TRAUMA

Kamikaze Fellowship Course
www.resus.com.au
TRIMODAL DISTRIBUTION

leading cause of death in 1-40yo
• Ensure multidisciplinary approach
• **Prehospital phase**
  – Stay and play vs scoop and run
    • German/French vs Anglo-American model
  – Critical
    • High risk patients taken to hospital able to care
• **Hospital phase**
  – Team approach
  – Multisystem vs one system approach
  – Standardised approach-why?
DETERMINANTS OF LIFE THREATENING INJURY

**Vitals**
- GCS $\leq 13$
- SBP $< 90$
- RR $< 10$ or $> 29$

**Injury**
- Penetrating
- Significant injury to $\geq 2$ body areas
- $\geq 2$ long bone fractures

**Mechanism**
- High speed impact
- Fall $\geq 6$ m
- Crash speed $\geq 60$ km
- Compartment intrusion
- Rollover
- Ejection
- Death in same accident
Primary survey and resuscitation
- A = Airway and cervical spine
- B = Breathing
- C = Circulation and haemorrhage control
- D = Dysfunction of the central nervous system
- E = Exposure

Secondary survey
Definitive treatment
the purpose of the primary exam is to EXCLUDE LIFE THREATENING EMERGENCIES
airway

- **Airway and cervical spine**
  - Assume cervical spine injury
  - Talking = have and able to maintain own airway
  - If airway compromised - jaw thrust? and clear airway
  - If GCS<=8 will need endotracheal tube (ETT)
    - In-line immobilisation
• Check position of trachea, respiratory rate and air entry

• If open chest wound seal with occlusive dressing

• If clinical evidence of tension pneumothorax will need immediate relief

• Place venous cannula through second intercostal space in the mid-clavicular line
- Assess pulse, capillary return and state of neck veins
- Identify exsanguinating haemorrhage and apply direct pressure
- Place two large calibre intravenous cannulas
  - Take venous blood for FBC, U+Es, and Cross match
- Give intravenous fluids
  - Crystalloid or colloid in adequate volume
- Attach patient to ECG monitor

PRIMARY SURVEY
circulation and haemorrhage control
– Assess level of consciousness using AVPU method
  • A = alert
  • V = responding to voice
  • P = responding to pain
  • U = unresponsive
– Assess pupil size, equality and responsiveness
PRIMARY SURVEY

exposure
- Airway obstruction
- Open pneumothorax
- Flail chest
- Tension pneumothorax
- Massive haemothorax
- Cardiac tamponade

PRIMARY SURVEY
detect immediate life-threatening emergencies
COMMON QUESTIONS

• when do we log roll?-part of primary

• when do we do a F.A.S.T.? - part of primary
• Good decision making tool for identifying the need for laparotomy in hypotensive patients (Systolic BP < 90):
  – sensitivity 100%, specificity 96% and
  – negative predictive value of 100% (NPV).

F.A.S.T.
SECONDARY SURVEY

- Head to toe examination
- **Complete** neurological examination
- *Tubes and fingers in every orifice*- maybe
- Remaining diagnostics, imaging and special studies
- Definitive treatment
- Stabilization and transfer
CHEST INJURIES
Flail Chest

• part of chest isolated
• paradoxical movement
• pulmonary contusion
• intubation and ICC
PNEUMOTHORAX
TENSION PNEUMOTHORAX

• due to flap-valve effect

• air enters pleural space but can’t escape

• results in haemodynamic compromise

• needs decompression
  
  • 14G 2nd IC space mid-clavicular line

• beware mimics
HAEMOTHORAX

1500 mL after ICC insertion and 200mL/hr for 2 hours are indications for thoracotomy.

- Stable patient
  - >200mL/hr
  - >1500mL total

- Unstable patient
  - >100mL/hr
  - >1000mL total
PERICARDIAL TAMponade

1. Hypotension
2. Diminished heart sounds
3. Jugular venous distension

-Very difficult to ascertain
-Only occurs in <30% of trauma patients
PERICARDIAL TAMPONADE
More Chest Trauma
• Clinical diagnosis

• 50% chance of seeing on CXR

• Beware other injuries
  • liver and spleen

• Rule out serious injuries
  • pneumothorax

• analgesia

• intercostal blocks
1st and 2nd rib #

• Large forces needed
• Deceleration injury
• May indicate severe underlying injury
• 30% mortality
Sternal Fracture

• Low mortality if isolated
  • usually low force if wearing belt
  • If not wearing seat belt beware
    • up to 60% chance of other significant injuries

• CXR- exclude other injuries
• Sternal views- aren’t predictive
• ECG

• if isolated and good pain control can go home
Pulmonary Contusion

- about 75% of flail chest
- also occurs following blunt trauma
- Xray lags about 24 hrs
- 80% develop ARDS
- 50% develop pneumonia
- ventilate/keep dry/PEEP
Pneumomediastinum

- Subcut emphysema
- Hamman’s Sign- ‘crunch’ in systole
- air stripe around mediastinum
- treat conservatively
- PNEUMOMEDIASTINUM
  - breath sounds equal but increased JVP
  - decreased cardiac output
  - dissect neck at suprasternal notch and release
Pneumomediastinum

• Beware as can occur following ventilation
indications
- penetrating trauma
  - precordial stab wounds - >40% survival if:
    - performed within 10 min of arrest
    - an organised rhythm had been present
- not for blunt trauma - <3% survival
Mediastinal Injuries

AORTIC INJURY
Aortic Injury

• Mostly deceleration injury
• Lateral and frontal impact can cause
• High forces
• Chest pain, dyspnoea
• Hypertensive
• Pulse difference in legs vs arms
• Rupture usually die at scene
  • 85% die pre-hospital
  • 10% survive 4 hours

85% die pre-hospital
10% survive 4 hours
CXR in aortic injury

CXR cannot exclude aortic injury
- widened mediastinum
- blurred aortic knob
- left haemothorax
- right deviation of trachea and NGT
- depressed left mainstem bronchus

INVESTIGATIONS
CT chest- shows haematoma- good to screen, angiography (gold standard), TOE

will need repair, endoluminal or OR otherwise nearly all die.

widened mediastinum is 90% sensitive and 10% specific for thoracic transection, ie., 10% will have a normal CXR

Overall about 85% mortality
Beware aggressive fluid resuscitation of stable (SBP>90) patient with aortic injury.
Subgroup with CAD or >55yo do worst with immediate repair.
Ruptured diaphragm
• Most missed- of concern as they need surgical repair

• usually result from penetrating trauma

• most have other abdominal injuries

• most injuries are left sided as liver cushions the right

• investigations may not be diagnostic

• beware the low stab wound to the back

• injuries associated with higher risk of diaphragm rupture are:
  • lat rib fractures
  • penetrating left upper quad wounds
  • pelvic fracture

Ruptured Diaphragm
Tracheobronchial

- 80% near carina
- mediastinal and cervical emphysema
- Consider in persistent airleak
- Needs operative repair if persistent
Abdominal Trauma
Risk Factors for abdo injury

• High speed
• Pedestrian struck by vehicle
• Fall from greater than standing height
• Hypotension ie., SBP<100mmHg
• Significant injuries above and below
  • ie., chest and pelvis
Presentation

• Penetrating or blunt
• Seat belt marks- lap belts associated with:
  • Chance fracture (L1)
  • Small bowel injury
  • Pancreatic injury
• PR blood- from injured bowel
• High riding/mobile prostate - urethral rupture
• Hypotension
  • <30% of patients have both hypotension and tachycardia
Immediate laparotomy

- Evisceration
- Gunshot wound
- Stab wound and peritoneum breach
- Continued hemodynamic instability
- Peritonism
- Free gas on X-ray
- Ruptured diaphragm

Beware: A positive FAST or positive DPL are EMERGENT indications for a laparotomy
CT - Abdo

- IV contrast, discussion re triple contrast

- PROS
  - high sensitivity and specificity for haemorrhage
  - anatomical information
  - gives retroperitoneal structures
  - chest and pelvis views

- CONS
  - not at bedside
  - false negatives for hollow organs
  - difficult environment if unstable
  - contrast risks
  - access issues
DPL

• Frank blood aspiration >20mL adults, >10mL children
• RBC/mL - >100,000 in blunt, >5000 in penetrating
• WCC - >500/mL
• Good sensitivity
• Performed at bedside
• Skill set
• Confounds CT by fluid in abdo
• False negatives
• not organ specific
• retroperitoneal injuries?
FAST

• In hypotensive patient (SBP<90) it’s ability as a decision making tool to decide who needs a laparotomy has:
  • NPV of 100%
  • Sensitivity of 100%
  • Specificity of 96%
FAST

• identifies free fluid
• identifies pericardial effusion
• 50% of abnormal scans will be identified in Morrison’s pouch
• Several views
• picks up between 250 and 800 mL

• **PROS**
  • easy, quick, repeatable, non-invasive, done at bedside
  • used for other things also
  • Can look at chest and pelvis

• **CONS**
  • operator dependant
  • may be difficult if obese, bowel gas
  • false negatives/positives
  • hollow viscus injury
  • Normal FAST may still need CT
CXR

• gas under the diaphragm
• elevated hemidiaphragm
• Grey Turner’s
  • flank discolouration
  • late sign retroperitoneal haematoma, also in haemorrhagic pancreatitis

• Kehr’s sign
  • left shoulder referred pain due to subdiaphragmatic irritation

• Cullen’s sign
  • periumbilical echymosis due to retroperitoneal bleed, haemorrhagic pancreatitis, ectopic pregnancy

• Rovsing’s sign
  • RLQ pain with LLQ palpation- appendicitis
PELVIC FRACTURES
5-20% mortality
30% if open
50% if haemodynamic compromise

Potential injuries

- **Vascular**
  - Common iliac artery
  - Superior gluteal artery
- **Neurological**
  - Lumbar and sacral plexus
- **Urogenital**
  - Bladder, urethra
  - Vagina, cervix, uterus
  - Seminal vessels
- **Bowel**
  - Sigmoid colon
  - Rectum, anus
Key and Cornwell/Kane

- **Type I**
  - Individual bone fracture
  - Intact pelvic ring
  - Stable

- **Type II**
  - Single break in ring
    - Eg ipsilateral pubic rami, Pubic symphysis
  - 25% have major soft tissue and visceral injuries

- **Type III**
  - Double Break in ring
    - Bilat fractures of pubic rami
  - Unstable

- **Type IV**
  - Acetabular fractures
MANAGEMENT

- ABC
- Fluid resuscitation
- Analgesia
- Stabilise the fracture
  - Commercial device
  - Sheet to wrap pelvis
- Definitive treatment
  - Fixation
  - Angiography and embolisation
Angiography in pelvic #

- Posterior ring fractures cause arterial/venous injury
Over 50% of trauma deaths are associated with head injury.

Neurotrauma is associated with the majority of trauma deaths.
<table>
<thead>
<tr>
<th>Neurotrauma severity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Minimal</strong></td>
</tr>
<tr>
<td>No loss of consciousness, and</td>
</tr>
<tr>
<td>Glasgow Coma Score (GCS) 15, and</td>
</tr>
<tr>
<td>Normal alertness and memory, and</td>
</tr>
<tr>
<td>No neurological deficit, and</td>
</tr>
<tr>
<td>No palpable depressed fracture or other sign of skull fracture</td>
</tr>
<tr>
<td><strong>Mild</strong></td>
</tr>
<tr>
<td>Brief (&lt;5 minutes) loss of consciousness, or</td>
</tr>
<tr>
<td>Amnesia for event, or</td>
</tr>
<tr>
<td>GCS 14, or</td>
</tr>
<tr>
<td>Impaired alertness or memory</td>
</tr>
<tr>
<td>No palpable depressed fracture or other sign of skull fracture</td>
</tr>
<tr>
<td><strong>Moderate or potentially severe</strong></td>
</tr>
<tr>
<td>Prolonged (&gt;5 minutes) loss of consciousness, or</td>
</tr>
<tr>
<td>Persistent GCS &lt;14, or</td>
</tr>
<tr>
<td>Focal neurological deficit, or</td>
</tr>
<tr>
<td>Post-traumatic seizure, or</td>
</tr>
<tr>
<td>Intracranial lesion on CT scan, or</td>
</tr>
<tr>
<td>Palpable depressed skull fracture</td>
</tr>
</tbody>
</table>
Head Trauma

• Head injury and hypotension - look elsewhere

• Primary Injury
  • will occur at point of injury
  • Axonal shear injury
    • cerebral oedema
  • MRI better than CT
  • Cerebral Contusion
    • in about half of cases with haematomas
    • frontal and temporal lobes

• Haematomas

• SAH- distinguish if SAH is primary or secondary event
Head Trauma

• Secondary Injury
  • due to hypoxia
  • due to ischaemia
  • due to oedema
BEWARE
head injury + hypotension
LOOK elsewhere for cause of hypotension

Cushing’s response
Hypertension
Bradycardia
Apnoea

late and unreliable

Cushing reflex
autoregulation
CPP = MAP - ICP
How to assess Head Injury
Assessment of HI

• Loss of Consciousness - important predictor for severity of BLUNT trauma.
  • duration = severity
  • May not occur in penetrating or localised blunt
• Level of Consciousness
  • change in GCS of >2 is significant
• Amnesia - antegrade or retrograde
  • >24 is a marker for severe head injury
• Headache - common
• Nausea - common
• Vomiting = increased severity of injury
• Other
  • Age >65 have greater chance of complications
  • anticoagulation
  • VP shunt etc..

Kas’s ‘HAGLE’ Score
who to CT?

major and moderate head injury YES

ie anything < GCS of 13!

What about minor head injury?

GCS 13-15 following LOC
LOC < 30 min
any amnesia
Panel 1: Canadian CT Head Rule

CT Head Rule is only required for patients with minor head injuries with any one of the following:

- High risk (for neurological intervention)
  - GCS score <15 at 2 h after injury
  - Suspected open or depressed skull fracture
  - Any sign of basal skull fracture (haemotympanum, 'raccoon' eyes, cerebrospinal fluid otorrhoea/rhinorrhoea, Battle’s sign)
  - Vomiting > two episodes
  - Age > 65 years

- Medium risk (for brain injury on CT)
  - Amnesia before impact > 30 min
  - Dangerous mechanism (pedestrian struck by motor vehicle, occupant ejected from motor vehicle, fall from height > 3 feet or five stairs)

Minor head injury is defined as witnessed loss of consciousness, definite amnesia, or witnessed disorientation in a patients with a GCS score of 13-15.
Glascow Coma Scale

- Used for prognosis - but not strong correlator with outcome
  - GCS 15 - 0.2% mortality
  - GCS < 8 - 40% mortality
  - GCS 8 is
Base of skull fracture

• Haemotympanum

• Battle’s sign (mastoid area echymosis)

• Raccoon’s eyes (orbital area echymosis)

• CSF leak - oto / rhino
  • halo test.

• Plain XR-NO

• CT head - air in sphenoid sinus
Battle’s sign
Raccoon eyes
Skull fractures

Depressed - neurosurgery
linear - no surgery
open - surgery
Occipital - contrecoup
Extradural

• post branch middle meningeal artery

• Not severe underlying brain injury

• present with
  • brief LOC
  • skull fracture 90%
  • mortality 30%
Subdural

- More common than extradural (6x)
- Tearing of veins between dura and arachnoid
- Occur in alcoholics, demented patients and the elderly
- Higher mortality than extradural

Classification

- Acute - < 24hrs - greatest mortality
- Subacute - 1-14 days
- Chronic > 14 days
Intracerebral bleed
C spine injuries
Nexus

- No midline cervical tenderness
- No focal neurology
- Normal level of alertness
- No intoxication
- No distracting injury
Canadian C spine

8900 pt

• High Risk
  • >65yo
  • paraesthesia
  • mechanism
    • fall >1m/ 5 stairs
    • high speed MCA
    • rollover
    • bicycle acciden
 Atlantiso-axial dislocation

- Fatal most of the time
- transverse ligament rupture of dens
Teardrop fracture

- Extension injury
- Unstable
facet dislocation

• Stable if no fracture
• look for facet fracture
• 50% subluxation
• reduce under GA-neurosurgery
Odontoid fractures

- Flexion injury most likely

- Type I
  - tip of dens

- Type II
  - most common
  - at junction of body and dens - non displaced

- Type III
  - through body
  - unstable
Hangman’s fracture

- Extension
- Bilat # pedicles of axis
- Unstable
- Probably no cord injury as widest point
Jefferson fracture

- Compression # C1
- Uare
- Unstable
Clay shoveler’s fracture

- C6, C7 or T1 spinous process fracture secondary to sudden load on a flexed spine
Neck Wounds
Neck wounds

1. Clavicles to cricoid
2. Cricoid to angle of mandible
3. Angle mandible and base skull

Diagram:
- Clavicles to cricoid
- Cricoid to angle of mandible
- Angle mandible and base skull
Neck trauma

• Zone II most common
• Airway may easily become compromised
• Can exsanguinate
• Air embolus
  • Machine murmur
  • Trandelenburg + left lat decubitus
  • Prevents air bubble migration
Neck trauma

• OR if
  • penetration of platysma
  • gas from wound
  • neuro deficit
• Other ie angio
  • if expanding haematoma
  • altered pulses
Burns
<table>
<thead>
<tr>
<th>Criteria</th>
</tr>
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<tbody>
<tr>
<td>Partial-thickness burns &gt;20% in all age groups, or &gt;10% in the under 10</td>
</tr>
<tr>
<td>and over 50 age groups</td>
</tr>
<tr>
<td>Full-thickness burns &gt;5% in any age group</td>
</tr>
<tr>
<td>Burns involving face, eyes, ears, hands, feet, genitalia, perineum or</td>
</tr>
<tr>
<td>a major joint</td>
</tr>
<tr>
<td>Inhalation burns</td>
</tr>
<tr>
<td>Electrical burns, including lightning injury</td>
</tr>
<tr>
<td>Burns associated with other significant injuries</td>
</tr>
<tr>
<td>Smaller burns in patients with pre-existing disease that could</td>
</tr>
<tr>
<td>complicate management</td>
</tr>
</tbody>
</table>
Spinal Cord Injury
Dorsal Columns

Lateral Corticospinal

Lateral Spinothalamic

Ventral Corticospinal

Lateral Corticospinal

Lateral Spinothalamic

Proprioception

vibration, joint position, pressure, touch

MOTOR

Pain, temperature

Proprioception

Proprioception

Proprioception

Proprioception

Ventral Spinothalamic
**Dorsal Columns**

- Vibration, joint position, pressure, touch

**Lateral Corticospinal**
- MOTOR
  - Pain, temperature

**Lateral Spinothalamic**
- Proprioception

**Ventral Corticospinal**
- Axial and prox limb

**Ventral Spinothalamic**

Lateral corticospinal fibers cross at medulla and project to the spinal cord. Lateral spinothalamic fibers also cross at medulla, while ventral corticospinal fibers cross at a higher level within the spinal cord. Dorsal columns carry sensory information, while lateral columns are involved in motor functions.
SCIWORA

• Diagnosed with MRI

• Usually poor prognosis
Transverse Spinal Cord Syndrome

• Following total damage transversely across cord

• there is total paralysis and anaesthesia and areflexia below the level of the injury
Sacral Sparing

- The sensitivity + motor function is preserved in otherwise transverse injury.
- This implies incomplete damage
Anterior cord synd

• Anterior cord injury (ant spinal artery)
• Flexion/rotation or vertical load injury
• Deficits are:
  • Motor loss below level injured
  • Spinothalamic affected so loss of temp/analgesia and coarse touch
• Dorsal columns intact
• Poor prognosis
Dorsal Column Synd

• Rare
• Usually hyperextension or direct injury to the back

• Clinically
  • Proprioception, vibration and fine touch are affected
Central Cord Synd

- Hyper-extension injury
- Incomplete paralysis and sensory loss
  - arms>legs
  - Proximal>distal
Brown-Sequard

• One half of the cord is damaged

• Ipsilateral loss of
  • motor
  • light touch
  • joint position
  • vibration

• Contralateral (Spinothalamic) loss of
  • Pain
  • Temperature
Steroids in Cord Injury

- Controversial
- Contraindicated in
  - contaminated open injuries
  - perforated bowel
  - established sepsis
- Relatively Contraindicated
  - DM
Spinal Shock

Do not confuse this with neurogenic shock
Spinal Shock

• There is a loss of cord activity below the lesion
• It may last hours to weeks
• In recovery
  • There is return of function or
  • a spasticity occurs
• Recovery is heralded by
  • return of the Babinski Reflex followed by
  • the perineal reflexes
Neurogenic Shock

- Bradycardia - 50-60bpm
- Hypotension - <100mmHg
- Poikilothermic
Beware

• The patient with spinal cord injury may also have other injuries

• In these patients HR of 90 may represent a significant tachycardia
  • Look for the bleed.
Management

- Immobilisation
- ABC - may need ETT
- IVF
- Temp monitoring
- Treat the cause - ie if bony injury to cord - repair
- Steroids - use in association with spinal unit directions
  - Benefit if <8hrs
  - Methylprednisolone as per protocol
    - Load 30mg/kg IV
    - Then infusion
Trauma and Pregnancy
• More spleen and liver injuries

• Blunt trauma is leading cause of maternal death

• Penetrating trauma is leading cause of fetal death

• Stabilize the mother

• right side up at > 20 weeks

• CTG for 4 hours

• Beware abruptio placentae
  • abdo pain, uterine tetany, +/- PV bleed
  • fetal distress -tachy/ brady

• RhoGAM if Rh neg
FAXMAX TRAUMA
Facial Trauma

• Up to 60% will have injuries of other systems
• If >= 3 facial fractures, it is associated with 33% chance of base of skull
• In ~ 5% haemorrhage can be massive and difficult to manage.
• Techniques to manage haemorrhage include:
  • direct pressure
  • anterior nasal packs
  • Foley catheters
The Nose

- 2/3 cartilage
- Repair can be delayed, until swelling improves
- Look for septal deviation
- Exclude septal haematoma
  - may only be minor blueish discolouration
  - can result in necrosis with superimposed infection within 24 hours
    - leads to cartilage destruction within 24 hours
Mandibular fractures

- 3 x force needed to fracture nose
- Malocclusion
- Jaw/facial deformity
- Mental nerve affected

X-ray- mandible may not be satisfactory
OPG (orthopantamogram) - must be able to sit upright.
Zygoma
• Common to have fractures
• May appear as depression
• Needs elevation, but not needed immediately
• Beware other facial injuries
• Usually not isolated but associated with:
  • zygomaticomaxillary fracture
  • Orbital blowout fracture
Maxilla
Maxilla

Beware orbital floor fractures
Look for diplopia (present in 85%)
inferior rectus entrapment
Look for other injuries
OR if entrapment of muscle.
LE FORT FRACTURES
- **LE FORT I**
  - Horizontal fracture of lower third of maxilla
  - Upper dental arch mobile

- **LE FORT II (most common)**
  - Maxillary, nasal bones and medial orbit
  - Nose + upper dental arch mobile

- **LE FORT III (craniofacial dysjunction)**
  - Fractures through zygoma, orbits and base of nose - mid-facial skeleton is separated from the cranium
  - Maxilla + Zygoma mobile
• Can you get different LeFort fractures on each side of the face?
Management

• Airway control

• Haemorrhage control- may need OR for this

• Significant injury- C-Spine protection
  • Clear spine early to sit patient up

• Analgesia

• Tet tox

• Antibiotics
Penetrating facial injuries
Penetrating facial injury

• Can result in significant injury

• Airway may be compromised early
  • may need surgical airway

• Arterial injury is not uncommon
  • up to 40% need carotid and vertebral artery angiography

• Nerve injuries are not uncommon
  • facial nerve
  • mandibular branch of trigeminal