MANAGEMENT OF PAEDIATRIC TRAUMA, MAJOR HAEMORRHAGE AND CHILDREN OF JEHOVAH'S WITNESSES

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Introduction

- Structured approach to adult and paediatric trauma
  - APLS, EPLS, ATLS courses
  - Primary survey
  - Initial resuscitation
  - Secondary survey
  - Emergency treatment
  - Definitive care
- Survival: good prehospital care, appropriate triage, effective resuscitation
- Trauma leading cause of death in <1 yr
  - Upto 30% deaths may be preventable

Overview

- Systems approach for managing paediatric trauma patients in ED
  - Trauma team
  - Preparation: drugs and equipment in ED
  - Primary survey ABCDE
  - Secondary survey: head, chest, abdo, limb, spinal
- Major haemorrhage
- Children of Jehovah’s witnesses

Systems approach to children

- Complements ABCDE and APLS
- Involves trauma team: introduce and role
  - ED consultant
  - Paediatrician/intensivist
  - Anaesthetist
  - Nursing staff
  - Radiographers
  - Blood bank and labs
- Details of trauma: MOI, age, weight, injuries, treatment
- Preparation: drugs and equipment

- Use checklist and KIDS sheet: https://kids.bwc.nhs.uk

KIDS Clinical Guideline - Drug dose calculator

Date	Weight (kg):	Name:
01/07/19	30	

All drugs to be given by intravenous route unless otherwise stated. It is the responsibility of the clinician to ensure drugs are used appropriately according to the clinical situation and doses double checked. KIDS/NTS does not accept any liability.

Single drug doses:

Induction agents for intubation	Dose
Ketamine (2 mg/kg)	60mg
Thiopentone (2-4 mg/kg)	60 - 120mg
Fentanyl (1-5 micrograms/kg)	30 - 150micrograms
Propofol (2-5 mg/kg)	60 - 150mg
Muscle relaxants for intubation	
Suxamethonium (Weight <10kg: 2mg/kg)	-
Suxamethonium (Weight >=10kg: 1mg/kg)	30mg
Rocuronium (1mg/kg)	30mg
Vecuronium (0.1mg/kg)	3 mg
Emergency drugs for cardiac arrest	
Adrenaline 1:10,000 (0.1ml/kg)	3ml
Atropine (20micrograms/kg)	600micrograms
Adenosine (0.1 - 0.5 mg/kg)	3-12mg
Amiodarone (5mg/kg)	150mg
Calcium gluconate 10% (0.5ml/kg)	15ml
Sodium Bicarbonate 8.4% (1ml/kg)	30ml
Anticonvulsants and drugs for raised ICP	
Lorazepam (0.1mg/kg)	3mg
Phenytoin (20mg/kg - over 20 mins)	600mg
Phenobarbitone (20mg/kg)	600mg
Paraldehyde 50%:Olive oil 50% (0.8ml/kg)	20ml PR max
Mannitol dose (0.25 - 0.5 g/kg)	8 - 15grams
Mannitol volume Peripheral: 10% solution	75 - 150 ml
Mannitol volume Central: 20% solution	38 - 75 ml
3% saline (3ml/kg)	90ml

Drug doses for infusion:

Sedation		Amount	Dilutent - see key*	Total Volume	Rate	Dose
Morphine		30mg	D5/D10/NS	50ml	0.5 - 2 ml/hr	10-40micrograms/kg/h
Midazolam		90mg	D5/D10/DS/NS	50ml	0.5 - 3 ml/hr	0.5-3 micrograms/kg/min
Paralysis						
Rocuronium		Neat solution 200mg in 20ml			1.8 - 3 ml/hr	0.6 - 1mg/kg/h
Vecuronium		180mg	D5/D10/NS	50ml	0.5 - 2ml/hr	1 - 4micrograms/kg/min
Vasoactive drugs						
Dopamine	Peripheral	80mg	D5/D10/NS	50ml	5.6 - 22.5ml/hr	5 - 20micrograms/kg/min
	Central	450mg	D5/D10/NS	50ml	1 - 4 ml/hr	5 - 20micrograms/kg/min
Dobutamine	Peripheral	80mg	D5/D10/NS	50ml	5.6 - 22.5ml/hr	5 - 20micrograms/kg/min
	Central	450mg	D5/D10/NS	50ml	1 - 4 ml/hr	5 - 20micrograms/kg/min
Adrenaline	Peripheral	1mg	D5/D10/NS	50ml	0.9-45ml/hr	0.01 - 0.5 micrograms/kg/min
	Central	8mg	D5/D10/NS	50ml	0.11-5.63ml/hr	0.01 - 0.5micrograms/kg/min
Noradrenaline	Central	8mg	D5/DS	50ml	0.11-5.63ml/hr	0.01 -0.5micrograms/kg/min
Ductal patency drugs omitted as patient over 10kg						
-		-	-	-	-	-
-		-	-	-	-	-
Asthma drugs						
Salbutamol		For Salbutamol bolus dose please refer to BNFc				
Infusion	Peripheral	10mg	D5/NS	50ml	9.0 - 18.0 ml/hr	1 - 2micrograms/kg/min
Infusion	Central	25mg	D5/NS	50ml	3.6 - 7.2 ml/hr	1 - 2micrograms/kg/min
		Caution - monitor for toxicity if salbutamol dose higher than 20mcg/min				
Aminophylline	*Loading dose:*	150mg over 20 minutes; use 500mg/500ml concentration as per infusion				
Use ideal wt if obese		500 mg	D5	500ml	30 ml/hr	1mg/kg/h
		If patient is aged greater than 12 years please refer to BNFc for aminophylline dosing				
Magnesium sulphate 50%		2.4 ml	D5/NS	60 ml	180 ml/hr	1200 mg over 20 mins
DKA drugs				*Note: decimal point below*		
Insulin		50units	D5/D10/NS	50ml	3.0ml/hr	0.1units/kg/h

*Dilutent key: D5 = 5% glucose D10 = 10% glucose NS = 0.9% saline DS - 0.45% saline and 5% glucose

Initial assessment

- Primary survey and resuscitation: ABCDE
- Simultaneous investigations: CXR, bloods, G&S, glucose
- Special considerations
  - C-spine and head injuries
  - Full stomach
  - Anatomical and physiological differences
  - Difficulties in history taking, communication and assessment
  - Parents

Primary survey: airway and breathing

- Anatomy – obstruction
- Physiology – RR and O2 consumption
  - Establish patent airway early
- C-spine injury uncommon <2%
- TBI common <75%
- Indications for intubation
  - Respiratory inadequacy
  - GCS <8
  - Suspected raised ICP
  - Need for prolonged ventilation
  - Need for transport to tertiary centre
- RSI with MILS and N/OG placement

Primary survey: circulation

- Evaluation: colour, mental status, HR, BP, CRT
- Compensation for haemorrhage maintains BP
- Secure IV access – IO
- Warm crystalloid boluses
- Blood and products
- ?permissive hypotension

- Normal physiological parameters in children

Age (yr)	Respiratory rate	Systolic BP	Heart rate
<1	30-40	70-90	110-160
1-2	25-35	80-90	100-150
2-5	25-30	80-105	95-140
5-12	20-25	90-110	80-120
>12	15-20	100-120	60-100

- Estimated blood volume:
  - Preterm infant – 90-100ml/kg
  - 0-3 months - 80-90ml/kg
  - 3 months + ~70ml/kg
- Max allowable blood loss = (Hb intial/Hb low)/Hb initial x EBV
  - Eg MABL 30kg 10 year old = (13-7)/7 x 2100 = 970ml

Primary survey: disability

- AVPU
- Pupils and neurological assessment
- Aim: identify TBI and start neuroprotection
- TBI classification
  - Mild – GCS 13-15
  - Moderate – GCS 9-12
  - Severe – GCS 3-8
- Indications for CTB:
  - GCS <12
  - LOC at injury
  - Amnesia
  - Neurological signs or symptoms
  - Severe injury

Ongoing assessment

- Secondary survey and treatment
  - Head and neck
  - Spinal cord injury
  - Chest injury
  - Abdominal injury
  - Limb injuries
  - NAI

Secondary survey: head and neck

- Fundoscopy and CTB
  - Retinal heamorrhages and SDH = NAI
- Indications for neurosurgical referral:
  - Focal neurology
  - Deteriorating neurological signs
  - Evidence of increased ICP
  - Abnormal CT
  - Penetrating injury or depressed skull fracture

Head and neck continued

- TBI neuroprotection
  - Prevent hypoxia and hypotension
  - O2, CO2 control, head up, ETT tape, analgesia, anaesthesia, muscle relaxation, normoglycaemia, prevent hyperthermia
- ICP control and maintain CPP
  - Osmolar tx: mannitol 1g/kg or hypertonic saline 5ml/kg if ICP >20mmHg
  - Maintain CPP >40mmHg
- Surgical evacuation of mass lesions <4hr

Secondary survey: SCI

- Uncommon in children, <2%
- Cartilaginous vertebrae
- Elastic ligaments
- Energy dissipated over several segments
- High C-spine injuries and subluxations can occur (C1-3)
- SCIWORA in 50%

Secondary survey: chest and abdominal trauma

- Elastic ribs mean fractures uncommon but energy transferred to internal organs
- PTX and haemothorax and contusions
- Splenic, liver and renal lacerations
- Examine for brusing, abrasions, guarding, tenderness, distension
- CT chest and abdomen if nature and extent of injuries uncertain
- Unrecognised injuries lead to preventable deaths

Secondary survey: limb injuries

- Skeletal injuries 10-15% paediatric trauma
- Uncommon to be life threatening
- Most don’t require surgery
- Immobolise long bone fractures early – haemorrhage

Definitive care

- Stabilization prior to transfer
- Should not be sole anaesthetist duty
- KIDS transfer to nearest PICU
- Advice from lead paediatric centre for cases where awaiting transfer team clinically inappropriate
  - Either transfer undertaken by senior skilled team
  - Or intervention undertaken in local hospital

Major haemorrhage in children

Principles of management of major haemorrhage

- Assess blood loss
- Control haemorrhage
- Preserve clot
- Prevent coagulopathy, acidosis, hypothermia
- Volume replacement

Assess blood loss

- Signs, symptoms, investigations, monitoring
- Activate MHP
  - UHCW criteria
    - blood loss requiring >20ml/kg/hr PRBC replacement or any resuscitation fluid requirement >40ml/kg/last hour
- Administer O2, secure IV access, send *urgent* baseline cross match, FBC, U&E, Ca, PT/APTT, fibrinogen, ABG prior to transfusion
- Determine urgency of transfusion: O-/group specific/cross-matched

- Control haemorrhage
  - Elevation, pressure, torniquet, splint
- Preserve clot
  - Avoid haemoilution
  - Antifibrinolytics:
    - Tranexamic acid 15mg/kg/bolus then 2mg/kg/hr for 8 hours
  - Avoid hypertension and sympathetic surges
    - Analgesia
    - Vasopressors inappropriate in trauma
- Prevent coagulopathy, acidosis, hypothermia
  - Warm volume replacement
  - PRBC:FFP 1:1, platelets and cryo
  - Adequate tissue perfusion
  - TEG/rotem

Volume replacement

- Prescribe blood products by volume
- PRBC: 10ml/kg (aliquots)
- FFP: 10ml/kg (aliquots, 1:1 PRBC:FFP)
- Platelets: 10ml/kg
- Cryoprecipitate: 5-10ml/kg (max 300ml)
- PRBC 10ml/kg increases Hb by ~20g/L

Paediatric MHP at UHCW

Table 1: MHP Pack 1

Weight	RBC	OCTAPLAS
< 5 kg	80 - 100 mls	80-100mls
5 – 10.9 kg	1 adult unit 250 ml.	1 unit
11 – 20 kg	2 adult units 500 ml	2 units
20 kg- 50 kg	3 adult units 750 mls	3 units
Over 50 kg	4 adult units 1000 mls	4 units

Table 2: MHP Pack 2

	20 ml/kg	20 ml/kg	10ml/kg	15-20ml/kg
Weight	**RBC**	**OCTAPLAS**	**Cryo (If Fib <1.5)**	**Platelets**
< 5 kg	80 - 100 mls	octaplas 1 unit	50 mls	50-80mls
5 – 10.9 kg	1 adult unit 250 ml.	1 unit Octaplas	80 mls	100 mls
11 – 20 kg	2 adult units 500 ml	2 units of Octaplas	1 pool	1 adult unit
20 kg – 50 kg	3 adult units 750 mls	3 units of Octaplas	2 pools	1 adult unit
Over 50 kg	4 adult units 1000 mls	4 units of Octaplas	2 pools	1 adult unit

Major haemorrhage continued

Ongoing management

- FBC, PT/APTT, fibrinogen – every 30-60 min
- Avoid crystalloid
- Warm blood products and patient
- Send second cross match sample
- Investigate and treat cause of bleeding ASAP
- Prepare theatres and refer to ICU
- Every 90mins/4 units PRBC transfused: FBC, PT, APTT, fibrinogen, Ca, U&E, ABG and TEG

Aims of management of major haemorrhage

- Perfusion with volume replacement not vasopressors
- Normal acid base status and temperature
- Treat coagulopathy with FFP (15-30ml/kg) or platelets: aim plt >75 x109/L, APTTR<1.5, fibrinogen >1.5g/L
- Ca++ >1.0: give 0.2ml/kg of 10% CaCl over 30 mins
- Haemostasis, stability and stand down MHP
- Complete documentation, end fate, green slips for O-
- Consider thromboprophylaxis

Complications of massive transfusion

- Massive transfusion in paediatrics
  - PRBC transfusion of 50% total blood volume in 3 hours

  OR
  - 100% in 5 hours

  OR
  - 10% TBV per minute
- Dilutional coagulopathy
- Incompatibility reactions
- Metabolic/electrolytes: hypothermia, ↓Mg & Ca, ↑K
- TRALI
- TACO
- Infection

Children of Jehovah's witnesses

- UHCW guideline
- *Views and wishes of adult patients regarding blood transfusion must be respected but this in not always the case with children*
- Discuss with
  - Consultant lead of transfusion team and heamatologist (bleeps 1287, 2280, 1750)
  - Legal department x28813
  - Birmingham Liaison Committee for JW 02089062211

Jehovah's witnesses

- Faith: sanctity of life and blood
- JW 36 Hospital liaison committees (UK)
- Most don't accept: PRBC, FFP, Plt
- May accept: cryoprecipitate, fibrinogen, prothrombin concentrate complex, human albumin solution
- Often accept: erythropoietin, iron
- Individuals: cell salvage, normovolaemic haemodilution, RRT/haemofiltration/haemodialysis, ECMO, cardio-pulmonary bypass

Children of Jehovah's witnesses

- <16 – parental responsibility for consent
- 16-17 year olds: "young persons" – presumed capable of consenting to treatment, although refusal of treatment can be over-ruled by parental responsibility or court
- Competent 0-15
  - Can consent – discuss with hospital lawyer if parents refuse transfusion
  - Cannot refuse – but giving transfusion is affront to human rights/battery so obtain HCO when possible
  - Child and parents refuse but transfusion required – apply for HCO
- Parents and clinicians differ:
  - Apply for High Court order
  - Elective – in court
  - Emergency – over phone
  - No time to phone – treat in child's best interest and apply to high court ASAP

Summary

- Paediatric trauma causes preventable deaths
- Anatomical and physiological differences make assessment more difficult and influence management
- Major haemorrhage management – protocol
- Act in best interests of children of Jehovah's witnesses/refusal of blood product – seek court order

References

- Guidelines
  - AAGBI: Blood product transfusion 2016
  - AAGBI: Anaesthesia and perioperative care for Jehovah's witnesses and patients who refuse blood products 2018
- BJA education
- Paediatric trauma (P Cullen)
- RCOA CCT in anaesthesia – intermediate and higher curriculum
- UHCW guidelines:
  - Major haemorrhage
  - Jehovah's witnesses and patients who refuse blood products