



Queensland
Trauma Education

EXTREMITY TRAUMA

Fat emboli syndrome

Immersive scenario

Facilitator resource kit

CSDS



Clinical Skills Development Service



Queensland Trauma Education

The resources developed for Queensland Trauma Education are designed for use in any Queensland Health facility that cares for patients who have been injured as a result of trauma. Each resource can be modified by the facilitator and scaled to the learners needs as well as the environment in which the education is being delivered, from tertiary to rural and remote facilities.

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Queensland Trauma Education

**Extremity Trauma – Fat emboli syndrome: Immersive scenario – Facilitator resource kit
Version 1.0**

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About this training resource kit

This resource kit provides healthcare clinicians with the skills to assess and manage a patient with fat emboli following orthopaedic limb trauma.

National Safety and Quality Health Service (NSQHS) Standards



Target audience

Emergency department medical and nursing clinicians

Duration

45-60 minutes (set up, scenario and debrief)

Group size

4-6 participants (or team composition applicable to local area)

Learning objectives

By the end of this session the participant will be able to:

- Identify the potential causes for the deteriorating patient following limb trauma
- Perform an assessment of the patient with an altered conscious state following trauma
- Describe the management of fat emboli syndrome

Facilitation guide

1. Facilitator to provide participant resource kit to the learner.
2. Facilitator to discuss the pre-simulation briefing and deliver the immersive scenario on fat emboli syndrome.
3. Utilise the supporting documents to maximise the learning throughout immersive scenario.
4. Utilise the debriefing guide to evaluate participant performance and provide feedback.

Overview of Fat Emboli Syndrome

Fat embolization Syndrome is an uncommon but significant complication of orthopaedic trauma. Fat globules from bony injury are embolised throughout the circulation causing microvascular occlusion. It can mimic pulmonary emboli with increased right ventricular (RV) pressure and pulmonary hypertension if in the pulmonary capillaries. It is most likely to occur 24-72hours after injury and may present with respiratory distress, confusion or seizures, tachycardia, petechial rash and renal failure. Pathological abnormalities include Disseminated intravascular coagulation (DIC), anaemia, acute renal and hepatic failure.

Acute symptoms may take days to weeks to resolve, with some patients having persistent neurological deficits and mortality remains 2-15% despite intervention.

Further readings

Emergency management of fat embolism syndrome	
Publication	Journal of Emergencies, Trauma and Shock
Link	https://doi.org/10.4103/0974-2700.44680

Fat embolism syndrome: clinical and imaging considerations: case report and review of literature	
Publication	Indian Journal of Critical Care Medicine.
Link	https://doi.org/10.4103/0972-5229.40948

Timing of definitive fixation of major long bone fractures: Can fat embolism syndrome be prevented?	
Publication	Injury
Link	https://doi.org/10.1016/j.injury.2017.04.015

Fat Embolism	
Publication	StatPearls
Link	https://www.ncbi.nlm.nih.gov/books/NBK499885/

Fat embolism syndrome: Experience from an Australian trauma centre	
Publication	International Journal of Orthopaedic and Trauma Nursing
Link	https://doi.org/10.1016/j.ijotn.2019.100746

Supporting resources

Original Gurd and Wilson's criteria, Modified Gurd's criteria, and Schonfeld's criteria for diagnosis of fat embolism syndrome (FES).

Criteria	Gurd and Wilson's	Modified Gurd's	Schonfeld's	Score
FES Diagnosis	2 major or 1 major + 4 minor	1 major + 3 minor or 2 major + 2 minor	Five points	
Major	Petechiae Hypoxemia	Petechiae on conjunctiva and upper trunk PaO₂ <60 at FIO₂ 0.2 l with or without pulmonary infiltrate on chest X-ray	Petechiae X-ray infiltrate on chest (diffuse alveolar infiltrate) Hypoxemia	5 4 3
	Altered mentality	Altered mentality with multiple cerebral white matter lesion on brain MRI	Mental confusion	1
Minor	Tachycardia Fever	HR >100/min Temperature >38°C	Tachycardia Fever Tachypnea	1 1 1
	Thrombocytopenia Unexplained anemia	Platelet <100×10 ³ /μL Anemia with coagulopathy or DIC without definite ongoing bleeding site		
	Anuria or oliguria Retinal embolism Fat globule in urine or sputum Jaundice High ESR	Anuria or oliguria Retinal embolism on ophthalmoscopic examination		

Note: Bold text represents major criteria.

Abbreviations: DIC, disseminated intravascular coagulation; ESR, erythrocyte sedimentation rate; FES, fat embolism syndrome; HR, heart rate; PaO₂, arterial oxygen pressure.

Source: [Original Gurd and Wilson's criteria, 9 Modified Gurd's criteria, 16 and Schonfeld's criteria 47 for diagnosis of FeS](#)

Simulation event

This section contains the following:

1. Pre-simulation briefing poster
2. Immersive scenario
3. Resource requirements
4. Handover card
5. Scenario progression
 - a. State 1
 - b. State 2
 - c. State 3
 - d. State 4
6. Supporting documents
7. Debriefing guide

Pre-simulation briefing

Establishing a safe container for learning in simulation



1

Clarify objectives, roles and expectations

- Introductions
- Learning objectives
- Assessment (formative vs summative)
- Facilitators and learners' roles
- Active participants vs observers

2

Maintain confidentiality and respect

- Transparency on who will observe
- Individual performances
- Maintain curiosity



3

Establish a fiction contract

Seek a voluntary commitment between the learner and facilitator:

- Ask for buy-in
- Acknowledge limitations

4

Conduct a familiarisation

- Manikin/simulated patient
- Simulated environment
- Calling for help

5

Address simulation safety

Identify risks:

- Medications and equipment
- Electrical or physical hazards
- Simulated and real patients

Note: Adjust the pre-simulation briefing to match the demands of the simulation event, contexts or the changing of participant composition.

Immersive scenario

Type	Immersive scenario
Target audience	Emergency Department medical and nursing clinicians
Overview	<p>Fat emboli syndrome is a rare but significant complication following orthopaedic injury that should be considered in the patient with respiratory distress and cognitive decline following trauma.</p> <p>This scenario will explore a patient requiring transfer to a tertiary centre for definitive management and deteriorates en route requiring the prompt recognition and management of a patient suffering fat emboli syndrome following limb trauma.</p>
Learning objectives	<p>By the end of this session the participant will be able to:</p> <ul style="list-style-type: none">• Identify the potential causes for the deteriorating patient following limb trauma• Perform an assessment of the patient with an altered conscious state following trauma• Describe the management of fat emboli syndrome
Duration	45 minutes, including debrief

Resource requirements

Physical resources

Room setup	Resuscitation bay in ED
Simulator/s	ALS advanced, SimMan ALS, SimMan 3G
Simulator set up	Street clothes lying supine Moulage: normal patient, traction splint on R leg, Hudson Mask, attached to transport monitoring (if available)
Clinical equipment	Standard resus bay setup and equipment Intubation medications and equipment
Access	2 x IVC setups. 1x 18G R ACF and 1x 'No IV' sticker attached
Other	ED chart and relevant paperwork Radiological and laboratory resources

Human resources

Faculty	2 facilitators (Dr/Nurse with debriefing experience) to take on roles of scenario commander and primary debrief
Simulation coordinators	Simco X 1 for manikin set up and control
Confederates	Retrieval Doctor/paramedic to perform handover (if available)
Other	Team composition as appropriate for local environment Available staff to call in

Handover card

Handover from flight doctor performing interhospital transfer

Carl is a 24-year-old man who was involved in a motor bike collision 48 hours ago. He was initially managed in a rural facility until the weather cleared and he could be retrieved. Injuries identified by the team who initially cared for him include R clavicle and R proximal femoral fractures. This has been managed with traction splinting and femoral nerve block. He has had a CXR which is normal. His vitals were within normal limits when we arrived at the rural hospital approx. 1 hr ago. But I'm worried as he's deteriorated since we retrieved him, his vitals are presently: BP 100/80, HR 120, SpO2 92% 6LHM, RR 26 and his GCS is 14 (E4V4M6).

In addition to the femoral nerve block, his pain has been managed with IV morphine (total 80mg in 48 hours) and IV ketamine (total 500mg in 48 hours). With us he has been managed with IV ketamine during the flight (included in the above total).

He is previously well, with no medical history, is on no regular medications and has no allergies.

His parents are on the way to the hospital via road.

Scenario progression

STATE 1: INITIAL ASSESSMENT				
Vital signs		Script	Details	Expected actions
ECG	ST	Carl: Moaning: 'Oh my leg hurts' 'I can't breathe' *mild agitation*	Primary survey results A: Intact B: Crepitus bilaterally, L > R, no chest wall tenderness or bruising C: well perfused, HS dual, tachycardic D: Confused to place, unable to move R leg due to pain E: afebrile	Commence Primary Survey <input type="checkbox"/> Identify respiratory distress <input type="checkbox"/> Optimise oxygenation, increase oxygen flow <input type="checkbox"/> Call for help, escalate concerns
HR	120			
SpO₂	90% RA			
BP/ART	100/80			
RR	28			
Temp	37.9			
BGL	6.0			
GCS	14 (E4V4M6)			

STATE 2: ONGOING MANAGEMENT / SECONDARY ASSESSMENT				
Vital signs		Script	Details	Expected actions
ECG	ST	<p>Carl “Ahhhh, I’m...ahhhhh’ *Less responsive, mumbling words only, localizing to pain*</p> <p>Confederate (prompt participants if required) “Carl’s breathing seems to be getting worse...”</p>	<p>Secondary survey results</p> <ul style="list-style-type: none"> • No external evidence of facial or head injury • Fine petechial rash to face and torso • Abdo soft, non-tender • Pelvis aligned, no tenderness • R femur deformity, no wounds, neurovasc intact distally, femoral splint in position <p>Results</p> <p>CXR: diffuse bilateral opacification</p> <p>Pelvic XRay: ring intact, binder well placed</p> <p>R femoral XRay: midshaft femoral fracture- traction splint in-situ, fracture displaced</p>	<p>Secondary survey</p> <ul style="list-style-type: none"> <input type="checkbox"/> Head to toe assessment <p>Investigations</p> <ul style="list-style-type: none"> <input type="checkbox"/> Bloods- trauma panel, XMatch <input type="checkbox"/> CXR, Pelvic XRay and R femoral XRay <p>Management</p> <ul style="list-style-type: none"> <input type="checkbox"/> Ensure fracture immobilised <input type="checkbox"/> Neurovascular assessment R leg <input type="checkbox"/> Recognise and communicate ongoing respiratory and CNS deterioration with team
HR	120			
SpO ₂	92% NRB 15L/min			
BP/ART	100/80			
RR	28			
Temp	37.9			
BGL	6.2			
GCS	11 (E3V3M5)			

STATE 3: AIRWAY MANGEMENT				
Vital signs		Script	Details	Expected actions
ECG	ST	<p>Confederate <i>Prompt team if required</i> “He really seems to be struggling to breathe... and is he responding?”</p>	<p>Further deterioration of conscious state and respiratory status</p> <p><i>Continue to reduce SpO2 and BP if team fails to recognise deterioration</i></p>	<p>Assessment</p> <ul style="list-style-type: none"> <input type="checkbox"/> Identification of escalating respiratory support required in the setting of CNS dysfunction <p>Management</p> <ul style="list-style-type: none"> <input type="checkbox"/> Intubation for oxygenation/ventilation- protective lung strategy <ul style="list-style-type: none"> • Could use NIV as bridge to RSI • Avoid hypovolaemia • DVT/PPI <p>Arrange advanced imaging</p> <ul style="list-style-type: none"> <input type="checkbox"/> Discuss options with team and consultant <input type="checkbox"/> CTB: to exclude mass lesion (SDH/EDH), confirm DAI pattern with FES <input type="checkbox"/> CT Chest: identify pulmonary infiltrates, exclude chest trauma, exclude PE <input type="checkbox"/> CT Abdo/pelvis: exclude trauma injury
HR	120			
SpO ₂	89% NRB 15L/min			
BP/ART	100/80			
RR	35			
Temp	37.9			
BGL	6.5			
GCS	11 (E3V3M5)			

STATE 4: POST ADVANCED IMAGING/SENIOR PARTICIPANTS				
Vital signs		Script	Details	Expected actions
ECG	ST		<p>For Senior Participants scenario can be paused and restarted as patient returns from CT</p> <p><i>Patient intubated and ventilated</i></p> <p><i>Patient has returned following CT imaging:</i></p> <p>Provide participants with CT slice of CTchest, CTBrain and CTAbdo/Pelvis</p>	<ul style="list-style-type: none"> <input type="checkbox"/> Senior participants discuss findings of CT images with team <input type="checkbox"/> Discuss immediate/ongoing patient management strategies <ul style="list-style-type: none"> • protective lung strategy – mechanical ventilation ARDS • inotropic support for RV failure • management of cerebral oedema <input type="checkbox"/> Discuss ongoing options patient disposition <input type="checkbox"/> Consult with specialist surgical/Ortho/neuro and intensive care teams
HR	105			
SpO ₂	93% FiO ₂ 1.0			
BP/ART	105/75			
RR	16			
Temp	37.1			
BGL	7			
GCS	3 (E1VTM1)			
ETCO ₂	55 (reduce to 38 if hyperventilate)			

Supporting documents

The following supporting documents are provided for this immersive scenario:

1. Specific management of Fat Emboli Syndrome

Pathology results

2. Group and hold
3. Coagulation
4. Chem20
5. FBE

Radiology results

1. CXR
2. Pelvic Xray
3. CT Chest: Findings - diffuse centrilobular air space consolidation with surrounding ground-glass opacity and smooth interlobular septal thickening in the lungs.
4. CT Abdo/Pelvis: Findings - fat density filling defect in proximal right femoral vein upstream from femoral fracture.
5. CT Brain: Findings - subtle hypodensity in subcortical white matter

Specific management of Fat Emboli Syndrome

- Supportive therapy - mechanical ventilation (ARDS), inotropic support for RV failure, management of cerebral oedema (1)
- Prevention - early fixation of long bone fractures (ARDS 7% with early fixation vs 39% if >24 hours) (2) Pharmacological treatments largely ineffectual
- Heparin - increased risk bleeding
- Corticosteroids - no benefit
- IVC filter - not studied

Group and hold

Transfusion Medicine - Group and Antibody Screen

Blood Group: B Rh(D) POSITIVE

Antibody Screen: Negative

Coagulation

GENERAL COAGULATION		Specimen: Blood
INR	1.2	
Prothrombin Time	14 H	
APTT	30	
Fib (derived)	4.2	

Comment: Use shift-insert to view reference ranges. 24 years

FBE

Diff: Automated Specimen: Blood

Hgb : 97 L WBC : 10.1

PLT : 110 L :

RBC : 3.16 L HCT : 0.28 L

MCV : 90 MCH : 30.7

RDW : MCHC :

Press shift-insert to view reference ranges

Neut (73 %): 7.39

Lymph (14 %): 1.46

Mono (7 %): 0.70

Eosin (5 %): 0.50

Baso (0 %): 0.03

NRBC /100 WBC

SusFlg

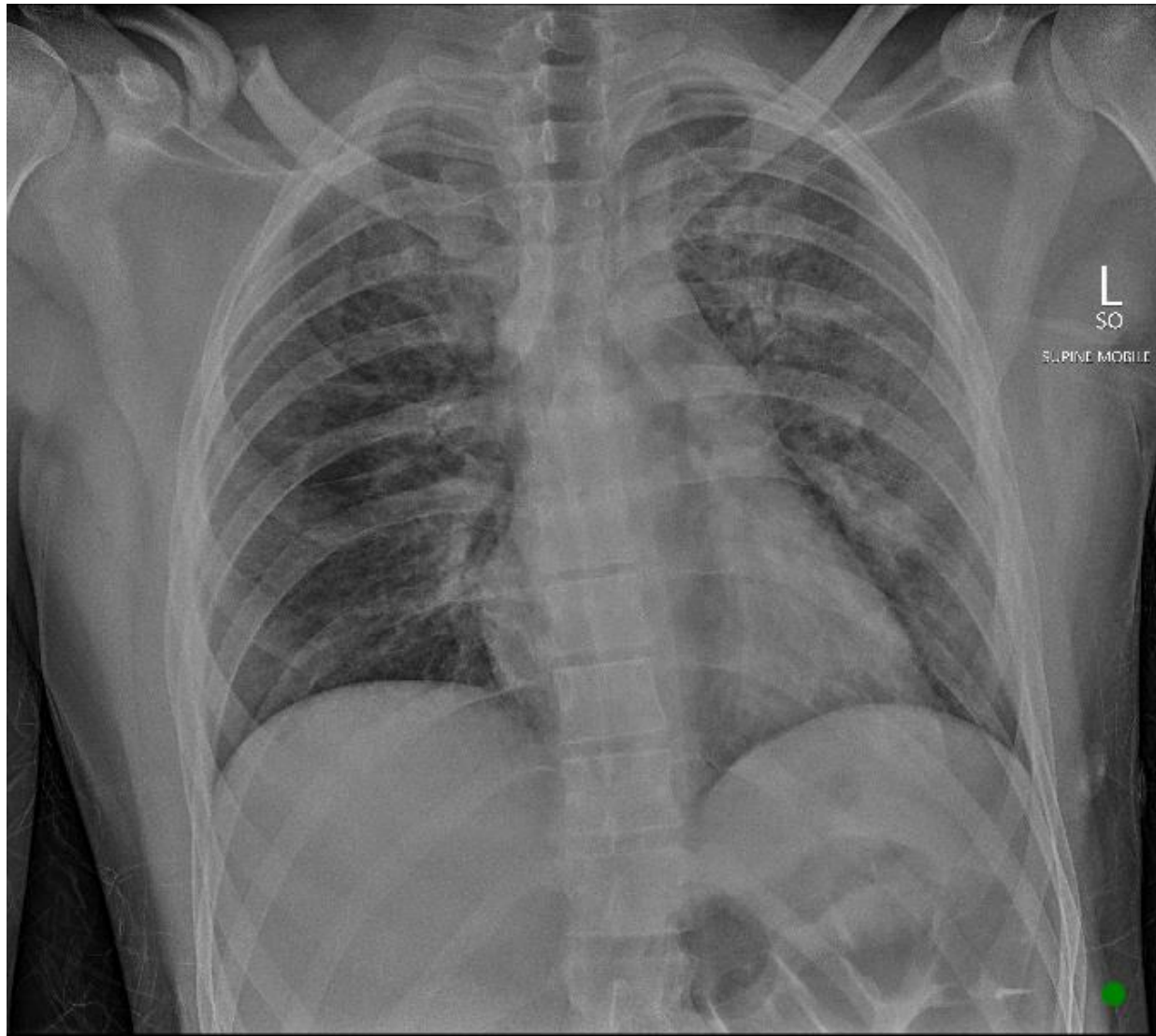
Comment: Patient Age: 24 years Val: sys



Arterial blood gas

Arterial		Temp.	37.0	Degree C	Na	133 L	mmol/L
Airway	Natural	Corr pH	7.41		K	4.1	mmol/L
FI02	0.30	Corr pCO2	35	mmHg	Cl	105	mmol/L
pH	7.41	Corr pO2	55	mmHg	Anion Gap	7	mmol/L
pCO2	35	Total Hb	138	g/L	Creatinine		umol/L
pO2	55 C	Oxy Hb	88	L %	Ca (Ionised)	1.12 L	mmol/L
O2 Sat.	90 L %	Carboxy H	0.9	%	Glu	8.0 H	mmol/L
p50	25.0	Met Hb	1.1	%	Lact	1.3	mmol/L
HCO3-	21 L	Sulph Hb			Bili (Total)		umol/L
ABE	-2.2 L				Fetal Hb		%
Comp. Val.	Yes	MODE 1			MODE 2		
COMMENT:							

CXR



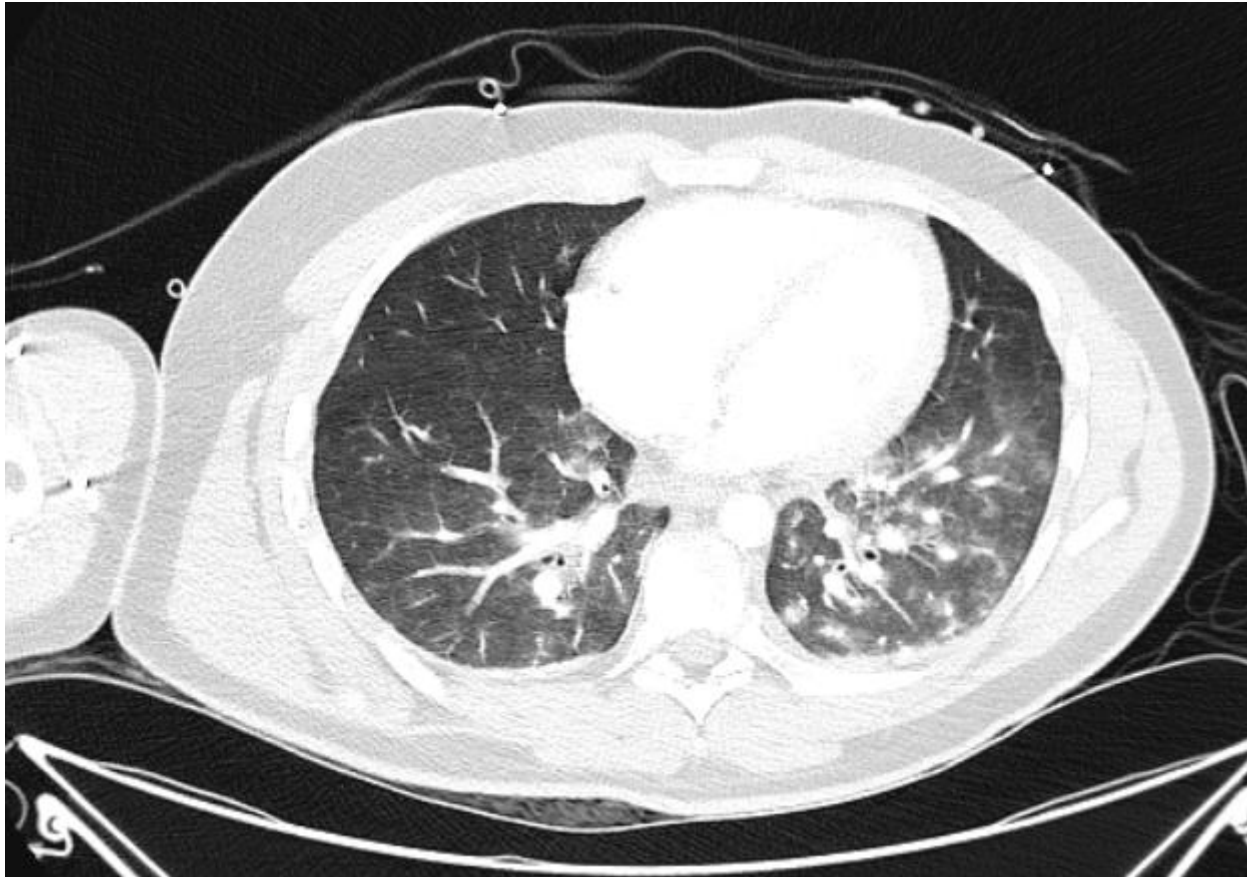
Pelvic Xray



R femur Xray



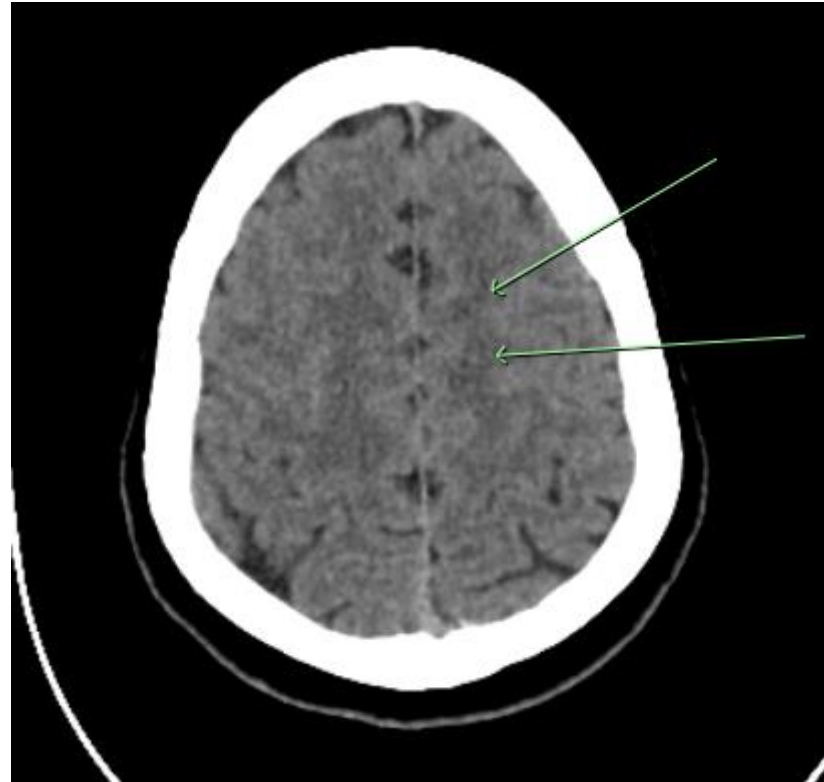
Additional images for senior participants, CT Chest



CT Abdo/pelvis



CT Brain



Debriefing guide

Scenario objectives

1. Identification of the deteriorating patient
2. Assessment of the patient with altered conscious state
3. Management of fat emboli syndrome

Example questions

Exploring diagnosis

- Describe the assessment of this patient, who was a delayed trauma assessment?
- How does this differ in injury risk from early presentations?
- What is the significance of the skin rash and respiratory distress?
- What are the criteria for diagnosis of fat emboli syndrome? When does it occur? Can it be prevented?

Discussing management

- Should the femoral traction splint be adjusted in this scenario?
- In suspected fat emboli syndrome is there a preference for fluid choice in resuscitation? (Albumin preferred as will bind free fatty acids)
- What strategy was used to manage the patient's respiratory distress?
- What are the pros and cons for NIV vs Intubation in this patient?

Discussing teamwork/crisis resource management

- How do you prioritise your team in clinical assessment of the trauma patient?
- What roles are allocated?
- What strategies do you utilise to encourage all team members to voice their concerns/recognition of the deteriorating patient?

Key moments

- Decision process for respiratory support- NIV vs intubation
- Identification of fat emboli syndrome
- Management of multiple orthopaedic splint/binders

Acronyms and abbreviations

Term	Definition
FES	Fat emboli syndrome
NIV	Non-invasive ventilation
ARDS	Acute respiratory distress syndrome
RV	Right ventricular

References

1. Kwiat, M. E., & Seamon, M. J. (2013). Fat embolism syndrome. *International journal of critical illness and injury science*, 3(1), 64–68. <https://doi.org/10.4103/2229-5151.109426>
2. Johnson, K. D., Cadambi, A., & Seibert, G. B. (1985). Incidence of adult respiratory distress syndrome in patients with multiple musculoskeletal injuries: effect of early operative stabilization of fractures. *The Journal of trauma*, 25(5), 375–384. <https://doi.org/10.1097/00005373-198505000-00001>
3. Gurd A. R. (1970). Fat embolism: an aid to diagnosis. *The Journal of bone and joint surgery. British volume*, 52(4), 732–737.

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