagnosis and management of vascular injury.* **Ir J Med Sci 1998; 91 (4): 126-128.**

Appendix 8

MANAGEMENT OF PENETRATING NECK TRAUMA

The debate over mandatory versus selective exploration of penetrating injuries has existed for decades and continues. In general, patients with penetrating neck injuries are treated according to the *depth* of the injury (injuries that do not penetrate the platysma require nothing more than primary closure or delayed primary closure if contaminated) and *anatomical location,* with the neck being divided into anterior and posterior triangles by the sternocleidomastoid muscle.

While injuries to the posterior triangle have a low chance of damaging vital structures (in particular, the great vessels, upper airway and digestive tract), those of the anterior triangle carry a significant morbidity and require workup. Anterior neck injuries are divided into three zones (see figure) with Zone I extending from the clavicles to the cricoid cartilage, Zone II from the cricoid to the angle of the mandible, and Zone III from the angle of the mandible to the base of the skull. Zone II injuries are much more straightforward operatively, whereas Zones I and III injuries may present a formidable challenge. The third important anatomical landmark in penetrating neck injuries is the platysma muscle.

Historically, Zone II injuries have been treated with immediate exploration, regardless of haemodynamic status (with up to 20% of such explorations being non-therapeutic). Because of the formidable task of exposure in most Zones I and III injuries, these are usually first approached with a diagnostic evaluation in haemodynamically stable patients, although some generally accepted clinical indications for early surgical exploration exist and are shown in the table below.

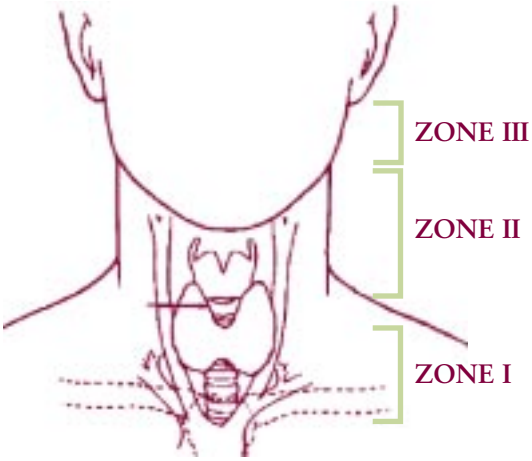
Diagnostic evaluation includes endoscopy, laryngoscopy, oesophagography, and/or angiography. Recently, computerised tomogram (CT)[1], and duplex ultrasonography[2] have been used as substitutes, or precursors, to angiography, which remains the gold standard investigation. While several studies exist suggesting that such non-invasive studies may replace routine neck exploration for Zone II injures[3], they tend to be retrospective and involve small numbers of patients and thus require great care in their interpretation. However, if the trajectory of the penetrating object can be clearly determined on CT as being distant to vital anatomical structures a conservative course may be reasonable.[4 5 6]

The issues to be considered include the morbidity and mortality of negative neck exploration and the consequences of a missed injury (such as embolisation from an undetected dissection or rupture of a pseudo-aneurysm) which may not become apparent for many months or even years.

[1] Gracias VH et al. *CT in the evaluation of penetrating neck trauma.* **Arch Surg 2001; 136: 1231-1235.**
[2] Demetriades D et al. *Evaluation of penetrating injuries of the neck.* **World J Surg 1998; 22 (5): 41-7.**
[3] Jarvik JG. *Penetrating neck trauma.* **Am J Neuroradiology 1995; 16: 647-654.**
[4] Munera F et al. *Diagnosis of neck injuries.* **Radiology 2000; 216 (2): 356-362.**
[5] Munera F et al. *Penetrating neck injuries.* **Radiology 2002; 224 (2): 366-372.**
[6] Gonzalez RP et al. *Penetrating zone II neck injury.* **J Trauma 2003; 54 (1): 61-64.**

Appendix 8

MANAGEMENT OF PENETRATING NECK TRAUMA



Zones of the neck (Trunkey 1991)

Clinical criteria for early surgical exploration	Clinical criteria indicating vascular injury
	History or of active arterial bleeding
Haemoptysis	Moderate/large or expanding haematoma
Stridor	Carotid bruits
Crepitus	Decreased/absent carotid or upper limb pulses
Signs of vascular injury (see next column)	Neurological signs suggestive of CNS ischaemia Systemic hypotension (BP <90 mmHg)

Appendix 9

MANAGEMENT OF MAJOR INCIDENTS

While a *major incident* can be defined in a number of ways the key features are that such an event will be associated with a serious threat to health, disruption of the Health Service and will involve so many casualties that special arrangements must be made. Thus, a major incident is *"any event, which overwhelms the resources or capabilities of the emergency services"*. Ireland has not been immune to such events: the "Stardust" nightclub fire, the Buttevant Rail disaster, the Dublin-Monaghan bombings and the Air India plane crash are a few examples. More recently, the threat of "bio-terrorism" or "dirty bombs" has heightened the awareness of the need to be ready for all sorts of accidental or intentional calamities. By their nature, these events are infrequent but the consequences (including the simultaneous production of multiple victims of injury of differing degree) are to some extent predictable. Although the precise nature of a major incident cannot be predicted, failing to plan is widely recognised as "planning to fail".

Major incidents are generally described as:[1]

- *Compensated/uncompensated*. This refers to whether or not the resources mobilised as a result of major incident are sufficient to deal with the incident;
- *Simple/compound*. This refers to whether or not the infrastructure necessary to deal with the incident (e.g. roads and hospitals) is intact after the incident.

Preparation for these events is imperative and requires: *planning, training and equipment*

Efficient co-ordination between the ambulance, fire and rescue services, the Gardai and healthcare workers is critical to an effective response.

Common Objectives of the Emergency Services:

- Save life
- Prevent escalation
- Relieve suffering
- Protect environment and property
- Restore normality
- Assist in ensuing investigations

The *key players* in any response to a major incident include:

- The Gardai who are responsible for creating inner and outer cordons, maintaining overall security and access to and from a major incident site;
- The Fire and Rescue Service, which is responsible for establishing and maintaining safety levels at the site;
- The Ambulance Service, which is responsible (with the Mobile Medical Team) for triage, treatment and transport of casualties;
- The Hospital, which is responsible for the provision of mobile medical team(s) of appropriate doctors and nurses, and definitive care of casualties;
- The Health Board, which is responsible for the overall ambulance and hospital response, the welfare of displaced persons and mortuary arrangements;
- The Media, which are responsible for monitoring implementation of the major incident plan and reporting in the public interest. It is crucial to cater for their requirements with, for example, a sensible vantage point, regular information and refreshments.

[1] Hodgetts, T.J, Mackway-Jones, K., (eds for the Advanced Life Support Group): *Major Incident Medical Management and Support, The Practical Approach*. **BMJ Publishing Group, London (1995) 116.**

MANAGEMENT OF MAJOR INCIDENTS

The following is the *sequence* of priorities at the scene, requiring close co-operation between the various emergency services:

Command, Safety, Communications, Assessment, Triage, Treatment, Transport

Declaration of a Major Incident:

The declaration of a major incident can be by any arm of the emergency services and should lead to an immediate pre-determined and co-ordinated response by all three services. The outline response begins after this declaration:

- *"Stand-By"* followed by either:
- *"Declared/Active"*, or *"Cancelled/Stand-down"*.

Standby: e.g. with notification of key clinical personnel, administration and the emergency authorised and informed person.
All those involved should be stood down and arrangements for debriefing made. It may be appropriate to locate key people and gather further information about the incident and its potential for escalation. Other issues, e.g. bed state, theatre and ITU bed availability can also be clarified;

Declared/Active: the ensuing response "cascade" may cause major disruption of hospital activity and should only be taken by an appropriately authorised and informed person;

Cancelled/Stand-down: it is vital that the decision to de-activate the major incident plan or standby be taken by an appropriately qualified and experienced person.

Levels of control: The command structure throughout the major incident should be organised by convention into three tiers:

1. *Bronze* (operational);
2. *Silver* (tactical);
3. *Gold* (strategic).

Bronze: this is the *inner* cordon, containing the actual scene of the incident. Depending on the nature of the event, more than one area may be designated bronze. However, all will be contained within a single silver control unit;

Silver: the *outer* cordon. This should be strictly policed, with access restricted, for reasons of safety and security, to those with essential business at the site. Operational control requires close liaison between the Site Garda Officer, Site Fire Officer, Site Ambulance Officer and Site Medical Officer;

Gold: Gold control is remote from the incident scene and is attended by senior members of each of the emergency services. Overall co-ordination and strategic planning of the response occurs here.

Every acute hospital should have a written plan to deal with any major incident in its catchment area (or in the catchment area of neighbouring hospitals). Such a plan must be regularly updated and, vitally, rehearsed as desktop and simulated exercises. This plan should be an "all hazards" approach to disasters so that a reproducible generic response can be easily rehearsed and rapidly activated in the actual event of a major incident. Once alerted, a hospital should have in place a "cascade" system of alerting and activating relevant personnel. This may best be enabled by issuing pre-printed dedicated, individualised task cards to doctors, nurses, managers and paramedical staff members as they present to a fixed point within the hospital.

At the "scene" or "focus" of an incident, the responsibilities of the **Medical Incident Officer** [MIO] are:

- Co-ordination of the medical response at the scene.
- Liaison with Ambulance Incident Officer [AIO] and Police (Garda) Incident Officer [PIO].
- Establishment of a Casualty Clearing Station [CCS].
- Documentation of victims.
- Appropriate evacuation to particular hospital

At no stage should the MIO directly treat individual patients.

MANAGEMENT OF MAJOR INCIDENTS

The Mobile Medical Team (MMT): This team should ideally come from a hospital other than the *primary receiving hospital*, so as not to deprive it of essential staff. This can be difficult to achieve in practice. A team might include: a Registrar in Emergency Medicine, a Registrar in Anaesthetic Registrar, an SHO in Surgery and 3 Emergency Department nurses.

COMMUNICATION

The quality of the communication passed from the scene is crucial in allowing an effective response to a Major Incident. The acronym **METHANE** is recommended as a guide of the key information to be passed.

M	=	Major Incident	"Stand-by" or "Declared"
E	=	Exact location	Grid reference
T	=	Type of Incident	Rail, chemical, road.
H	=	Hazards	Present and potential
A	=	Access	Direction of approach
N	=	Number of casualties	And their severity/type
E	=	Emergency Services	Present and required

THE IDEAL SITE RESPONSE

The ideal response is the rapid establishment of a "structure" around the incident site, with a bronze area, containing paramedical personnel (and others if available), a casualty clearing station (where the MMT is based), an ambulance loading point, temporary mortuary, and transport routes to receiving and secondary hospitals.

TRIAGE SIEVE

This involves a rapid medical assessment in the bronze area and aims to divide patients into groups that require either *immediate*, *urgent* (treatment within 2-4 hours), *delayed* (safely beyond 4 hours) or expectant (injuries that are unsalvageable and therefore interventional efforts would be best expended on less severely injured patients) prioritisation. Patients who can walk therefore are placed in the third category (delayed) and advised to keep walking (with escort if needed) to the Casualty Clearing Point (CCP). If they collapse, they are re-triaged. Those unable to walk are checked for airway and breathing. If there is none, an airway opening manoeuvre is performed. If they do not start breathing, they are categorised as Dead and no further effort is expended on them. If a breathing patient has a problem identified with airway or breathing (see *Triage Sort* below), they are categorised as Priority One as are those with no problem with airway or breathing but with signs of shock. Those unable to walk, but without a problem yet identified in A, B or C are designated into Category 2.

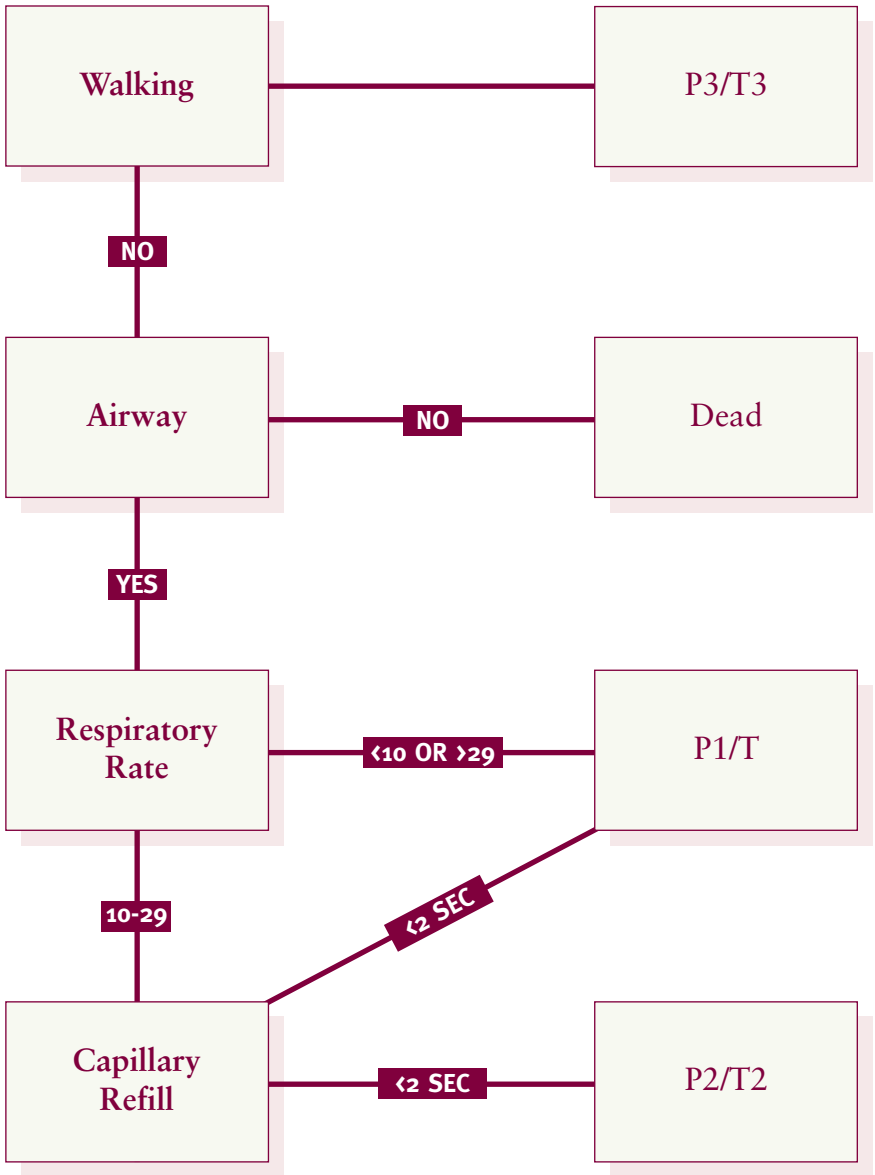
Triage Priorities

Category	Priority "P" System	Treatment "T" system	Description	Colour
1	1	1	Immediate	Red
2	2	2	Urgent	Yellow
3	3	3	Delayed	Green
4	1 Hold	4	Expectant Blue	(not standard)
5	Dead	Dead	Dead	White or Black

Appendix 9

MANAGEMENT OF MAJOR INCIDENTS

Triage Sieve (diagram) - see Triage Priorities Table (p54)



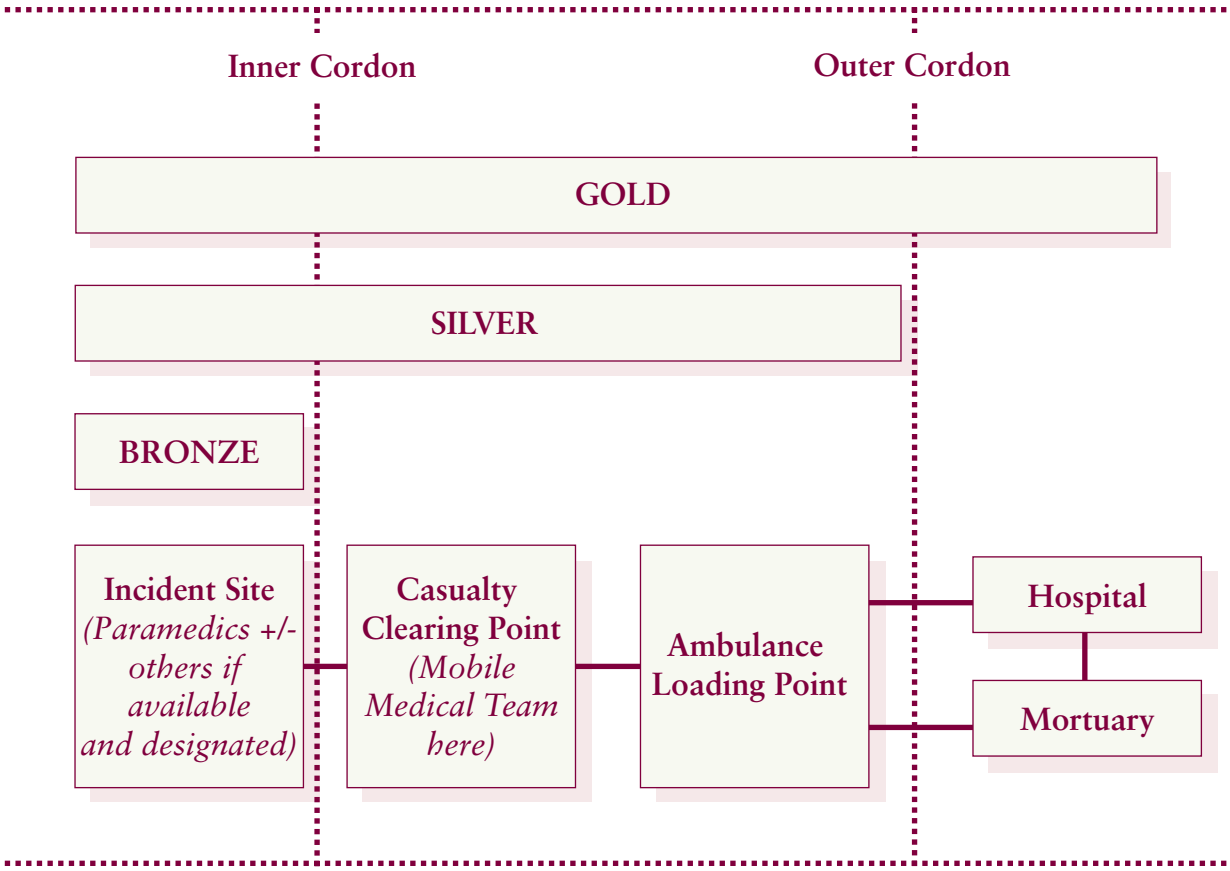
MANAGEMENT OF MAJOR INCIDENTS

Triage Sort

This is a more detailed assessment along the same lines, but using the *Triage Revised Trauma Score (TRTS)* to prioritise casualties according to three physiological parameters: respiratory rate, systolic blood pressure and Glasgow Coma Scale. Each patient can then be designated a score of between 0 and 12 and then categorised as in the Table (if the expectant category is being used, this would comprise patients with a score of 1-3).

TRTS	Priority
1-10	T1
11	T2
12	T3
0	Dead

IDEAL SITE RESPONSE



Appendix 10

COCHRANE LIBRARY REVIEWS

The *Cochrane Library* is a unique source of reliable and up-to-date information on the effects of interventions in health care and is designed to provide information and evidence to support decisions taken in health care and to inform those receiving care. It comprises high-quality systematic reviews of all available published and unpublished material concerning a particular topic and, while by no means a complete reference, it is continually updated and expanded as new information becomes available and new reviews are submitted. It can be accessed free of charge via the Health Research Board website (www.hrb.ie) or from Update software.

Evidence-based Reviews: Acute Traumatic Spinal Cord Injury.

Review: *Bracken MB. Steroids for acute spinal cord injury.*

Objective: To determine the effects of steroid treatment in the early hours of the injury in reducing the extent of permanent paralysis during the rest of the patient's life.

Reviewer's conclusions: There are few trials in this area of medical care and more are urgently indicated. Only one steroid has been extensively studied, Methylprednisolone Sodium Succinate, which has been shown to improve neurological outcome up to one year post-injury if administered within eight hours of injury and in a dose regimen of: bolus 30mg/kg administered over 15 minutes with a maintenance infusion of 5.4 mg/kg per hour infused for 23 hours. This analysis indicates significant recovery in motor function after methylprednisolone therapy when administration commences within eight hours of injury. A more recent trial indicates that if methylprednisolone therapy is given for an additional 24 hours (for a total of 48 hours), additional improvement in motor neurological function and functional status is observed. This is particularly observed if steroid treatment cannot be started until between three to eight hours after injury.

The same methylprednisolone therapy has been found effective in whiplash injuries and a modified regimen found to improve recovery after surgery for lumbar disc disease.

Review: *Kwan I, Bunn F, Roberts I, on behalf of the WHO Pre-Hospital Trauma Care Steering Committee on spinal immobilisation for trauma patients.*

Objective: To quantify the effect of different methods of spinal immobilisation (including immobilisation versus no immobilisation) on mortality, neurological disability, spinal stability and adverse effects in trauma patients.

Reviewers' conclusions: The effect of spinal immobilisation on mortality, neurological injury, spinal stability and adverse effects in trauma patients remains uncertain. Because airway obstruction is a major cause of preventable death in trauma patients, and spinal immobilisation, particularly of the cervical spine, can contribute to airway compromise, the possibility that immobilisation may increase mortality and morbidity cannot be excluded. Large prospective studies are needed to validate the decision criteria for spinal immobilisation in trauma patients with high risk of spinal injury. Randomised controlled trials in trauma patients are required to establish the relative effectiveness of alternative strategies for spinal immobilisation.

Evidence-based Reviews: Acute Traumatic Brain Injury.

Review: *Forsyth R, Baxter P, Elliott T. Routine intracranial pressure monitoring in acute coma.*

Objective: To determine whether routine intracranial pressure monitoring (ICP) in all acute cases of severe coma reduces the risk of all-cause mortality or severe disability at final follow up.

Reviewers' conclusions: There are no data from randomised controlled trials that can clarify the role of ICP monitoring in acute coma.

Review: *Gadkary CS, Alderson P, Signorini DF. Therapeutic hypothermia for head injury.*

Objectives: To estimate the effects of mild induced hypothermia in moderate and severe head injury on mortality, long-term functional outcome, complications, and short-term control of intracranial pressure (ICP).

Reviewers' conclusions: There is no evidence that hypothermia is beneficial in the treatment of head injury. The earlier, encouraging, trial results have

COCHRANE LIBRARY REVIEWS

not been repeated in larger trials. The reasons for this are unclear. Hypothermia increases the risk of pneumonia and has other potentially harmful side effects. Therefore, it would seem inappropriate to use this intervention outside of controlled trials in subgroups of patients for whom there is good reason to think the treatment would be beneficial.

Review: *Yanagawa T, Bunn F, Roberts I, Wentz R, Pierro A. Nutritional support for head-injured patients.*

Objective: To quantify the effect on mortality and morbidity of alternative strategies of providing nutritional support following head injury.

Reviewers' conclusions: This review suggests that early feeding may be associated with a trend towards better outcomes in terms of survival and disability. Further trials are required. These trials should report not only nutritional outcomes but also the effect on death and disability.

Review: *Forsyth R, Jayamoni B. Noradrenergic agonists for acute traumatic brain injury.*

Objective: To evaluate the evidence that amphetamines improve final outcome after traumatic brain injury.

Reviewers' conclusions: At present there is insufficient evidence to support the routine use of methylphenidate or other amphetamines to promote recovery from traumatic brain injury.

Review: *Fleminger S, Greenwood RJ, Oliver DL. Pharmacological management for agitation and aggression in people with acquired brain injury.*

Objective: To evaluate the effects of drugs for agitation and/or aggression following acquired brain injury (ABI).

Reviewers' conclusions: Numerous drugs have been tried in the management of aggression in ABI but without firm evidence of their efficacy. It is therefore important to choose drugs with few side-effects and to monitor their effect. Beta-blockers have the best evidence for efficacy and deserve more attention. The lack of evidence highlights the need for better evaluations of drugs for this important problem.

Review: *Schierhout G, Roberts I. Mannitol for acute traumatic brain injury.*

Objective: To assess the effects of different mannitol therapy regimens, of mannitol compared to other intracranial pressure (ICP) lowering agents, and to quantify the effectiveness of mannitol administration given at other stages following acute traumatic brain injury.

Reviewers' conclusions: There are insufficient data to recommend one form of mannitol infusion over another. Mannitol therapy for raised ICP may have a beneficial effect on mortality when compared to pentobarbital treatment. ICP-directed treatment shows a small beneficial effect compared to treatment directed by neurological signs and physiological indicators. There are insufficient data on the effectiveness of pre-hospital administration of mannitol to preclude either a harmful or a beneficial effect on mortality.

Review: *Schierhout G, Roberts I. Hyperventilation therapy for acute traumatic brain injury.*

Objectives: To quantify the effect of hyperventilation on death and neurological disability following head injury.

Reviewers' conclusions: The data available are inadequate to assess any potential benefit or harm that might result from hyperventilation in severe head injury. Randomised controlled trials to assess the effectiveness of hyperventilation therapy following severe head injury are needed.

Review: *Alderson P, Roberts I. Corticosteroids for acute traumatic brain injury.*

Objectives: To quantify the effectiveness and safety of corticosteroids in the treatment of acute traumatic brain injury.

Reviewers' conclusions: Neither moderate benefits nor moderate harmful effects of steroids can be excluded. The widely practicable nature of the drugs and the importance of the health problem suggest that large simple trials are feasible, and worthwhile, to establish whether there are any benefits from corticosteroids in this situation.

COCHRANE LIBRARY REVIEWS

Review: *Roberts I. Aminosteroids for acute traumatic brain injury.*

Objectives: To quantify the effectiveness and safety of aminosteroids in the treatment of acute traumatic brain injury.

Reviewers' conclusions: There is no evidence to support the routine use of aminosteroids in the management of traumatic head injury. On the basis of the existing evidence from randomised trials of aminosteroids in head injury it is not possible to refute the possibility of moderate but potentially clinically important benefits or harms. A further randomised controlled trial of Tirilazad Mesylate with 1156 participants has been completed, the results of which should become available in the near future.

Review: *Roberts I. Barbiturates for acute traumatic brain injury.*

Objectives: To assess the effects of barbiturates in reducing raised intracranial pressure, mortality and morbidity in people with acute traumatic brain injury. To quantify any side-effects resulting from the use of barbiturates.

Reviewers' conclusions: There is no evidence that barbiturate therapy in patients with acute severe head injury improves outcome. Barbiturate therapy results in a fall in blood pressure in 1 in 4 treated patients. The hypotensive effect of barbiturate therapy will offset any ICP lowering effect on cerebral perfusion pressure.

Evidence-based Reviews: Traumatic Hypovolaemic Shock.

Review: *Bunn F, Alderson P, Hawkins V. Colloid solutions for fluid resuscitation (Cochrane Review).*

Objectives: To compare the effects of different colloid solutions in patients thought to need volume replacement.

Reviewers' conclusions: From this review, there is no evidence that one colloid solution is more effective or safe than any other, although the confidence intervals are wide and do not exclude clinically significant differences between colloids. Larger trials of fluid therapy are needed if clinically significant differences in mortality are to be detected or excluded.

Review: *Alderson P, Schierhout G, Roberts I, Bunn F. Colloids versus crystalloids for fluid resuscitation in critically ill patients.*

Objectives: To assess the effects on mortality of colloids compared to crystalloids for fluid resuscitation in critically ill patients.

Reviewers' conclusions: There is no evidence from randomised controlled trials that resuscitation with colloids reduces the risk of death compared to crystalloids in patients with trauma, burns and following surgery. As colloids are not associated with an improvement in survival, and as they are more expensive than crystalloids, it is hard to see how their continued use in these patient types can be justified outside the context of randomised controlled trials.

Review: *Kwan I, Bunn F, Roberts I, on behalf of the WHO Pre-Hospital Trauma Care Steering Committee. Timing and volume of fluid administration for patients with bleeding following trauma.*

Objectives: To assess the effects of early versus delayed, and larger versus smaller volume of fluid administration in trauma patients with bleeding.

Reviewers' conclusions: We found no evidence from randomised controlled trials to support early or larger volume of intravenous fluid administration in uncontrolled haemorrhage. There is continuing uncertainty about the best fluid administration strategy in bleeding trauma patients. Further randomised controlled trials are needed to establish the most effective fluid resuscitation strategy.

Review: *Hill SR, Carless PA, Henry DA, Carson JL, Hebert PC, McClelland DBL, Henderson KM . Transfusion thresholds and other strategies for guiding allogenic red blood cell transfusion.*

Objectives: To examine the evidence on the effect of transfusion thresholds, on the use of allogenic and/or autologous blood, and the evidence for any effect on clinical outcomes.

Reviewers' conclusions: The limited published evidence supports the use of restrictive transfusion triggers in patients who are free of serious cardiac disease. However, most of the data on clinical outcomes were generated by a single trial. The effects of conservative transfusion triggers on

COCHRANE LIBRARY REVIEWS

functional status, morbidity and mortality, particularly in patients with cardiac disease, need to be tested in further large clinical trials. In countries with inadequate screening of donor blood the data may constitute a stronger basis for avoiding transfusion with allogenic red cells.

Review: *Roberts I, Schierhout G. Human albumin solution for resuscitation and volume expansion in critically ill patients.*

Objective: To quantify the effect on mortality of human albumin and plasma protein fraction (PPF) administration in the management of critically ill patients.

Reviewers' conclusions: There is no evidence that albumin administration reduces the risk of death in critically ill patients with hypovolaemia, burns or hypoalbuminaemia, and a strong suggestion that it may increase the risk of death. These data suggest that the use of human albumin in critically ill patients should be urgently reviewed and that it should not be used outside the context of a rigorously conducted randomised controlled trials.

Review: *Bunn F, Roberts I, Tasker R, Akpa E. Hypertonic versus isotonic crystalloid for fluid resuscitation in critically ill patients.*

Objective: To determine whether hypertonic crystalloid decreases mortality in patients with hypovolaemia with and without head injuries.

Reviewers' conclusions: This review does not provide enough data to be able to state whether hypertonic crystalloid is better than isotonic crystalloid for the resuscitation of patients with trauma, burns, or those undergoing surgery. However, the confidence intervals are wide and do not exclude clinically significant differences. Further trials are needed comparing hypertonic to isotonic crystalloid. Trials need to be large enough to detect a clinically important difference.

Review: *Use of military antishock trousers (MAST) in the treatment of traumatic hypovolaemic shock.*
Objectives: To quantify the effect on mortality and morbidity of the use of medical anti-shock trousers (MAST)/ pneumatic anti-shock garments (PASG) in patients following trauma.

Reviewers' conclusions: There is no evidence to suggest that MAST/PASG application reduces mortality, length of hospitalisation or length of ICU stay in trauma patients and it is possible that it may increase these. These data do not support the continued use of MAST/PASG in the situation described. However, it should be recognised that, due to the poor quality of the trials, conclusions should be drawn with caution.

Evidence-based Reviews: Antibiotic Prophylaxis in Trauma

Review: *Medeiros I, Saconato H. Antibiotic prophylaxis for mammalian bites.*

Objective: To estimate the usefulness of antibiotics in reducing the risk of developing a wound infection after a mammalian bite.

Reviewers' conclusions: There is evidence from one trial that prophylactic antibiotics reduces the risk of infection after human bites but confirmatory research is required. There is no evidence that the use of prophylactic antibiotics is effective for cat or dog bites. There is evidence that the use of antibiotic prophylactic after bites of the hand reduces infection but confirmatory research is required.

Review: *Gillespie WJ, Walenkamp G. Antibiotic prophylaxis for surgery for proximal femoral and other closed long bone fractures.*

Objective: To determine whether the prophylactic administration of antibiotics in patients undergoing surgical management of hip or other long bone fractures reduces the incidence of wound and other hospital acquired infections.

Reviewers' conclusions: Antibiotic prophylaxis should be offered to those undergoing surgery for closed fracture fixation. On ethical grounds, further placebo controlled randomised trials of the effectiveness of antibiotic prophylaxis in closed fracture surgery are unlikely to be justified while trials addressing the cost-effectiveness of different effective antibiotic regimens would need to be very large.

Appendix 11

USEFUL TRAUMA-CARE, INFORMATION AND TRAINING WEBSITES

Emed-induction (www.emed-induction.ie) (website resource run by the Emergency Department in St. Vincent's University Hospital aimed at Junior Doctors working in A&E)

British Association for Accident and Emergency Medicine (www.baem.org.uk)
American College of Emergency Physicians (ACEP) (www.acep.org)
Canadian Association of Emergency Physicians (CAEP) (www.caep.ca)
The Australasian College of Emergency Medicine (www.acem.org.au)
Asian Society for Emergency Medicine (www.asem.org.sg)
Database of International EM Rotations (www.ed.bmc.org/iem/search.cfm)

Hong Kong Society of Emergency Medicine and Surgery Home Page (http//home.netvigator.com/~hksems2p/)
Society for Academic Emergency Medicine (SAEM) (www.saem.org)
Society for Emergency Medicine of Singapore (SEMS) (www.sems.org.sg)
Society of Emergency Medicine, Taiwan (www.sem.org.tw)

Trauma.org (www.trauma.org)
The Royal Society of Medicine (www.roysocmed.ac.uk)

Joint Royal Colleges Ambulance Liaison Committee (www.jrcalc.org.uk)
The UK Resuscitation council (www.resus.org.uk)

Liverpool Trauma Home Page (www.swsahs.nsw.gov.au/livtrauma)

Radiology Cases In Paediatric Emergency Medicine (www2.hawaii.edu/medicine/pediatrics/pemxray/pemxray.html)
Emergency Medicine Curriculum Home Page (www.stg.brown.edu/projects/emc/index.html)
Medical, Emergency, Rescue and Global Information Network (www.merginet.com)
Weekly Web Review in Emergency Medicine (www.wwrem.com)

Association of Anaesthetists of Great Britain and Ireland (www.ncl.ac.uk/~nassoca)
The Pain Society (www.ncl.ac.uk/~nrjh/painsoc)

Royal College of Radiologists (www.rcr.ac.uk/enquires)
Society of Thoracic Surgeons (www.sts.org)
US National Library of Medicine (www.nlm.nih.gov)
WebDoctor. (www.gretmar.com)
World Health Organisation (www.who.ch)

American College of Surgeons (www.facs.org)
American Academy of Orthopaedic Surgeons (www.aaos.org)
Emergency Medicine Research Group (www.emerg-uk.com)
British Orthopaedic Association (www.boa.ac.uk)
Royal College of Pathologists (www.rcpath.org)

Further Reading

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NOTES

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