

## 06 Polytrauma – adult + paediatric

### PRO TIPS

- Think about your strategies for managing polytrauma, in your institution, in advance!
- Actively manage the terrible triad
- Hypothermia - 1 degree temperature loss equates to a 10% loss in clotting. The function of the enzymes involved in clotting are logarithmic, based around 37degrees.
- Coagulopathy – The first clot is the best clot, the second clot is the person who disrupts the first clot. Do not rely on standard clotting measurements (INR, APTT), they are slow to acquire and are performed in a waterbath at 37 degrees. TEG (thromboelastography) allows you to replace the clotting factors as they are needed in ‘real time’ + >10 mins.
- Acidosis – This is cumulative. The longer it takes to turn off the tap and restore perfusion the longer it will take to actively correct and the bigger the physiologic hit. Acquire a familiarity with base deficit and lactate. These are surrogate markers but they are the best we have. Tempo and trend are more useful than single results.
- Managing Monotrauma = EASY, Polytrauma = DIFFICULT, Multiple Monotrauma (in the same patient) = EASIER. Solution = Use a **polytrauma matrix** to list
  - 1<sup>st</sup> Column – Each problem (injury and active medical co-morbidity)
  - 2<sup>nd</sup> Column – Completed treatment / management with date (time)
  - 3<sup>rd</sup> Column – Planned further treatment / management. As they are completed transfer with date (time) into 2<sup>nd</sup> column.
  - Then prioritise and establish ‘escape points’ with entire surgical team as part of WHO brief. ‘Escape points’ can then be used if the patient becomes unstable and the surgery must finish ASAP.

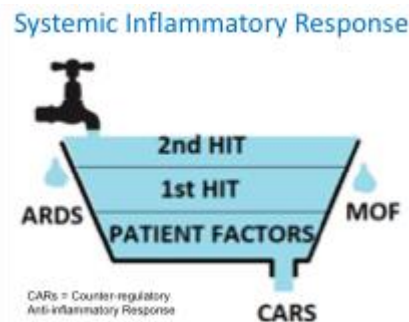
### DAY 1

INJURY	Time: 16/1/20 2300	Mechanism: Motorcycle vs car
<b>INJURIES + EVENTS</b>	<b>Completed Management</b>	<b>Outstanding Management</b>
Head Injury (LOC 5 mins)	16/1 CT head -ve	Head injury obs
LC 2 Pelvic Fracture	16/1 Binder	17/1 PXR out of binder
Left femur #	16/1 Thomas splint	17/1 Left femoral nail
Left knee swelling	16/1 XR - NAD	17/1 EUA
Right Gd IIIb open tibia	16/1 Photo, dressed, tetanus, aBx, POP BS	17/1 D+W+Ex-Fix
<b>ACTIVE MEDICAL</b>		
Cystic lesion kidney	16/1 Trauma scan	18/1 Urology referral
Smoker		Smoking cessation
<b>Other PMHx</b>	Asthma, depression, previous IVDU	
<b>Weight Bearing Status</b>		
<b>Range Of Motion</b>		
<b>Braces / Splints / Casts</b>		
<b>Follow Up Plans</b>		
<b>GP RECOMMENDATIONS</b>		

### DAY 70

<b>INJURIES + EVENTS</b>	<b>Completed Management</b>	<b>Outstanding Management</b>
Head Injury (CT head -ve)	16/1 27/2 Referred to neuropsychology	Review by neuropsychology
LC 3 Pelvic Fracture	17/1 SI + rami screws 27/2 XR - OK	On-going physio
Left femur #	17/1 Left femoral nail	9/4 XR left femur
Left knee swelling	16/1 XR – NAD, 17/1 EUA – NAD	Resolved
Right Gd IIIb open tibia	17/1 D+W+Ex-Fix 19/1 Tibial nail + Free Flap	9/4 XR right tibia
<b>ACTIVE MEDICAL</b>		
Cystic lesion kidney	18/1 Urology referral	Review by Urology with outpatient US scan
Smoker		Smoking cessation
<b>COMPLICATIONS</b>		
18/1/20 PE	18/1 IVC filter inserted , 30/1 removed	
<b>Other PMHx</b>	Asthma, depression, previous IVDU	
<b>Weight Bearing Status</b>	FWB	
<b>Range Of Motion</b>	Unrestricted	
<b>Braces / Splints / Casts</b>	None	
<b>Follow Up Plans</b>	9/4/20 Polytrauma Clinic XROA (as above)	
<b>GP RECOMMENDATIONS</b>	Local smoking cessation support	

- Trauma bath
  - The body can only cope with a finite amount of inflammation. Beyond this point, inflammation causes organ dysfunction that clinically manifests itself through Acute Respiratory Distress Syndrome (ARDS) and Multi Organ Failure (MOF) – ‘the bath overflows’.
  - You cannot do anything about patient factors. These factors will contribute to the baseline level of inflammation and the amount of physiologic reserve.
  - The first hit continues until the patient is resuscitated. Aggressive damage control resuscitation and haemostatic interventions minimises the first hit.
  - You have control over the magnitude of the second hit. You should not progress beyond damage control surgery if the patient’s physiology is deteriorating or failing to improve with on-going resuscitation.
  - The bath ‘empties’ as a result of the Counter-regulatory Anti-inflammatory Response (CARs). This will take time and is variable between patients.



- AFTER ALL THIS – Remember the biggest determinant of successful outcome in the multiply injured patient is MENTAL HEALTH

## UK ISCP TRAUMA + ORTHOPAEDIC SYLLABUS

### Knowledge

0 = No experience expected / 1= Has observed or knows of / 2= Can manage with assistance / 3 = Can manage whole but may need assistance / 4= Able to manage without assistance including potential common complications			
Green text = Oxford Trauma Service suggestions			
Topic	CORE	ST3-ST8	>ST8
<b>Pathology</b>			
Shock - types, physiology, recognition and treatment	4	4	4
Metabolic and immunological response to trauma	3	4	4
Blood loss in trauma/surgery, fluid balance and blood transfusion	3	4	4
<b>Physiology</b>			
Physiological response to trauma - CRITICAL CONDITION	3	4	4
<b>Investigations</b>			
Radiological investigations to assess the injured patient	3	4	4
<b>Critical Conditions</b>			
Physiological response to trauma	2	4	4
<b>Assessments</b>			
Initial clinical assessment of the polytrauma patient	4	4	4
Priorities of treatment and identification of life/limb-threatening injuries	2	4	4
Ongoing management of polytrauma patient in first week, including prioritisation of treatment and multi-disciplinary care	2	4	4
Assessment of the limb at risk, including decision re limb salvage vs. amputation	2	3	3
<b>Treatments</b>			
The trauma team & multidisciplinary collaboration	3	4	4
<b>Operative</b>			
Management of multiple injuries in a polytrauma patient	2	4	4
<b>Non-operative</b>			
Management of psychosocial aspects of trauma	3	4	4

## Technical

0 = No experience expected / 1= Has observed or knows of / 2= Can manage with assistance / 3 = Can manage whole but may need assistance / 4= Able to manage without assistance including potential common complications

Green text = Oxford Trauma Service suggestions

Topic	CORE	ST3-ST8	>ST8
Major trauma resuscitation (CEX) – CRITICAL CONDITION			

Please find below, resources that cover the syllabus objectives.

### DISCUSSION SLIDES

OTA Resident Lectures – [Initial Assessment and Management in Multi-trauma Patients](#)

OTA Resident Lectures – [Lower Extremity Amputations Secondary to Trauma](#)

OTA Resident Lectures – [Disaster Management](#)

OTA Resident Lectures – [Chest Wall Trauma & Rib Fractures](#)

OTA Resident Lectures – [Depression and Stress in Orthopaedic Trauma: The Patient & The Surgeon](#)

### RECOMMENDED KNOWLEDGE REVIEW RESOURCES

#### GENERAL

- Rockwood + Green Chapter 13a: Management of the Multiply Injured Patient p434-462
- [JBJS Clinical Summary](#) – key papers
- Orthobullets - [ARDS](#)
- Orthobullets – [Fat Embolism Syndrome](#)
- Bates – [Demystifying damage control in musculoskeletal trauma](#), Annals RCS 2016 (attached)

#### PAEDIATRIC

- Rockwood + Green Chapter 4p: Multiply Injured Child
- AO Surgery Reference – [Paediatric](#)

#### CHEST WALL INJURY

- Rockwood + Green Chapter 45: Chest Wall Injuries
- BOA Standard – [The Management of Blunt Chest Wall Injury](#), 2016

#### MENTAL HEALTH

- Rockwood + Green Chapter 21a: Psychosocial Aspects of Recovery After Trauma p677-684
- Vranceanu – [Psychological Factors predict Disability and Pain Intensity After Skeletal Trauma](#), JBJSa 2014
- Schemitsch – [Psychological factors and recovery from trauma](#), Inj 2019

#### REHABILITATION

- BOA Standard - [Rehabilitation and Communication with Trauma Patients](#), 2016

#### DCS vs EAC vs ETC

This long running debate has pretty much run its course. The concept of Early Appropriate Care (EAC) is largely accepted, even if the terminology is not eg PRISM (Prompt Individualised Safe Management). The Pape group and the Vallier group continue to slug it out over where to draw the line using multiple physiologic parameters. If you would like a more detailed understanding of the subject, I would recommend these papers.

Key original work:

- Pape – [Effects of Changing Strategies of Fracture Fixation on Immunologic Changes and Systemic Complications after Multiple Trauma: Damage Control Orthopedic Surgery](#), J Orth Res 2008

	Parameter	Stable (grade i)	Borderline (grade ii)	Unstable (grade iii)	In extremis (grade iv)
Shock	Blood pressure (mmHg)	100 or more	80–100	60–90	>50–60
	Blood units (2 h)	0–2	2–8	5–15	>15
	Lactate levels	normal range	around 2.5	>2.5	severe acidosis
	Base deficit mmol/L	normal range	no data	no data	>6–8
Coagulation	ATLS Classification	I	II–III	III–IV	IV
	Platelet count (µg/mL)	>110,000	90,000–110,000	<70,000–90,000	<70,000
	Factor II and V (%)	90–100	70–80	50–70	<50
	Fibrinogen (g/dL)	>1	around 1	<1	DIC
	D-Dimer	normal range	abnormal	abnormal	DIC
Temp.		>34°C	33–35°C	30–32°C	30°C or less
Soft tissue injuries	Lung function; PaO <sub>2</sub> /FiO <sub>2</sub>	350–400	300–350	200–300	<200
	Chest scores; AIS	AIS I or II	AIS 2 or more	AIS 2 or more	AIS 3 or more
	Chest score; TTS	0	I–II	II–III	IV
	Abdominal trauma (Moore)	< or = II	< or = III	III	III or >III
	Pelvic trauma (AO class.)	A type (AO)	B or C	C	C (crush, rollover abd.)
Surgical strategy	Extremities	AIS I–II	AIS II–III	AIS III–IV	Crush, rollover
	Damage control (DCO) or Definitive surgery (ETC)	ETC	DCO if uncertain ETC if stable	DCO	DCO

ETC = early total care, DCO = damage control orthopedics.

- Vallier – [Timing of orthopaedic surgery in multiply injured patients: development of a protocol for Early Appropriate Care](#). J Orthop Trauma 2013;27:543–51 .

‘The threshold recommendations were **pH ≥7.25, base excess ≥–5.5 mmol/L, or lactate < 4.0 mmol/L**, to proceed with definitive fixation of fractures of the thoracolumbar spine, pelvic ring, acetabulum, or femur, as long as the patient was responding to resuscitation, and was not requiring vasopressor support’

#### Recent summary work:

- Pape – [Timing of major fracture care in polytrauma patients - An update on principles, parameters and strategies for 2020](#), Inj 2019
- Moore (Vallier) – [Fracture fixation in the polytrauma patient: Markers that matter](#), Inj 2020

#### RESUSCITATION

- Spahn – [The European guideline on management of major bleeding and coagulopathy following trauma: fifth edition](#), Crit Care 2019 [Full text available online]

#### TRAUMATIC BRAIN INJURY

- Jodoin – [Comorbid mild traumatic brain injury increases pain symptoms in patients suffering from an isolated limb fracture](#), Inj 2017

### RECOMMENDED TECHNICAL REVIEW RESOURCES

#### EMERGENCY THORACOTOMY

- EEMCrit – [Emergency Thoracotomy Simulator Demonstration](#), 2018
- OxTrauma – [Resuscitative Thoracotomy](#)

#### REBOA

- VuMedi – [REBOA 2019](#)
- Castellini – [Resuscitative endovascular balloon occlusion of the aorta \(REBOA\) in patients with major trauma and uncontrolled haemorrhagic shock: a systematic review with meta-analysis](#), World J Emerg Surg 2021 [Full text]
- Johnson – [Partial resuscitative balloon occlusion of the aorta \(P-REBOA\): Clinical technique and rationale](#), J Trauma Acute Care Surg 2015
- Thraikill – [Resuscitative Endovascular Balloon Occlusion of the Aorta \(REBOA\): update and insights into current practices and future directions for research and implementation](#), Scand J Trauma Emerg med 2021\*

#### PELVIC PACKING

- VuMedi – [Pelvic Packing](#)
- Mauffrey – [The past, present, and future management of hemodynamic instability in patients with unstable pelvic ring injuries](#), Inj 2020  
Discusses TEG / ROTEM.

## GUIDES + PROTOCOLS

### OXFORD UNIVERSITY HOSPITAL NHS FOUNDATION TRUST PROTOCOLS

- [Damage Control Protocols](#)

### NICE (NATIONAL INSTITUTE FOR CLINICAL EXCELLENCE)

- [Trauma \(QS166\)](#)
- [Major trauma: service delivery \(NG40\)](#)
- [Major trauma: assessment and initial management \(NG39\)](#)
- [Fractures \(complex\): assessment and management \(NG37\)](#)
- [Head injury: assessment and early management \(CG176\)](#)
- [Spinal injury: assessment and management \(NG41\)](#)
- [Post-traumatic stress disorder \(NG116\)](#)
- [Rehabilitation after traumatic injury \(NG211\)](#)

## ABSTRACTS + FULL TEXT PAPERS

### ASSESSMENT

#### DCS vs EAC vs ETC

- Mutschler – [Renaissance of base deficit for the initial assessment of trauma patients: a base deficit- based classification for hypovolemic shock developed on data from 16,305 patients derived from the Trauma Register DGU](#), Crit Care 2013 [Full text available online]
- Weinberg – [Assessment of resuscitation as measured by markers of metabolic acidosis and features of injury](#), BJJ 2017
- Tan – [Definitive surgery is safe in borderline patients that respond to resuscitation](#), JOT 2021
- Vallier – Complications are reduced with a protocol to standardize timing of fixation based on response to resuscitation, J Orthop Surg Res 2015
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### BASIC SCIENCE

- Gaski – [Early Immunologic Response in Multiply Injured Patients with Orthopaedic Injuries Is Associated With Organ Dysfunction](#), JOT 2019
- Shires – [Fluid Therapy in Haemorrhagic Shock](#), Arch Surg 1964
- Shires – [Fluid Resuscitation in the Severely Injured](#), Surg Clin North Am 1973
- McClelland – [Balanced Salt Solution in the Treatment of Hemorrhagic Shock](#), JAMA 1967

### TECHNIQUE

#### Damage Control Resuscitation

- Holcomb – [Damage Control Resuscitation: Directly Addressing the Early Coagulopathy of Trauma](#), JoT 2007

### REHABILITATION

#### Mental Health

- Muscatelli – [Prevalence of Depression and Posttraumatic Stress Disorder After Acute Orthopaedic Trauma: A Systematic Review and Meta-Analysis](#), JOT 2017
- Castillo – [Pain, Depression, and PTSD Following Major Extremity Trauma Among United States Military Serving in Iraq and Afghanistan: Results from the METALS Study](#), JOT 2020

### OUTCOME

#### Chest Injury

- Walters – [Surgical Stabilization Improves 30-day Mortality in Patients with Traumatic Flail Chest](#), JOT 2019
- Weninger – [Early Unreamed Intramedullary Nailing of Femoral Fractures is Safe in Patients With Severe Thoracic Trauma](#), JoT 07

#### Pelvic Fracture

- Bott – [Long-Term Patient Reported Functional Outcome of Polytraumatized Patients with Operatively Treated Pelvic Fractures](#), JOT 2019

#### Financial

- Vallier – [Early Appropriate Care: A Protocol to Standardize Resuscitation Assessment and to Expedite Fracture Care Reduces Hospital Stay and Enhances Revenue](#), JOT 2016

## COMPLICATIONS

- Weinberg – [Prolonged resuscitation of metabolic acidosis after trauma is associated with more complications](#), J Orthop Surg Res 2015