HANDBOOK of
TRAUMA CARE

THE LIVERPOOL HOSPITAL
TRAUMA MANUAL
6TH EDITION

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Sydney, Australia
It has been a rewarding challenge to coordinate, edit, revise and complete a project involving so many contributors. This is the 6th edition of the Liverpool Hospital Trauma Handbook and it has been renamed “Handbook of Trauma Care - The Liverpool Hospital Trauma Manual.” This is the first edition of this manual to be published in a pocket-book format to allow easier reference.

The goal of this 6th edition was to involve more of the many people at Liverpool Hospital who have a special interest or expertise in trauma care and who have been leaders in trauma care at local, national and international levels. By making this Handbook of Trauma Care a multidisciplinary and mainly practical approach to trauma care, we hope to increase the usability of this manual for all trauma caregivers who will read and carry it.

The intent of this manual is to provide users with a solid, consistent and practical approach to managing severely injured patients. No two patients present with the same clinical findings and injuries and it can be difficult to generalise rules to cover all clinical settings, however, the principles set out in this Handbook are safe and will guide the user appropriately. There is no substitution for the guidance that an experienced consultant can provide and he or she should always be included in decision-making for difficult cases.
As our knowledge of “better practice” expands and the specifics of day-to-day management of the injured patient are changed or improved, future versions of the Handbook of Trauma Care will be published. Additionally, we plan to maintain this manual as a “living document” with regular updates online at the Liverpool Trauma website:


The impact of injury and its effect on life quality and productivity in Australasia and around the world remains vastly underappreciated. Injury is still the leading cause of death in young people and is a significant cause of morbidity and mortality in older patients. All those who are involved in care of the injured patient are encouraged to think, ask questions, and attend as many lectures, workshops and conferences as you can to expand your knowledge and better your abilities.

Scott K D’Amours
ACKNOWLEDGEMENTS

It is impossible to complete a project like this without the help of others whose names do not necessarily appear in the list of contributing authors. The editors would like to thank all who contributed to the Handbook for their hard work and suggestions as to ways to improve this manual over previous editions.

In addition, special thanks are due to our local hardworking desktop publishing expert, Charmaine Miranda, for her tireless efforts in piecing this project together. Without her dedication to this project (in addition to many others) it would have been very difficult to complete. Additional thanks to Thelma Allen and Monika George for their continuing support in the front office.

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# SECTION 1

**TRAUMA SERVICE OVERVIEW AND ADMINISTRATION**

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Liverpool Hospital is the designated major trauma service for the South Western Sydney Area Health Service (SWSAHS). It serves the population of South Western Sydney (in excess of 750,000) acting as a referral hospital for one rural and four urban hospitals: Fairfield, Campbelltown, Camden, Bankstown and Bowral. As the major trauma service we are here to serve, rather than manage our urban and rural colleagues. Our mission is to optimise trauma patient care in the region. To achieve this we must strive to be a world leader in trauma care aiming to improve communication and ensure patient outcomes are continuously monitored and improved.
In 1992 the New South Wales (NSW) trauma plan designated eight major trauma services in metropolitan Sydney, one of which was Liverpool Hospital. This trauma service has recently successfully undergone the formal verification process of the Royal Australasian College of Surgeons Trauma Committee. This was the first hospital to do so in Australasia. We, at Liverpool, have a commitment to learning, teaching, quality assurance, performance improvement and a desire to impart common sense and a practical approach to optimising trauma care.

The Trauma Department consists of a Trauma Director, Deputy Director, Trauma Fellow, Trauma Nurse Coordinator, Regional Trauma Coordinator, Trauma Case Manager, Trauma Data Manager, and secretarial support. We also have a part-time Research Assistant, and Project Officers from time to time. We are privileged to have a visiting Honorary Fellow, and visiting final year and 4th year medical students in trauma.

To maintain our standards in trauma care we undertake some key performance improvement activities:

1. Clinical teaching and orientation, which is multidisciplinary in nature, is now available on our website: 

The Trauma Department itself does not look after individual trauma patients, rather facilitates the liaison with individual specialists in different disciplines who bear the direct responsibility of patient care.

2. The Trauma Audit is a weekly meeting on Thursdays commencing at 0730h for 30 minutes, it is designed to afford the opportunity for learning through, in general, positive reinforcement of issues that occur on a weekly basis.

3. Our Registry and data collection system allows us to collect performance indicators on the process and delivery of trauma care at the hospital and throughout the area. On a monthly basis the registrars in surgery are given feedback on their performance in relation to key indicators. The indicators and the thresholds for reasonable performance are available in the South Western Sydney Regional Trauma Registry Report 1995 - 1999, or on our website under “Registry”.

4. The Trauma Service facilitates a number of committees (see chart next page) which include:
   (a) Hospital Trauma Committee – direct responsibility for the process of day to day hospital trauma care.
   (b) South Western Sydney Area Health Service Trauma Network Management Group – direct area responsibility for the process of trauma patient care.
   (c) South Western Sydney Area Trauma Committee – a confidential process of peer review of trauma deaths.
   (d) The Injury Advisory Committee – a peer group involved in the development of Better Practice Guidelines for the area.

The Trauma Department at Liverpool Hospital is responsible to the Division of Surgery and the Hospital Administration.
VISITING TRAUMA MEDICAL STUDENTS

Medical students in their 4th and final year may opt for an elective in trauma, the following requirements need to be observed:

1. Registration with the Medical Board of NSW needs to take place.
2. A criminal record check needs to be completed.
3. Registration with the hospital for identification badges and key access.
4. The following provides some guidelines in relation to the code of conduct of students in trauma:
   - Universal precautions must be taken when in the resuscitation room once the red line has been crossed.
   - No photography can be undertaken without approval of the Trauma Director and that of the patient, and our staff.
   - Access to the Trauma Department is generally allowed on a 24 hour basis subject to Department Head approval.
   - Complimentary Trauma Manual is provided.
   - Access to computers is permitted with Department Head approval.
The following are departments or facilities frequently and actively involved in trauma patient care at Liverpool Hospital. The roles of some of their members are highlighted to demonstrate their frequent involvement with the trauma system and its patients.

**TRAUMA DEPARTMENT**

**Director / Deputy Director**
Responsible for planning, directing and implementing systems to ensure optimum delivery of care is provided to trauma patients in SWSAHS.

**Trauma Fellow**
Coordinates the activities and outcomes of trauma by the provision of leadership and expert skills. Supports other roles within Liverpool and urban / rural hospitals by teaching, supervising, researching and providing feedback. Monitors patients' progress and outcome. Major role in resuscitation is to plan patient care / investigations with surgical registrar and Trauma Team Leader.

**Surgical Registrar**
Is responsible for the detailed examination of the patient after the primary survey is completed, coordinating surgery and communication with specialty teams. When experienced, will make decisions regarding definitive management.

**Trauma Clinical Nurse Consultant (CNC)**
Coordinate the activities and outcomes of trauma by the provision of leadership and expert clinical advice to patients, carers and other health care professionals. Monitors patients' progress and outcome. Reports adverse events, errors in care and near misses.
Trauma Case Manager
Assists as required during trauma team activations. Follows patients with specific injuries, to monitor implementation and validation of clinical pathways. The Trauma Case Manager also plays a significant liaison role allowing better continuity of patient care.

Trauma Data Manager
Maintains registry of trauma admissions to SWSAHS. Collects and reports on patient demographics, injury details, diagnostic and treatment interventions, and outcomes.

Regional Trauma Coordinator
The Regional Trauma Nurse Coordinator (RTNC) is responsible for the monitoring and coordination of regional trauma and Area Health Service Injury Management Programs in close collaboration with the Trauma Director and the Area Trauma Committee. Areas of responsibility:

• Collects data and reviews trauma management and outcomes for regional trauma admissions.
• Monitors Trauma Hotline, NEWS Checklist and all SWSAHS interhospital transfers.
• Reviews all transfers to Liverpool Hospital.
• Consults with regional nursing and medical staff re: trauma management and transfer, providing feedback.
• Trauma education to regional hospital staff.
• Follow up trauma transport decisions and liaises with ambulance personnel.

EMERGENCY DEPARTMENT (ED)

Emergency Registrar
Responsible for overall coordination, documentation and placement of patient. Assists with resuscitation in the primary and secondary surveys. If the patient does not require admission, assumes overall care. Takes on role of Trauma Team Leader for the first half of every month.
Staff Specialist in ED
Acts as a resource for the ED registrar and as Trauma Team Leader or Airway Doctor as required by the situation.

ED Nurses
Form the nursing core of the trauma team, acting as Airway Nurse, Procedure Nurse and Scribe. For multiple traumas more nurses are recruited from ED as needed.

INTENSIVE CARE UNIT (ICU)

ICU Registrar
When responsible for airway management should remain with the intubated patient (includes visits to CT) until final placement. Is responsible for allocating ICU beds in consultation with senior ICU staff. Also has a major role in answering Trauma Hotline calls and ensuring rapid and safe interhospital patient transfers.

ICU Consultant
Utilised by the ICU registrar to provide backup and as a resource for difficult critical care related problems. The ICU consultant is also involved for any ICU or HDU admission / consultation of major trauma patients.
ICU Nurses
Ongoing care of critically ill trauma patients.

OPERATING THEATRE (OT)

Anaesthetic Registrar / Anaesthetic Consultant
Available for anticipated or difficult airway management problems. **Available on extension 84405 or speed dial 2927 after hours.** Contact early when surgery anticipated. Pre-hospital SBP <90 mandates notification of anaesthetic registrar.

Operating Theatre (OT) Coordinator
Contact as soon as decision is made to operate on a patient so that theatre staff can organise a room and equipment. As the OT coordinator is part of the trauma pager group, ensure that theatres are "stood down" should an operation not be required. **Available on extension 84404.**
SECTION 1

SUBSPECIALITIES
Neurosurgical, Orthopaedic, Cardiothoracic, Plastic, Vascular, Urology and Paediatric specialties will attend promptly as required. Contactable via switchboard.

RADIOLOGY

Radiographer
Responds to resuscitation room as part of trauma team activation. Positions portable x-ray machine. Supine chest, pelvis and lateral c-spine x-rays are the routine trauma series.

Radiologist
Available through switchboard and can review films by a teleradiology link. If urgently required or for interventional procedure advise as early as possible to permit transport time to hospital.

Radiology Registrar
Assists consultant radiologist. Will immediately interpret films when contacted directly.

LABORATORY

Rapidly ensures patient cross match. Ensure request for blood availability is made early if need is anticipated. Also responsible for rapidly processing arterial blood gases and evaluation of DPL effluent.
All the hospitals within South Western Sydney Area Health Service (SWSAHS) offer different acute levels of trauma service according to resources.

**BANKSTOWN HEALTH SERVICE**

**ED:**
- Level 5 designation (see Appendix Page 16).
- 1 full time Director, and
- 2 full-time equivalent (FTE) staff specialist positions covering day and evening shifts (no night duty staff specialist cover). Amount of staff specialist cover varies from day to day and on different shifts.
- 1800 – 0800 one senior Career Medical Officer (CMO), Resident Medical Officer (RMO) and intern staff mix.
- **No formal trauma team.**
- **ED has individual roles for resuscitation.**

**Theatre:**
- 8 functional suites, 2 endoscopy rooms.
- Fully staffed 0730 – 2300.
- On-call nursing staff within 10 mins distance.
- 24 hours on-site anaesthetic registrars.

**ICU:**
- 1 full time Director in hours.
- After hours 1 dedicated registrar and 1 dedicated resident.
- 7 ICU / 4 HDU beds.
- Does not accept any complex trauma cases.
- Accepts short and long-term ventilated patients.

**Pathology:**
- 0700 – 2400, then on-call.
- Blood bank facilities available on call after hours.
Radiology:
• 24 hour radiographer on site.
• CT 0800 – 1800, then on call service.
• U/S 0830 – 1730 then on call service.

BOWRAL HOSPITAL

ED:
• Level 3 designation\(^1\).
• No Director.
• 1 Medical Officer (MO) in ED at all times – the only on site MO in whole hospital.
• Weekends and Public Holidays (PH) (and pre-recognised busy times) extra MO 1200 – 2000 in ED.
• Physician (Director of Clinical Services) is on site in hours and available to attend emergencies as needed.
• No formal trauma team.
• ED has protocols for trauma patients.
• Every shift at least one senior ED nurse with post graduate ED Certificate, TNCC and / or ARC qualifications on duty.

Theatre:
• 2 suites fully staffed 0730 – 1800, then on call nursing staff within 30 mins distance.
• Weekends 0800 – 1700, then on call.
• Anaesthetists within 30 mins distance.

HDU:
• 8 beds.
• No Director.
• Can accept only 1 ventilated patient short-term 12 – 20 hrs.

Pathology:
• 0800 – 1800 weekdays, then on call.
• 0900 - 1700 weekends, then on call.
• Blood bank facilities available on call after hours.
**Radiology:**
- On-site fully private practice – radiologists / radiographers / ultrasonographers and CT operators.
- 0800 - 1800 weekdays, then on call.
- 0900 - 1700 weekends, then on call.
- After hours all services available on call.
- Radiologist reporting available 24 hrs via teleradiology.

**CAMDEN HOSPITAL**

**ED:**
- Level 3 designation\(^\text{\textsuperscript{1}}\).
- 0800 – 1800 1 Medical Officer (MO) ED
- 0730 - 1600 1 RMO in the wards, 1 RMO rehab, and 1 part-time palliative care registrar.
- 1800 – 0800 1 locum, CMO or RMO in the hospital, stationed in ED.
- 1 off-site Director (Director of Campbelltown ED).
- No formal trauma team.

**Theatre:**
- Day surgery only, weekdays 0800 - 1800 (no weekends).
- All trauma surgery cases transferred to either Campbelltown or Liverpool Hospitals.
- No emergency surgery done at all.

**ICU:**
- No ICU services available.
- 4 bed HDU.
- No ventilator capacity (oxylog for ED and transfers).

**Pathology:**
- 0830 – 1630, then on-call blood bank facilities available only.
- Urgent bloods for analysis go to Campbelltown Hospital 1630 - 2400 via courier or taxi.
- 2400 - 0830, all pathology goes to South Western Area Pathology Service (SWAPS).
Radiology:
- 0900 – 1700, then on call.
- All CT and U/S performed off-site.

CAMPBELLTOWN HOSPITAL

ED:
- Level 5 designation\(^{(1)}\).
- 1 full-time Director (who is also the Camden ED off-site Director), and
- 1 full-time staff specialist ED weekdays.
- 2 part time emergency paediatric specialists.
- CMO senior cover 0800 – 2400, then locums.
- **No formal trauma team.**
- **ED has a resuscitation team response.**

Theatre:
- 3 main suites, 2 day surgery suites and 1 procedure room.
- Weekdays 0600 – 2300, then on call staff.
- Saturdays 0930 – 1800, then on call staff.
- Sundays 0830 – 1730, then on call staff.
- Nursing and anaesthetic staff within 30 mins distance.

ICU:
- No Director. 1 dedicated registrar per shift.
- 4 ICU / 8 Coronary Care Unit (CCU) beds.
- No complex trauma cases accepted.
- 2 ventilator capacity either short or long term.

Pathology:
- 0730 – 2400, then on call.
- Blood bank facilities available on call after hours.

Radiology:
- 0800 – 0100, then on call.
- CT and U/S 0800 – 1700, then after hours on call, subject to operator availability and radiologist approval.
• Radiologist on site 0800 - 1700 weekdays.
• Planning for: 24 hour radiography; also angiography subject to radiologist availability.

FAIRFIELD HEALTH SERVICE

ED:
• Level 4 designation.
• 2 part-time Directors weekdays (1 FTE), covering all weekdays except Tuesdays.
• 0800 - 1800 2 staff specialists (incl. Directors) Monday / Tuesday / Wednesday.
• 1 staff specialist (Director) Thursday and Friday.
• CMOs 0800 – 2200, then locums (7 days).
• No formal trauma team response.

Theatre:
• 4 suites 0830 – 1730, then on call.
• Nursing staff within 30 mins distance, anaesthetists on call, on site.

ICU:
• 1 Director.
• 4 ICU / 5 CCU beds.
• No complex trauma cases accepted.
• Short term ventilator patients only – either overnight or up to 24 hrs.

Pathology:
• 0800 – 2400, then on-call blood bank facilities available only.
• Urgent bloods for analysis go to Liverpool Health Service.

Radiology:
• 0800 – 2400, then on call.
• CT 0800 - 1700 weekdays, then 1700 - 2400hrs only non-contrast head CT performed. No CT after 2400hrs.
• U/S 0830 – 1630, no on call facility available for U/S.
APPENDIX: ED DESIGNATION DESCRIPTION

Level 1: No planned Emergency service. First aid treatment only. Access to medical practitioner.

Level 2: Emergency service in small hospital. Designated assessment and treatment area. Limited resuscitation and stabilisation capacity. Visiting Medical Officer (VMO) on call, nurses from ward available to cover emergency presentations.

Level 3: As level 2 plus designated ED nursing staff (some with relevant postgraduate studies), and Nurse Unit Manager (NUM). 24 hr access to MO on-site or within 10 mins distance. Full resuscitation facilities in separate room. Specialist consultation for general surgery, anaesthetics, paediatrics and medicine. Access to Clinical Nurse Consultant (CNC) and liaison psychiatry. Qualified Medical Director Pathology, radiology and operating theatres during normal hours, and on-call after hours. Education programs for nursing and medical staff.

Level 4: As level 3 plus stabilisation and assisted ventilation, and definitive care for most patients. Director with emergency training and experience. Experienced ED nursing and medical staff 24 hrs on-site, at least 1 RN per shift with postgraduate emergency qualifications. Specialists on-call 24 hrs for ICU, general surgery, orthopaedics, anaesthetics and medicine. 24 hr psychiatry liaison. Formal nursing and medical educational programs. Access to CNC and Clinical Nurse Educator (CNE). 24 hr access to pathology, radiology and operating theatres.

Level 5: As per level 4. Medical Director, FACEM (Fellow of the Australasian College of Emergency Medicine) accredited. Access to CNC and CNE. Has designated ACEM (Australasian College of Emergency Medicine) accredited registrar, ED staff specialists 16hrs / 7days. 24hr on-call emergency consultant cover. 24 hr psychiatry liaison. Extended hour access to allied health (social work services and physiotherapy).

Level 6: As per level 5 plus neurosurgery and cardiothoracic surgery
on-site. Sub-specialists available on rosters. Advanced subspecialty registrar on-site 24 hrs. After hours roster for ED staff specialists 24 hrs / 7 days. Frequent major trauma and other emergency capacity. Invasive monitoring and short term ventilation. Designated Nursing Director and / or NUM 24 hrs. Provides advice and stabilisation for complex cases transferred from other network hospitals. Active research program. CT and nuclear medicine available on-site.

REFERENCE:
The Trauma Hotline facilitates the interhospital transfer of seriously injured trauma patients from any hospital within South Western Sydney Area Health Service (SWSAHS) who require transfer to Liverpool Hospital. As the designated Major Trauma Service in the area health service, Liverpool Hospital has a responsibility to accept all major trauma patients from SWSAHS, regardless of ICU or HDU bed availability\(^1,^2\).

All trauma patients, including paediatric and those with spinal cord injury, are accepted. If there is no ICU bed available at Liverpool, we will accept the transfer, stabilise the patient on arrival, and organise further transfer as required.
ICU REGISTRAR’S ROLE FOR HOTLINE CALLS:
The Hotline call comes via the switchboard on a dedicated line. The ICU resuscitation registrar will receive the following message on their pager: “83012 TRAUMA HOTLINE CALL.” The switchboard operator will document (on the Hotline Log) the referring doctor’s or nurse’s name, ICU registrar’s name, patient’s name, and the length of time taken for the ICU registrar to respond. WE AIM TO LIMIT THE WAITING TIME TO LESS THAN 2 MINUTES.

The resources - both physical and human - at other hospitals are easily overwhelmed when faced with serious trauma and the referring doctor or nurse should not be made to wait on the phone for any extended period of time.

As the ICU resuscitation registrar, you will be responsible for taking all Hotline calls during your shift. If you know you will be busy with a procedure, or if you are attending an emergency elsewhere, you must make arrangements for your pager to be answered immediately by another doctor for the period you will be unavailable.

We aim to limit the number of calls made between the referring hospital and Liverpool Hospital to one – i.e. one call made by them to effect the transfer, and one call back to them if required. Some complicated trauma cases may require more communication, however, please be mindful of the limited personnel available at most other hospitals in the area.

You should obtain all necessary information - the referring hospitals should hand over using the ‘MIST’ acronym (see page 27). The referring doctor should also describe all resuscitation information (primary and secondary survey), and all definitive care information (e.g. intubation / ICC / drugs etc.). To ensure the patient is well packaged and ready for transfer please ask the referring hospital to complete the NEWS Checklist and to place all relevant documentation and x-ray films in the NEWS Checklist Envelope (Figure 1).
**N.E.W.S. Checklist**

The preferred approach for the transfer of trauma patients

South Western Sydney Local Health Service

INTERHOSPITAL TRAUMA TRANSFER
TO
LIVERPOOL HOSPITAL

Liverpool Hospital Trauma Hotline (02) 9828 3666

Date: ___________________________  Referring Doctor: ___________________________

Referring Hospital: ___________________________  Accepting Doctor: ___________________________

_Airway:_

- ET: _____ Gagging protection: _____

_Breathing:_

- O2: _____ Self: _____ TUBE: _____ Chest tubes: _____

_Circulation:_

- Volume: _____ lines: _____ drugs: _____

_Diagnostics:_

- X-rays: _____ chest: _____ C-spine: _____ L/S: _____ I/L: _____

_Equipment:_


_Family:_

- _____

_Gastrostomy:_

- _____

_Handover:_

- MSU: _____ SAMPLE: _____

Include all photocopied documents, lab and X-rays and ambulance sheets: _____


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This N.E.W.S. Checklist is copyright. The trauma department of Liverpool Hospital would like to acknowledge their support in the N.E.W.S. Checklist system. We only use the information that is provided in the N.E.W.S. Checklist form. We are not liable for any mistakes or omissions. This N.E.W.S. Checklist checklist must be filled out before the patient is transferred.
From the time of first contact from the referring hospital, the patient is your responsibility as well as the responsibility of the staff currently managing the patient. This remains to be the case until the patient arrives at Liverpool and is handed over to the trauma team in the resuscitation room.

**PAEDIATRIC TRAUMA**

With regards to paediatric trauma, Liverpool Hospital will accept the patient, stabilise and if necessary transfer to a children’s hospital. Upon consultation, both you and the referring doctor may feel the child will be better served if taken directly to a children’s hospital. If there is any doubt, accept the patient for transfer to Liverpool Hospital.

**BURNS TRAUMA**

All burns trauma should go directly to a Burns Unit from the referring hospital. The referring doctor should be advised to contact a Burns Unit directly (see page 297).

**RETRIEVAL SERVICE – MEDICAL RETRIEVAL UNIT (MRU)**

1800 650 004

If retrieval is to be organised to transport the patient to Liverpool, then it is your duty to contact the Medical Retrieval Unit (MRU – above number) and supply all the details. The MRU will ring the referring hospital to make further arrangements and obtain further details as necessary. As per policy you must consult the ICU consultant on call if for some (very good) reason the patient cannot be accepted, or if air transport is to be used in the retrieval.

**PREPARING LIVERPOOL**

Your next obligation is to prepare Liverpool Hospital for the incoming trauma. ED is to be notified as all trauma transfer patients enter the ED as first port of entry into Liverpool. The patient will have a trauma team activation, and a full primary and secondary survey repeated on...
Notify and prepare all relevant specialties – orthopaedic, general surgery, neurosurgery, cardiothoracic, Trauma Fellow, etc. as required. Also notify radiology and theatres as indicated - this is especially important after hours, but necessary at all times as the departments may need time to clear a CT room / theatre suite, bring in more staff, etc.

**MONITORING THE HOTLINE**

The Regional Trauma Nurse Coordinator may contact the resuscitation registrar and the referring doctor or nurse to assess the transfer. Any issues raised regarding the transfer will be discussed, investigated, resolved and documented.

**NEWS CHECKLIST**

The NEWS Checklist was devised by the Liverpool Hospital Trauma Department to facilitate the transfer of trauma patients from the urban centres in SWSAHS to Liverpool Hospital. It is designed to be used as a quick but comprehensive guide for the packaging of trauma patients for transfer. All photocopied notes and x-rays are placed in the NEWS Checklist Envelope, and the whole package is sent to Liverpool Hospital with the patient. All trauma transfers from within SWSAHS should arrive with the envelope; all EDs have received the envelopes and have been instructed on its use.

NEWS is a mnemonic for:
- Necessary
- Enough
- Working
- Secure.

With each of the points on the list, the staff at the referring hospital is to ask the “NEWS” questions, and address each aspect as they assess and stabilise the patient for transfer (Figure 2).
E.g.: A - Airway:
  • Is any airway intervention **Necessary** for this patient? i.e. is an ETT necessary?
  • Is the intervention **Enough**? i.e. is a NRB mask enough, or should the patient be intubated?
  • Is the intervention **Working**? i.e. is the tube fully patent? Is the patient being adequately ventilated? Are there any kinks in the tubing? Are there any cuff leaks?
  • Is the intervention **Secure**? i.e. has the ETT been adequately tied?

The staff then goes through the list and checks each individual item, assessing each one in the same manner using the NEWS system.

**REFERENCES:**
3. O’Connor PM, Steele JA, Dearden CH, Rocke LG and Fisher RB. The accident and emergency department as a single portal of entry for the reassessment of all trauma patients transferred to specialist units. *J Accid Emerg Med*, 1996; 13(1); 9-10.
Communication is a pivotal aspect of trauma care. Trauma management requires prompt decision making but decisions in isolation are fraught with problems. Therefore, succinct and accurate communications are a vital component of good trauma care.

PRE-HOSPITAL
All pre-hospital communications should follow the “MIST” format and be completed in less than 30 seconds.

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</table>

It is important that information transfer follows this format to maximise preparation of the trauma team in the resuscitation room.

If the patient has a pre-hospital SBP <90mmHg or has other critical injuries requiring early surgery, the Trauma Surgeon on call must be notified before the patient reaches hospital.

IN-HOSPITAL
Wear your name badge in the resuscitation area and introduce yourself to the team as soon as possible. This ensures the Trauma Team Leader knows to whom to direct questions or instructions. It also creates an environment whereby the Airway Doctor knows the nurse, the Procedure Nurse knows the doctor, and so on. This allows smooth functioning of the resuscitation and promotes team interaction.
Communication to other sectors of the hospital is crucial in the proper management of trauma cases including clear communication to the following:

- Radiology extension 83454
- Theatre extension 84404 - 24 hours a day
- Anaesthetist on duty 84405 or speed dial 2927 after hours
- Hospital Switchboard "9" to inform other key members who may be required.

Remember, it is not adequate to ask the switchboard to locate an individual without identifying its urgency and that they must get back to you. Occasionally the busy switchboard will not be able to locate an individual or might leave a message on a mobile phone not realising the priority of the situation.

**ALWAYS SEEK HELP FROM A SECOND CONSULTANT IF THE ONE YOU REQUEST IS NOT AVAILABLE.**
The hospital switchboard will oblige if adequately informed of the urgency of the situation leaving you free to continue resuscitation of the patient.

Care, however, must be exerted in relation to multiple communications with different specialties. Avoidance of the C.O.C.U.P. must be considered. The C.O.C.U.P. (Consortium of Care for Urgent Priorities) occurs when multiple disciplines are asked to offer management advice with no clear leader. The Trauma Registrar and Trauma Surgeon are directly responsible for the patient’s care, and as such, the overall responsibility for the patient lies with them specifically.

BETWEEN HOSPITALS
Interhospital trauma transfer requests are one of the more challenging communications as strangers must communicate clearly and quickly regarding situations that can often be life threatening. At Liverpool Hospital we accept ALL requests for admission to the hospital for major trauma. This is our designated role as a major trauma service, even if we are full. The request should come through the Trauma Hotline (see previous chapter) if the patient potentially requires high dependency or ICU treatment.

If the patient has an isolated injury such as a digital nerve transection – transfer can be organised directly with the relevant subspecialty. The majority, however, fall into the Hotline category. It is important that individual specialty registrars do not accept patients with multisystem trauma. They should direct the referring doctor through to the trauma Hotline, recommending they use the NEWS Checklist transfer system to facilitate transfer.

Effective communication allows minimal duplication of work, an aware team and optimal patient care.
DAILY

Radiology Rounds: A review of all trauma films for patients admitted over the preceding 24 hour period. Weekdays only, in Radiology at 0830h.

Ward Rounds: After individual patient review by the trauma medical students, each admitted trauma patient is seen and examined by the medical students and Trauma Fellow. Daily at 1000h.
WEEKLY

Trauma / ICU Intake Rounds: All trauma patients admitted over the weekend to any of the critical care areas are reviewed on a round by the Trauma Director, Trauma Fellow, registrars, and medical students. The trauma medical students present the patients on this round. Mondays at 1100h commencing in ICU1.

Trauma Student Rounds: An interesting case is presented by the Trauma Fellow for an interactive session focusing on specific common problems in trauma patient care and assessment. Tuesday afternoons in the Emergency Department tutorial room or the trauma resuscitation room.

Trauma Audit: A detailed review and critique of the resuscitative and definitive care phases of individual trauma patient admissions. This audit is an interactive multimedia presentation. It is organised by the Trauma Fellow, presented by a registrar and chaired by a rotating roster of staff specialists in Surgery, Emergency, Anaesthesia and Critical Care as well as the Trauma Fellow. Thursday mornings in the Education Centre at 0729h; breakfast served.
Trauma / Critical Care Grand Rounds: An ICU trauma patient is presented by one of the trauma medical students, and interesting aspects of his or her care are reviewed in an interactive style with ICU staff, the Trauma Director and Trauma Fellow. Friday afternoons in ICU1 at 1330h.

Trauma Ward Nursing Rounds: Ward trauma patients are presented by the trauma nursing staff and issues pertaining to ward care and nursing are reviewed. Afternoon tea is served. Friday afternoon in the Conference Room at 1400h, 3rd Floor of the Clinical Building.

MONTHLY

Regional Hospital Rounds: Regional Hospitals in the South West Sydney Area Health Service have a trauma education session on a rotating basis roughly every 4 to 6 weeks. These sessions are arranged and attended by the Regional Trauma Nurse Coordinator and Trauma Fellow. Contact Regional Coordinator for exact schedule page 48552.

OTHER

SWAN Trauma Conference: This two-day conference involves trauma care providers from all phases of care: pre-hospital, doctors, nurses, paramedical professions and more. Invited speakers are some of the biggest international names in trauma care today. The conference topics are directed at a broad range of interesting, current and controversial areas of trauma care. The annual SWAN (South Western Area Network) Trauma Conference is held in early August each year. Information on topics, invited speakers and registration details are available from the Department of Trauma Services by February each year. Early registration is encouraged, as numbers are limited.
**DSTC (Definitive Surgical Trauma Care) Course**

The DSTC course is designed to assist surgeons in their involvement in acute surgery and decisions relating to serious trauma. It assumes all of the ATLS®/EMST principles and builds on them. If EMST deals with the “first hour”, this course will deal with the “second hour”. It is a response to the lack of written material and teaching on strategic issues of surgical resuscitation, early definitive care and surgical priorities. One aim of the DSTC course is to refine and promote an international standardised course package. Course dates are available from the Trauma Department at Liverpool Hospital.

**Trauma Service Orientation:** These sessions are held twice yearly for new registrars to Liverpool Hospital. All registrars from Surgery, Critical Care, Anaesthesia and the Emergency Department are required to complete the package which involves didactic, interactive and web-based units vital to the understanding of the process of trauma care at Liverpool Hospital. This manual also serves as a primary source of information for registrars along with the orientation package. Schedule and dates available from each Department prior to term commencement.

**Contact Details**

Trauma Department, Liverpool Hospital
Locked Bag 7103, Liverpool BC NSW 1871
Phone: 02 9828 3038  
Facsimile: 02 9828 3926  
All trauma admissions since September 1994 to Liverpool and the other five hospitals in SWSAHS are captured in the Regional Trauma Registry.

A comprehensive data set is maintained on injuries to head, internal organs, major long bone and pelvic fractures or patients with injuries to more than one body region. This includes patient demographics, pre-hospital interventions, resuscitative care and interventions, progress within the hospital system, operations, complications and an analysis of outcomes. There is a minimal data set on skeletal or soft tissue injuries to a single body region.

Information is obtained prospectively at Liverpool and retrospectively at urban and rural hospitals. Documentation accuracy and completeness is vital to allow comprehensive data collection. Registry Reports are published at regular intervals. The 5 year report (1995-1999) was published in 2000 and is available from the Trauma Department.

Request for information can be obtained from the Trauma Department on 02 9828 3038.
The Trauma Registry has produced two major reports on Trauma:

1. South Western Sydney Area Health Service
   Regional Trauma Registry Report 1995 - 1997
   ISBN 1 875909 63 X
2. South Western Sydney Area Health Service
   Regional Trauma Registry Report 1995 - 1999
   ISBN 1 875909 88 5

The 5 year report is available on our website
# SECTION 2

## TRAUMA TEAM

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The Liverpool Hospital trauma team consists of the following members:

- Trauma Team Leader
- Airway Doctor
- Procedure / Circulation Doctor
- Airway Nurse
- Procedure / Circulation Nurse
- Scribe Nurse
- Orthopaedic Registrar
- Wardsperson
- Radiographer
- Social Worker

In addition, the following are often present in the resuscitation:

- Trauma Fellow
- Emergency Consultant
- Trauma Medical Student

**What’s in?:** Communicating Name tags

**What’s out?:**
- Egos
- Hands in pockets
- No gowns / gloves
TRIAMA TEAM LEADER
The Trauma Team Leader is generally HANDS OFF, acting as a manager of the team, coordinating care preferably from the end of the bed, standing beside the Scribe Nurse. Specifically responsible for ensuring that pre-arrival preparation has taken place with universal precautions, lead gowns, goggles and gloves for all trauma, name tags and clear delineation of roles before the patient arrives ensuring that all members are present. The Trauma Team Leader must ensure that IV fluids are hung and appropriate special requirements such as intraosseous needles are available in specific cases. The Trauma Team Leader
must also ensure that the radiographer has the film cassette in place and is primed, ready for action. The Trauma Team Leader must ensure that communication has occurred beyond the resuscitation room for all serious trauma – have theatre, CT scan and surgical specialists been notified?

It is policy to notify the Trauma Surgeon on call for any patient with a reported pre-hospital SBP < 90mmHg. The Trauma Surgeon must be notified before the patient arrives in the resuscitation room. On arrival of the patient the Trauma Team Leader must ensure adequate hand over in the MIST format (see page 27), ensure the team are working with airway, breathing and circulation simultaneously. The Airway Doctor’s role is to perform a check of airway, breathing and circulation with the surgical registrar acting as the Procedure Doctor.

The Trauma Team Leader must complete the following mental check list:

- Pre-arrival preparation?
- Trauma Surgeon notified if SBP < 90mmHg?
- Trauma team activated?
- Name tags worn?
- Universal precautions in place?
- Lead gowns in place?
- X-ray cassette in place?
- Warmed IV fluids hanging?
- Blood “O” negative ready and Level 1™ rapid infuser primed for action, if necessary?
- Theatre notified?
- Radiology notified?

On patient arrival:

- Clear and concise hand over (ALL listening for 30 seconds).
- HANDS OFF approach.
- Clear communication.
- Promoting good teamwork and discussion.
- Staying calm (take a deep breath!).
AIRWAY DOCTOR (ICU OR ED REGISTRAR)
The Airway Doctor’s role is to ensure:
1. Adequate pre-arrival preparation of airway equipment, checking of tubes, masks, laryngoscopes, etc.
2. Possible alternative airways, where is the laryngeal mask? What would I use for a cricothyroidotomy?
3. CHECK with the Airway Nurse about drugs if necessary.
4. Evaluation of paediatric chart to ensure correct dosages for kids.

PROCEDURE / CIRCULATION DOCTOR (TRAUMA REGISTRAR)
1. Pre-arrival preparation – know the name of the Procedure Nurse.
2. Venous access and bloods.
3. Ensure only necessary bloods are taken.
4. Urinary catheter or gastric tube ready.
5. Secondary survey.
6. All other procedures.
7. Consider DPL or FAST, only report on FAST when accredited.
8. Liaison with team players, communication with Trauma Surgeon, subspecialist and theatre (extensions 84404 + 84405).

THE NURSE IN THE TRAUMA TEAM
Emergency nurses tend to be a fairly constant group and have an excellent knowledge of policies and procedures in the resuscitation room, ensuring smooth facilitation of trauma care. Trauma nurses play a critical role in the management of the trauma patient. This assessment spans from the time of the patient’s arrival at the hospital to discharge home and in the rehabilitation setting. It is important for nurses to be knowledgeable about trauma assessment, mechanism of injury, and the high risk and frequent complications that threaten the trauma patient.

Upon trauma team activation, previously assigned nurses will proceed to the resuscitation room and communicate with the Trauma Team Leader and the other members of the trauma team. In order to avoid confusion and perform efficiently, the trauma team members wear
nametags labelled according to their role. There are three key nurses on the team:

- Airway
- Procedure
- Scribe.

Nurses are allocated to their specific roles at the beginning of each shift and nursing roles are interchangeable from shift to shift. Additional nurses are required for multiple traumas. The nurses’ response to trauma team activations is excellent. A recent review of the nursing performance as part of the trauma team at Liverpool found all three nursing members present on arrival of the trauma patient in 94% of daytime activations and 80% after hours [2].

**AIRWAY NURSE**

The Airway Nurse is responsible for airway equipment including preparation for emergency airway procedures. Together with the Airway Doctor, the nurse calculates drug dosages and prepares the appropriate drugs. This is especially critical when paediatric trauma is involved. Stabilisation of the cervical spine may not be achieved in the pre-hospital setting and it is the Airway Nurse’s responsibility to ensure that the collar is correctly sized and fitted. Once the patient arrives, the nurse assists the doctor with maintaining an airway, drug administration, cricoid pressure, securing the tube and ensuring monitors are connected appropriately. The Airway Nurse ensures all portable equipment is ready if the patient needs to be moved to another facility within the hospital e.g. CT scanner, theatres, etc.

**REMEMBER TO REMOVE PATIENT’S EARRINGS AND OTHER JEWELLERY BEFORE X-RAYS ARE TAKEN.**
SECTION 2
PROCEDURE / CIRCULATION NURSE
The Procedure / Circulation Nurse works in conjunction with the Procedure / Circulation Doctor (trauma registrar). The Circulation Nurse, according to the pre-hospital information, ensures that all equipment is available. Warm fluids are primed in a blood pump set and the Level 1™ rapid infuser is kept on standby. Blood is available in the resuscitation room and should be at hand. Procedures performed in the resuscitation room include:

- emergency cricothyroidotomy
- packing of bleeding from major facial fractures
- saphenous vein cut down
- diagnostic peritoneal lavage
- urinary catheter insertion
- chest drain insertion
- emergency room thoracotomy, and
- stabilisation of fractures.

Intraosseous needles are available for paediatric trauma. On arrival of the injured patient, the Procedure / Circulation Nurse assists with removal of clothing and provides warm blankets to prevent hypothermia. Monitoring is attached to the patient and the nurse assists with securing intravenous lines. Both the Procedure / Circulation Nurse and Doctor liaise regarding procedures. During major trauma, additional assistance may be required to facilitate the use of the Level 1™ rapid infusion device.

KNOW THE RAPID INFUSER (LEVEL 1™) INSIDE & OUT!!
SCRIBE NURSE
The Scribe Nurse has a very complex role. Upon pre-hospital notification of arrival of the trauma patient, it is the Scribe Nurse’s responsibility to notify the operating theatres on extension 84404. This number contacts the Operating Theatre Coordinator who will be provided with the following information:

- M - Mechanism
- I - Injury
- S - Signs
- T - Treatment

This facilitates rapid transportation to the operating theatre when necessary.

It is the Scribe Nurse’s responsibility to obtain patient identification labels from the clerical personnel and attach two armband labels to the patient. The Scribe Nurse documents vital signs every 15 minutes (or every 5 minutes in the unstable patient). All fluids and medications are documented and a chronological record of events and procedures of the resuscitation is maintained.

The nursing members of the trauma team are a strong link in trauma care. They must be familiar with roles, which may vary from hospital to hospital.

Remember to document the patient’s temperature and respiratory rate.

WARDSPERSON
- Remove trousers, shoes and socks.
- Hold patient as directed by the Trauma Team Leader.
- Check suction and oxygen available.
- Transport console.
- Priority key to lifts and ready to transport patient.
RADIOGRAPHER
- Check with Team Leader before patient arrives regarding possible x-ray.
- Have x-ray plates in place ready to shoot.
- Put portable x-ray machine on patient’s left!
- Count “5, 4, 3, 2, 1, shoot!”
- Scan all x-rays onto the server.
- Ensure all earrings and other radio-opaque clothing, jewellery removed (brasieres, necklaces, etc).

SOCIAL WORKER
- Liaise with family and friends; provide support.
- Provide additional information when instructed by the Trauma Team Leader.

REFERENCES:
Anticipating the immediate needs of a pending trauma patient arrival is a critical role played by the Trauma Team Leader.

Pre-hospital information directly from ambulance crews or via ambulance dispatch can be limited, however, it is important to use these clues to better prepare and equip the trauma team to meet the immediate and urgent needs of the pending arrival.

**GENERAL**

- Ensure all team members are present in the resuscitation area. If members are absent, alert switchboard operator to send out a specific page to the missing member. Otherwise recruit a replacement team member.
- Ensure the team is appropriately gowned, gloved and wearing eye protection. THE TEAM LEADER MUST ENSURE THIS OCCURS.
- Give advance direction to the radiographers so that film cassettes are in position for rapid imaging on patient arrival.
- Ensure that the Trauma Surgeon on call is paged for any patient with a pre-hospital SBP < 90mmHg.
- Ring 84404 (operating theatre coordinator) if pre-hospital information makes urgent operation likely so that an operating theatre, staff and equipment can be prepared.
- Contact subspecialty services as necessary.

**AIRWAY**

The airway trolley at the head of the patient stretcher should always be stocked and ready to use. The Airway Doctor must ensure everything is ready and in working order. The emergency airway / cricothyroidotomy pack (all you need is a size 10 scalpel and a size 6 ET tube) is beneath the airway trolley and should be prepared in the following situations:
• Massive facial injuries with pre-hospital reports of difficulty ventilating.
• Stridor and suspected laryngeal injury with pre-hospital reports of hypoxia.
• Any pre-hospital reports of hypoxia and difficulty securing airway or failed intubation.
• If pre-hospital information suggests intubation is likely to be required, draw up drugs for a rapid sequence induction.

BREATHING
Breathing problems can be anticipated in patients suffering massive chest injuries. Chest tube trays should be opened in the following settings:
1. Pre-hospital decompression of a tension pneumothorax.
2. Reports of a flail chest or open pneumothorax.
3. History of a penetrating chest injury.

In the setting of a penetrating chest injury, consideration should also be given to the potential need for an ED thoracotomy. The thoracotomy pack should be readily available. Always consider opening the pack, as an extra 3 minutes taken to prepare after the patient’s arrival can be the difference between life and death.

CIRCULATION
The overwhelming principle of this aspect of trauma care is to arrest all bleeding. This must be the focus of resuscitation. Gaining IV access is important but secondary to control of ongoing external haemorrhage. Pressure must be placed on any site of external blood loss. If surgical control of bleeding is likely to be needed, then the appropriate surgeon must be advised as the information is gained.

All major trauma patients require intravenous access. If there are pre-hospital reports of difficult access, either percutaneous large bore access or venous cutdown access should be organised.
• All fluids must be given warmed. Bags should be hung and lines primed just prior to patient arrival.
• All fluids to be given with a pump set.
• Rapid infusing device (Level 1™) to be primed and ready if there has been any history of pre-hospital hypotension.

Type O blood from the resuscitation bay refrigerator is to be hung if the patient remains hypotensive pre-hospital despite fluid administration, or in a situation where massive injury and hypovolaemia is likely (massive pelvic fracture, large haemorrhage at scene, etc).

**DISABILITY**
The following pre-hospital information mandates contact with the on-call neurosurgeon before the patient reaches the resuscitation room:
• Open head injuries
• Decreased GCS
• Pupillary asymmetry.

**BE CAREFUL WITH ELDERLY PATIENTS: THEY DO NOT TOLERATE ANAEMIA VERY WELL.**

**THE GOAL OF PREPARATION IS TO ANTICIPATE THE IMMEDIATE NEEDS OF THE PATIENT. (BETTER TO BE OVER-PREPARED THAN LOOKING FOR STAFF AND EQUIPMENT IN AN EMERGENCY).**
ACTIVATION CRITERIA

The following criteria mandate the activation of the Liverpool Hospital trauma team. These are based on specific anatomical injuries and physiological parameters that indicate actual instability or a patient at high risk. In addition, certain specific mechanisms of injury or arrays of symptoms will activate the trauma team because, at this hospital, they have in the past indicated a very high risk of injury. Some of these patients may, after assessment, have no demonstrable injuries and be discharged. A certain number of “false alarms” are required to ensure that potentially unstable patients or patients with occult injury are not undertriaged. It is important to respond immediately to the page so that timely investigation and intervention can optimise patient outcome.

MECHANISM / HISTORY
- Motor vehicle crash with ejection.
- Pedal cyclist, motorcyclist or pedestrian hit by vehicle >30 km/h.
- Fall >5 metres.
- Fatality in same vehicle.
- Interhospital trauma transfer meeting activation criteria.

ANATOMICAL
- Injury to two or more body regions.
- Fracture to two or more long bones.
- Spinal cord injury.
- Amputation of a limb.
- Penetrating injury to head, neck, torso, or proximal limb.
- Burns >15% BSA in adults, >10% in children or airway burns.
- Airway obstruction.
PHYSIOLOGICAL

- Systolic blood pressure <90mmHg or pulse >130 bpm.
- Respiratory rate <10 or >30 per minute.
- Depressed level of consciousness or fitting.
- Deterioration in the Emergency Department.
- Age >70 years WITH chest injury.
- Pregnancy >24 weeks with torso injury.
Blood and body fluids can carry disease and cause infection in care providers. In the resuscitation areas of each trauma bay, fluid and blood splashes are common and there is a greater chance of coming into contact with infected fluids. It is imperative and a job requirement that you ensure maximal protection for yourself and others on the trauma team by wearing appropriate protection. All precautions must be in place before crossing the red line into the patient area. Barrier protection is an individual responsibility and the Trauma Team Leader must also ensure that team members are adequately protected. Those without adequate protection are not permitted in the trauma bays.

Occasionally, patients are brought in after exposure to various chemicals and environmental hazards. This situation also mandates careful attention to team member protection from exposure to these potentially hazardous substances. Special filtration masks are available in the resuscitation room for this purpose.

EYE PROTECTION
Adequate protection means wearing a curved eye shield or full facial shield. Both are available by the scrub sink in the resuscitation area. Eyeglasses alone are not adequately protective.
SECTION 2

GOWNS
Disposable fluid-resistant gowns are available on racks in the resuscitation area. These must be used to protect body and clothing from fluid contamination and splashes. If contaminated, they must be thrown away.

GLOVES
Available throughout the resuscitation room and must be used as with all other patient contact. Hypoallergenic gloves are available for those with a latex allergy.

LEAD GOWNS
Must be worn by Airway Doctor and Nurse, Procedure Doctor and Nurse, trauma registrar and anyone else required to remain within the trauma bay during resuscitation. Thyroid lead protection is also available. For those not within the immediate resuscitation area, a distance of 3 metres from the portable radiology equipment is considered safe for care providers.

BE PREPARED FOR ANYTHING AND EVERYTHING BY PROTECTING YOURSELF AS THE FIRST PRIORITY. ENSURE ALL GEAR IS ON BEFORE THE PATIENT ARRIVES.
Smooth functioning of the trauma team is associated with improved survival, reduction of mortality and morbidity. This requires prioritisation and resource management by all members of the team in conjunction with the Trauma Team Leader.

TEAM LEADER ROLE IN DETERMINING INVESTIGATIONS

The Trauma Team Leader should have a clear plan, after consultation with the surgical registrar and the Airway Doctor, about the patient’s planned investigations.

TIPS

- Be clear about instructions / management plan.
- Be willing to change your mind.
- Ensure adequate communication.
- Ensure you are thinking of the next stage after the investigation.
- Ensure the relevant speciality is notified.
- Use the clock.
- Set your goals and targets.
- Make sure anaesthesia and theatre are aware.

All seriously injured trauma patients should have c-spine, chest and pelvic x-rays. The order of this should be:

1. chest x-ray
2. pelvis x-ray
3. c-spine x-ray.

In a critically ill patient, request that the radiographer not scan the films until after the trauma team has reviewed them. Occasionally, but rarely, patients will need urgent surgery without any radiology. This is exceptional and usually relates to penetrating trauma. It is important
that investigations such as cystograms and urethrograms are prioritised to their place after stabilisation and control of circulation.

Patients travelling to radiology must be haemodynamically stable. There is no role for CT in the unstable patient.

In relation to team management, the Trauma Team Leader is ultimately responsible for ensuring that the patient is progressing. This includes ensuring adequate input and response from surgical and intensive care teams. In the event of any concern, the Trauma Surgeon should be notified. It is policy to notify the Trauma Surgeon via switchboard, the anaesthetic registrar on extension 84405 (speed dial 2927 after hours) and the Operating Theatre Coordinator on extension 84404 of the impending arrival of a patient with pre-hospital hypotension.
MULTIPLE TRAUMA PATIENTS
The concurrent arrival of two trauma patients to the resuscitation room is not an infrequent occurrence. Most often this situation can be managed by the team in attendance with the Trauma Team Leader and emergency physician triaging both patients and dividing the available doctors and recruiting further nursing staff from the emergency department.

Each team must have a Trauma Team Leader, an Airway Doctor and Airway Nurse, Procedure Nurse and Scribe Nurse. The role of Procedure Doctor can be taken by a single surgical registrar who starts with the patient triaged as having the most urgent needs. The second patient is seen as soon as the first patient has been adequately assessed and treated. Recognising that trauma patient needs can quickly change, it is the responsibility of each Trauma Team Leader to frequently assess the urgent needs of their patient. If more help is required, another surgical registrar, the Trauma Fellow or Trauma Surgeon can be recruited to assist.

If three or more patients arrive concurrently, or if two patients have critical injuries and require urgent treatment, the Trauma Surgeon on-call must be in attendance to assist. The call to request assistance must be made early and without hesitation.

LIVERPOOL HOSPITAL SURGEONS ARE ALWAYS HAPPY TO COME IN. YOU MUST CALL THEM EARLY. CALL IN THE TRAUMA FELLOW AS WELL IF AFTER HOURS.
DISASTER RESPONSE

Liverpool Hospital has defined specific responses to both external and internal disasters. These are available in the Liverpool Health Service Corporate Manual - Administrative Volume A-Section 5.

In short, the disaster plan for trauma is set into action when the emergency department and resuscitation bays are expected to be overwhelmed by the impending arrival of multiple injured patients. The exact number of patients to trigger this response depends on the severity of injuries and the number of staff required and available. It should be seriously considered with the arrival of more than 5 patients with significant injury. The disaster response is initiated by the Emergency Physician in consultation with the nurse in charge. The Corporate Manual has further details as to the chain of notification and decision making.

The Trauma Surgeon on-call should be alerted and on-site as should the duty anaesthetist. Further surgeons and anaesthetists can be recruited as seen fit. The Operating Theatre Coordinator must be kept appraised of operating theatre requirements to permit preparation of staff and equipment. Nursing staff can be recruited for the emergency department and resuscitation bays from the ICU, operating theatres and wards as required.

1. There is no substitute for common sense and good judgement! It is critical to make the decision to call an internal disaster early to allow for maximum team preparation and briefing.
2. Disaster response decisions are often made based on limited and occasionally erroneous information. It is better to be over-prepared and send extra staff away if not required, than to try to manage multiple seriously injured patients all at once whilst trying to recruit assistance!
All members of the trauma team must carefully make notes regarding injuries found and interventions required during the resuscitative phase of care.

The Trauma Team Leader completes the detailed trauma assessment form based on information obtained during primary and secondary surveys. The surgical registrar makes detailed notes and diagrams of injuries found during the secondary survey and makes additional notes about any interventions required.

The other critical information gatherer is the Scribe Nurse who makes detailed notes whilst the resuscitation is in progress. The detail of these notations and times is a critically important element of trauma care. Accuracy, speed and detail are absolute requirements.

It is important that the Trauma Team Leader reviews all information at the end of the secondary survey including the trauma series of x-rays and, after reviewing the findings with the Trauma Registrar, Trauma Fellow and any subspecialty consultants, formulates and documents a detailed plan for patient investigation and care. Whilst recognising that trauma care is a dynamic process and priorities change based on changes in the patient, it is still important to document these changes and the consequent changes to a plan of investigation or treatment.

Good trauma patient care and management often requires input and treatment from numerous subspecialists. The patient’s notes (chart) are the critical link that allows each carer to know the plans of each involved consultant. Without detailed notes, care can become fragmented - creating delays, errors and potentially increasing patient morbidity.

ENSURE TEMPERATURE AND PRE-INTUBATION RESPIRATORY RATE ARE RECORDED.
1. Ensure all notes in the patient’s chart are written clearly with a detailed plan for investigations and treatment.
2. Write the date and time with each note.
3. Contact subspecialty consultants directly if there is conflict or confusion about another team’s plan for investigations or management.
4. Write down laboratory results in the notes.
5. Ensure all radiographs are reviewed and note the name of the consultant radiologist who reviewed them along with the results in the patient notes. Others will then not need to waste their time and that of another (or the same!) radiologist to learn the same thing.
## SECTION 3

### CLINICAL GUIDELINES

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SECTION 3
The acronym for the rapid transmission of necessary information from the pre-hospital care providers is ‘MIST’:

- **M** Mechanism of injury
- **I** Injuries sustained or suspected
- **S** Signs: vitals on scene and during transport
- **T** Treatment initiated (drugs, fluid, etc)

Whether you are getting information from ambulance control via the “BAT” phone or in direct communication with the ambulance attendants via the radio in the resuscitation room, this information allows the best preparation for the arriving injured patient. If the information is not transmitted, ask for it and then document it on the whiteboard at the head of each patient bay in the resuscitation room well before patient arrival.

This is the information that the rest of the trauma team relies on to assist in preparation. Missed information is a missed opportunity to provide quicker, more directed care.

With the arrival of the pre-hospital care providers and the patient, it is important that this information along with the most recent observations and treatment be reiterated. The Trauma Team Leader must ensure that the resuscitation area is absolutely quiet and that the information is audible to all team members.
Once this information is transmitted (should take less than 30 seconds), the ambulance officer or paramedic then ensures that the correct MIST information is on the whiteboard at the head of the patient trolley.

Transfer of the patient from the ambulance trolley to the resuscitation bay can occur during hand-over as long as quiet is maintained. If required by an obvious need, the Airway Doctor commences primary survey during hand-over.

ENSURE THE HAND-OVER ADHERES TO THE ‘MIST’ INFORMATION ONLY. ANY FURTHER INFORMATION OR CLARIFICATION CAN BE COMMUNICATED AFTER THE PRIMARY SURVEY.
The primary survey provides for the **systematic evaluation, detection and management of immediately life threatening complications resulting from severe trauma**. It is imperative that each step is followed in the correct sequence and that progress to the subsequent step only occurs if the prior step has been fully assessed and managed. Each team member can follow the sequence as a team and members allocated roles such as “Airway”, “Circulation”, etc. will be fully aware as to the timing of their involvement. This allows for greater team cohesion and ease of management by the Team Leader.

**PRIMARY SURVEY**

- **Airway** - and total spine control
- **Breathing**
- **Circulation** - with haemorrhage control.
- **Disability** - brief neurological evaluation (AVPU).
- **Exposure** - completely undress the patient.

**GREAT MISTAKES OF THE PRIMARY SURVEY**

- A  Forgetting to look into mouth  
  Neglecting the spine
- B  Inadequate examination  
  Leaving clothes on!
- C  Resuscitation but not stopping the bleeding
- D  Doing “D” before “C”
- E  Under and over exposure
Step 1: (Airway Doctor) Ask the patient his / her name. If the patient fails to respond appropriately (i.e. vocalise, eyes open and look towards the doctor) then such patients are immediately identified as high risk.

Step 2: If the patient responds appropriately, he / she should be asked to take a deep breath. Observe and listen for evidence of upper airway obstruction (tracheal tug, use of accessory muscles, inability to perform manoeuvre adequately, presence of stridor, etc). Look for chest expansion abnormalities (one side hyperinflated with poor expansion suggesting pneumothorax, in-drawing suggesting obstruction, paradoxical movement suggesting high cervical spine injury, flail segment, etc).

Step 3: Ask the patient to cough. This allows for a second observation of a deep breath and assesses ability of the patient to close his / her glottis (laryngeal injury, which also may have become obvious when patient first vocalised, chest wall integrity and pain from rib fractures or subdiaphragmatic abdominal organs, etc). Patients with penetrating eye injuries, pulmonary barotrauma, significant head and spinal injuries should not be asked to cough.

AIRWAY
Problems may be a direct result of injury or as a complication of other injuries (e.g. severe head injuries, effects of drugs / toxins (e.g. alcohol, nonprescription drugs, carbon monoxide, etc).
Oxygen Starvation?
Apply oxygen via a self-inflating resuscitation bag and mask which can be used to support ventilation for bradypnoeic patients pre-intubation and post-intubation. All other patients should receive high flow oxygen (at least 15 l/min) via a facemask fitted with a reservoir.

Upper Airway?
Restoration of an obstructed airway can involve oropharyngeal suction, jaw thrust (avoid chin lift for those at risk of cervical spine injury) and oropharyngeal airways. The latter are only a “bridge” to insertion of an oral endotracheal tube (ETT) and should never be relied upon as a substitute for an ETT.

Secure the Airway!
ETT insertion should always be performed using a pre-rehearsed algorithm, that includes a difficult to ventilate and difficult to intubate drill with which you are familiar. A failed emergency oral endotracheal intubation should be followed up with an immediate surgical airway. The laryngeal mask airway (LMA) can be considered as a means for attaining temporary airway and / or ventilatory control during an initial failed oral intubation or as a “bridge” to a surgical airway. All other artificial airway manoeuvres at this stage should be otherwise largely disregarded.

Anaesthesia should always be induced with appropriate medications as judged from the clinical circumstances. At least 3 assistants are required. One to maintain manual in-line cervical spine immobilisation, another to draw and give drugs and hand over airway equipment and a third to apply careful cricoid pressure.

Capnography must be used for initially confirming ETT placement and then continued. ETT position within the trachea should be verified by CXR.

CERVICAL SPINE
Always apply an appropriately sized hard collar with sandbags and appropriate head tapes.
**BREATHING**

Immediate life threatening problems of tension pneumothorax should be addressed by insertion of an under water sealed pleural drain. The indications for emergency department needle thoracocentesis are very infrequent. All needle thoracocentesis (pre-hospital and in-hospital) should be immediately followed by insertion of a pleural drain (32Fr in an adult).

**Alert!**

Mechanical ventilation should be commenced with great care and always be monitored with capnography and pulse oximetry. In the presence of any unresolved ventilatory problems, the patient should be immediately disconnected from the ventilator and hand ventilated with inspired oxygen of 100% whilst the problems are assessed.

Don’t forget inspection – a key to diagnosing tension pneumothorax and flail chest.

**CIRCULATION**

The 4 most common causes of shock in trauma patients:

- Haemorrhage
- Bleeding
- Exsanguination
- Hypovolaemia

Hypovolaemia is the most common cause of shock in trauma. Therefore, in the presence of hypotension, it is reasonably safe to assume haemorrhage and direct team efforts toward stopping the bleeding. Other causes that may require immediate attention are: tension pneumothorax, cardiac tamponade, cardiac dysfunction as a result of contusion, spinal shock and anaphylaxis.
Management involves initiation of intravenous fluids, definitive surgical and / or angiographic intervention. Never delay the latter so as to “catch up” with the fluid administration.

All obvious external haemorrhage should be identified by adequate patient exposure and managed by applied pressure. Appropriate splinting of long bone fractures through alignment and immobilisation is also important.

Initial fluids may be isotonic crystalloids or colloids. It probably does not matter which, as long as they are warm (taken directly from the fluid warmer and administered through a Level 1™ warmer). These can be followed up by O negative blood (immediately available), group specific blood (delay of 20 - 30 minutes) or fully cross-matched blood (delay of 45 minutes).

Intravenous access should consist of 2 large bore IV cannulae (16G or greater in adults). Failing that, a venous cutdown (saphenous vein or antecubital) or femoral central access with a large bore rapid infusion, single-lumen catheter. There is no place for multi-lumen central venous catheters in early trauma resuscitation.

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<td>6 minutes</td>
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<td>Abdomen</td>
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<td>5 minutes</td>
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<td></td>
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<tr>
<td>Pelvis</td>
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<td>Eyes</td>
<td>2 minutes</td>
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<tr>
<td>External</td>
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STOPPING THE BLEEDING IS THE MOST IMPORTANT PRIORITY!!
SECTION 3
OTHER IV ACCESS SITES
• Cutdowns – ankle / groin.
• Intraosseous – remember BIG™ (Bone Injection Gun) in adult.
• Corpus cavernosum (men only).

DISABILITY
Disability, in terms of the primary survey, is assessed by the AVPU scale:
A - alert, that is responds to voice appropriately, i.e. obeys commands
V - vocalises, may be inappropriate or incomprehensible sounds
P - responds to pain only (should be assessed in all 4 limbs if initial limb fails to respond)
U - unresponsive to pain.

A more complete Glasgow Coma Score can be determined as part of the secondary survey. Care should be taken when interpreting the Vocal and Eye components as these can be affected by injury or presence of ETT, etc. The most reliable is the Motor component and this should always be scored accurately after assessing all limbs.

EXPOSURE
• Expose the patient.
• Log roll and examine the back.
• Attend to PR examination. This must be done prior to male catheterisation.

Expose the patient only for the duration of the external examination. Once this has been completed, cover the patient with warm blankets and keep him / her covered unless re-examination is necessary.

A RAPID INFUSION CATHETER CONNECTED TO THE LEVEL 1™ IS BEST IN AN UNSTABLE PATIENT – KNOW HOW TO USE ONE!!
Adjuncts to the primary survey include:

**Radiology:**
- CXR first
- PXR second
- C-spine third
For physiologically unstable patients a chest and pelvic x-ray should be taken and developed immediately. All other radiological investigations (including cervical spine) can follow. Patients with uncorrected cardiovascular / respiratory systems should only be going to the radiology department for immediate definitive angiographic procedures and cerebral CT scans (avoid the temptation to add to the initial radiology management plan). Patients must always have an appropriate medical escort.

In haemodynamically unstable patients only (otherwise, these wait until after secondary survey):

1. **Diagnostic Peritoneal Lavage (DPL):** open technique, lower section of the umbilicus (non pregnant)

   OR,

2. **Focused Abdominal Sonography for Trauma (FAST):**
   only by trained and accredited operators.
The secondary survey involves a full assessment of the patient after the initial primary survey and resuscitation. It should be guided, in part, by the MIST hand-over and the severity of injury to the patient. It is a systematic and definitive examination by the trauma or general surgery registrar from head to toe and guides the trauma team’s subsequent management. It is imperative that the secondary survey is performed methodically and all findings are carefully documented. Identification of all major injuries allows a rational treatment algorithm to be formulated. A missed injury may lead to unexpected morbidity and mortality.

The secondary survey covers (in this order):
1. Head and scalp / maxillofacial.
2. Cervical spine and neck.
4. Abdomen and pelvis.
5. Back and perineum.
7. Neurological.
The entire scalp / head should be examined for contusion / bogginess / laceration / fracture.

**DO NOT forget the bleeding occipital laceration as the patient can slowly exsanguinate whilst other injuries are being attended to. Haemorrhage should be controlled before continuing the secondary survey.**

The eyes should be reassessed before haematoma / oedema closes them i.e. pupils / acuity / conjunctival haemorrhage / ocular penetration / ocular entrapment / contact lenses (remove).

LOOK FOR SIGNS of base of skull fracture such as otorrhoea / rhinorrhoa / Battle’s sign and raccoon eyes. Check midface mobility / loss of teeth / mandibular occlusion / mandibular fractures.

USE AN OROGASTIC tube if midface or frontal bone fractures are suspected.

REMEMBER orbital rim deformity / infraorbital nerve entrapment.
CERVICAL SPINE AND NECK

Patients with head injury / maxillofacial trauma or those wearing helmets must be assumed to have an unstable cervical spine injury. Absence of neurological signs DOES NOT exclude a c-spine injury.

CHECK for cervical spine tenderness. BEWARE of distracting injuries.

CHECK for subcutaneous emphysema, tracheal deviation / laryngeal fracture / carotid artery dissection / penetrating neck wound / expanding haematoma / arterial bleeding / airway compromise / brachial plexus injury.

DO NOT explore neck wounds that penetrate the platysma in the emergency department (i.e. avoid the “cranio-digital reflex”!!).

DO NOT REMOVE a cervical collar until the cervical spine has been assessed clinically and radiologically. Remember in-line immobilisation if the patient is to be moved or log rolled. A lateral c-spine x-ray should be obtained as an adjunct to the primary survey along with chest and pelvic x-rays.

Remember the best way to access the mandible as part of the secondary survey is to take off the cervical collar – if you do, get someone to hold the head and stabilise the c-spine.
CHEST

The entire chest should be inspected for adequate expansion / sucking wound / flail segment.

Palpation of the clavicles / ribs / sternum for tenderness / subcutaneous emphysema. Auscultate for absent air entry (haemothorax / pneumothorax / ruptured diaphragm), Hamon's crunch (pneumo- pericardium), noisy air entry, distant heart sounds plus distended neck veins / hypotension (cardiac tamponade).

Clinical signs of a tension pneumothorax:
- Respiratory distress “I can't breathe”
- Hyperinflated chest
- Deviated trachea
- Decreased breath sounds / increased resonance
- Tachycardia
- Hypotension.

BEWARE rapid progression of pulmonary injury / contusion to respiratory failure in the elderly patient.
ABDOMEN
The anterior abdomen extends from the 4th intercostal space to the symphysis pubis / inguinal ligaments. The upper abdominal viscera are partially covered by the lower bony thorax. The abdominal viscera may be injured by a direct blow or torn by decelerating forces such as a high speed motor vehicle crash (MVC).

Take a careful history of the mechanism of injury i.e. blunt / penetrating / stab / high or low velocity gunshot / number of wounds / exit sites / distance from the assailant / amount of external bleeding at scene. The relevant history in an MVC includes closing speed / type of collision / patient trapped or crushed / deployment of airbags / use of and type of seatbelts / patient position in vehicle and status of other passengers.
A large amount of blood may be present in the peritoneal cavity without any change in girth / appearance. The diagnosis of peritonitis may be compromised in the injured patient by decreased level of consciousness / altered sensorium e.g. spinal cord transection / distracting injuries. Remember the pancreas can be fractured on the vertebral body by a direct blow / MVC.

BEWARE the patient with abdominal bruising from seatbelt lapsash as they may have a bowel injury (mesenteric or hollow viscus) which can be missed on CT scanning.

The key to determining bowel injury in a patient with a seat belt mark is identifying tenderness and guarding distant from the seat belt burns.

A DPL is a very useful test!

BEWARE the cyclist with handlebar injury to abdomen and shoulder tip pain.

The abdominal examination includes inspection / auscultation / palpation / percussion.

LOOK for:
- penetrating wounds
- abrasions
- contusions
- lacerations
- impaled foreign body
- evisceration
- blood at the urethral meatus.
LISTEN for the presence / absence of bowel sounds.

**Bowel sounds may be important:**
- Absent bowel sound = ? peritonitis
- This clinical test requires a stethoscope and 20 seconds of your time.

PALPATE for signs of peritonitis i.e. involuntary muscle guarding / rebound tenderness. Check for pelvic instability.

PERCUSS for hypertympany in acute gastric dilatation / diffuse dullness of haemoperitoneum / subtle signs of peritoneal irritation.

**BACK AND PERINEUM**
After the anterior abdomen has been assessed the patient should be log rolled with in-line immobilisation of the cervical spine. The entire spinal column should be palpated for tenderness.

- Any entry / exit wounds should be noted.
- Scrotal or perineal bogginess.
- Bruising may indicate a urethral tear.
- Rectal examination may reveal loss of anal tone (cord transection).
- High riding prostate gland (ruptured urethra).
- Blood in the rectum (bowel injury).
- Pelvic fractures.
- Check for vaginal lacerations.
SECTION 3

EXTREMITY

LOOK / FEEL / MOVE. Inspect and palpate for deformity / tenderness /
pulses / haematoma.

Loss of sensation or function may be due to cord or nerve transection,
but remember ischaemia or compartment syndrome as causes.

Ligament rupture and fractures of small bones of hands and feet may
not be apparent until the tertiary survey.

NEUROLOGICAL

This involves a re-evaluation of the GCS score, complete sensory and
motor assessment of the upper and lower limbs.

Remember to check for sensory level / priapism / loss of anal sensation
or tone.

REFERENCE:
1. Advanced Trauma Life Support for Doctors. Instructor Course
   Manual Book 1 - Sixth Edition, 1997, American College of
   Surgeons, Chicago.
The trauma radiology series (CXR, PXR, lateral c-spine) is performed during the patient’s resuscitation and assessment as part of the primary survey. Further specialised tests may be needed during the secondary survey.

Maximum Time to Imaging:
- CXR 1 - 3 minutes
- PXR 5 - 10 minutes
- C-spine 10 - 15 minutes

CONTRARY to what you have been taught – a tension pneumothorax SHOULD be on a CXR!

**Why?**
Because the patient should have an x-ray by the 1 minute mark.

‘MIST’ information transfer takes 45 seconds and the team MUST be lead gowned for all trauma team activations.

**IF IT’S NOT ON – IT’S NOT ON!**

The trauma patient SHOULD NOT be transferred out of the resuscitation area for diagnostic tests unless haemodynamically stable.

**REMEMBER: A YOUNG PATIENT WILL COMPENSATE WITH SINUS TACHYCARDIA AND VASOCONSTRICTION BEFORE ANY CHANGES IN BP ARE APPARENT.**
CHEST

Mediastinum
If a widened mediastinum (aortic injury) or lung field opacity (haemothorax, pulmonary contusion) is present on supine CXR, an upright CXR should be done (after the c-spine is cleared). Persistent mediastinal widening mandates arch aortography. Erect CXR's are often not possible.

Echocardiography
Patients with blunt chest trauma and unexplained hypotension (i.e. no haemorrhage) or ECG changes (cardiac contusion / “slow” tamponade) require cardiac echo.

ABDOMINAL / PELVIC

Gastric Tube
Patients with head injury / LOC / severe injuries will invariably have acute gastric dilatation and should be decompressed with a gastric tube. USE OROGASTRIC tubes if suspected base of skull / cribriform plate fracture.

Diagnostic Peritoneal Lavage (DPL)
A DPL is used to assess the presence of a visceral injury in the patient with abdominal trauma. It should be performed in the haemodynamically unstable patient. Other DPL indications include:
a. patients who cannot respond appropriately to abdominal examination (altered LOC, altered sensation, distracting injuries, unreliable patient);
b. absence of CT / FAST for noninvasive abdominal assessment.
ONLY ACCREDITED personnel should perform DPL or FAST.

**Beware** the missed retroperitoneal injury if FAST or DPL is used for rapid abdominal assessment. (see pages 155 and 161 respectively)

**Urinary Catheter**

Urinary catheters **SHOULD NOT** be passed in suspected urethral injury:
- blood at meatus
- boggy perineum
- fractured pelvis
- high-riding prostate
- scrotal bruising.

**Get a Urethrogram before attempting to pass catheter** (remember ABC – comes before UI).

**Cystography** should be performed in patients at high risk of bladder injury (e.g. pelvic crush fractures), where there is frank haematuria.

**Abdominal CT Scan**

Abdominal CT with IV and oral contrast documents organ injury in the stable patient. **Beware** free fluid on CT in the absence of solid organ injury i.e. bowel and mesenteric injury.
SECTION 3

OTHER

Spinal x-rays
Vertebral x-ray series should be performed in patients with neurological signs, pain on palpation of spine, falls from height, high-speed motorcycle crashes and some car crashes. Additionally, patients with significant mechanisms of injury and a decreased level of consciousness require spinal x-rays.

REFERENCES:
BLOOD TESTING GUIDELINES FOR TRAUMA PATIENTS
These guidelines apply to all trauma patients who are managed by the trauma team. They are evidence-based, and are designed to reduce unnecessary testing without compromising the quality of patient care.

The Trauma Team Leader is responsible for determining which tests should be ordered, and should generally follow the guidelines. However, they may deviate from the guidelines if sound clinical reasons exist.

Patients should be considered under one of three categories, depending on injury severity. Some modifications occur for co-morbidities.

1. **Mild To Moderate Injury**
   - Airway, breathing and circulation are stable and not predicted to deteriorate.
   - **No blood tests** required unless there are specific medical indications.

2. **Serious Injury**
   - Airway or breathing may be compromised. Circulation is stable, with less than 2 litres fluid requirements.
   - **Full Blood Count (FBC)**
   - **Group and Hold**
   - Urea, Electrolytes, Creatinine (UEC) **only** if >60 years or known pre-existing co-morbidity.
3. Serious Injury Obviously Requiring Transfusion.

Patient has poor perfusion or ongoing haemodynamic instability.

- FBC
- UEC
- Cross Match - O Negative or O Positive blood awaiting cross-match.

BLOOD ALCOHOL

The NSW Motor Traffic Act 1990 (white certificate) legislates mandatory blood alcohol testing for all drivers, motor cyclists, pedestrians, pedal cyclists, skateboarders, rollerbladers, horseriders etc. who present to hospital following an incident on a public property and are aged 15 years or greater. The Rail Safety Act 1993 and Marine Act 1991 cover boat drivers and train drivers requiring care following an accident (mustard certificate). Medical or nursing staff may complete the certificate and requirements. The packs are self explanatory and the serial number should be recorded in the nursing flow chart and trauma sheet.

OTHER GENERAL GUIDELINES

1. Amylase – rarely indicated.
2. Coagulation studies – not indicated acutely unless the patient is taking warfarin (then INR should be done).
3. CPK – only indicated to confirm rhabdomyolysis – so please do not order routinely, it is useless!
4. Cardiac enzymes – only if myocardial ischaemia suspected (CPK has no role in managing "myocardial contusion". Troponins are more useful).
5. Liver enzymes – only if hepatic injury suspected.
6. Arterial Blood gases – indications:
   a. Seriously injured patient with abnormal breathing or poor perfusion.
   b. 15 minutes after instituting mechanical ventilation.
   c. Elderly patient.
   d. Blood gases are under utilised – they are very useful indicators of:
     • Oxygenation status,
     • CO₂ (ventilation status), and especially
     • perfusion.
     They may be the only indicator of underperfusion and hypovolaemia.

   Please do a blood gas routinely on trauma patients > 65 years. Look at their base deficit, if abnormal, think “this patient is potentially worse than I recognise”.

7. Serum lactate - like ABG’s, serum lactate may provide a useful monitor of perfusion – if abnormal, repeat every 2 hours and assess the trend.
RADIOLOGY

The use of radiology within the resuscitation room should conform with guidelines published by the Department of Health with regard to Radiation Safety.

“…mobile x-ray equipment be used only for examinations where it is impractical or not medically acceptable to transfer patients to a stationary radiological installation and only after proper attention has been given to the radiation protection measures required in its use” International Atomic Energy Agency-SS115, II.16.c, 1996.

“There are some patients who cannot or should not be moved from their beds, although some seriously ill patients can often be transported to the Radiology Department without detriment to their condition for a much improved radiographic result. Every effort must be made to ensure that patients are not radiographed unnecessarily or more frequently than necessary and that radiation to staff and other patients in adjacent areas is minimised.” NHMRC, Radiation Health Series No14, paragraph 54, 1985.

Staff essential to patient care during an x-ray examination must wear a radiation protective lead apron. Pregnant women must never be called on for this purpose.

The trauma team should actively consider whether it is safe for a patient to be transferred from the resuscitation room for further investigation (see page 243).
All patients transferred for further investigation require an appropriately skilled nursing escort. Appropriate cardiorespiratory monitoring should be in place prior to transfer. Suction, oxygen supply and an appropriate oxygen delivery device must accompany the patient. If appropriate, the drug and treatment pack should accompany the patient. Where there has been documented hypotension or where there is the potential haemodynamic instability, a medical member of the trauma team skilled in resuscitation must accompany the patient.

Ventilated patients must be accompanied by a medical member of the trauma team who has specific airway skills. The medical officer must remain with the patient during transfer and while the patient is undergoing further investigation. The use of continuous pulse oximetry and ETCO$_2$ monitoring is mandatory in the ventilated patient.

Investigation with CT scan, angiography, duplex or cardiac echo may be appropriate for an individual patient (see Management Algorithms page 105)

REFERENCES:
1. Emergency Department Orientation Handbooks for RMO / Interns and Registrars, Liverpool Hospital, 2002.
The trauma victim requires a multidisciplinary approach to care. Coordination between ED, surgery, ICU, anaesthetics, orthopaedics and other subspecialties is a complex task requiring knowledge, confidence, speed and diplomacy. This is the role of the Trauma Team Leader.

A good Trauma Team Leader inspires confidence in the team by anticipating problems and giving clear direction. This process begins from the initial notification of impending patient arrival. Anticipation of the patient’s likely requirements allows a smoother, faster, safer movement through the system. For example, if a patient is coming from an MVC in 10 minutes with hypotension and a GCS of 6, a number of things can be put in place:

1. Arrange the trauma team and make sure roles are well defined.
2. Team to put on splash gowns, gloves, goggles and lead gowns.
3. Contact Trauma Surgeon on call.
4. Follow an A,B,C approach to organisation, therefore:
   A---Get airway drugs drawn up, check tubes, laryngoscopes, 
      O sat mon, chest tube trolley standing by
   B---CXR plate in place before the patient arrives.
   C---Prime Level 1™ infuser, organise IV lines, warmed fluids
   D---Contact CT to tell of patient and notify theatre / neurosurgeon.

Then make sure there is quiet for the MIST hand-over and minimise any unnecessary external noise.

The Trauma Team Leader must have the knowledge base to anticipate which algorithm each patient will require. Each subspecialty team will have different priorities so the team leader must negotiate the appropriate investigations and treatment. This is a dynamic situation and will require vigilance and regular updating as well as discussion with the Trauma Fellow, Trauma Surgeon and involved subspecialists.
FLUIDS

Chapter 8

TYPES OF FLUID AVAILABLE
Debate remains on which fluid or fluids are the most appropriate to restore volume and tissue oxygenation, and whether the specific choice of fluid has any impact on morbidity or mortality. The only two indisputable facts are that in comparison with colloid, larger volumes of crystalloid are required to restore intravascular volume, and colloids, but not crystalloids, can cause anaphylaxis.

CRYSTALLOIDS
Solutions containing approximately isotonic concentrations of sodium (e.g., 0.9% saline, Hartmann’s solution) will distribute rapidly across most of the extracellular space. It is estimated that 1500 ml to 2000 ml of crystalloid is needed to replace an acute blood loss of 450 ml over 1 hour, depending on how fast normal blood volumes are reached. Thus, when replacing blood loss with crystalloid, a volume 3-4 times greater than the blood lost is required. EMST (ATLS®) recommends lactated Ringer’s (Hartmann’s) rather than saline as the initial fluid for trauma patient resuscitation. The rationale for this is that large volumes of saline will induce a hyperchloremic metabolic acidosis. Whether this acidosis is potentially harmful is uncertain. In comparison with plasma, Hartmann’s has a lower osmolality and large volumes of Hartmann’s will reduce serum osmolality and may contribute to cerebral oedema. This effect is enough to encourage the use of 0.9% saline rather than Hartmann’s in head-injured patients.
COLLOIDS
Colloids contain particles that are large enough to exert an oncotic pressure. In comparison with crystalloids, they have greater intravascular persistence.

Gelatin solutions (Haemaccel®, Gelofusine®)
Gelatin polypeptides are derived from bovine collagen. They are modified chemically to increase molecular size and intravascular retention. Gelatins may induce an anaphylactoid reaction but these appear to be rare in the trauma patient population. Gelatin solutions remain a very popular fluid for resuscitation in Europe and Australia.

Dextran
Dextran reduces blood viscosity, reduces platelet adhesiveness, and enhances fibrinolysis. These properties make dextran useful for prophylaxis against thromboembolism but unpopular in the trauma setting. They may cause anaphylaxis and are not used in trauma patient resuscitation.

Hydroxyethyl starch
Hydroxyethyl starch (HES) solutions are modified natural polymers of amylpectin. Some HES is extravasated into the interstitial space where a proportion is taken up by the reticuloendothelial system. HES may cause coagulopathy by the reduction of Factor VIII and von Willebrand factor. There is preliminary evidence suggesting HES reduces the capillary leak associated with the systemic inflammatory response syndrome. HES is not available in Australia at this time.

Albumin
Human albumin is a single polypeptide. The use of albumin in critically ill patients has not been shown to improve outcome and is expensive. It is provided in glass bottles and is not used during acute resuscitation of trauma patients.
HYPERTONIC FLUIDS
Hypertonic 7.5% sodium chloride produces a transient increase in intravascular volume of many times the volume infused. This may be an advantage in the pre-hospital setting where storage and the ability to carry weight are limited. Hypertonic saline causes an increase in heart rate and contractility, and a reduction in peripheral vascular resistance and the addition of colloid extends its intravascular persistence. Several pre-hospital trials of hypertonic fluids are ongoing.

Haemoglobin-based oxygen carriers
A number of haemoglobin-based oxygen carriers (HBOC) are now at advanced stages of development. The main sources of HBOCs are bovine blood, out of date human blood, and recombinant biotechnology. For the immediate future, human donor blood will remain the only method with which to provide an increase in oxygen carrying capacity.

Blood
A full blood cross match will take at least 45 minutes (not including transport times). Type specific blood is available in about 20 minutes.

Un-crossmatched blood (2 units of O-ve and 4 units of O+ve) is available in the blood fridge in ED resuscitation area. Blood should be administered after 2 litres (adults) or 40 ml/kg (children) of crystalloid or colloid have failed to stabilise the patient, or where there is obvious exsanguinating haemorrhage.
SECTION 3
TEMPERATURE
Hypothermia, defined as a core temperature of less than 35°C, results from exposure, hypoperfusion, and infusion of cold fluids. In trauma patients, hypothermia is a significant predictor of mortality. Hypothermia causes a reduced heart rate and cardiac output and increases arrhythmias. Hypothermia shifts the oxyhaemoglobin dissociation curve to the left, impairing peripheral oxygen delivery in the hypovolaemic patient at a time when it is most needed. Shivering increases the lactic acidosis. Hypothermia contributes to coagulopathy by retarding the function of enzymes in the clotting cascade, enhancing plasma fibrinolytic activity, and reducing platelet aggregation. Even mild hypothermia increases peri-operative blood loss and appears to be associated with an increased incidence of infectious complications.

All IV fluids should be warmed. Use of high capacity fluid warmers, such as the Level 1™, in seriously injured patients will minimise the hypothermia associated with fluid resuscitation. Forced air warming blankets are very useful in patients with mild or moderate hypothermia and all other measures must be taken to prevent hypothermia.

RAPID INFUSION DEVICES
The Level 1™ fluid warmer is capable of warming fluids and blood from cold to warm at rates of 500ml/min. It needs to be primed and should be thought of early during the resuscitation process. Be aware that there is a possible risk of air embolism when using this device.

GIVE BLOOD EARLY IN ELDERLY PATIENTS.

REMEMBER: RAPID INFUSION DOES NOT STOP THE BLEEDING.
RATES OF INFUSION
Hypovolaemia causes cardiovascular decompensation, reduced oxygen delivery and the development of lactic acidosis. If oxygen delivery is not restored quickly, irreversible cell damage results in organ failure or death. Acute anaemia is better tolerated than hypovolaemia, therefore, intravascular volume should be increased first. This must be balanced against the risk that fluid resuscitation may worsen outcome by disruption of thrombus, coagulopathy, haemodilution and rebleeding.

Rule number one in fluid management for trauma patients is: STOP THE BLEEDING.

ASSESSING HYPOVOLEMA
The ATLS® / EMST classification of haemorrhage is well established. However, the physiological responses to injury and haemorrhage are not as consistent as is commonly believed. Heart rate and blood pressure may be poor measures of hypovolaemia and haemodynamic stability, particularly in young and fit patients. The effects of numerous cardiovascular drugs used by trauma patients with pre-existing disorders adds to these difficulties of assessment.

RATE OF FLUID ADMINISTRATION
The concept of permissive hypotension was derived from studies demonstrating that aggressive fluid resuscitation in penetrating trauma patients increased blood pressure, but also reversed vasoconstriction, dislodged early thrombus and increased blood loss. Survival was improved by allowing blood pressure to remain low until haemorrhage was controlled. Care should be taken in extrapolating this concept to all trauma patients, particularly those with severe brain injury. When there is profound initial blood loss or when there is likely to be a delay until the patient can get to an operating theatre, significant hypovolaemia and hypoperfusion will develop. The risk of organ ischaemia may outweigh the risk of provoking more bleeding with fluid resuscitation and the best approach may be judicious fluid
infusion while expediting surgical haemostasis (i.e. controlled resuscitation for uncontrolled haemorrhagic shock). The challenge lies in tolerating hypotension before haemorrhage is controlled, whilst watching closely for indicators of severe ischaemia. Attempts at fluid replacement should not delay surgical control of bleeding.

**FLUID BOLUS (WHEN AND HOW MUCH)**
When faced with continued hypovolaemia in the trauma patient the following general approach is suggested:

- Expedite surgical haemostasis.
- Initial crystalloid bolus (0.9% sodium chloride solution) of 1000ml for adults (20 ml/kg for children).
- Re-evaluate.
- Second bolus of 1000ml crystalloid or colloid - gelatin solution (20 ml/kg for children).
- Re-evaluate.
- Give blood Group O Rh-ve or O Rh +ve.
- Clear evidence of exsanguination is an indication to administer blood earlier.

Once haemorrhage is controlled, normovolaemia should be restored and fluid resuscitation targeted against conventional endpoints. In practice, fluid resuscitation for major trauma will include a mixture of blood, colloid and crystalloid solutions.

**REMEMBER:** To stop bleeding, surgery or embolisation is required. This decision-making must involve the Trauma Surgeon.
## SECTION 4

### MANAGEMENT ALGORITHMS

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*Authors: S. D’Amours, M. Sugrue, M. Heetveld, I. Harris, G. Schlaphoff*
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### MANAGEMENT ALGORITHMS (continued)

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Suspected Blunt Abdominal Injury

Haemodynamically Stable

Complete 2nd Survey*, and CXR / PXR

FAST

- Significant mechanism
- Concomitant head injury or other significant injury

Observe

CT Abdomen with contrast

No FAST

Abdomen soft and non tender

Observation: Serial clinical exam by same examiner

Haemodynamically Unstable

Early FAST or DPL (15min)

Positive FAST

LAPAROTOMY

CT Abdomen with contrast

Negative FAST

Repeat FAST or DPL

CT Abdomen with contrast

*If seat belt stripes (bruising) present, have a low threshold for DPL as it is most sensitive for hollow viscus injury.

*S D’Amours: 2002
SECTION 4

PENETRATING ABDOMINAL TRAUMA

Haemodynamically unstable?

YES

NO

LAPAROTOMY

Anterior or Lateral Wound?

YES

NO

Gunshot Wound?

YES

NO

Frank Peritonitis?

YES

NO

Evisceration?

YES

NO

Positive Diagnostic Laparoscopy*

NO

Observation

Stable Flank and Back Wounds

Triple Contrast CT scan, +/- DPL, +/- Diagnostic Laparoscopy

LAPAROTOMY

Observation

* Preferred Investigation
DPL/Local wound exploration are options but laparoscopy is better.
• Blunt thoracic injury with significant deceleration mechanism and
• abnormal mediastinum on CXR.

**WIDENED MEDIASTINUM**

- Very high index of suspicion
  - Pseudoacoarctation
  - Paraplegia
- High index of suspicion
  - Mediastinum >12cms
  - or
  - ≥ 3 radiological signs
  - Arch Aortogram and Contact Cardiothoracic surgeon (simultaneously)
- Low to moderate index of suspicion
  - Mediastinum 8-12cms
  - or
  - < 3 radiological signs
  - Spiral CT Scan of Chest
  - Repair
  - Observe

Radiological signs include:
- Left haemothorax, apical cap
- Depressed left mainstem bronchus or elevated right mainstem bronchus
- 1 st or 2 nd rib #’s or multiple rib #’s
- Deviation of NG tube or trachea to right
- Poorly defined aortic knuckle
- Loss of aortopulmonary window
- Widened right paratracheal stripe.

‡ All efforts should be made to optimise the CXR including placement of the NG tube and PA/upright film, assuming no spinal injury present.

§ Radiological signs include:
SECTION 4
PENETRATING CHEST

PENETRATING CHEST TRAUMA

Central Chest 'The Box'
- Between nipple lines
- Xiphisternum to clavicles

Loss of cardiac output in ED

Haemodynamics unstable
- "patient is dying"

Haemodynamics stable

L Antero-lateral Thoracotomy

CONSIDER:
- Incision of pericardium
- Repair hole in heart
- Clamp aorta
- Clamp hâm
- Internal cardiac massage
- Pack apical vessels
- See algorithm page 112

Thoracotomy

Upright CXR

Chest tube if significant haem/o pneumothorax

Echocardiography or FAST and consider:
- Aortogram
- Oesophagram
- Oesophagoscopy

FAST (optional):
- Pericardial effusion

CXR

Chest tube to side of injury

Median sternotomy with cardiothoracic surgery

Contd.

Medial sternotomy or thoracotomy median sternotomy

• Cardiothoracic surgery consultation and
• Thoracotomy or median sternotomy
PENETRATING CHEST TRAUMA

Thoracoabdominal?

Also see Penetrating Abdomen page 108

Lateral Chest Lateral to nipple lines

Haemodynamics unstable

CXR

Chest Tube to side of injury

FAST (optional): Pericardial effusion?

Call Cardiothoracic surgeon

+Arrange thoracotomy

Haemodynamics stable

Upright CXR

Pneumo or haemothorax

Chest tube placement (minimum 32Fr)

Bleeding:

>1500 mls immediately, or,

>200 mls/hour

Repeat upright CXR in 4 hours

Pneumothorax larger?

YES

Call Cardiothoracic surgeon

+Arrange thoracotomy

NO

NO

Haemodynamics stable

Minimal or no pneumothorax

YES

Upright CXR

Pneumothorax larger?

YES

Call Cardiothoracic surgeon

+Arrange thoracotomy

NO

Contd.
MORIBUND PENETRATING CHEST

MORIBUND PENETRATING CHEST TRAUMA
(No pulse but still has ECG rhythm)

A
ET Tube (cold)
1-2 mins

B
Chest Drains
2-3 mins

C
ED Thoracotomy
(Left anterolateral thoracotomy)
4 mins
(chest open <6 mins)

CHECK FOR TAMPONADE

YES
Release

NO
Cross Clamp Aorta

Apply Digital Pressure
Resuscitation

TO OPERATING THEATRE

TIME

2003/ Sugrue
**PENETRATING EXTREMITIES**

X-rays of limb (2 views) with radio-opaque markers at entry / exit wounds

Hard signs of Vascular Injury?
- Expanding haematoma
- Arterial Bleeding
- Audible bruit or palpable thrill
- Distal ischaemia

**YES**
Operative Exploration

Consider angiography first if multiple levels of injury possible (multiple GSW’s) or consider doing angio in OT

**NO**
Measure ABI (ankle brachial index)

- <0.9
  - Consider angiography or duplex in consultation with Vascular Surgeon
- >0.9
  - Low likelihood of significant arterial injury. Observe patient.
SECTION 4

PENETRATING NECK INJURY

"A B C's"

Stable

Unstable *

EXPLORE SURGICALLY

Zone I

Zone II

Zone III

Arteriography

Endoscopy

Gastrograffin

EXPLORE SURGICALLY

EXPLORE SURGICALLY

OBSERVE

EMBOLISE

* Includes rapidly expanding haematomas and active arterial bleeding.

Zones of the Neck:
I Inferior to cricoid cartilage
II Between cricoid cartilage and angles of mandible
III Above angles of mandible.

2002: Sugrue/T Annoue
PELVIC FRACTURES - HAEMODYNAMICALLY UNSTABLE PATIENT WITH A MAJOR PELVIC FRACTURE

- Stop external blood loss
- Assess long bones
- Deal with haemo / pneumothorax first

CXR, PXR

Diagnostic Peritoneal Aspiration (DPA) and/or FAST *

- DPA with >10mls of frank blood or FAST showing free fluid

Aim to transfer out of resuscitation room within 45 minutes

Stabilise pelvis in Resus

Angiography

Haemodynamics unstable / Repeat FAST positive

Laparotomy

Stabilise pelvis in OT

Haemodynamics unstable / Big pelvic haematoma

Angiography

Methods of stabilising the pelvis include:
- Non-invasive rotational correction: sheet or a specially designed belt
- Invasive rotational correction: anterior external fixation using 5 mm pins into iliac crests, connected by rods
- Vertical shear correction: femoral pin on traction.

* Positive is DPA with >10mls of frank blood or FAST showing free fluid

2002 Heedt/Heetveld/Harris/Schlaphoff
SECTION 4
CERVICAL SPINE CLEARANCE

POSSIBLE C-SPINE INJURY:
Maintain c-spine precautions

Neck Pain or tenderness?

NO

GCS 15?

Distracting Injuries

YES

NO

Any Alcohol or Drugs

NO

Abnormal Neurological Exam

NO

Discontinue C-Spine Precautions

Plain X-rays; 3 views (lat, AP, odontoid) ± Swimmer’s or Obliques ± CT Scan

Abnormal

Normal but still has pain

Review by Neurosurgeon

Normal

Abnormal Neurological Exam

Review by Neurosurgeon

Plain X-rays: 3 Views (lat, AP, odontoid) ± Swimmer’s or Obliques ± CT Scan

Unconscious or Decreased GCS

Active Flexion / Extension Views

Any Alcohol or Drugs

Normal

Review by Neurosurgeon

2002 D’Amours/Sheridan
SUSPECTED SPINAL CORD INJURY

Suspected Cord Injury
- by mechanism of injury and clinical assessment +/- radiographs
- contact neurosurgeon on-call

Airway + Breathing Adequate?

- YES
- NO

Hypotensive?

- YES
- NO

Detailed neurological exam and 2nd survey

- Consider commencing steroid protocol in consultation with neurosurgeon
- Evidence of cord compression?

- YES
- NO

Fracture fixation if mechanically unstable and other injuries permit.

- Complete cord injury
- Incomplete cord injury

FIXATION OF FRACTURE WHEN PATIENT STABLE
URGENT DECOMPRESSION

Source of haemorrhagic shock?
- CXR
- PXR
- FAST or DPL
- Physical examination

Treat appropriately

1. Intubate with inline cervical stabilisation
2. Ventilate as required.
SECTION 4
MINOR HEAD INJURY (GCS 13 – 15)

15
Check History and Physical examination

- LOC >5 minutes
- ? depressed skull #
- lateralising signs

14
CT head – (non contrast)

13
Possibly activate Trauma Team

HOME with head injury instruction sheet

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SECTION 4

HEAD INJURY - SEVERE

SEVERE HEAD INJURY (GCS 12 OR LESS)

Multiple System Injuries

Check & Clear
A & B

C

Isolated Head Injury

NOTIFY OT
Coordinating extension 84404
and Neurosurgery

<20 min

CT Head (non contrast)
and c-spine with all
reconstructions

CXR

FAST or DPL

PXR

Look at Limbs

Splint

Consider Surgery

Consider Angioembolisation + External fixation

Once C fixed

Then "D"

CT Head and c-spine
SECTION 4
SUSPECTED URETHRAL INJURY

Blood at Meatus or High Riding Prostate

YES

Urethrogram

(Remember ABC before U)

NO

Pass Urinary Catheter
(remember let anaesthetic gel work!)

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SECTION 4

MORIBUND PATIENT

- If Advance Notice – Get Extra Help From VMOs
- Set Up: Work With Team

AIRWAY
- Check Drugs
- Check Tubes
- THINK Laryngeal Mask or Cricothyroidotomy If Necessary

BREATHEING
- Open ICC Tray
- 2nd ICC Ready

CIRCULATION
- N or Cutdown
- DPL or FAST
- ED Thoracotomy Tray Open

2002: Sugrue
MAST SUIT REMOVAL

Trauma Patient with MAST

Initiation of the A B C D E of Primary Survey
Assessment and Resuscitation

Definitive trauma management plan established

Immediate surgery necessary
Persistent physiological instability

Do not deflate MAST
Transfer to OT

CNS/RESP/CVS optimisation continues (do not delay surgery so as to deflate MAST unless surgically necessary)

CNS/RESP/CVS resuscitation objectives achieved

Incrementally deflate MAST commencing with most proximal compartment.

Expectant or conservative surgical management

CNS/RESP/CVS systems adequate to compensate for expected systemic effects of MAST deflation

YES
Optimise CNS/RESP/CVS systems

Unresolved systemic effects of MAST deflation

NO

2002: Flabouris
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## SECTION 5

### PROCEDURES (continued)

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EXTREMITY IMMOBILISATION

WHY?
Splinting a fracture serves several purposes:
- Prevention of further damage to soft tissues especially muscle, bone, nerves and blood vessels.
- Relief of pain.
- Reduction of blood loss.
- Protection of both patient and injury prior to definitive treatment.

A FRACTURE IS A MAJOR SOFT TISSUE INJURY WITH AN ASSOCIATED BROKEN BONE.

WHEN?
The primary survey and resuscitation take priority. Open fractures may need to be treated as part of circulation to arrest haemorrhage.

Other fractures should be identified during the secondary survey and the need for reduction and splinting assessed.

Open fractures should be dressed and, where possible, photographed before application of the splint. This will allow others to assess the nature of the injury without disturbing the dressing and splint.

The neurovascular status of the limb distal to the fracture must be assessed and recorded before and after any procedure. If there is any vascular compromise, reduction should take place as soon as possible.
HOW?
The method of splinting will depend on the equipment available. Liverpool Hospital options include:

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<td>Sheet, if appropriate, External fixateur, Lower limb traction, if appropriate (vertical displacement)</td>
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![Donway Splint](image)
WHY?
Spinal immobilisation aims to prevent any new damage to the spinal cord during treatment and transfer.

WHEN?
Immobilisation of the cervical spine should occur as part of the assessment of airway in the primary survey.

A basic idea of peripheral neurological function may be gained whilst assessing D during the primary survey, but a full assessment should be made during the secondary survey.

In the pre-hospital environment the patient should be put on a spinal board for transfer to hospital. As the patient is log-rolled for this the opportunity of examining the back should not be missed.

HOW?
The cervical spine is immobilised either by manual in-line stabilisation or by 3-point immobilisation.

This uses:
- A hard cervical collar.
- Blocks either side of the head.
- Tape or straps over the forehead and chin.

Apply all of these to patients where there is a high index of suspicion of c-spine injury.
This should remain in place until the cervical spine is cleared. For most other patients, a hard cervical collar is sufficient.

Beware the confused or uncooperative patient – apply what measures the patient will tolerate but do not use the equipment as a restraint. This also applies to children.

Spinal boards are uncomfortable for the patient at best and often painful. In the elderly or unconscious patient pressure sores may form within two hours. On arrival in hospital the spinal board should be removed when the log-roll is performed. The hospital trolley will provide adequate support to the supine patient but care must be taken during any movement of the patient.

When the patient arrives and is transferred to the trauma bed, log roll the patient OFF the spine board. This will:
- improve x-ray quality
- allow FAST
- decrease pressure sore formation.
INDICATIONS
Venous cutdown is only indicated when more rapid and less invasive venous access is not obtained. Options include cannulation of the femoral vein or neck veins and intraosseous infusion in children and adults. Subclavian and internal jugular lines are not normally feasible in the resuscitation room in trauma patients.

TECHNICAL ASPECTS
The most commonly used vein for venous cutdown is the greater saphenous vein at the ankle. It is located, in the adult, at a point approximately 2 cm anterior and superior to the medial malleolus. Also used is the antecubital medial basilic vein located 2.5 cm lateral to the medial epicondyle of the humerus at the flexion crease of the elbow. The limb selected should be immobilised and a tourniquet applied proximal to the site.

1. Following antiseptic preparation and draping of the selected area, local anaesthetic is injected over the vein.

2. A 2.5 cm full thickness transverse skin incision is made.

3. The vein is identified by blunt dissection with a curved haemostat and freed for a distance of approximately 2 cm from its bed.

4. The distal vein is ligated, leaving the suture in place for traction.
5. A tie is passed proximally around the vein.

6. A small transverse venotomy is made and dilated with a closed haemostat.

7. A plastic cannula is inserted through the venotomy and the proximal tie used to secure the vein and cannula. Alternatively, a cannula with an introducer needle can be used in the usual manner but under direct vision. A venotomy is unnecessary in this situation. In this way a guidewire can be threaded through a small cannula, and a large bore rapid infusion device placed over it. A primed fluid giving set is connected.

8. The incision can then be closed with interrupted sutures.

9. A sterile dressing is applied.
EQUIPMENT
- 14 gauge cannula or 7.5 Fr rapid infusion cannula.
- Venous cutdown tray (retractor, haemostats, forceps).
- Scalpel (#10).
- 3-0 absorbable suture.
- 3-0 non-absorbable suture.
- Needleholder, forceps.

PITFALLS
- Bleeding.
- Loss of landmarks and difficulty localising veins.

RISKS / COMPLICATIONS
- Haematoma.
- Phlebitis.
- Cellulitis.
- Venous thrombosis.
- Saphenous nerve injury.

FIXATION
Bring the IV tubing between the 1st and 2nd toe and fix with elastoplast roll to prevent dislodging.

IT CAN BE VERY DIFFICULT TO CANNULATE A SUBSTANCE ABUSER – CONSIDER FEMORAL LINE EARLY!
SECTION 5
CENTRAL VENOUS CATHETERS

INDICATIONS
1. Emergency venous access.
2. Volume loading.
3. Central venous pressure monitoring.
4. Routine venous cannulation.
5. Infusion of concentrated solutions and vasoactive drugs.
6. Placement of pulmonary artery catheters, transvenous pacemakers, and short term haemodialysis catheters.
FEMORAL APPROACH

Procedure:
1. Place the patient in a supine position.
2. Cleanse the skin well around the venepuncture site and drape the area. Sterile gloves should be worn when performing this procedure.
3. Locate the femoral vein by palpating the femoral artery. The vein lies directly medial to the femoral artery (nerve, artery, vein, empty space). A finger should remain on the artery to facilitate anatomical location, and to avoid insertion of the catheter into the artery. (Caution: Do not press too hard as the vein may be squashed flat and prove difficult to locate).
4. If the patient is awake, use a local anaesthetic at the venepuncture site.
5. Introduce a 19-gauge needle attached to a 5ml syringe with 0.5-1ml of saline. (In obese patients, the inner needle from an 18g or 16g IV cannula or Cook’s needle may be required). The needle, directed cephalad, should enter the skin directly over the femoral vein.
6. The needle and syringe are held parallel to the sagittal plane.
7. Directing the needle cephalad and posteriorly, slowly advance the needle while gently withdrawing the plunger of the syringe.
8. When a free flow of blood appears in the syringe, remove the syringe and occlude the needle with a finger to prevent air embolism.
9. Insert the guidewire and remove the needle.
10. Push directly down the line of the guidewire with the point of a #15 (or #11) scalpel to enlarge the skin puncture.
11. Thread the catheter and dilator assembly over the guidewire down to the skin surface.
12. Hold the end of the guidewire firmly. DO NOT ALLOW IT TO ADVANCE WITH THE CATHETER.

The 8.5 Fr wide bore rapid infusion devices have 2 lengths: 6.4 and 10cms. Use the longer one for the femoral vein to reduce the chances of it dislodging.
13. Advance the dilator and catheter assembly 2 cm at a time, grasping it close to the entry port each time and using a gentle twisting motion.
14. Advance the hub of the catheter to skin level, then remove the dilator and guidewire as one, placing thumb over end of catheter.
15. Aspirate to ensure catheter is in venous circulation.
16. Connect to primed intravenous tubing.
17. Affix the catheter in place (i.e. with suture), and dress the area.
18. Tape the intravenous tubing in place.

Complications of Femoral Venepuncture
- Haematoma formation with vein perforation.
- Arterial puncture.
- Nerve injury.
- Cellulitis.
- Thrombosis.
- Phlebitis.
- Arteriovenous fistula.
- Lost catheters and guidewires.
- Improperly placed catheters.
- Air embolism.

SUBCLAVIAN APPROACH FOR CVC

Not to be used in resuscitation room. Use with caution in patients with head injury as positioning required will increase ICP!

Procedure
1. Place the patient in a supine position, at least 15 degrees head-down to distend the neck veins and to prevent air embolism. Turn the patient’s head away from the venepuncture site. The patient must be monitored by ECG to allow detection of arrhythmias.
2. This is a surgical procedure and sterility is of utmost importance. A proper scrub and donning of mask, sterile gown and gloves are essential.

3. Cleanse the skin well and widely around the venepuncture site and drape the area carefully.

4. If the patient is awake, use a local anaesthetic (1% Lignocaine) at the venepuncture site.

5. Introduce a 5 cm Cook’s needle, attached to a 5-ml syringe (with 0.5-1 ml of saline optional), 1 cm below the junction of the middle and medial thirds of the clavicle.

6. The needle and syringe are held parallel to the frontal plane.

7. Direct the needle medially, slightly cephalad, and posteriorly behind the clavicle toward the posterior, superior angle of the sternal end of the clavicle (toward finger placed in the suprasternal notch).

8. Slowly advance the needle while gently withdrawing the plunger of the syringe.

9. When a free flow of blood appears in the syringe, remove the syringe and occlude the needle with a finger to prevent an air embolism.

10. Insert the guidewire to about 20 cm and withdraw the needle.

11. Push the point of the scalpel along the line of the guidewire to enlarge the skin opening.

12. Dilate the tract by threading the dilator over the guidewire.

13. Remove dilator, leaving guidewire in place.

14. Insert the catheter to a predetermined depth (tip of catheter should be above the right atrium for fluid administration).

15. Remove the guidewire and use a syringe to aspirate blood to ensure intravenous catheter placement.

16. Connect the catheter to the intravenous tubing. Aspirate and flush all unused lumens with normal saline to prevent clotting.

17. Suture the catheter in place and cover with a sterile transparent dressing.
18. Obtain a chest x-ray to ascertain position of the catheter tip and to exclude pneumothorax.

Complications of Subclavian Approach:
- Arterial puncture.
- Pneumothorax / haemothorax.
- Line sepsis.
- Thrombosis.
- Cardiac arrhythmia.
- Air embolism.
- Phrenic nerve injury.
- Thoracic duct injury on left.

INTERNAL JUGULAR APPROACH

Not to be used in resuscitation room. Use with caution in patients with head injury as positioning required will increase ICP!

Indications:
As for subclavian venepuncture.
The internal jugular route may be preferred in a number of circumstances. These are:
1. When the operator is more skilled and confident at using that route.
2. Where a coagulopathy is known to exist.

The disadvantages are a higher risk of infection and slightly higher risk of arterial puncture. The lines are also more difficult to secure and immobilise.
Procedure:
1. Place the patient in a supine position, at least 15 degrees head-down to distend the neck veins and to prevent air embolism. Turn the patient’s head away from the venepuncture site. The right internal jugular is usually preferred as the internal jugular and brachiocephalic veins and the superior vena cava are in a straight line.
2. This is a surgical procedure and sterility is of utmost importance. A proper scrub and donning of mask, sterile gown and gloves are essential.
3. Cleanse the skin well and widely around the venepuncture site and drape the area carefully.
4. If the patient is awake, use a local anaesthetic (1% Lignocaine) at the venepuncture site.
5. Introduce a Cook’s needle attached to a 5ml syringe (with 0.5-1ml of saline) into the centre of the triangle formed by the two lower heads of the sternomastoid and the clavicle.
6. Direct the needle caudally, parallel to the sagittal plane, at a 30-degree posterior angle with the frontal plane.
7. Slowly advance the needle while gently withdrawing the plunger of the syringe.
8. When a free flow of blood appears in the syringe, remove the syringe and occlude the needle with a finger to prevent air embolism. If the vein is not entered, withdraw the needle and redirect it 5 to 10 degrees laterally.
9. Alternatively, the internal jugular vein may be punctured halfway along an imaginary line joining the mastoid process and the sternoclavicular joint, immediately lateral to the carotid pulse.
10. Insert the guidewire to about 20 cm and withdraw the needle.
11. Push the point of the scalpel along the line of the guidewire to enlarge the skin opening.
12. Dilate the tract by threading the dilator over the guidewire.
13. Remove dilator, leaving guidewire in place.
14. Insert the catheter to a predetermined depth (tip of catheter should be above the right atrium for fluid administration).
15. Remove the guidewire and use a syringe to aspirate blood to ensure intravenous catheter placement.
16. Connect the catheter to the intravenous tubing. Aspirate and flush all unused lumens with normal saline to prevent clotting.

17. Suture the catheter in place and cover with a sterile transparent dressing.

18. Obtain a chest x-ray to ascertain position of the catheter tip and to exclude pneumothorax.

Complications of Internal Jugular Approach:

- Arterial puncture.
- Pneumothorax / haemothorax.
- Line sepsis.
- Thrombosis.
- Cardiac arrhythmia.
- Air embolism.
- Phrenic nerve injury.
- Brachial plexus injury.

Equipment
The choice of catheter depends on the indication for the cannulation.

- Single, double or triple lumen catheters are not suitable for fluid resuscitation due their small caliber and long length. They are used in the trauma setting only to allow central venous pressure monitoring and infusion of drugs.
- Large bore (7.5 Fr or 8.5 Fr) cannulae are appropriate for rapid infusion.
- Sterile swabs.
- Skin preparation solution.
- Drapes.
- Syringe and needle for injection of local anaesthetic.
- Lignocaine 1%.
- Scalpel blade.
- Suture / needleholder.
- Normal saline for flushing lines.
- Sterile transparent dressing.
### Pitfalls and traps

- Central venous cannulation should only be considered when peripheral cannulation is unsuccessful. Unless a large bore cannula is used, it is also inadequate for rapid infusion of fluid.

- In any catheter over guidewire technique, it is essential that the guidewire is not advanced with the catheter. The wire should be held firmly in one hand, while the catheter is advanced with the other.

- **Short** (i.e. not a CVC catheter), large bore (7.5-8.5 French) catheters only should be used. Central lines are too small and too slow for trauma resuscitations.

- **When surface anatomy is unclear**, a cannula can be used instead of the Cook needle. This allows easier connection to a transducer or manometer to exclude arterial puncture and to avoid subsequent dilation of the artery.

### REFERENCES:


Indications
To gain access to the circulation in an infant where intravenous cannulation is not rapidly obtainable. In the trauma setting this is often in the child with hypovolaemic shock but may be required in other circumstances e.g. head injury. Rule of thumb: >2 failed attempts or 90 seconds without access in a shocked infant should lead to intraosseous access.

Equipment
- Sterile gloves.
- Gown and drape.
- Dressing pack.
- Chlorhexidine.
- 1% Lignocaine with a 5ml syringe.
- 24g needle.
- Intraosseous needle.
- Paediatric extension tubing.
- 5ml N/S flush.
- Thin brown tape.
- Clear plastic cup.

Technical Aspects
1. The needle is inserted with a sterile technique. It is important that one nurse assists in keeping the leg still and whose sole responsibility is to look after the line.

2. Insertion is best performed at the proximal tibia approximately 1cm below the tibial tuberosity medially on the tibial plateau. Alternative site is 1cm proximal to the medial malleolus.

3. Prepare site with chlorhexidine and drape.
4. Inject a few ml's of local anaesthetic down to the periosteum.

5. Use a twisting action to screw the needle into the bone. Entrance to the bone marrow is felt with a “give”.

6. The trocar is then removed and the metal cannula will stand unsupported in the bone.

7. Bone marrow may then be aspirated to confirm position. Fluid should be able to be injected with constant pressure without swelling of the tissues.

8. Cannula is then secured with brown tape turned around the base and a plastic cup is taped over the cannula to protect it from accidental dislodgment.

9. Attach flushed T extension tubing to allow safe injecting of the cannula without dislodgment.
**TIPS**
- Make sure the leg is kept immobile during the procedure and that looking after the cannula is the sole duty of one specific person.
- Insertion, especially in the older infant, requires stronger screwing forces.
- Make the decision early to use an intraosseous needle rather than as a “last ditch effort”.
- Aspiration of bone marrow may occasionally be impossible or take considerable force. Free injection without swelling can then be used to confirm position.
- Intraosseous cannulae should be removed after good IV access is established following resuscitation.

**Risks / Complications**
- Avoid inserting through areas of infection, burns or fractures.
- Dislodgment may cause soft tissue swelling and the possibility of compartment syndrome.
- Fat and bone emboli occur commonly but are seldom of clinical significance.
- Osteomyelitis may occur but is uncommon.

---

**LIVERPOOL HOSPITAL IS TRIALLING AN ADULT INTRAOSSEOUS INFUSION DEVICE – BIG™. INDICATIONS ARE SIMILAR**
Non invasive blood pressure (NIBP) recording devices have significant limitations for critically ill trauma patients. Invasive blood pressure (IBP) recordings provide an invaluable amount of information, which is more specific and sensitive than other commonly applied monitors (e.g. ECG, SaO₂, NIBP, etc).

The clinical value of IBP increases in proportion to the seriousness of the patient’s injuries. It should never create a delay to definitive, often surgical, therapy. Preparation is essential (cables, pressure transducer and tubing readily available). There are rare indications for its use in resuscitation.

**Indications**

1. Need for beat to beat blood pressure recording and evaluation (e.g. unstable physiological conditions: need for real time therapeutic intervention / decision making).

2. Need for frequent arterial blood sampling and analysis.

3. NIBP techniques unavailable, unreliable or inappropriate: eg. NIBP impossible / difficult due to injury or intravenous cannula site. The latter is especially important if intermittent disruption of drug administration would be of clinical concern.
Absolute Contraindications
- Insertion into a traumatised artery.
- Insertion proximal to the site of critical limb perfusion.
- Insertion into an arterial graft or surgically repaired artery.
- Insertion through a proposed urgent angiography site.
- Insertion through an infected skin site.
- Perfusion to limb distal to site of insertion cannot be clinically monitored.

Relative Contraindications
- Proximal or end artery
- Coagulopathy

Techniques (in order of preference)
1. Seldinger.
2. Flush back, following insertion through only the anterior wall of artery.
3. Flush back, following insertion through anterior and posterior arterial walls.
- No matter what the technique, it should be done under sterile conditions (betadine and chlorhexidine skin preparation, sterile gloves, drapes and tray).
- For adult patients, use a 20G cannula (the longer the better, especially for femoral arterial access).
- For children, use a 22 or 24G cannula.
- Do not suture the cannula to the skin.
- Secure cannula and monitoring tubing thoroughly with a transparent dressing.
- For monitoring tubing use low compliance, transparent, short, minimum volume tubing clearly differentiated from other vascular
tubing (usually a red line, tape or label) and with no intravenous drug injection port.

- Appropriate transducer and cable.
- Normal saline intravenous fluid bag as the source of the flush solution (no need to add heparin or other anticoagulant to it)

Intravenous fluid, pneumatically controlled pressure infuser (pressurize to at least 20+ mmHg above arterial pressure – commonly set at 300 mmHg).

**Pressure Monitoring**

1. Check position of transducer, in reference to the level at which you wish to record blood pressure (commonly at level of cannulated artery) and zero reference (to atmosphere) prior to recording.
2. Examine the arterial trace for over and under damping effects, which can lead to misleading measurements and trace interpretation.
3. Monitor trace continuously.
SECTION 5
In the 1970’s it was popular to use a Nelson Empyema Trochar and Cannula with insertion of a Malecot or a De Pezzer catheter through the cannula. Dr. Cliff Pollard designed the Pollard intercostal catheter forceps, allowing a Seldinger type insertion of a chest tube through a metal dilating forceps (1). More recently, Waksam and colleagues have advocated the use of an endoscopic trocar cannula for chest drain insertion (2).

Complications that occur are related to insertion in 20% of cases, residual pneumothorax in 25% and infection in 55% (3).

THE OPEN TECHNIQUE OF INSERTION IS THE SAFEST.

NOTE:
Inappropriate placement - left chest drain is too low.
Outlined below are the 9 S’s of successful, safe chest tube insertion:

- **Sedation**: it is essential that the patient receive adequate analgesia and perhaps amnestic agents (of course tailored to the patient’s haemodynamic stability).
- **Site**: a safe area above the nipple level posterior to the anterior axillary fold should be chosen.
- **Sensitive**: finger dissection will reduce insertion complications.
- **Sterility**: is paramount, with single-dose antibiotic prophylaxis\(^4\).
- **Suturing**: to fix drain and place purse-string using a heavy silk suture.
- **Suction**: should be applied to the drain (~ 20cm H\(_2\)O).
- **Seal carefully**: on removal of chest tube.
- **Side effects**: are related to poor technique \(^5\).
- **Sessions**: with cardiothoracic operating list will improve the technique.

The technique for chest tube insertion must be safe, thoughtful and may involve, on occasion, the use of adjuncts such as a flexible introducer, Pollard intercostal forceps or an endoscopic insertion.

**TIPS**
- Know the name of the Procedure Nurse.
- Be familiar with the chest trolley in resus.
- If you are taking more than 5 mins - get help.
- Use antibiotic prophylaxis.
- Do not insert too far.
- Rarely use a thoracocentesis needle.
- Do not insert too low or over internal mammary artery.

**WHEN DO YOU USE A THORACOCENTESIS NEEDLE?**

When you get caught unaware:
- CT scan
- Lift!

It indicates that you are out of control.
You should be able to place an ICC just as quickly – IF NOT, PRACTISE!
REFERENCES:


**REMEMBER THE 3 GREAT CHEST DRAIN LIES**

- “I will only put it in a little bit” (in >8cm will kink!)
- “It will not take long” (often takes >5 minutes)
- “There will be no problems” (>10% complication rate)
INTRODUCTION
The use of ultrasound in the evaluation of abdominal trauma continues to evolve. Much has been written as to the utility of ultrasound in both blunt and penetrating abdominal injury\(^4\). In many centres, FAST has largely replaced diagnostic peritoneal aspiration (DPA) in the immediate abdominal evaluation of the haemodynamically unstable patient in the resuscitation room.\(^5\)-\(^7\): The procedure is performed by an accredited person and the information used to decide on subsequent investigations or operations. The areas examined include the hepatorenal space, splenorenal recess and the retrovesical space. When indicated the pericardium should also be evaluated. FAST can also be used to evaluate the pleural space for evidence of effusion.

APPLICATIONS / INDICATIONS
FAST is currently used in the rapid evaluation of the abdomen for evidence of free fluid. This is of course most useful in the haemodynamically unstable patient suffering multiple system blunt injury to quickly determine whether the patient should proceed to immediate laparotomy. It is also useful in the evaluation of a haemodynamically stable patient suffering blunt abdominal injury, but results should not be used to make a decision to operate immediately in this particular situation as CT scanning is more specific and provides more information.

Penetrating abdominal trauma can be assessed with FAST but its sensitivity for small amounts of free fluid or hollow viscus penetration is poor. FAST is most useful in penetrating trauma to assess the pericardium in wounds near the heart for evidence of pericardial effusion or tamponade.
SECTION 5

LUQ - No free fluid

RUQ - large amount of free fluid

Large pericardial effusion
ADVANTAGES OF FAST
• Rapid.
• Repeatable.
• Non-invasive.
• The investigation of choice in pregnant women.

LIMITATIONS OF FAST
• Operator dependent.
• Poor sensitivity in penetrating trauma.
• Misses hollow viscus (bowel) injuries.
• Does not evaluate retroperitoneal organs or retroperitoneal space for bleeding.
• Does not assess specific organ injury or function.
• Subcutaneous emphysema and bowel gas limit sensitivity.
• After hours availability.
• Hard to do when patient is on spine board.

ACCREDITATION / QUALIFICATION
Accreditation varies between institutions and countries. Currently FAST at Liverpool Hospital can be performed by any doctor who has met certain requirements. These include completion of a recognised course in the application of ultrasound in the emergency department or trauma setting. The course will include technical information on ultrasound mechanics and theory as well as procedural and machine variations. The course should also include real-time examinations of live patients, some of which have positive findings.

Once the course is completed, accreditation includes the examinations of at least 30 patients, of which at least half must be indicated in trauma and ten percent must have positive findings. The accuracy of the FAST examination is proportional to the experience of the individual user and the frequency of examinations. Each provider utilising FAST should maintain a record of examinations for ongoing QA purposes.
REPORTING

Results should be reported as positive or negative.

• All pertinent areas must be adequately visualised to make this determination.
• If the bladder is empty then it should be distended with 150-200 mls of sterile normal saline.
• If unable to visualise all areas then another examination (DPL or CT) should be performed to adequately assess the peritoneal cavity.
• The result is to be recorded by the scribe nurse in the patient’s resuscitation record along with the name of the accredited doctor performing the examination.

Examinations by unaccredited users should not be reported, nor the information used in clinical decision-making.

PS: If you would like a free copy of our MUST (FAST) Manual - contact the Trauma Department at Liverpool Hospital.
REFERENCES:
2. Rozycki GS. Prospective evaluation of surgeons’ use of ultrasound in the evaluation of trauma patients. J Trauma 1993; 34; 516.
7. Scalea MS, Rodriguez A. Focused Assessment with Sonography for Trauma (FAST): Results from an international consensus conference. J Trauma 1999: 46(3); 466.
DPL has been around since 1965. It is a good test, with some limitations and should be used in Liverpool for the unstable blunt trauma patient or patients with suspected bowel injuries.

Remember DPL is NOT an antiquated test – there were 383 DPLs performed between 1995 and 1999 at Liverpool of which 30% were positive.

**BLUNT TRAUMA**

The choice of definitive investigation in blunt trauma rests with DPL, FAST, CT scan and laparoscopy. The choice depends on two key factors:

1. Patient’s stability

**DIAGNOSTIC PERITONEAL ASPIRATION (DPA) / DIAGNOSTIC PERITONEAL LAVAGE (DPL)**

In the presence of haemodynamic instability, a DPA or FAST is ideal in determining the presence of haemoperitoneum and the need for immediate laparotomy. Remember, up to 50% of patients with suspected intra-abdominal injury are hypotensive due to a non-abdominal cause. Therefore rapid assessment of the abdomen is essential.

A further key issue in the stable patient is whether one will adopt an operative or non-operative approach as indicated by the mechanism of injury. If one is tending to a non-operative approach, such as in a patient following contact sport trauma with potential splenic injury, DPA is contraindicated as a positive result in terms of RBC will increase the pressure for operative management, which in a stable patient is inappropriate.
If one has a high index of suspicion of small bowel injury, DPL is the test of choice. DPL has, in the past, been a gold standard for evaluation of haemoperitoneum. It is highly sensitive in detecting the presence of intra-peritoneal blood. It has the disadvantage however of not predicting the need for laparotomy per se and will increase non-therapeutic laparotomy rate. It has been extensively validated.

**PITFALLS OF DPA / DPL**

1. Technique – closed technique, increased risk of bowel perforation. Over 8 mins required for infusion of fluid if standard IV used. All catheters tend to plug with omentum resulting in restriction of effluent return. Frequent adjustment of catheter is required to get return.

The Liverpool Hospital open technique using a large bore catheter is much quicker. (see Figure 1)

**FIGURE 1 – Large Bore DPL Catheter**
2. Interpretation of DPL.

Whilst over 50% of surgeons utilise bedside interpretation of DPL effluent for RBC count, this is fraught with hazards. Ability to read print through IV tubing is an inaccurate art. The effluent should be sent for objective laboratory analysis.

The following constitute a positive DPL in blunt trauma:
- Red cell count > 100,000/mm$^3$.
- White cell count > 500/mm$^3$.
- Alkaline phosphatase > 20 IU/L.
- Amylase > 20 IU/L.

The use of Gram stain and detection of vegetable matter is not a particularly useful technique. Recently it has been suggested that quantitative white blood cell criterion for detection of intestinal injury, supplemented by an adjusted white cell count/red cell count ratio, will decrease non-therapeutic laparotomy rate associated with DPL. It is suggested that the white cell count to red cell count ratio of 150 or greater, indicates a gastrointestinal tract perforation requiring surgery.$^2$

**DISADVANTAGES OF DPA / DPL:**
- Oversensitive RBC count – giving rise to non-therapeutic laparotomies.
- Does not provide organ specific diagnosis.
- Misses retroperitoneal haematomas.
- Invasive.
- Painful in conscious patients.

Sequential DPL is very useful particularly in multi-system trauma patients undergoing multi-cavity surgery where the DPL catheter can be left in place and repeat DPL performed (See Figure 2). Remember that 25-30mls of frank intraperitoneal blood in a patient with a normal haemoglobin will result in a DPL fluid red cell count of 100,000/mm$^3$. 

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Special concerns have been raised in the past in performing DPL in pregnant women, children and in patients with pelvic fractures.

- FAST is superior in pregnancy.
- In paediatric trauma, the problem with DPL is its over sensitivity and the tendency to lead to non-therapeutic laparotomies, particularly with solid viscus injuries.
- In pelvic fractures, care must be taken as false positive rates of up to 30% have been reported.

The reported high false positive rate in DPL in the presence of pelvic fractures have been attributed to many factors:

1. Dissection of the retroperitoneal pelvic haematoma.
2. Direct placement of the catheter into the retroperitoneal haematoma.
3. Extravasation of blood from the retroperitoneal haematoma.
4. Time dependent diapedesis of red cells across the peritoneum.

It is important to undertake DPA or DPL early in patients with pelvic
fractures (<30 minutes post arrival). The haemodynamically stable patient with a positive diagnostic peritoneal lavage may be treated non-operatively in certain circumstances, particularly in the presence of a normal white cell count, alkaline phosphatase or amylase. Therefore, in a stable patient, the only definite indication for DPL is a high index of suspicion for bowel injury.

DPL is useful in penetrating trauma but we recommend laparoscopy to determine if there is peritoneal penetration (see page 108).

**LIVERPOOL TECHNIQUE OF DPA / DPL**

1. Use an assistant.
2. Umbilical approach.
3. 10mm incision: use 2 cats paw retractors.
4. Through umbilical cord into peritoneal cavity.
5. This is an avascular plane-no diathermy required.
6. Use a big bore catheter.
7. Attempt to aspirate blood (>10mls frank blood = +ve DPA)
8. Infuse 1L warm normal saline through a TURP giving set.
9. Remember to send and GET the results of the DPL before discarding effluent.
10. You can leave the catheter in to repeat later.

**REFERENCES:**

The greatest mistake in ED Thoractomy is not doing it early enough!

Thoracotomy in the ED should only be performed by an appropriately trained surgeon. A trauma patient who loses vital signs in the ED may be saved by immediate thoracotomy, especially those with penetrating injury.

**Therapeutic manoeuvres include:**

1. Pericardial incision and evacuation of pericardial blood causing tamponade.
2. Direct control of exsanguinating thoracic haemorrhage.
3. Open cardiac massage.
4. Cross clamping of descending aorta to stop blood loss below diaphragm and allow heart filling to achieve cardiac and brain perfusion.
5. Cross clamping of pulmonary hilum to control exsanguinating pulmonary haemorrhage.

The consultant Trauma Surgeon should be informed of any haemodynamically unstable patient prior to arrival in the ED.
EQUIPMENT FOR THORACOTOMY
- Skin preparation – providine.
- Heavy Mayo scissors.
- Scalpel - #10 blade.
- Forceps.
- Long needle holders.
- Finochietto retractor.
- Lung retractor.
- Vascular clamps.
- Prolene vascular sutures.
- Protective goggles / clothing.

APPROACH
The approach is via an anterior left thoracotomy, which gives access to the left hilum, descending aorta, left ventricle and pericardium.

1. Haemopericardium should be relieved by incising the pericardium longitudinally anterior to the phrenic nerve.
2. A penetrating cardiac injury may be temporarily controlled with a finger or pledget sutures.
3. A bleeding lung or pulmonary vessel can be controlled by a hilar clamp. Consider extending incision across chest into a clam shell.

The aim of an ED thoracotomy is to salvage a dying patient until a definitive procedure is performed in the operating theatre.

**INDICATIONS**

1. **All** penetrating chest injuries with systolic BP <70 on arrival who do not respond within 5 minutes to blood i.e. the moribund patient!

2. All patients with **no** BP on arrival with penetrating chest injury who have had signs of life or ECG within 10 minutes (if tubed) or 6 minutes if not tubed.

3. Patients with a systolic BP >80 should go to theatre.

**REFERENCES:**


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**HOT TIP**

- Thoracotomy performed by untrained staff is not only futile, but also time consuming and can expose the trauma team to unnecessary risks.

- Remember – don’t wait 5 minutes and then ask to open the thoracotomy tray.
- If the MIST information is good – have it open before patient arrives.
Cricothyroidotomy is an emergency procedure by which an opening is made in the cricothyroid membrane to establish an airway. Surgical cricothyroidotomy is the use of a blade to create an opening; needle cricothyroidotomy is the use of a small cannula or needle which then allows jet insufflation to prevent hypoxic injury to an otherwise dying patient.

**INDICATION:**
The decision to perform emergency cricothyroidotomy is made to prevent hypoxic encephalopathy and death. It is a life saving procedure and must be accomplished quickly as hypoxic brain injury occurs within 3-5 minutes of the inability to effectively oxygenate.

The only indication is an inability to effectively oxygenate by other means.

Intubation is the usual method of obtaining airway control. In some situations this may be impossible or contraindicated and therefore mandates cricothyroidotomy. Team members should defer to those who have at least performed the procedure in a simulated environment (e.g. EMST, ELS, APLS or other course).

**CONTRAINDICATIONS:**
1. Patients who can be effectively ventilated by other means (LMA, bag-mask, via ETT).
2. Transection of the trachea with retraction of the distal end.
3. Known fractured larynx or other significant damage to the larynx or cricoid cartilage.
TECHNICAL ASPECTS:

Anatomy
The cricothyroid membrane is a dense fibroelastic membrane between the thyroid cartilage (above) and the circumferential ring of the cricoid cartilage (below). The laryngeal prominence or “Adams apple” (anterior superior edge of the thyroid cartilage) is the most important landmark.

Identify the cricothyroid membrane by feeling for a notch, indentation or dip in the skin inferior to the laryngeal prominence. The average size in the adult is 22-30mm wide and 9-10mm high, found usually 2-3cm below the laryngeal prominence.

In children less than 12 years, needle cricothyroidotomy is the preferred technique, as the cricothyroid membrane is not as well developed as in the adult.

SURGICAL CRICOTHYROIDOTOMY

Equipment:
- A #10 scalpel blade.
- Size 6.0 endotracheal tube.
- +/- tracheal spreader or artery forceps.

or
Use the Meiker cricothyroidotomy set located at bed 3 in the resuscitation room.
Procedure:
1. Place patient in supine position with neck in neutral position. If there is no risk of neck injury consider extending the neck. Palpate the thyroid notch (Adams apple) and cricoid cartilage and locate the cricothyroid membrane.
2. Prepare the skin and anaesthetise the skin if there is time and the patient is conscious.
3. Stabilise the thyroid cartilage with the left hand.
4. For an emergency cricothyroidotomy make a central transverse skin incision about 3-4cm long. A longitudinal skin incision can be used as it can also be extended if placed too high or too low.
5. After the skin incision a short stabbing 1cm incision is made in the cricothyroid membrane in the lower half (to avoid the cricothyroid arteries), allowing only the tip of the scalpel blade to enter the trachea.
6. Insert artery forceps, scalpel handle or tracheal spreader into the incision to enlarge the opening.
7. Insert a cuffed tube into the hole directing the tube distally into the trachea. Stabilisation of the larynx is crucial to allow entry of the tracheostomy tube with the larynx lifted and held anteriorly in the anatomical position.
8. Remove the introducer.
9. Inflate the cuff of the tube, attach a connector to the tube, then a self filling bag.
10. Ventilate the patient and secure the tube into position.

NEEDLE CRICOHYOIDOTOMY
Use in children < 12 years age for jet ventilation.

Equipment:
- Long bore cannula 12 or 14 gauge.
- 5ml syringe.
- O₂ tubing.
- Y connector.
- Oxygen flow meter.
Procedure:
1. Attach a cannula to a 5ml syringe.
2. Place patient supine. If there is no risk of cervical spine injury extend the neck by plugging a folded towel under the shoulders.
3. Locate the cricothyroid membrane and surgically prep the skin.
4. Stabilise the neck with your left hand.
5. Puncture the skin in the midline directly over the cricothyroid membrane aiming directly downwards.
6. Aspirate as you advance as the aspiration of air indicates entering trachea.
7. When air is aspirated, aim the needle 45° caudally and then advance the cannula over the needle taking care not to perforate the posterior wall of the trachea. Withdraw the needle and recheck air can be aspirated from the cannula.
8. Attach the hub of the cannula to a size 3 ETT adaptor and then an oxygen flow meter via a Y-connector.
9. Initially set the oxygen flow rate in litres at the child’s age in years. This may well require adjustment to ensure oxygenation. In an adult set the oxygen flow at 15L/min (50 PSI).
10. Ventilate by occluding the open end of the Y-connector with the thumb for 1 second directing gas flow into the lungs. If this does not cause the chest to rise, increase the flow rate by 1 litre and reassess the effect of 1 sec occlusion of the Y connector.
11. Use a rhythm of 1 sec on, 4 sec off. Ensure there is chest movement confirming adequate ventilation.
12. Inspect the neck to ensure there is no swelling indicating flow of gas into the tissues rather than the trachea.
13. Secure the cannula.
14. Arrange for emergency management in theatre as a patient can only be effectively ventilated for 15 minutes using this technique.
SECTION 5

SURGICAL CRICOHYOIDOTOMY: avoid making blind stabs as controlled incisions minimise the risk of haemorrhage and damage to adjacent structures. Attempt to hold the scalpel with the thumb and index finger low on the scalpel handle, just above the blade so to control the depth of the scalpel blade insertion.

NEEDLE CRICOHYOIDOTOMY: it is not possible to effectively ventilate a patient via a needle cricothyroidotomy using a self-inflating bag. Exhalation must occur via the upper airway, even when the upper airway is partially obstructed. Should upper airway obstruction become complete, the gas flow will need to be reduced. Insufflation provides oxygenation but little ventilation. This temporising measure may buy 15 minutes for an attempt at securing a definitive surgical airway.

COMPLICATIONS OF CRICOHYOIDOTOMY:
- Hypoxia.
- Hypercarbia.
- Aspiration.
- Obstruction of ETT.
- Local bleeding.
- Creation of a false passage.
- Emphysema.
- Vocal cord paralysis.
- Pulmonary barotrauma.
- Subglottic oedema or stenosis.
- Oesophageal perforation.
- Cellulitis.

PITFALLS & TRAPS: Although a relatively simple technique when described, in reality the patient is often struggling as they are hypoxic, the surgical field may become bloody and the operator may not feel confident. Cricothyroidotomy is a lifesaving procedure and the literature supports the view that cricothyroidotomy is safe with relatively few complications.
REFERENCES:
Pericardiocentesis is not a good idea in trauma patients because:
- the patient you are convinced needs it (in extremis) actually needs a thoracotomy,
- the patient you are considering it for (stable) usually needs a thoracotomy.

There are many risks:
- damage to organs (myocardium, lung, stomach, bowel, oesophagus, spleen, kidney),
- laceration of coronary artery,
- failure to aspirate blood from the pericardial sac because it is clotted (common).

By performing a pericardiocentesis you will be effectively committing a patient to a pericardial exploration, so, get an ultrasound if you can and a surgeon if you are suspicious of tamponade.

**PERICARDIOCENTESIS**

PERICARDIOCENTESIS may be performed if the following criteria are met:
- You are unable to do a thoracotomy.
- A surgeon is not available.
- The patient is in extremis (about to die).
- You have a high degree of suspicion that tamponade is present.
HISTORY
In 1903, Crile described a pneumatic rubber suit, a device he had designed so as to prevent or minimise the extent of postural hypotension in neurosurgical patients. This concept was further expanded for flight suits worn by military pilots for the prevention of G force induced blackout. The principle behind its use was that it prevented the pooling of blood in the lower extremities which otherwise resulted in decreased venous return and therefore cardiac output. All such patients were otherwise euvoalaemic. The efficacy of the pneumatic device in these settings is firmly established.

HYPOVOLAEMIC SHOCK
Since the early 1970s that same concept was taken one step further to the treatment of profound haemorrhagic shock in the prehospital and hospital emergency department settings. The theory was that blood in the lower extremities would be displaced centrally and venous return, and thus cardiac output, would be enhanced. All such patients were obviously profoundly hypovolaemic.

The efficacy of MAST in this setting is unsupported. The evidence suggests that the use of MAST for such patients is associated with a greater mortality, increased ICU and hospital length of stay. It is contraindicated for patients with head, chest or penetrating abdominal injuries.

The development of MAST for haemodynamically unstable trauma patients was at a time when current Early Management of Severe Trauma (EMST) principles were in their infancy. The appreciation of the benefits of rapid control and management of hypovolaemic shock were much less appreciated than they are today. This principle very much underlies the approach to such patients by the Liverpool Trauma System.
LIMB FRACTURES / SPLINTING

More recently MAST has been applied for “splinting” of lower limb fractures. The basis to adequate splinting of any limb fracture is that early realignment and immobilisation reduces fracture-associated tissue damage, bleeding, pain, and subsequent multisystem organ dysfunction and mortality.

MAST, when utilised for lower extremity fractures, provides possibly some immobilisation but no traction / realignment. Any immobilisation would require the MAST to be inflated to some degree. In patients who are shocked, the application of external pneumatic pressure results in reduced arterial blood flow, increased venous stasis / engorgement and increased ischaemia / acidosis to an already injured extremity.
The effectiveness of the MAST in such circumstances has never been established, nor was the current design ever developed for such use. The same applies to its suggested use for pelvic fractures.

**MAST is never used at Liverpool Hospital for hypovolaemic shock in the setting of trauma. It is however still occasionally used in the pre-hospital setting and, therefore, critically ill trauma patients may arrive to Liverpool Hospital with an inflated MAST in situ.**

**MANAGEMENT** (see page 122)

The challenges faced by the trauma team from the pre-hospital application of MAST are:

**Distraction:** the trauma team may be distracted from the fact that such patients are likely to be severely haemodynamically unstable or partially resuscitated and in need of ongoing resuscitation and urgent definitive surgical care.

**Reperfusion Problems:** potentially life threatening systemic effects of sudden reperfusion of the lower limbs as MAST is deflated. The longer the application time of the MAST, the more severe the systemic consequences.

1. Ignore the MAST. Leave it inflated (if the abdominal compartment is inflated – which is rare – deflate it immediately).
2. Fully concentrate on completion of the ABCDE of the primary survey and resuscitation of the patient. Then formulate an assessment and definitive management plan for the patient.
3. Reperfusion issues are dependent on the patient having an adequate respiratory capacity and intravascular volume to compensate for the systemic consequences of MAST deflation. This mandates adequate volume resuscitation or surgical control of ongoing haemorrhage. Patients with reduced respiratory reserve (acute or chronic) should receive respiratory assistance including,
If necessary, intubation and ventilation prior to MAST deflation. All this may occur in the operating theatre.

4. MAST deflation should occur incrementally, each compartment being deflated as the systemic effects of the prior deflated compartments have resolved. Start with the most proximal compartment. Patients with any compartment of the MAST still inflated should be considered unstable and not taken to the radiology department.

REFERENCES:
A small group of patients present to the trauma service with severe facial haemorrhage, and will exsanguinate from this injury without early recognition and definitive first aid.

These patients usually have high-speed motor vehicle crashes or are the victim of an assault with a heavy object (or have been kicked). Those with combined head and facial injuries have a high mortality and those with isolated mid-face fractures usually can be saved if treated properly.

The severity of the haemorrhage may be insidious or obvious, with oozing and blood staining of the top of the bed, on the attendants and the floor. Attempts to CT scan these patients without control of the blood loss results in death by exsanguination, and damage to the CT scanner with expensive downtime.

1. The recognition and treatment of this condition follows securing the airway and ventilation in terms of priority. Two 22G Foley catheters are passed through the nostrils and hooked by the index finger into the mouth to avoid intracranial incursions. A matchbox-sized pack made of vaginal packing gauze is secured through the eyes of the catheters, with 0 nylon sutures incorporating a trailing retrieval stitch.
2. It is wedged into the postnasal space both by digital pressure and traction on the catheters. At least two bottles of 1.5 cm packing gauze is packed with blunt plain forceps into each nostril with the catheters on traction. The initial bottle must be layered well back in the nose to avoid a cavity between the posterior pack and the nostrils.

3. The Foley catheters are tied over a bolster with a reef knot under tension. Further anterior packing and/or inflation of the balloons may be required. Ongoing oral bleeding can be controlled with surgical packs into the oropharynx and oral cavity.

4. Definitive maxillofacial surgery is undertaken after the acute haemorrhage has been controlled and other life threatening injuries have declared their intentions. Embolisation of branches of the maxillary artery, and bilateral external carotid artery ligation may be of value in selected cases, but the first aid treatment should be undertaken first.
5. Prolonged pressure from the packing will sometimes cause necrosis of the soft palate requiring elective cleft palate type repair, but this is a trade off in favour of initial survival.

6. When the patient is stable, normothermic, with normal Hb and coagulation, the packing can be progressively removed leaving the Foley catheters in place for 24 hours.

7. The pack may be left for 48-72 hours if required with suitable antibiotic cover for oral flora and culture of the pack upon removal.
## SECTION 6
### DEFINITIVE CARE

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INTRODUCTION

Trauma patients require minimisation of:
1. Hypoxia
2. General hypoperfusion
3. Regional hypoperfusion (extremity / organ ischaemia)
4. Internal leakage of secretions.

These adverse events determine the occurrence and magnitude of:
1. MOF (SIRS, MODS)
2. Sepsis
3. Secondary brain injury
4. Death.

Understanding the cellular events is central to determining the priorities and strategies in both the “first hour” (initial assessment) and in the “second hour” (early definitive care). This “second hour” requires very strong surgical direction and coordination.
The above figure attempts to highlight some of the complexity of decision making in trauma care. The algorithm begins with “initial assessment”. Major decisions are required at each point highlighted by the words “prioritise” or “intervene.”
Decision making in trauma care is largely determined, at the clinical level, by:

The probabilities include the:
- Probability of a particular injury being present.
- Probability of an adverse outcome occurring from that injury.
- Probabilities within a range of severities for each possible adverse outcome.

Despite the many variables which have an impact on our clinical decisions, the foundations for those decisions need to be supported by:
- Evidence.
- Protocols.
- Education.
- Supervised Experience.
- Clinical Review.

Evidence helps us construct or calculate the PROBABILITIES.

Good PROTOCOLS express both the evidence and the experience of experts.

Education should, wherever possible, be based on sound evidence and will often be expressed through PROTOCOLS.

Supervised experience and clinical review lead to PATTERN RECOGNITION which can become a most powerful positive influence on decision making.
The passage and consumption of TIME is of great significance. A patient’s early outcome is usually determined by the **physiological** consequences of injuries rather than the **anatomic** disruption of the injury itself.

Thinking of the patient in terms of physiological risk may help us to set better priorities and effect more rapid treatment.

**REMEMBER:** A good trauma care system minimises time from injury to definitive care!
The goals in the “second hour” can be summarised in the following list which is ranked from highest to lowest priority:

- Prevent early death.
- Minimise late MOF (MODS).
- Minimise late sepsis.
- Minimise long term disability.
- Minimise short term disability / complications.
- Minimise length of stay.

This requires a mental focus on cellular pathophysiology as indicated above.

**GoALS IN THE SECOND HOUR**

If the above goals and the ranking of those goals are generally agreed, they can be expressed as a set of practical priorities as follows (ranked from highest to lowest priorities):

- Airway maintenance.
- Breathing – optimising oxygenation and ventilation.
- Perfusion – general.
- Raised ICP.
- Perfusion – regional.
- Contamination / sepsis.
- Crushed, contused, ischaemic wounds.
- Fracture stabilisation.

None of the above items are unimportant and a number may co-exist within the same region of injury.

**To treat the patient, treat the cells!**

Check blood gases and lactate.

**PRIORITIES IN THE SECOND HOUR**
Airway
In most situations, this will be corrected in the “first hour”. Airway risks in the “second hour” relate to:
(a) Problems with an unprotected airway (glottic oedema, aspiration of blood and vomitus).
(b) Displacement or occlusion of artificial airways.

Breathing
On most occasions, this has also been corrected in the “first hour”. It particularly becomes an issue in the “second hour” when:
(a) There is a massive air leak, which may require a thoracotomy.
(b) There is an increasing requirement for respiratory support (e.g. major flail with pulmonary contusion).

Perfusion - general
This is usually a problem of inadequate blood volume and relates to active bleeding. There are five principal areas of bleeding, all of which should have been identified in the “first hour”:
1. External. While temporary control may have been achieved during “initial assessment”, definitive control may be a significant issue to be addressed among the priorities in “definitive care”.
2. Chest – significant continuing bleeding may require thoracotomy.
3. Abdomen.
4. Pelvis.
5. Long bones - these should have at least been splinted in the “first hour”.

In the situation of massive bleeding, and when it is not possible to perform simultaneous surgery in multiple body regions, it will most often be appropriate for massive intrathoracic bleeding to take priority over major intra-abdominal bleeding and for both of these to take priority over pelvic bleeding.

In the Australian situation, general hypoperfusion (shock) as a consequence of primary cardiac dysfunction is unusual. Pericardial tamponade is infrequent where penetrating trauma rates are low.
Significant myocardial contusion is rare and does not correlate with the vast majority of sternal fractures which predominantly occur in the older members of the community. Myocardial infarction needs to be considered as a possible cause of the injury event or as a possible consequence of shock.

Raised ICP
Only after thoroughly attending to the issues of airway, breathing and general perfusion, should we be directing attention to intracranial strategies. The three principal strategies available to us in the “second hour” are:
1. CT scan.
2. Intracranial pressure monitoring.
3. Craniotomy.

Neurosurgical involvement and input is critical toward prioritising head injury interventions.

Perfusion - Regional
Regional ischaemia most commonly relates to the upper and lower extremities. Early diagnosis and confirmation of ischaemia should have been achieved within the “first hour”. Benefits from traction and splintage should also have been achieved within the “first hour”.

The issues for the “second hour” relate to:
• early restoration of blood flow
• early fasciotomy.

Particular emphasis needs to be given to restoring regional perfusion in order to minimise late MOF.

Regional ischaemia should be corrected inside six hours from the time to injury - that means a plan must be in place within the first hour!
Contamination / Sepsis
Knowledge of bacterial proliferation rates in wounds, combined with increasing understanding of the release and adverse effects of toxic inflammatory mediators, support the following.

Surgeons wishing to minimise the chance of late multiple organ failure and late sepsis need to be "watching the clock" while they proceed with appropriate interventions to control bleeding, restore general and local perfusion, control contamination, and debride major wounds.

Control of contamination should be achieved within 3 - 4 hours from the time of injury!

Debridement of major wounds should occur within 6 hours from the time of injury!

Crushed, contused, ischaemic wounds
The principles are much the same as those discussed in relation to the previous two priorities.

Fracture Stabilisation
While this may appear low down the list of urgent priorities, it is often a mistake to simply regard this as an anatomic exercise. Displaced and unstabilised fractures may have significant early adverse physiological features especially relating to continuing bleeding, regional ischaemia, and continuing soft tissue laceration and contusion.

REMEMBER: The clock started ticking at the time of injury!
Nature Of Decisions

The above statement relates to therapeutic interventions in trauma care. It is an aspect of significant difference between decision making in trauma care and decision making in much of the rest of medical practice. This is the nature of triage – a statistical exercise to maximise the numbers of good outcomes. As more clinical data are accumulated with the passage of time, the performance of repeated clinical evaluations, and the performance of investigations, the relative contributions of probabilities and certainties to the making of clinical decisions change. However, the surgeon and the management team are often far advanced down the definitive care pathway before a situation can be reached where there is a high level of certainty about a patient’s overall status and total list of injuries.

Decisions are bases on chances, not certainties!

Signals are an important feature of the differentiation of trauma management from some other aspects of the practice of medicine. Examples of this probability-based paradigm are as follows:

1. A widened mediastinum denotes a ruptured thoracic aorta.
2. Blood at the urethral meatus denotes a ruptured urethra.
5. Differential pulse pressures between two limbs denotes a vascular injury.
6. Localised peritoneal signs denotes a bowel injury.

Making decisions is more important than making diagnoses!
Each statement of this nature has a sequence of mathematical probabilities attached to it. Our current difficulty is that we do not have reliable indications of the magnitude of most of these probabilities. Hence, our decisions can lie along a spectrum – at one end is a type of “clinical judgement” which is little better than an idiosyncratic response; at the other end are versions of protocols which are promoted as inflexible dogmas. Our difficulty, and particularly so in Australia, is that for “clinical judgement” to be the expression of a well developed fabric of “pattern recognition” requires many years of experience. The process can probably be advanced by concentrated periods of exposure to experts in the context of high volume case management or case scenario discussion; it can also be greatly assisted by robust clinical review with peers. This is the context which best justifies a weekly trauma audit meeting.

Pattern of errors in trauma care
Not only do we need to know patterns of disease, we need to know patterns of errors in care delivery.

The ability to recognise patterns of injury as well as patterns of error can lead towards better decision-making.
Our discussion has already indicated many points in trauma patient management where a decision needs to be made and a choice of decisions is available. The use of the term “critical decision nodes” is helpful to our thinking and to our leadership of trauma teams in “the second hour”. They often involve competing priorities of possible or probable injuries in different body regions. It may be that more than one potential decision pathway will lead to a satisfactory outcome but the choice of the pathway, the strategic direction, and the assessment of progress requires great clinical maturity and a firm commitment to understanding the clinical priorities across multiple surgical and nonsurgical disciplines. The above figure lists some general examples of the pivotal questions at some of these critical decision nodes. Also indicated above are some of the categories of data which will influence the selection of the pathway from among the available choices.
Because of the number of variables involved, the sharp differences between available options, and the lack of probability data, these critical decision nodes often cannot be codified with sufficient clarity to enable the construction of clear guidelines or protocols.

COMBINING THE CLINICAL VARIABLES
Let us reconsider the variables which we may need to address for any one particular injury, in an effort to answer the most generic question “what should be done?”

POSSIBLE INJURY
- Likelihood of injury
- Potential of injury
- Ease of intervention
- Risk of intervention

CLINICAL CONTEXT
- Known associated injuries
- Possible associated injuries
- Age and co-morbidity
- Physiological stability
- Time from injury
The complexity of the decision making can then be represented as follows:

In reality, there are multiple potential injuries being evaluated within the same clinical context and resources context. When multiple interventions are required, a new level of complexity enters the decision making.
LEADERSHIP
When decisions need to be made regarding multi-specialty interventions, the decisions need to be agreed among a number of “leaders”, or a style of leadership needs to have been previously agreed where one designated surgical leader orchestrates the multi-specialty performance. The added complexity can readily expose a poorly organised surgical trauma care system, differing perceptions of relative risks of different injuries, and differing personalities and ego strengths.

It is the recognition of these levels of complexity which particularly justify senior clinical leadership (with pattern recognition skills), attempts to pass on the pattern recognition in education programs, the need for sophisticated research with extensive trauma registry data (and controlled trials where possible) to further elucidate the probabilities, and the importance of appropriate protocols.
The levels through which our thinking needs to escalate while making these trauma care decisions can be further summarised in the following diagram:

PERSONALITIES AND VALUES
Strategic errors may be independent of particular injuries, the clinical context or the resources context. They may relate to the surgeon within a personal, professional and ethical context.

1. Patient Value
   Examples:
   - Children - fear of the intellectual consequences of brain injury can perversely elevate the importance of a head CT scan above that of adequate oxygen delivery to peripheral cells.
   - Pregnant - concern about the unborn child can focus attention away from the immediate high priority needs of the mother.
   - Intoxicated - allocation, in the clinician’s mind, of a label of
“intoxicated” to a patient, and allocation of a sense of value or priority to that label can perversely prevent attention to the issue of oxygen delivery to stressed cells.

- Elderly - particularly in the presence of multiple younger patients, inappropriately low ranking of priority can be given to this subgroup of patients who are less able to tolerate cellular insult than their younger counterparts.

2. Medical Specialist Availability
    Examples:
    - A specialist who is “here now” may inappropriately elevate the priority of an intervention requiring his/her presence.
    - A specialist who is “elsewhere” may inappropriately devalue the priority of an intervention which requires his/her physical presence.
    - Unsupervised trainees may be inappropriately invited to exercise their own clinical judgement, uninformed by a mature kit of pattern recognition skills which is normally acquired over years of practice.
    - A team may have no leader.

3. Distorted Personal Judgement
    Examples:
    - Deciding to do the “easy” thing rather than the most appropriate thing.
    - Taking on an inappropriate technical “challenge” rather than a more appropriate but less challenging temporising measure.
    - Undervaluation of regional ischaemia as a systemic threat.

4. Ego Issues
    These issues derive from a frame of reference which often reflects self, “favourite” data, and external stresses. Within what needs to be a team approach, ego differences can express themselves as interpersonal rivalries, the spirit of a gambler, the defence of personal values and judgement which are contradicted by data, inappropriate “convictions”. Perhaps worst among these problems, particularly when teamwork is required, is erratic performance and erratic decisions which can sometimes be the manifestation of clinical practice insecurities which have been difficult to appropriately address.
CONCLUSION
As you approach CRITICAL DECISION NODES in the management of trauma patients, you may be assisted by remembering these summarising principles:

- The patient is his/her cells!
- Healthy living cells are the goal!
- “Listen to the cells” as time passes!
- Decisions are based on probabilities!
- Protocols protect from inexperience!
- Leadership protects from perverse decisions!
- Resources recalibrate the priorities!
Documentation is an extremely important issue for all caregivers involved with trauma patients. This includes Trauma Team Leader, surgical registrar, nurses, radiologist and subspecialty consultants. Clinical findings in trauma patients are a dynamic entity. Throughout the course of care of any given patient, caregivers change and it is vital that all be able to examine the patient’s record to determine previous clinical findings. This issue is of primary importance for good clinical care but is also very important from the medicolegal perspective.
TESTS
All radiological and laboratory findings must be determined and documented in progress notes. You are responsible for total patient care and for all tests that have been done. Results and sound decision-making based on them is your responsibility from the perspective of good patient care. With regard to radiology, you are required to review results with an experienced radiologist and subsequently record the results in the patient notes with the time reviewed and the name of the radiologist with whom the images were reviewed.

INTERVENTIONS
Equally important is the documentation of any procedures or interventions carried out by you on the patient. A procedure note in the patient’s progress notes should document all interventions such as chest tube insertion, DPL (with a follow-up note specifying cell counts and chemistry), suturing of lacerations, central line insertion, etc. Any findings with these interventions (e.g. large haemothorax, grossly positive DPL) must also be documented. Complications arising from any procedure are to be included in the procedure note.

DAILY CARE AND FOLLOW-UP
Patients must be seen and examined on a daily basis. Notes should be written by the team caring for the patient detailing findings as well as an assessment and plan for that day.

REMEMBER – Ordering the test is one thing, but it is the result that the patient needs!
The acute management of critically ill trauma patients requires critical judgement and decision making to ensure optimal outcomes. An error in prioritisation or judgement may result in the death of a patient. The great tragedy is that it is easy to say that critically ill patients would have died irrespective of the treatment.

We know from peer review analysis of trauma deaths at Liverpool Hospital and other major trauma services, that:
1. failure to control bleeding, and
2. delay to the operating theatre
are the most important errors contributing to avoidable deaths.

There are a number of key points to prioritisation:
1. Recognition of a critically ill patient.
2. Recognition of patterns of disease and probabilities.
3. Fundamental to the thought process is the need to stop the bleeding. This takes precedence over resuscitation.
4. Obviously Airway and Breathing must be sorted before proceeding to Circulation. Ideally in a trauma situation, this should be done simultaneously with the Airway Doctor intubating, the Surgical Registrar and/or another member placing bilateral chest tubes or unilateral chest tubes as appropriate, then proceeding to identification of a cavity responsible for the major bleed.
History is Critical
Pre-hospital characteristics would predict patients at risk for exsanguination. They include:
1. Unrelenting hypotension, systolic BP < 60.
2. Unable to mount compensatory tachycardia.
3. Truncal penetrating trauma.
4. Non-reactive pupils.
5. Weak pulse.
6. Compromised or absent spontaneous ventilation.

Having identified a patient with life threatening haemorrhage, some conflicts can occur in the following classical scenarios:
- Major haemothorax, distending abdomen.
- Obvious intracranial injury versus intra-abdominal injury.
- Limb exsanguination versus intra-abdominal or chest injury.

Fortunately, the double jeopardy of thoraco-abdominal or limb injuries requiring surgical intervention is unusual. It is important to have objective evidence of bleeding. This requires either a chest x-ray showing massive haemothorax or a chest tube with more than one litre of blood drained. Remember that chest tubes, even when put in quickly, do not give an immediate indication of a massive haemothorax (surprising but true), and time is not on your side to sit there and wait to see how much is coming out of the chest tube. In a moribund patient, frank blood from a chest tube requires a thoracotomy.

**MORIBUND PATIENT**
- Frank blood from ICC = immediate ED thoracotomy
- Blood ++ from ICC but BP > 70 = immediate thoracotomy in Operating Theatre

- If the systolic BP is 70 or more, thoracotomy should be done in the operating room.
- If the systolic BP is less than 70, thoracotomy should be done in the emergency department. When should thoracotomy be done?? There and then!
Following are 2 algorithms for prioritisation in blunt and penetrating injury:

**PRIORITISATION IN AN UNSTABLE BLUNT INJURY**

Hypotensive Blunt Trauma Patient

A ✓ Check

B – Haemothorax
Diagnose and Fix

DECIDE

Massive > 1.5L or “white out” on CXR

Thoracotomy First
(before laparotomy)

< 70 mmHg
Thoracotomy
in ED

> 70 mmHg
Thoracotomy
in OT

Moderate Haemothorax

Assess Abdomen
(FAST / DPA)

If +ve

Laparotomy First

Consider 2nd Surgical Team for Chest
In all cases of severe head injury, remember to stop the bleeding first, rather than dealing with the subdural or the extradural. Remember bleeding is usually in the abdomen or chest. It is important to remember that "C" always comes before "D". The concept of doing a CT scan to see if the patient is salvageable from the head point of view, is inappropriate. These decisions are often extremely difficult to make.
WHY CONSENT IS NECESSARY?
Guidelines to consent reflect the common law right of all legally competent people aged 16 years or over to make their own informed decisions about medical treatment. No procedure or treatment should be undertaken without the full consent of the patient unless the patient is unable to give consent and treatment is urgently required. Failure to procure informed consent could result in litigation against the practitioner for assault and battery.\(^{1,2,3,4}\)

OBTAINING CONSENT
The treating medical officer is responsible for providing information and advice, and for obtaining consent of the patient\(^{3,4}\). Registrars and resident medical officers (RMOs) may be delegated the task of informing a patient and obtaining consent.

Nursing or administrative staff cannot obtain consent for a proposed operation, procedure or treatment and cannot be delegated the task of informing a patient about the material risks involved.

FOUR REQUIREMENTS FOR A ‘VALID’ CONSENT\(^{3,4}\)
The criteria listed below must be met whether obtaining a written or oral consent.
1. The patient must be capable of giving consent – i.e. they must be able to understand the implications of having treatment. This excludes:
   a) children under the age of 14 years,
   b) some people affected with mental illness, dementia, brain damage or intellectual disability; and
   c) some people temporarily or permanently impaired by drugs or alcohol.
2. The consent must be given freely, with no coercion from hospital staff, medical practitioners or family.
3. The consent must be specific.
4. The patient must be informed in broad terms of the proposed procedure, operation or treatment.

USING INTERPRETERS TO CONSENT
Interpreters should be used for any non-English speaking patient in order to ensure a valid consent is obtained. The interpreter must also sign the consent form.3,5

Relatives must NOT be utilised as interpreters5; bilingual staff members should not be used to interpret at professional levels (i.e. with consent for procedure, treatment or operation). Utilising anyone other than accredited and recognised Health Care Interpreters may invalidate the obtained consent.6

WRITTEN CONSENT
Consent may be given either orally or in writing, or may be implied from a person’s conduct (i.e. putting out his / her arm for cannulation).
Legally, consent does not need to be documented.\textsuperscript{4} It is both NSW Health Department and Liverpool Hospital policy to obtain written consent for invasive procedures.\textsuperscript{5,6}

\textbf{WHEN CONSENT IS NOT REQUIRED}
Consent is not required in the following circumstances (these apply to both adults and children):
\begin{enumerate}
\item where immediate treatment is necessary to save a person’s life; or
\item to prevent serious injury to a person’s health; or
\item to prevent the patient from suffering or continuing to suffer significant pain or distress.\textsuperscript{3}
\end{enumerate}

\textbf{WHO MAY CONSENT TO TREATMENT}
\begin{itemize}
\item In a patient under the age of 14 years, the consent of a parent or legal guardian is required.
\item A person aged 16 years and over is able to provide their own consent.
\item A child aged 14 or 15 years of age should have parental or guardian consent (unless the child objects), provided the patient adequately understands and appreciates the nature and consequences of the operation, procedure or treatment.\textsuperscript{1,6}
\item For patients aged 14 to 16 years, it is advisable to obtain parental or guardian consent, however, if the views conflict, the child’s views should take precedence and the Medical Administrator should be contacted.
\item Where a patient is unable to give consent, a “person responsible” may do so on the patient’s behalf. A “person responsible” includes: (in hierarchical order - keep moving down the list until the first suitable variable is fulfilled):
\begin{enumerate}
\item \textbf{Spouse or de facto} where a close relationship continues;
\item \textbf{Carer} where the carer provides unpaid domestic support on a regular basis, or organises same;
\item \textbf{Close personal friend or close relative} where there is a personal interest in the patient’s welfare on an unpaid basis.
\end{enumerate}
\end{itemize}
NB - Where there exists a guardian appointed by the Guardianship Board who has been granted consenting capability for medical procedures for the patient, this person becomes the “person responsible” overruling all others.\textsuperscript{1,3,7}

If nobody fits the “person responsible” role, the Guardianship Board can consent to major medical treatment and Medical Administration should be contacted. This, however, does not apply when emergency treatment is necessary.

REFERENCES:
Subspecialty consultants may also be a secondary admitting doctor, but primary care should remain with the Trauma Surgeon. If the patient has single system injury (e.g. head, orthopaedic), primary care may be transferred to the subspecialty consultant when the tertiary survey has been completed and both the subspecialty consultant and Trauma Surgeon have agreed. Most often transfer will occur between 24 and 48 hours following admission to hospital. Once this occurs, a note must be made in the chart to confirm this and the ward clerk can then change the primary doctor in the hospital computers.

These requirements recognise that even injuries which appear uncomplicated and single-system may be otherwise, and that continuity of care and repeat examination along with tertiary survey are vital to consistent and better trauma patient care. Subspecialty consultants are able to care for patients very well, however, the trauma surgery team is able to offer a unique and general approach to the patient permitting improved patient care.

Handovers between registrars and teams must be thorough to ensure optimal care.
The team of the admitting Trauma Surgeon is responsible for the daily care and examination of the trauma patient. Any investigations must be viewed and documented in the patient progress notes before the end of the day. Responsibility for this may be delegated by the registrar of the admitting surgeon.

If the patient’s clinical condition is unstable or rapidly evolving then the follow-up must change to keep up with this. All significant changes and results must be communicated to the admitting surgeon by the team registrar involved.

If a patient’s primary care is to be transferred to a subspecialty consultant then the team of that subspecialty consultant assumes primary care and the Trauma Surgeon’s team can “sign-off” on the patient. If however a problem arises or there is a question best suited to the trauma surgery team, then the team that admitted and cared initially for that patient is to be recontacted. Any new problems arising are NOT to be deferred to a new trauma surgical team or the team on call unless outside of normal hours or if the original Trauma Surgeon is on leave. This ensures adequate continuity of patient care. Admitted trauma patients are usually followed by the trauma surgery team for at least 48 hours from admission. Patients with multiple system injuries and those in the ICU should be followed longer to ensure all issues are addressed and complete patient care is achieved.
The tertiary survey is a complete head-to-toe examination of the patient and review of any investigations or imaging from the time of the patient’s admission. This occurs following completion of most aspects of definitive care and should occur within 24 hours of patient admission. It is to be carried out by the registrar of the admitting Trauma Surgeon except when the patient is admitted to one of the critical care areas (ICU, CCU) in which case the tertiary survey is undertaken by the Trauma Fellow.

Any further studies or investigations mandated by the tertiary survey should be documented in the progress notes and the results similarly documented when completed.

At Liverpool Hospital it has been previously shown that unrecognised injuries are found in up to 65% of patients and these are clinically significant in 15%. These injuries, although unlikely to result in mortality, can often lead to significant functional morbidity if left untreated. It is for these reasons that all trauma patients undergo a tertiary survey following admission.

It is important to remember that a tertiary survey in the first 24 hours can still miss injuries. Up to 40% of injuries are diagnosed in the two weeks following completion of the tertiary survey. Vigilance and careful re-examination is required to minimise the impact of these injuries and to effect treatment as early as possible.

REFERENCE:
These guidelines apply to all trauma patients who fit the criteria for admission into the clinical pathway. The clinical pathways have been based on extensive literature review, and have been designed to ensure common necessary elements of care are attended. They do not rule out need for clinical judgement, and are utilised only as a suggestion guide.

The five categories of clinical pathways are:

**Severe head injury** – any patient with a Glasgow Coma Score of 8 or less on arrival to emergency or during resuscitation, unrelated to drugs or alcohol alone.

**Fractured ribs** – fracture to 1 or more ribs based on clinical or radiological findings (includes fractured sternum).

**Fractured pelvis** – any break in the structural continuity of the pelvic ring and/or the acetabulum.

**Fractured femur** – any break in the structural continuity of the femoral shaft.

**Blunt abdominal trauma** – blunt injury to any solid organ, hollow viscus or other abdominal structure.

Patients are to be enrolled in the appropriate pathway in Emergency by the surgical registrar, or as soon as the patient is recognised to have injuries consistent with admission criteria of the clinical pathway.
REFERENCES:
PROBLEM
Incidence of proximal DVT without prophylaxis is 20%. 0.5 – 17% of patients with DVT’s will develop a fatal pulmonary embolus.

Adequate prophylaxis reduces the incidence of DVT to 10% and the incidence of fatal pulmonary embolus to < 0.1%.

No prophylactic regime is 100% effective in preventing thromboembolic events.

RISK STRATIFICATION

Highest  spinal cord injuries
spinal fractures
lower extremity fractures*
pelvic fractures*
venous / arterial injuries*
head injury*.

* The EAST (Eastern Association for the Surgery of Trauma) Group found no evidence of these specific groups of patients being high-risk, but most papers place these patients in the high-risk group.

High  Age > 60, major trauma patients.
Moderate  40 - 60 year old patients with trauma.
Low  Age < 40, minor injuries, patients likely to be mobilised early.
PROPHYLAXIS

High risk patients:
- Low molecular weight heparin (LMWH) enoxaparin.
- 30mg bd commencing within 12-36 hours of injury (or consider 40mg once daily in patients who are at increased risk of bleeding complications).*
- Elastic stocking (ES) / Intermittent pneumatic compressor (IPC) as soon as possible.
- No evidence that low dose unfractionated heparin is effective.

Moderate risk patients:
- Enoxaparin 30mg bd or heparin 5000 units s/c bd.*
- IPC or ES.

Low risk patients:
- Nil heparin or LMWH.

* 40mg once daily is used in most of Australasia and much of Europe.
SECTION 6

DELAY LMWH AND HEPARIN IN PATIENTS WITH:

- Intracerebral haemorrhage.
- Incomplete spinal cord injury with haematoma.
- Active bleeding.
- Coagulopathy
  [Liaise with primary team as to when it is safe to use LMWH or unfractionated heparin in these patients].

AVOID:  ES + IPC in patients with peripheral vascular insufficiency or known DVT.

CAVAL FILTER
Consider prophylactic insertion if you are unable to anticoagulate after 36 hrs and patient has one or more of the following:

- Closed head injury.
- Incomplete spinal injury.
- Complex pelvic fracture.
- Long bone fractures.

Also consider use in patients with:

- Recurrent PE despite adequate anticoagulant.
- Proximal DVT with contraindication to anticoagulant.
- Proximal DVT with active bleeding.
- Failed anticoagulation.
TETANUS PROPHYLAXIS

<table>
<thead>
<tr>
<th>TIME SINCE LAST TETANUS VACCINE</th>
<th>TYPE OF WOUND</th>
<th>ADT</th>
<th>TIG</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 5 years</td>
<td>all</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>5 - 10 years</td>
<td>clean minor wounds</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>5 – 10 years</td>
<td>all other wounds</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>&gt; 10 years</td>
<td>all wounds</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>Unknown or less than full series of 3 vaccines.</td>
<td>clean</td>
<td>Y</td>
<td>-</td>
</tr>
<tr>
<td>all other</td>
<td>Y</td>
<td>Y</td>
<td></td>
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</tbody>
</table>

REFERENCES:
Return of normal function to a patient following injury remains the goal of an optimally functioning trauma system. Rehabilitation is often thought of as a final step in care of injured patients yet it should really be considered as part of a continuum of care. In the acute phase of trauma patient care, rehabilitation is often a minor focus directed primarily towards preventing complications that may impair or inhibit return to normal day-to-day functioning. Once the risk to life has lessened, rehabilitation takes on an ever increasing and important role.

**Early rehabilitation includes prevention or lessening of:**
- Pressure area necrosis or skin breakdown.
- Muscle contractures (especially hands, arms and lower legs).
- Muscle atrophy from disuse.
- Inadequate nutrition.
- Thromboembolic complications.
- Delirium (especially in the elderly).
The potential for long-term impact of injury is most significant when injury affects the brain, spinal cord and extremities and is less dependent on simple severity of overall injury. Early attention to aspects of care which decrease morbidity to each of these systems and subsequent early involvement of rehabilitation specialists are the best way of assuring an optimal outcome.

Liverpool Hospital has separate general rehabilitation and brain injury rehabilitation consultation services staffed by both specialists and registrars. These serve the inpatient population and have many links to the community that facilitate transition of the injured patient towards independent living. Additionally, Liverpool Hospital has an on-campus but separate unit for head injured patients, the Liverpool Hospital Brain Injury Rehabilitation Unit (BIRU).

When to call the rehabilitation teams:
- When the patient requires in-hospital rehabilitation before discharge.
- To obtain consultation advice on management options for complicated patients requiring acute care and rehabilitation.

How to contact the rehabilitation teams:
- Page the registrar directly for inpatient referral: General rehabilitation and aged care: pager 25233 Brain injury unit: pager 25344.
  or
- Contact the general rehabilitation and aged care intake officer directly on extension 84762.
- Contact the brain injury unit directly on extension 85495.
There are three subspecialty populations of injured patients that are not kept at Liverpool beyond the early phase of care and these include:

- Spinal cord injury.
- Severe paediatric injury.
- Severe burn injury.

The immediate operative needs of these patients can be taken care of at Liverpool Hospital but these groups of patients require highly specialised units with specialised paramedical support teams for rehabilitation. These are located at other sites in greater metropolitan Sydney.

**Spinal**
Royal North Shore Hospital and Prince of Wales Hospital.

**Paediatric**
Sydney Children’s Hospital, Randwick and Children’s Hospital, Westmead.

**Burns**
Royal North Shore Hospital, Concord Hospital and Children’s Hospital, Westmead.
(To contact Burns services, please see page 297).
The beginnings of this highly specialised unit were at Lidcombe Hospital in the mid 1970’s. The unit as part of the Liverpool Hospital campus moved to its new facility in 1995. Its mission is to provide assessment, rehabilitation and a community support service for adults with traumatic brain injuries and their families. In addition they strive to educate, advocate and conduct research all of which is ultimately directed at minimising patient dependency and maximising function.

The BIRU has five service components. These are:
- 16 bed inpatient unit.
- 4 bed transitional living unit (TLU).
- Work assessment unit (WAU).
- Community outreach service.
- 4 bed respite and short-term accommodation service (Camden Respite House).
The inpatient ward and community service are co-located in one building on the grounds of Liverpool Hospital. The TLU is a modified house, less than a kilometer away from the hospital in a residential street. The WAU is located in a light industrial area close to the hospital and the respite house is a modified house a half-hour drive from Liverpool Hospital.

The support services available through the BIRU include:
- Medical management and specialised nursing staff.
- Physiotherapy, occupational therapy, speech therapy.
- Neuropsychology, clinical psychology.
- Recreation officer and social work.
- Individual and group-based living skills programs.
- Structured family program including relatives and carers groups.
- Recreational assessment for leisure activities, vocational assessment and retraining.
- Transitional living service, respite and short-term accommodation.
- Long-term case management, community development.
- Behavioural management, sexuality assessments and suicide intervention.
- Research, education, training and consultation.

**REHABILITATION OF THE ELDERLY**

Injury is less well-tolerated with increasing age. An elderly patient with significant injury is less likely to return to his / her previous level of functioning however, independent living is most often still possible. These patients are at high risk for in-hospital complications such as falls, pressure sores and skin breakdown as well as delirium. It is especially important with elderly patients that early assessment takes place by the rehabilitation and aged care team. Elderly patients often require extensive arrangements for out of hospital support and, if returning home, assessment of the home environment is required to ensure patient safety on discharge. Although all of the specific changes required are beyond the scope of this text, it is important that the correct team of carers is assembled to both assess and plan the patient’s...
discharge. It is best if the established rehabilitation and aged care team coordinates this aspect of care with their expert multidisciplinary team.

Liverpool Hospital has good rehabilitation services, and access to the Brain Injury Rehabilitation Unit. Early involvement of the rehabilitation and aged care team or brain injury team is important as is early attention to patient care details that can significantly impact patient morbidity during later phases of care.

REFERENCES:

Thank you to Drs David Conforti and Adeline Hodgkinson for their assistance in reviewing this chapter.
Anaesthesia is an integral component of the surgical management of trauma patients. Anaesthetists are familiar with the principles of EMST and resuscitation; many have an active interest in the subspecialty of Trauma Anaesthesia. Early communication with and involvement of the Anaesthesia service facilitates early and appropriate anaesthesia care. Because anaesthetists commonly coordinate competing demands for operating time, clear information about the patient’s condition and urgency priority classification are essential. Use the “MIST” mnemonic to transmit information to the anaesthetist.

AIRWAY MANAGEMENT
The trauma patient can present with particularly difficult airway problems. Frequently, rapid airway control is required to protect the airway from blood and gastric contents, and to ensure adequate ventilation. Difficult intubation may be anticipated in the following circumstances:

- Airway injury.
- Head and neck injuries.
- Obesity.
- “Bull neck”.
- Reduced mouth opening / prominent teeth.
- Underslung jaw.

Although the majority of emergency intubations can be safely performed with a rapid sequence induction (RSI) of anaesthesia and in-line cervical spine stabilisation, anaesthetists contribute other advanced airway techniques and experience with:

- Fiber-optic intubation.
- Specialised laryngoscopes.
- Intubation aids (bougies, LMA introducer).
- Alternative airways (double lumen tubes).
INTRA-OPERATIVE RESUSCITATION

During operative treatment, resuscitation by the Anaesthetist continues and involves repeated assessment and reassessment of Airway, Breathing and Circulation. Anaesthetic requirements are highly dynamic and the vigilant anaesthetist must be alert for emerging or covert injuries. This is especially relevant when operative treatment is initiated before completion of the primary or secondary surveys. Of particular importance is the prevention of secondary neurological injury by ensuring adequate cerebral perfusion, and reducing cerebral metabolic requirements with anaesthesia. Invasive and non-invasive monitoring of patient physiology provides breath-to-breath and beat-to-beat information about the patient’s condition as well as laboratory investigations. The management of pre-existing diseases, such as diabetes, COPD, and ischaemic heart disease, further complicate intra-operative priorities.

Pharmacological control is achieved through balanced selection of anaesthetic techniques:

- General anaesthesia (inhaled volatile; intravenous drugs).
- Local anaesthesia (neuro-axial, major plexus, nerve, field and infiltration blocks).
- Sedation.

Special care is required when sedation is administered to trauma patients, especially outside anaesthesia locations or critical care areas with patient monitoring. Altered pharmacological responses are common in trauma patients due to abnormal pharmacokinetics, changed drug
sensitivity or drug interactions. Unexpected responses to sedation can include loss of consciousness and cardio-respiratory arrest. Anaesthesia also involves careful administration of potent haemodynamic agents to control perfusion. These include pressor agents such as adrenaline, noradrenaline and metaraminol.

Physiological control involves the restoration or preservation of the body’s homeostatic mechanisms. Seriously injured patients may have overwhelming disturbances which can interfere with surgical management. The multi-trauma patient is more likely to die from a triad of:

- coagulopathy
- hypothermia
- metabolic acidosis

than a failure to complete operative repairs. The anaesthetist has a primary role in treating and monitoring these complications during surgery. However, if the patient is to survive, the operation may need to be foreshortened so that transfer to the ICU can facilitate warming and correction of hypothermia and acidosis. A decision to limit surgery to ‘damage control’ should be made early and should not wait for the patient to reach threshold values for core temperature, acidosis or transfusion volume. “Damage control surgery” refers to the principle that the first ‘damage control’ procedure aims to control haemorrhage, prevent contamination and to protect the patient from further injury. Once metabolic failure is controlled, definitive surgery can proceed. Clear communication and planning is required between surgeon, anaesthetist and intensivist to accomplish smooth transfers of care and appropriately timed surgery.
SECTION 6
PAIN MANAGEMENT
Early initiation of pain management is essential to attenuate the stress response to trauma. Acute pain is ideally managed with multi-modal therapies including opioid agonists, anti-prostaglandins, and neural blockade. Effective acute pain management can reduce the risk of subsequent chronic pain syndromes.

Patients will often be managed post-operatively with narcotic intravenous patient-controlled analgesia (PCA). Consider the use of thoracic epidurals in select patients to further optimise pain management, mobility and pulmonary toilet. Discuss these options with the treating anaesthetist, intensivist and acute pain service team.
SECTION 7

TRANSPORT AND DISPOSITION

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Intra-hospital transfer of critically ill patients includes transfer of patients from ED to ICU, ICU to radiology, ICU to theatre, and ICU to ward.

Regardless of the final destination, the principles of transport of critically ill patients are the same. These can be thought of in terms of the 3 P’s:

1. Planning.
2. Personnel.
3. Properties.
PLANNING
This includes determining the reason, risks and benefits of the transfer by assessing the clinical status of the patient and if necessary making changes and / or asking for senior staff assistance.

Planning also includes communication with the receiving end. Give them the estimated time of arrival (ETA) and make sure that they are ready to receive the patient and are aware of the patient’s needs e.g. oxygen, ventilator, power points, infusion pumps, etc.

As intra-hospital transfers are usually of short duration, a point can be made of removing all the unnecessary equipment (NG feed, CVP monitor, excess lines) so that you do not get lost in the maze of lines and tubes.

PERSONNEL
The personnel required for the transfer depend on the patient to be transported.
If a medical escort is required, the doctor is in charge of the transfer.
If a medical escort is not required the RN is in charge.

Indications for a medical escort are:
- Patient with a potential airway problem
  - intubated
  - tracheostomy with ventilatory support.
- Patient with potential cardiovascular instability.
- Nursing staff worried about the patient.
PROPERTIES
Dedicated equipment for transport must be checked and functional.

The level of monitoring required for the transport of the patient depends on the patient’s stability. For unstable patients the level of monitoring should be as comprehensive as it is in ICU, while for the stable patient no monitoring may be required e.g. patient going to the ward.

Basic monitoring devices are an ECG, non-invasive BP, and a pulse oximeter.

Equipment required for intra-hospital transfer is:
- Oxygen cylinder at least ¾ full.
- Airway and intubation equipment.
- Suction devices.
- Emergency drugs, analgesics, sedatives, and muscle relaxants.
- Warmed crystalloid +/- colloid, blood.
- Infusion pumps. These must be charged and power cord available to plug in the wall.
- Defibrillator if there is a potential for arrhythmias.
- Chest clamps if underwater chest drains are present.
- Notes, x-rays, request forms, consent form.

Intra-hospital transfer of critically ill patients with little physiological reserve may have a negative outcome for the patient and in these patients there must be a good reason for the transport. To make the transfer as smooth as possible, preparation is essential and ask for senior staff advice and/or assistance.
REASONS FOR TRANSFER
1. Specific injury pattern (e.g. burns, spinal cord injury).
2. Paediatric patient requiring intensive care or high dependency support.

Prior to contacting another unit ensure you have available information concerning name, DOB, time of injury, nature of injury, treatment to date, current vital signs, estimation of weight, reasons for referral.

1. SPECIFIC INJURY PATTERN

a. Burns
Hospitals are asked to ensure that consultation takes place at presentation for patients fitting criteria for referral to specialist burns units. Hospitals are also encouraged to consult with burns units for advice and assistance at any stage (see next page).

- Deep Burns involving:
  - 10% or more of the body surface area in adults, or
  - 5% or more of the body surface area in children.
- Burns to the face, hands, feet, perineum, inner joint surfaces, and inhalation injury.
- Burns and any of the following: major pre-existing disease, suspected child abuse, concomitant injury.
- Electrical and chemical burns.
The NSW Health Guidelines for the Retrieval of the Critically Ill must be consulted when deciding which patients may require retrieval (MRU and NETS guidelines displayed in resuscitation room). Refer to Page 294 for retrieval criteria for burns patients.

If the patient fits retrieval criteria, NETS or the MRU will assist with bed finding. If the patient does not require retrieval the designated adult burn referral centres are Concord and Royal North Shore Hospital.

Concord Hospital
Royal North Shore Hospital
Children’s Hospital Westmead

For Burns hospitals contact details see page 297.

b. Spinal Injury
The designated adult spinal injuries units are Prince Henry / Prince of Wales Hospital and Royal North Shore Hospital. Ring either hospital and ask for spinal registrar or consultant on:

Prince Henry / Prince of Wales 9382 2222
Royal North Shore Hospital 9926 7111

For paediatric referrals call NETS.

2. PAEDIATRIC REFERRALS:

Contact NETS on 1300 362 500

You will be teleconferenced with a NETS retrieval consultant, a medical officer from the accepting institution (a fellow, intensivist or emergency physician) and the NETS transport medical officer. This service will assist you in ongoing management and bed finding if required.
3. **ADULT TRANSFER DUE TO LACK OF ICU / HDU BED:**
Local resources should be exhausted prior to requesting transfer. In particular the intensive care consultant on call must be involved in the decision to request transfer to another ICU. Each metropolitan Area Health Service is ultimately responsible for meeting the intensive care needs of that Area.

“If difficulty is experienced in locating an appropriate intensive care bed after consultation with the Area’s traditional referral intensive care unit(s), or if clinical advice is required, the Medical Retrieval Unit and a duty Medical Retrieval Consultant are available to assist” *NSW Department of Health Circular No. 97/118.*

**For adults contact the Medical Retrieval Unit on 1800 650 004.**

You will be teleconferenced with the Medical Retrieval Officer +/- the accepting institution.
In all situations the Trauma Team Leader is responsible for the patient from the time the patient arrives in the resuscitation bay and is handed over by the pre-hospital care providers. The Trauma Team Leader remains responsible until the patient’s care is handed over to another individual.

The trauma team is led by the ED registrar for the first half of the month and by the ICU/resuscitation registrar for the second half of the month. ICU, ED and Trauma Surgical consultants, the Trauma Fellow and surgical registrar will also lead the trauma team when required and then assume all of the responsibilities of the position.

**UNSTABLE OR CRITICALLY INJURED AND LEAVING THE ED**

All unstable patients should not leave the resuscitation bay unless going to the operating theatre.

All critically injured patients and patients who are intubated, ventilated, have invasive monitoring or otherwise potentially requiring medical intervention must have a doctor and nurse escort. Most often this is the Trauma Team Leader. This role can only be delegated to another doctor who would otherwise be qualified to lead the trauma team. These movements may be to theatre, radiology or the ICU.
In general, the patient is accompanied by the registrar leading the trauma team, regardless of whether the patient is likely to go straight to theatre or elsewhere following investigations. On occasion, the ICU registrar will assume responsibility for the patient after the secondary survey (even if not team leading) if it is likely that the patient will be going straight to ICU afterwards. Conversely, if it is likely that the patient is going to be transferred soon (e.g. critically injured paediatric and burns patients), then the ED registrar will take responsibility and care for the patient during investigations and in the resuscitation bay until the transport team arrives.

STABLE PATIENTS
Once the trauma team has completed the secondary survey, trauma series of x-rays and devised an investigation and treatment plan, patient stability can usually be ascertained. The stable patient can leave the emergency department for investigation or to go to the ward or theatre unaccompanied only if they are entirely stable.

Patients who have multiple injuries but are otherwise stable and not intubated or ventilated, patients who are uncooperative, or patients going to the CT scanner may go with an appropriately skilled nurse escort and orderly as long as a responsible doctor who knows the patient is available to respond quickly if needed.
# SECTION 8

## SPECIAL SITUATIONS

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The principles of treating paediatric trauma victims are in many ways similar to adults, however, there are some specific aspects of the care of the paediatric population worth highlighting.

Preparation and anticipation are even more important. Drug doses are weight based as are many pieces of equipment used e.g. ETT. Weight can be estimated by age using the formula:

\[
\text{Wt in kilos} = 2 \times \text{age (in years)} + 9
\]

Additionally, ETT diameter needed:

\[
\frac{(\text{Age} + 16)}{4}
\]

All Trauma Team Leaders should have a paediatric drug dose book (e.g. Drug Doses by Frank Shann) on their person to assist in accurate dosages.

Paediatric trauma patients under 14 years of age come under the care of the Paediatric Surgeon on call. All those over 14 years of age come under the Trauma Surgeon on call.

The paediatric registrar is not part of the trauma team, however, during the day they are available in the hospital and may be useful for advice. There is a neonatal registrar on site 24 hours a day and could
be invaluable to assist as an adjunct in the neonatal subgroup - contact on pager number 49361.

Some general comments on examination of children:

a) The ED is a loud, cold, frightening place for a child. Keep noise to an absolute minimum and speak gently and quietly to the child explaining all steps ahead of time.

b) When examining, warm your hands, use distractions such as toys or songs “Bananas in Pyjamas” often works. Avoid multiple examinations.

c) Parents / carers are part of the resuscitation process and should be with the child whenever possible.

d) Keep the child warm. A higher body surface area to weight means heat loss is faster than in adults. Warm IV fluids.

e) Give analgesia early. Give it IV. Give it in adequate doses e.g. 0.1 to 0.15mg/kg morphine IV. Titrate to effect.

f) Remember that the child has a smaller physiological reserve and may suddenly decompensate. Therefore ANTICIPATE and plan ahead.

g) Get the ED social worker involved early to assist in family dynamics.
Liverpool Hospital is not equipped to look after children in the ICU. As a result children may need to be retrieved to a children’s hospital. In an unstable patient they will have surgery here at Liverpool e.g. extradural drainage, then be transferred from the recovery bay. At other times e.g. “conservative” management of a splenic injury, the child will be transferred from the ED. In the ED the Trauma Team Leader usually coordinates this in consultation with the paediatric surgeon on call at Liverpool Hospital.

REGARDLESS OF DESTINATION, THE TRANSPORT PROCESS IS THE SAME
a) Give the NETS an early call so they are able to mobilise as efficiently as possible.
b) The NETS contact number is 1300 362 500. Once contacted they will organise a conference call with you, the NETS consultant and the ICU consultant. They will discuss the case and follow a retrieval check list (following the A,B,C,D priorities) to ascertain if there is anything they would like addressed before transfer.
c) They organise the bed and retrieval team and will contact you with a hospital and estimated time of team arrival.
d) Photocopy all notes and ask radiology to scan the films.
e) Contact the paediatrician on call so they are aware of the transfer.
f) Until formal hand-over occurs with the retrieval team the care of the patient remains with the trauma team led by the Trauma Team Leader.
Injury during pregnancy evokes a certain amount of anxiety because of its infrequent occurrence and the complex implications. By definition, it constitutes a multi-trauma and throughout the resuscitation and assessment of the woman, it is important to remember that there are two patients. Of particular importance is that one of these patients must be resuscitated aggressively to save the other and very occasionally the baby has to be delivered to save the mother.

The aim of this chapter is to provide an overview of the current management and issues in relation to trauma in pregnancy.

Trauma in pregnancy is a relatively uncommon event, reported as occurring in 6-7% of traumas in the United States(1). Data from around Australia currently provided by Nepean, Auckland, Royal North Shore, Westmead, John Hunter and Royal Perth Hospitals, suggest that trauma is relatively infrequent during pregnancy. Trauma in pregnancy can be divided into two categories – major and minor trauma. At Liverpool Hospital 5 serious injuries to pregnant women were seen between January 1996 and December 1997. This yields an incidence of significant trauma in pregnancy of approximately 0.1%.

Anatomical and physiological changes occur during pregnancy that can mask or mimic injury and physical signs can be misinterpreted. Occasionally trauma care givers have a fear of harming the baby or upsetting the patient and this can result in a passive “do nothing” approach that can have a potentially devastating effect on outcome. It is important that there is no delay in the correct diagnosis and prompt initiation of treatment. The physiological changes seen in pregnancy are shown in Table 1.
PHYSIOLOGICAL CHANGES ASSOCIATED WITH PREGNANCY

Table 1

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Non-pregnant</th>
<th>Pregnant</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cardiovascular</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heart rate</td>
<td>70-80 bpm</td>
<td>↑ to 10-15 bpm</td>
</tr>
<tr>
<td>Cardiac output</td>
<td>4.5 L/min</td>
<td>↑ to 6 L/min</td>
</tr>
<tr>
<td>Systolic blood pressure</td>
<td>110 mm Hg</td>
<td>↓ by 5-15 mm Hg</td>
</tr>
<tr>
<td><strong>Haematology</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blood volume</td>
<td>4000 mL</td>
<td>↑ by 30%-50%</td>
</tr>
<tr>
<td>Plasma</td>
<td>2400 mL</td>
<td>↑ to 3700 mL</td>
</tr>
<tr>
<td>RBC</td>
<td>1600 mL</td>
<td>↑ to 1900 mL</td>
</tr>
<tr>
<td>Haemoglobin</td>
<td>12-16 gm/dL</td>
<td>↓ to 10-14 gm/dL</td>
</tr>
<tr>
<td>Haematocrit</td>
<td>37%-48%</td>
<td>↓ to 32-42%</td>
</tr>
<tr>
<td>WBC</td>
<td>4500-10,000</td>
<td>5000-14,000</td>
</tr>
<tr>
<td><strong>Respiratory</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tidal volume</td>
<td>500 mL</td>
<td>↑ by 40% (700mL)</td>
</tr>
<tr>
<td>Residual volume</td>
<td>1200 mL</td>
<td>↑ by 40% (720mL)</td>
</tr>
<tr>
<td>Respiratory rate</td>
<td>12-20 breaths/min</td>
<td>Increased</td>
</tr>
<tr>
<td>PH</td>
<td>7.38-7.44</td>
<td>↑ 7.41 – 7.46</td>
</tr>
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In addition, there are significant anatomical and functional changes which occur during pregnancy:
- delayed gastric emptying
- increased gastroesophageal reflux
- upward displacement of the peritoneal contents
- displacement of the urinary bladder, and
- widening of the symphysis pubis.

MATERNAL FOETAL UNIT
The foetus is usually well compensated for life through higher affinity of foetal haemoglobin for oxygen. At any given partial pressure of oxygen, foetal haemoglobin has a higher affinity for oxygen than maternal haemoglobin. Oxygen transport in the foetal placental unit is intimately tied to the maternal uterine blood flow. Because of the
passive uptake of oxygen, foetal oxygenation is not higher than that in the uterine vein.

MATERNAL ASSESSMENT
When confronted with an injured pregnant patient the mother should be attended to first, as rapid resuscitation of the mother optimises foetal outcome. Maternal assessment should follow guidelines laid out by the EMST / ATLS® approach to trauma, with a detailed primary and secondary assessment. In relation to primary assessment, there are some slight differences from the assessment of the non-pregnant patient. In particular, positioning of the pregnant patient is very important especially in the third trimester. A supine patient often has vena cava compression reducing venous return. It is important to tilt the pregnant patient to the left by approximately 35°. The patient should be tilted as an entire unit, maintaining stabilisation of the cervical spine (Figure 1).
THE RISKS OF TRAUMA IN PREGNANCY
The risk to the pregnancy in “minor” or non-catastrophic trauma is still significant, with pre-term labour occurring in 8%, abruption in 1% and foetal death in 1%. For those with major trauma, mortality to the mother is approximately 9% depending on injury severity score. The foetal death rate is 20% or greater and foetal injuries occur in isolation in 5%. The pattern of serious injuries in pregnancy is slightly different from that of non-pregnant women with injuries to the abdomen more common than injuries to the head and chest.

INVESTIGATIONS

How does one approach abdominal evaluation during pregnancy?
The best indication of maternal or placental injury comes from clinical observation. Clinical findings of placental abruption may include vaginal bleeding, abdominal cramps, uterine tenderness, amniotic fluid leakage, and maternal hypovolaemia out of proportion to visible bleeding. Remember that up to 2 litres of blood can accumulate in the uterus and this can be a cause of maternal shock. The uterus may clinically seem larger than normal for gestational age. Change in foetal heart rate may also indicate placental injury. Abdominal signs can be more difficult to interpret in a pregnant woman and for this reason, ultrasound of the abdomen to detect free fluid is useful (Figure 2). Diagnostic peritoneal lavage can be used and has an accuracy of 92%. CT scanning can be used, however it should be avoided if at all possible especially in the first and early second trimester because of potential radiation side effects. Ultrasound has the
potential advantage of being able to detect significant foetal injuries, however it is not good in determining abruption or uterine rupture. It has an accuracy of only 50% in detecting abruption.

FOETAL MONITORING

Is it needed and how long should we use it for?
Any viable foetus of 24 weeks gestation or more requires monitoring after trauma. This includes patients with no obvious signs of abdominal injury. Pearlman has recommended a minimum of 4 hours of cardiograph (CTG) observation to detect intra-uterine pathology. This should be extended to 24 hours if at any time during the first 4 hours there is more than one uterine contraction every 15 minutes, there is uterine tenderness and a non-reassuring foetal monitor strip, vaginal bleeding, rupture of the membranes or any serious maternal injury.

Over the last 10 years at Liverpool Hospital we have had 6 foetal deaths, of which 5 arrived in our resuscitation room with foetal heart sounds, or CTG evidence of viability. It is important that there is a joint multidisciplinary monitoring approach to the pregnant trauma patient. Rapid caesarean section facilities should be available. In the presence of placental abruption, when the foetus is alive on presentation, foetal
distress is present in over 60% of these cases and an immediate caesarean section is required. Resuscitation of the mother is absolutely vital and if maternal shock occurs, the foetal mortality approaches 80%.

What about Peri-mortem Section?
Restoration of normal maternal and foetal circulation is the goal in trauma resuscitation. However, exclusive attention to the mother may prevent recovery of a potentially viable baby. Maternal revival after delivery of the foetus has been reported in peri-mortem circumstances, presumably due to relief of vena cava compression, however, this is rare. It has therefore been suggested that there is no such thing as a postmortem section only a perimortem section. If there is no response to advanced resuscitation within a few minutes, maternal CPR should be continued, (if necessary this can be performed through a thoracotomy without cross clamping the aorta) and an emergency room caesarean section performed.

In a review of 250 years of literature, Ritter has documented 120 successful perimortem caesarean sections*. Of these, 61 babies have survived perimortem caesarean section to discharge from 1900 to 1985. 70% were delivered in less than 5 minutes, 13% in 6-10 minutes, 12% in 11-15 minutes and 5% after 16 minutes. The incidence of neurological sequelae increased with longer delivery time. It is important to realise that there is a difference between survival rate from peri-mortem sectioning and discharge home, as less than half those who actually survive a perimortem section are discharged. Caesarean section should only be performed in the emergency department where the uterine size exceeds the umbilicus, where there is evidence of foetal life by clinical examination, either on doppler or ultrasound, and when the patient has not been receiving CPR for
more than 10 minutes.

It is important to remember other conditions that can occur in trauma in pregnancy:

- amniotic fluid embolism, which is rare but an important cause of disseminated intravascular coagulation and shock, and more commonly
- foetal maternal haemorrhage.

Foetal maternal haemorrhage (FMH) is the transplacental haemorrhage of foetal cells and is a unique complication of pregnancy. The reported instance of FMH is 8-30% compared to 2-8% for non-traumatic victims. Anterior placental location and uterine tenderness have been associated with an increased risk of foetal maternal haemorrhage. Complications of FMH include rhesus sensitisation in the mother, foetal anaemia, foetal paroxysmal tachycardia and foetal death. As little as 1ml of rhesus positive blood can sensitise 70% of rhesus negative women. Therefore, all rhesus negative mothers who present with a history of abdominal trauma should receive a prophylactic dose of Rh immune globulin. The Kleihauer-Betke test has been utilised to determine the presence of foetal maternal haemorrhage. It is not entirely accurate and is not necessary in Rh positive women.

CONCLUSION

- After injury during pregnancy, the key to a successful outcome for both the mother and child is prompt and adequate initial assessment and resuscitation of the mother.
- All patients with minor trauma should be admitted to hospital for at least 24 hours.
- Those with major trauma always require a multidisciplinary approach.
- Careful foetal monitoring is essential once foetal viability has been established.
- If maternal resuscitation fails, urgent perimortem caesarean section may be useful with short CPR times.
REFERENCES:
Although there are no changes in protocol, the elderly trauma patient poses a number of important challenges. Even relatively fit older persons have a reduced physiological reserve compared to younger counterparts, and will tolerate primary injuries and secondary insults less well. The effects of ageing also induce more serious damage from apparently minor accidents so a high index of suspicion should be maintained for occult injuries. In the face of higher mortality and morbidity the principles of treatment do not alter, but great attention to detail must be paid by the team in the primary resuscitative phase, and even more so during the rest of the hospital stay. The aim of treatment for the patient must be a return to independent living where possible. Although the elderly have a higher than predicted mortality from trauma, aggressive management produces good results and a high proportion can return to their previous mode of living.\textsuperscript{1,2}

\textbf{RESUSCITATION}

Trauma teams should be activated more readily for elderly patients with borderline mechanisms of injury such as same level falls.\textsuperscript{3,4} Being elderly is a criterion for team activation in some centres.\textsuperscript{5}

\textbf{Airway / Breathing:}
Reduced respiratory reserve may require that the patient be intubated and ventilated when a younger patient might not need it.

\textbf{Circulation:}
Pouring in 2L of crystalloid followed by blood intravenously may well push the elderly patient into heart failure. On the other hand withholding necessary fluids for fear of causing heart failure will also harm the patient. Therefore fluid administration and the response to it must be carefully watched.
Disability:
Some elderly patients will already have had strokes but do not assume this without definite confirmation from a carer. Weakness in any limb should be treated as part of the injury pattern initially. Remember that the motor component of the Glasgow Coma Scale is the best response obtained. If there is no response to pain on one side check the other.

Exposure / Environment:
Although the patient must be fully undressed to allow proper treatment, they should be kept covered whenever possible. The elderly are very susceptible to hypothermia.

CONCURRENT ILLNESS AND MEDICATIONS
The effect of concurrent illnesses and their treatment must not be forgotten. For example β-blockers may prevent patients mounting a tachycardia in response to blood loss, which will disguise the level of shock present. If the patient cannot give their past history and medications this must be swiftly obtained from relatives or carers. A search of belongings may yield useful information.

A patient taking warfarin who suffers a head injury must have a CT scan. This applies even if the injury seems trivial and the patient well with no history of loss of consciousness.

Many elderly people have reduced glucose tolerance even if they are not diagnosed as diabetics. All diabetics and those with reduced glucose tolerance who suffer traumatic injury must be assessed by the endocrine team during hospital admission.

INVESTIGATIONS
On the chest radiograph beware of bullae mimicking pneumothoraces. The cervical spine radiograph may be difficult to interpret due to degenerative changes; if unsure treat with care and get a second opinion from radiology and neurosurgery.
SECTION 8

POST-RESUSCITATION

Elderly patients suffer more and faster from the effects of immobility. They have a higher risk of thrombosis and must start prophylactic treatment early. Spinal boards can produce pressure sores within 2 hours and must be removed as early as possible.

Pulmonary complications are also frequent. Patients with proven or suspected rib fractures should be placed on the rib fracture pathway and adequate analgesia ensured. This may well require an epidural and admission to the Intensive Care Unit. Without proper analgesia and physiotherapy, pneumonia is likely, which may necessitate a longer ICU stay later in the course of treatment. For each rib fracture in the elderly mortality increases by 19% and the risk of pneumonia by 27%.

As well as physiotherapy a whole multidisciplinary team will be required for the patient. The Rehabilitation and Aged Care team will be required to manage and optimise any ongoing medical problems. Occupational
therapy will be needed to advise on the patient’s readiness for discharge and his / her home’s suitability. The attitude of the patient’s family is vital to a successful outcome for the patient and they should be involved as early and as fully as possible. There may be a requirement for a short-term rehabilitation placement prior to a return home.

**REFERENCES:**

1. Battistella FD, Din AM, Perez L. Trauma patients 75 years and older: long-term follow-up results justify aggressive management. *J Trauma* 1998: 44(4); 618-23.


It is a big problem in trauma (15% of all traumas).
- It is an independent cause of mortality.
- It is preventable.
- Solution: Think Tropical Always

WHAT IS HYPOTHERMIA?
- Hypothermia ≤ 35°C
- Severe ≤ 32°C.

WHAT IS THE INCIDENCE OF HYPOTHERMIA IN TRAUMA PATIENTS?
A study performed by Keith Gunning at Liverpool Hospital showed that 17% of patients with an ISS of more than 15 were hypothermic (< 35°C) at some stage during their first 24 hours in hospital. 3% of patients became hypothermic in the ED or CT scanner. All patients who underwent surgery in the first 24 hours were normothermic in the ED and became hypothermic in the operating theatre (OT).

The incidence of hypothermia in trauma victims in other countries may be as much as 50%. In some of these studies the greatest temperature losses occurred during the resuscitation period. In another study, 18% of trauma patients became hypothermic in the ED and only 1% of patients became hypothermic in the OT. Nonetheless, 47% of patients who had a trauma laparotomy were hypothermic in the OT.

REMEMBER - WARM THEM EARLY AND KEEP THEM WARM.
PRE-ARRIVAL PREPARATION IN RESUSCITATION

- Give warm fluids only.
- Keep patient covered.

COMPLICATIONS OF SEVERE HYPOTHERMIA

- Cardiac dysrhythmia.
- DIC.
- Stress ulcers.
- Pneumonia.
- Infections.
- Renal failure.
- Hepatic failure.
- Pancreatitis.
- Diabetes-like syndrome.
- Hypoglycaemia.

THE BIGGEST CAUSE OF HYPOTHERMIA IS BLEEDING

CONTROL HAEMORRHAGE EARLY!
COAGULOPATHY
The direct effects of hypothermia on clotting mechanisms are difficult to measure and are frequently masked by dilutional coagulopathy or DIC in the trauma setting. Hypothermia per se does not result in a reduction in clotting factor levels and conventional clotting studies will be near normal. Routine clotting tests are performed on blood that is warmed to 37°C.

When these laboratory tests are repeated at hypothermic temperatures the clotting times are prolonged in a dose-related manner. A temperature of 32°C equates to clotting factor activity of 2.5% of normal. It is postulated that the major effect on clotting factors during hypothermia is on the kinetic activity of clotting enzymes.

The appropriate treatment for hypothermia-induced coagulopathy is rewarming rather than administration of clotting factors.

Hypothermic coagulopathy is implicated as the cause of significantly increased blood loss and increased mortality following trauma laparotomy. Even when patients were stratified by injury severity score (ISS), blood loss was significantly increased by intraoperative hypothermia.
MYOCARDIAL ISCHAEMIA
Inadvertent peri-operative hypothermia has been shown to be associated with myocardial ischaemia, angina and hypoxia (PaO$_2$ < 80mmHg). A randomised, controlled trial of routine vs supplemental warming care in patients undergoing abdominal, thoracic or vascular surgical procedures with pre-existing coronary disease showed that maintaining normothermia reduced the risk of cardiac events by 55%.

OUTCOME
It has been pointed out that hypothermia naturally occurs during the process of dying and that retrospective data simply identify those that are succumbing to their injuries.

There are a number of retrospective studies identifying hypothermia as an independent predictor of poor outcome in trauma patients. The landmark study of Jurkovich et al showed that a core temperature of 35 - 32°C was associated with a significant increase in mortality from trauma. Patients with core temperatures less than 32°C were unlikely to survive.

More recently the same investigators in Seattle have published a number of papers extolling the virtues of rapid correction of hypothermia. A recent study was a randomised, controlled trial of conventional rewarming vs rapid rewarming of critically ill trauma patients. Rapid rewarming was achieved using a continuous arteriovenous rewarming device (CAVR) similar to an AV haemofiltration circuit, but with the filter replaced by a heat exchanger.

CAVR patients were rewarmed more quickly and required less fluid during resuscitation (~24L vs ~33L). Patients who underwent CAVR had significantly less early mortality (although the mortality advantage was non significant at discharge).

The case for rapid restoration of normothermia in the trauma patient is strong but not without dissenters. Those concerned with the treatment of brain injured patients point toward a small number of studies that suggest a beneficial outcome from hypothermia. These studies are
related to the treatment rather than resuscitative phase of the patients’ hospitalisation and not necessarily to patients with multiple injuries.

**WHY DO TRAUMA PATIENTS BECOME HYPOTHERMIC?**
- Environmental exposure (pre-hospital and in hospital).
- Impaired heat production.

The influence of environmental exposure is compounded by the reduction in heat production that is a feature of traumatic injury. Severely injured patients do not increase their metabolic rate to compensate for heat loss in the same way as the uninjured. An increase in metabolic heat production may simply be impossible during traumatic shock as the tissues are no longer adequately supplied with oxygen. Rapid resuscitation following trauma produces a rise in oxygen consumption above normal, suggesting that the metabolic response is appropriate when the tissues are adequately perfused.

**HOSPITAL ENVIRONMENT**
Particularly during the summer months a trauma patient may be exposed to a worse thermal environment when admitted to hospital. Most areas of the hospital, including the ED, OT and ICU are air conditioned and the temperature and humidity may both be considerably lower than outdoors. A normal human’s thermoneutral temperature when naked is 28°C. When exposed to a typical ED environment with dry air at 22°C, radiant and evaporative heat loss will continue unless specific measures are taken to reduce them. Many normothermic trauma victims become hypothermic in the ED.

**RESUSCITATION AND INVESTIGATION**
Exposure of the patient must, of course, continue to allow a thorough survey of injuries. Exposure is also necessary for many of the routine or diagnostic procedures associated with trauma resuscitation. Bladder catheterisation, peripheral and central intravenous access
and peritoneal lavage will all expose a good deal of the patient to further heat loss.

Intravenous fluids are seldom at optimal temperature when infused into the patient, despite efforts to warm them. Even normothermic fluid will simply prevent further heat loss rather than treat hypothermia from other causes. Room temperature crystalloid (the ‘hanging bag’) and poorly rewarmed blood products will significantly contribute to heat loss.

Initial and definitive radiological investigations require the removal of ‘excess’ coverings, and transfer to the x-ray department may increase environmental exposure, as well as postpone rewarming techniques.

Intubation bypasses the body’s normal humidification system. Up to 10% of total heat loss occurs via respiration, principally due to the specific latent heat required to vaporise water and humidify the inspired gases. Active warming and humidification of the airway is rarely a feature of ED resuscitation.

**ANAESTHESIA AND SURGERY**

The patient requiring surgery will be subjected to a whole new range of heat losing opportunities.

The **thermal environment** may be even worse than the ED as modern theatre suites possess air conditioning systems with high rates of air exchange. Evaporative heat loss is dramatically increased by air flow, particularly over moist body surfaces or cavities. In addition, conduction to the operating table becomes a significant factor.

**Surgery** itself demands not only exposure of relatively large areas of the body surface, but also involves covering significant areas in cold skin cleaning solutions, some of which are more volatile than water and will cause significant cooling during vaporisation. During any operation there is the potential for further blood loss, requiring fluid replacement. One or more body cavities may be opened, greatly increasing evaporative heat loss.
Anaesthesia causes the greatest heat loss in the OT despite all these ‘surgical’ factors. This occurs in four distinct ways:

1. All forms of anaesthetic agent reduce the basal metabolic rate from a normal of 50 to 40 W/m².
2. Anaesthesia and muscle relaxation abolish shivering thermogenesis, which can increase heat production by up to 5 times normal.
3. All forms of anaesthesia cause peripheral vasodilation, opposing vasoconstrictive heat conservation. This redistributes the body’s heat energy to the periphery, where it can be more easily lost to the environment.
4. Volatile and narcotic agents reset the hypothalamic control of temperature to a lower ‘normal’.

Additional heat losses will continue if intravenous fluid is inadequately warmed and if inspired gases are allowed to remain dry and cold.

**Measuring body temperature:** Core temperature can be misleading!!
The human body is not a thermally homogeneous mass. The body may be divided into three thermal areas:

- **Core** = brain, thoracic and abdominal organs, deep tissues in limbs
- **Intermediate zone** = can be part of core or can reduce in temperature
- **Shell** = variable depth, in contact with insulation from external environment.

Temperature regulation and the relative size of these areas is under central control in the pre-optic anterior hypothalamus which responds to both central and peripheral temperature receptors. Vasoconstriction in response to cold will increase the size of the intermediate zone and reduce the temperature of the shell in order to maintain the core temperature. Core temperature is maintained despite a considerable loss of heat energy, until a critical decrease in body heat content has already occurred.

*Measurement of core temperature alone will miss total body heat loss until decompensation. Waiting for core temperature to drop before instituting treatment is analogous to waiting for hypotension before treating blood loss.*
TREATMENT OF HYPOTHERMIA

Fiddling whilst Rome burns

According to the available evidence, ED physicians and anaesthetists are simply watching (and maybe documenting) whilst many of our sickest patients are progressively becoming more hypothermic. We are then expecting the surgeons to deal with a haemorrhaging patient whose clotting factor function is next to zero. In one series of trauma victims undergoing laparotomy, 90% of deaths occurred in the coldest patients (< 33°C). Nine of these ten patients exsanguinated either in the OT or in the immediate postoperative period.

The ideal scenario would be one of early identification of at-risk trauma patients and timely intervention to prevent the development of hypothermia. Local audit will identify those at risk and their differentiating features, protocols backed by staff education and awareness will provide a framework for intervention. This may not be as sexy as the dramatic intervention of a portable bypass machine but certainly better for patient outcome.

PREVENTION OF FURTHER HEAT LOSS

1. Drying
   The benefit of removing wet clothing and drying the patient as soon as possible cannot be overemphasised. Water is a much better thermal conductor than air and will convey heat away from the body by evaporation and conduction to any objects in contact with the patient.

2. Environment
   Radiation to surrounding objects and the air immediately adjacent to the skin accounts for 40% of heat loss. Convection of the surrounding air and conduction to surfaces in contact with the body (the resuscitation trolley) account for a further 30% of heat loss. These three forms of heat loss are dependant upon a temperature gradient between the patient and his or her surroundings.
Thus the thermal comfort of the staff working in ED, OT and ICU is paid for by the induction of hypothermia in a proportion of their patients. Similarly, evaporative heat loss continues to be a significant factor even when the patient is cold. Up to 20% of total body heat loss may be via evaporation. 100% humidity in the resuscitation areas would, of course, reduce this loss to zero.

More realistically, surgeons and anaesthetists who care for paediatric or burns patients are more acutely aware of the effect of the environment and describe ambient OT temperatures of up to 26°C as “tolerable”. In Liverpool Hospital this would mean a rise of 4°C in ED and OT temperature. A 4°C difference between the patient’s skin and the environment has the same thermal consequences as infusing 4 litres of room temperature fluid per hour.

3. Insulation

1. Blankets
   - Several layers trap air which acts as effective insulation.
   - Pre-warming blankets is important. Otherwise, the patient’s body heat is used to increase the blankets’ temperature.

2. Space blankets
   - Better insulation than a standard blanket.
   - Must be closely applied next to skin to act as radiant barrier - cover with normal blanket(s).

3. Convective air blankets
   - When body well covered and blanket ‘sealed’ by additional coverings around the edges - provides very effective (43°C) insulating layer.
   - Little active warming as air has minimal heat content.
   - Patient must be dry to prevent evaporative loss.

The closer the environmental temperature is to the patient’s thermoneutral temperature, the less the heat loss.
4. **Passive rewarming**

If thermal insulation reduces heat loss to less than metabolic heat production, then the patient’s temperature will increase. If all heat loss is prevented then basal heat production can be expected to achieve a rewarming rate of 1.2°C per hour. If the effects of hypoxia, trauma or anaesthetic agents do not prevent it, shivering can increase the rewarming rate to 3.6°C per hour. This will be at the expense of a greatly increased metabolic rate and oxygen consumption and may lead to anaerobic metabolism, lactic acidosis and significant cardiopulmonary stress. Passive rewarming should therefore be reserved for patients with moderate hypothermia who still have some physiological reserve to allow an increase in metabolic rate.

It should always be remembered that as much as 50% of radiant heat loss occurs from the head, particularly in those who lack their natural insulation.

5. **Active Rewarming**

**Afterdrop**

External active rewarming of a hypothermic patient will cause peripheral vasodilation. Increased blood flow through the peripheral tissues is thought to return cold, acidotic blood to the central circulation. Core temperature initially falls 0.5 to 1°C before rising again. In severe hypothermia the acidosis may increase myocardial irritability and acute peripheral vasodilation may cause a relative hypovolaemia and require volume correction.

6. **External rewarming**

1. Water-circulating heating blankets.
   - Electrically heated pads.
   - External active warming to body surface in contact with pad / blanket (20-30% of BSA).
   - More effective when placed over patient (decreased radiant heat loss).
   - May burn poorly perfused tissues.
2. Radiant heaters.
   - Radiant heat gain requires that the patient is uncovered.
   - Allows procedures without interrupting rewarming.
   - Heats attending staff as well as patient.
   - May cause thermal injury to underperfused tissues.

3. Airway rewarming.
   - Modest heat transfer.
   - 41°C supersaturated air - water condenses releasing latent heat of vaporisation.

7. Core rewarming
   Water is a very efficient conductor and therefore a donor of heat energy. Heat transfer is simply a function of the temperature change of the fluid that is being infused or circulated and the volume of the fluid. Core rewarming avoids the problem of afterdrop.

1. Warmed intravenous fluids.
   - Many IV warming devices are inefficient at resuscitation flow rates.
   - The greater the temperature difference between fluid and body, the greater the heat transfer.
   - Technique is volume limited.
   - Hyperthermic fluids would add benefit but < 45°C provides only modest heat transfer and 45 - 65°C requires central venous access to avoid tissue damage.

2. Body cavity lavage.
   - Stomach via NG tube (risks aspiration), rectum, peritoneal, pleural and bladder cavities.
   - Relies on a large supply of preheated (40°C) sterile balanced salt solution.
   - Delivers heat energy in proportion to the in-out temperature difference.
   - Rewarms faster than most other methods (approx. 3°C per hour).
3. Extracorporeal circulation.
   - Most efficient and rapid methods of rewarming.
   - Continuous arteriovenous rewarming (CAVR) or cardiopulmonary bypass (CPB).
   - Circumvent limitations imposed by patient’s volume or veno-veno bypass requirements.
   - Require specialist equipment and experience / training in use.
   - Invasive techniques with associated risks.

SUMMARY
On current evidence hypothermia is a common danger faced by trauma patients and every effort should be made to avoid its development. The majority of severely traumatised patients develop their hypothermia after arrival in the hospital. Techniques to prevent hypothermia are cheap, easy and relatively free of side effects. A fall in core temperature represents thermal decompensation and occurs only after considerable heat energy loss. Effective, rapid treatment of hypothermia requires equipment and expertise but may improve patient outcome.

All personnel should remain alert to the dangers of hypothermia in the trauma victim. Many are distracted during resuscitation by more obvious injuries but do not forget to minimise heat loss!
REFERENCES:
A patient with burns requires a multidisciplinary approach. In the initial phase of management of a seriously burnt patient, the ambulance personnel, Trauma Surgeon, Anaesthetist and Intensivist are part of this approach. After the resuscitation phase the plastic surgeon should be involved. Burns may be devastating in terms of morbidity and mortality and can lead to lifelong disfigurement and functional loss in survivors.

**BURN ASSESSMENT – THE BASIC INFORMATION**

- Age and weight.
- Estimate total body surface area (TBSA) burnt.
- Full or partial thickness burn, extent of full thickness area.
- Presence / absence of inhalation injury.
- Aetiology (thermal, electrical, chemical, contact, irradiation).
- Associated injury.
- Co-morbidity.

**BASIC PRINCIPLES OF BURN CARE**

- Implementation of basic resuscitation principles.
- Fast relief of life and limb threatening circumferential burns.
- Prevention of infection.
- Early excision of necrotic tissue and wound closure / coverage.
- Delivery of adequate nutrition.
- Achievement of maximum functional and aesthetic recovery.
TYPES OF BURN

Scald injury
- Commonest cause of thermal injury.
- Mostly partial thickness, but deeper injury more common in children and elderly.
- Full thickness burn is often patchy and early diagnosis difficult.

Flame burn
- Commonest cause of fatal injury.
- Generally full thickness.
- Associated inhalation injury occurs in enclosed space.
- Potential for circumferential limb / chest / neck injury.

Flash burn
- Explosion injury without clothing fire.
- Full or partial thickness.
- Commonly face and hands.
- Suspect injuries as in blunt trauma because of explosive force.

Contact burn
- Victim commonly unconscious (alcohol, epilepsy, drugs).
- Often full thickness.
- Suspect compartment syndrome because of prolonged pressure.

Electrical injury
- High (> 1000 V) or low (< 1000 V) tension.
- High tension causes dramatic tissue destruction.
- Entry / exit wounds are sites of focal skin burn.
- Muscle damage often severe and occult.
- Muscle necrosis causes myoglobinuria / acidosis with renal failure.
- Suspect compartment syndrome.
- Arrhythmias in 1/3 of patients with high tension injury. Myocardial damage is rare. Arrhythmia is rarely dangerous if patient reaches hospital.
- Domestic (low tension) electricity commonly causes small burns to the periphery without muscle damage.
Chemical injury
• Becomes deep without appropriate first aid. High volume water irrigation for at least 30 minutes (optimum temp = 15 degrees, prevent hypothermia in children).
• Hydrofluoric acid burn is very uncommon but very important. May cause fatal hypocalcaemia even in a relatively small cutaneous burn. Immediate excision and monitoring may be necessary.

RESUSCITATION PHASE
Early resuscitation can be divided into two phases: performed at the location of the burn by the ambulance personnel; and continuing when arriving in the resuscitation room.

1. Pre-Hospital Care
   • Removal of the patient from the source of the burn. This minimises risk to the patient and rescue team members.
   • Removal of burning clothing immediately.
   • Assessment, as for any trauma victim, following ABC
principles of resuscitation and communicating assessment to
the resuscitation room.

- If water is available cool the burnt surface with lots of water
  for up to 30 minutes. This is only useful for up to 3 hours post
  burn. Prevent hypothermia in paediatric patients. Optimal
temperature for water is 15 degrees Celcius. No iced water.
- Cover the burn with a clean sheet / towel or clingfilm.
- If possible get IV access and fluids running in burns > 15%
  TBSA. Pre hospital infusion: roughly 500mls.
- Nil by mouth in major burns (>15% TBSA).
- Analgesia: cooling works initially, morphine is required in burns
  > 5% TBSA.

The rule of nines
Airway / Breathing
It is best to assume that all patients have suffered smoke inhalation injury, therefore, administer high flow oxygen via a face mask until the situation becomes clearer. If the airway has to be protected, cervical spine precautions should not be overlooked. Apply collar if doubt exists about cervical spine injury.

2. Hospital Management
a. Initial reassessment
   - Establish A, B, C, D status. The burn wound does not take priority above potential life-threatening injuries.
   - Review of Airway. Particularly in unintubated, unventilated patients. In these patients the potential for deterioration always exists (for up to 72 hours post-burn). Clinically examine the hair, eyes, eyelashes, eyebrows, nose, mouth, oropharynx and chest for any signs suspicious of inhalation injury. Voice change is also an early clinical sign. Get chest x-ray and arterial blood gas. Remember to request carboxyhaemoglobin (COHb) estimation. The pulse oximeter is unreliable for assessing oxygenation as it cannot differentiate between oxyhaemoglobin (OHB) and COHb.

Table 1. Symptoms and signs of carbon monoxide (CO) poisoning

<table>
<thead>
<tr>
<th>Approximate inspired CO (%)</th>
<th>Blood COHb (%)</th>
<th>Symptoms and signs</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.007</td>
<td>&lt;10</td>
<td>None</td>
</tr>
<tr>
<td>0.012</td>
<td>20</td>
<td>Headache, nausea, vomiting</td>
</tr>
<tr>
<td>0.02</td>
<td>30</td>
<td>Severe headache, confusion, weakness, visual impairment</td>
</tr>
<tr>
<td>0.05</td>
<td>50</td>
<td>Tachycardia, tachypnoea, syncope, collapse</td>
</tr>
<tr>
<td>0.08</td>
<td>60</td>
<td>Coma, convulsions, cardio-respiratory depression or collapse, risk of death</td>
</tr>
<tr>
<td>0.2</td>
<td>80</td>
<td>Rapidly fatal</td>
</tr>
</tbody>
</table>
b. Intubate patients with loss of consciousness, patients with stridor / threatened airway and inadequately ventilating patients.

c. Obtain ECG.

d. Get history (time and place of burn), causing agent and details of the accident. Get past medical history, patient age and weight.

e. Assess fluids prior to admission, urine output since injury.

f. Assess what medication has been given and tetanus status.

g. Assess TBSA burnt. The rule of nines can be used in adults. The palm represents approximately 1% TBSA (infants and adults).

h. Assess burn depth. This is difficult in the first few hours after injury and experience is useful. Depth is classified as full or partial thickness. This is a better way than expressing in degrees. Get an idea of how much TBSA is probably full thickness. Do not waste too much time estimating burn depth as it is not included in calculations of fluid management.
   - Partial thickness: damage to epidermis, dermis intact. Skin can regenerate.
   - Full thickness: both epidermis and dermis are destroyed. Skin will not regenerate.
TREATMENT

IV fluids

When TBSA > 15%:

A. Adult replacement fluid:
   Volume = weight x % TBSA x 4ml

   Hartmann’s (lactated Ringers) solution
   Total volume is given at different rates:
   - First 8 hours: half of total
   - Next 16 hours: half of total

B. Adult maintenance fluid:
   - Daily maintenance requirement of 2-3 litres on top of replacement fluid.
   - Remember to correct for any pre-hospital volume given!
   - Adjust fluid volume to achieve urine output of minimum 30-35 ml/hour.

C. Child replacement fluid
   i. First 24 hours:
      Volume = weight x % TBSA x 3 mls
      First 8 hours: half of total
      Next 16 hours: half of total

   ii. Second 24 hours:
      Volume = weight x % TBSA x 0.5 mls as colloid
      Adjust fluid input to achieve urine output of 1ml/kg/hr.

FLUIDS ARE GIVEN BASED ON TIME OF BURN NOT TIME OF ARRIVAL.
D. Child maintenance fluid
Add on 4% Dextrose + N/5 saline to replacement fluid according to the following schedule:

First 0-10 kg 100ml / kg / 24 hrs
Next 11-20 kg Add 50 ml / kg / 24 hrs
Next > 20 kg Add 20 ml / kg / 24 hrs

Correct for any pre-hospital volume given! Adjust fluid input to achieve urine output of 1ml/kg/hr.

Analgesia
IV morphine, do not give IM.
Initial dose of 0.1 mg per kg is advised, then half this dose can be given hourly. However, this may need to be titrated to response as larger or smaller doses may be necessary.

CONSULTATION WITH / REFERRAL TO BURN UNIT
For all patients in the following categories, consultation should take place with the appropriate burns unit at presentation. Although not all patients in these categories will require transfer to a specialised burn unit, advice should be sought early in their management.

- Full thickness burns involving 10% or more TBSA in adults and 5% or more TBSA in children.
- Burns to the face, hands, feet, perineum, inner joint surface and inhalation injury.
- Burns and any of the following: major pre-existing disease, suspected child abuse, concomitant injury.
- Electrical and chemical burns.
It is recommended that patients who fulfill the following criteria be transferred as soon as is practical to a specialized Burns Unit by a medical retrieval team (MRT). The Medical Retrieval Unit (MRU) can also assist with finding appropriate beds.

- Any intubated patient.
- Facial or airway burns.
- Any child with burns > 10%.
- Any burns > 20% in adults.
- Any circumferential burn.
STABILISATION IN PREPARATION FOR TRANSFER

1. **Respiratory care**
   Give 100% oxygen (preferably humidified) to all patients, except in minor burn cases.

   Intubate any patient with cyanosis, respiratory distress, stridor or hoarseness. Consider intubation if there are burns to the face showing increasing swelling.

2. **Circulatory care**
   Two peripheral lines preferably through unburnt skin. 16 gauge in adults, no smaller than 22 gauge in children. Insert a urinary catheter for all patients with 20% or more TBSA burns. Follow the fluid resuscitation guidelines above.

3. **Gastrointestinal care**
   Nil by mouth at least until after consultation with the burns unit.

4. **Pain management**
   IV morphine. Do not give analgesia IM.
   Initial dose of 0.1 mg per kg is advised, then half this dose can be given hourly. However, this may need to be titrated to response as larger or smaller doses may be necessary.

5. **Burn wound care**
   Place the patient on a clean sheet and wrap around. The unburnt areas should be covered with a thermal blanket to avoid hypothermia.

6. **Check tetanus immunisation.**

7. **Transfer should take place within 4 hours if possible.**

8. **The NSW Burns Transfer Information Chart should be completed and faxed to the burns unit. A photocopy of the fluid balance chart should be attached.**
CONTACTING BURN UNITS

ROYAL NORTH SHORE HOSPITAL
To transfer patient first ring Senior Plastics Registrar:
02 9926 8940 page 41069 who will contact the Bed Manager
Fax 02 9926 7589
Nurse in charge of ward 9D
02 9926 8942
Wound management issues:
02 9926 8940 page 41244
Dressings Sister:
02 9926 7988 or 9926 8940 and page 42027
Main Switchboard
02 9926 7111.

CONCORD HOSPITAL
Burns Specialist & Plastic Surgical Registrar
02 9767 7775 then page
Fax 02 9767 7435
Wound management issues
NUM or CNC, Burns Unit: 02 9767 7775
Main Switchboard
02 9767 7791/5000.

CHILDREN’S HOSPITAL, WESTMEAD
Senior Surgical Registrar, Burns ward
02 9845 1114
Fax 02 9845 0546
After hours contact the Senior Registrar on call
02 9845 0000 then page
Reception desk Burns Unit
02 9845 1114
Wound management issues
Burns Surgical Liaison CNS (Mon – Fri 0730 – 1600 hrs)
02 9845 0000, page 6153.
IF AFTER CONSULTATION WITH A BURNS UNIT TRANSFER IS NOT NECESSARY, THE FOLLOWING PATIENTS SHOULD BE ADMITTED TO LIVERPOOL HEALTH SERVICE.

- Any burn over 10% TBSA (adults, children and elderly).
- Any suspicion of inhalation injury.
- Burns to face, neck, hands, feet, perineum.
- Electrical or chemical burns.
- Full thickness burns where grafting is indicated.

EARLY SURGICAL MANAGEMENT

Wound dressings

Dressings should:
- Reduce colonisation of the wound by environmental organisms
- Reduce evaporative heat and fluid loss
- Relieve pain by preventing drying and padding tender surfaces.

- In the emergency setting (prior to transfer) covering the burnt surface with polypropylene glycol 25% (Solugel) and plastic wrap is effective and prevents heat loss.
- Simple dressings with vaseline gauze are cost effective and work well initially.
- Most frequently used are topical silver sulphadiazine and bulky dressing to burn wounds, changed daily or more often if infection is suspected.

Antimicrobial agents

- Systemic antibiotics are contraindicated in children.
- Systemic antibiotics in adults are not recommended.
- Topical silver sulphadiazine dressings as stated above.
ESCHAROTOMY

In circumferential full thickness burns to the extremities, chest or neck, escharotomy may be required. Commonly required in flame burns. Less often this may be required in chest or neck circumferential burn to improve pulmonary compliance or prevent airway obstruction. Constriction occurs due to shrinkage and loss of elasticity in heat coagulated skin with associated intense underlying oedema which develops progressively. Raised tissue pressure damages the soft tissues, occludes blood vessels and necrosis develops if unrelieved. Escharotomy is an urgent procedure which should be carried out in the first few hours post-burn. It is ideally carried out by an expert surgeon under theatre-type aseptic conditions. Electrocautery should be available as major blood loss is possible.

Typical incisions

1. From the anterior axillary line down to the iliac crest, then proceeding down the lateral side of the leg to the lateral malleolus and along fifth metatarsal bone if necessary.
2. This can be supplemented by an incision across the chest along the costal margins, along the sternum and towards the lateral clavicles if necessary (X shaped escharotomy). The abdomen can be decompressed with a horizontal escharotomy along the superior border of the pubic bone.

3. Bilateral incisions down the anterior border of the sternocleidomastoid muscle relieves neck.
4. Incision along third metacarpal bone - dorsal forearm - lateral humerus to relieve arm.

5. If the legs are involved, escharotomies down the medial side of the leg give a better cosmetic result. However, they must be supplemented by lateral escharotomies if decompression is inadequate.
FASCIOTOMY
A compartment syndrome of the muscles may occur in electrical burns, deep flame burns and crush / burn injuries. Diagnose by clinical suspicion and compartment pressure measurement. Pressure monitoring is particularly useful in unconscious, intubated patients and in the proximal part of the limb in electrical conduction injury. Escharotomy / fasciotomy is useful to identify and excise devitalised muscle.

REFERENCES: