Workshop D

Rib Fracture Management

Analgesia Management

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Declarations

- No conflicts of interest

- Slides belonging to Prof Hewson used with permission

Background

- Over 15,000 patients per year are admitted to hospital in England and Wales with rib fractures (Womack et al. 2019)
- Number of fractures directly correlates with presence of intrathoracic injury (Sirmali et al. 2003)
- Pain may be more harmful than the injury itself:
  - Atelectasis
  - Sputum retention
  - Reduced FRC
  - Infection

The source of pain

- **Direct periosteal and parietal pleural disruption**

- Tears to thoracic musculature
- Sternal, scapula, clavicular, shoulder girdle and humeral injuries
- Vertebral column and paraspinal muscle injury and spasm
- Pleural inflammatory responses
- Abdominal wall or visceral injury
- Distant distracting injury
- Affective & psychological components of trauma pain

Posterior cutaneous branch

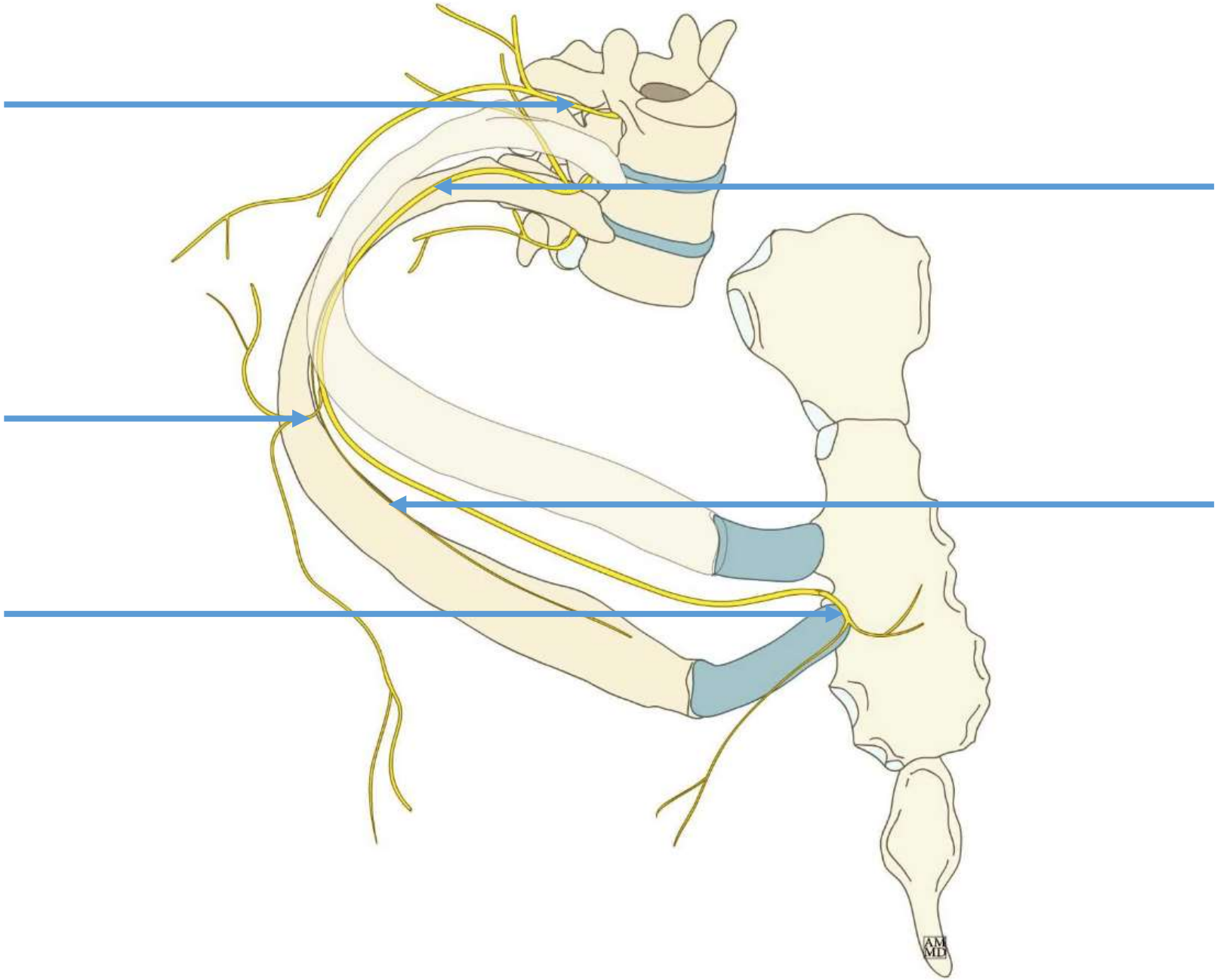
- Skin

Lateral cutaneous branch

- Skin

Anterior cutaneous branch

- Skin



Intercostal nerve

- Parietal pleura
- Rib periosteum
- Muscles

Collateral branch

- Parietal pleura
- Rib periosteum
- Muscles

Davies F. J Anat. 1932; 66: 323-333

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Case study

- Pre-hospital
- 35 F, normally fit and well
- Kick to chest from horse
- Left sided chest wall deformity
- Sats 88% air, RR 35, HR 130, BP 105/65, GCS 15
- In agony

- A-E assessment?
- Interventions?
- Analgesia?

FROM HERE, HEALTH

FACULTY OF PRE-HOSPITAL CARE
THE ROYAL COLLEGE OF SURGEONS OF EDINBURGH

The pre-hospital management of life-threatening chest injuries: a consensus statement

Caroline Leech, Keith Porter, Richard Steyn, Colville Laird, Imogen Virgo, Richard Bowman, & David Cooper

- Analgesia is critical in the early management of rib fractures.
- A pain score should be performed early and repeated at frequent intervals.
- Analgesic agents such as intravenous Paracetamol, Morphine or Fentanyl, Ketamine or intranasal Diamorphine should all be considered depending on availability and expertise.
- Entonox cannot be recommended as approximately one third of patients with >3 rib fractures have an underlying pneumothorax (personal communication TARN).

Intravenous opioid

- Familiar
- Effective
- Low risk of dysphoria

- CNS depression
- Morphine – slow onset, ~30 mins to peak effect
- Opioid induced ventilatory impairment
- Opioid toxicity
- Cough suppression
- Nausea and vomiting

Intravenous ketamine analgesia (0.1-0.3mg/kg)

- Preserved upper airway reflexes
- Generally preserves respiratory function
- Sympathetic stimulation
- Bronchodilator
- At least as effective as opioids

Sandberg et al. 2020

- Dysphoria (5-30%)
- Hypersalivation
- Nausea and vomiting (lower than morphine)
- Rarely laryngospasm

Case continued

- You are in Resus
- 35 F, normally fit and well
- Kick to chest from horse
- Left sided chest wall deformity, thoracostomy (minimal blood, stopped bubbling)
- Sats 96% NRB, RR 28, HR 110, BP 105/65, GCS 14
- Shallow breathing

- A-E assessment?
- Interventions?
- Analgesia?
- Risk assessment?

Multimodal systemic analgesia

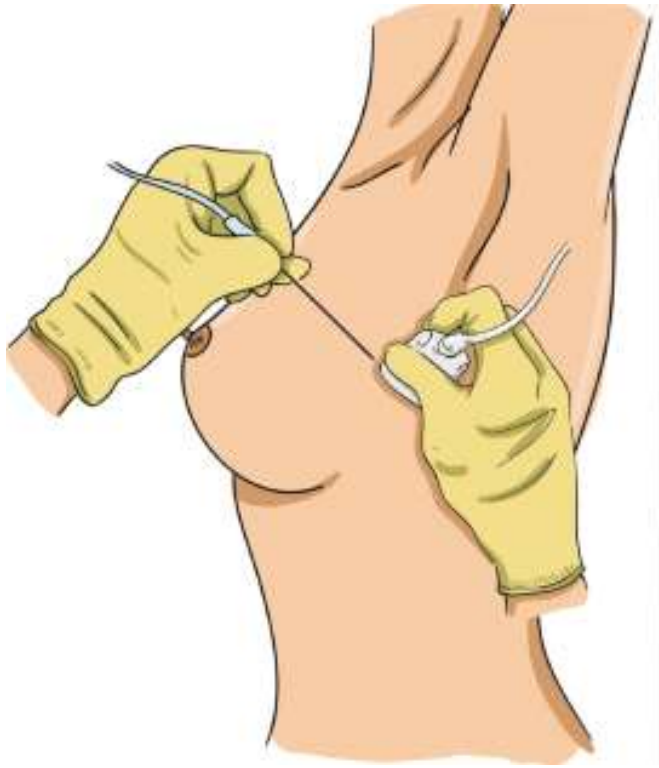
- Paracetamol
- NSAIDs
- Systemic opioids – no clear superiority of route
- Ketamine
- Lidocaine patch
- Gabapentinoids

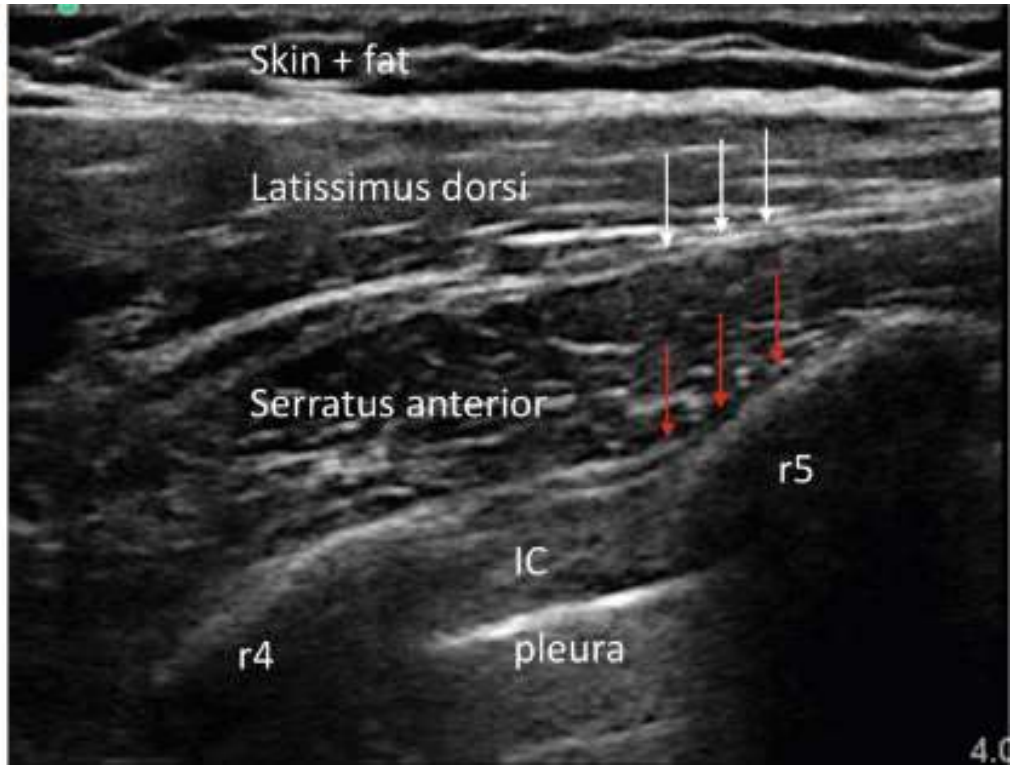
Multimodal systemic analgesia only?

- Age <65
- <3 rib fractures
- No significant pulmonary compromise
- No comorbidities

Kim and Moore. Curr Opinion Anaes. 2020

US guided serratus plane block





Versyck. Regional nerve blocks in anaesthesia and pain therapy.

Serratus plane blocks

- Effectively reduces pain scores
- Can perform supine (no repositioning required)
- Low risk of complications
- ‘Safe’ in the anticoagulated
- Catheters can be inserted (advanced technique)

- Small risks of
  - PTX
  - Nerve injury
  - Vascular puncture
  - Infection
  - LAST
- May be less effective for posterior fractures, intercostal drains

5. Management of Rib Fractures Confirmed in ED

1.	Provide respiratory support
	Monitor SpO_2
	Encourage to sit up and mobilise wherever possible
	Provide humidified oxygen at lowest concentration to achieve appropriate SpO_2 (94-98% or 88-92% if COPD)
	Prescribe NaCl 0.9% 10ml nebulisers 4^0 or PRN to aid with sputum clearance
	Consider prescribing Salbutamol 2.5mg nebulisers PRN

NUH Adult blunt chest wall trauma and rib fracture management. Rattenberry, Morgan, Turner. 2020.

2. Assess risk *(STUMBL score)*[1,7]

Variable	Score
Age	+1 per every 10 years after 10 years old
SpO_2 levels	+2 per 5% decrease in SpO_2 below 95%
No. of rib fractures	+3 per rib fracture
Anticoagulant use pre-injury	+4
Chronic lung disease	+5

Risk score	Probability of complications*
0-10	13%
11-15	29%
16-20	52%
21-25	70%
26-30	80%
31+	88%

*Complications defined as:

- in-hospital mortality,
- morbidity including all pulmonary complications (chest infection, pneumonia, haemothorax, pneumothorax, pleural effusion, empyema),
- ICU admission,
- prolonged length of stay ≥7 days[7]

It is essential to understand that patients with severe injuries and/or co-morbidities, who are at high risk of deterioration and mortality, can appear to have acceptable analgesia in the acute setting. The STUMBL score, alongside regular assessment of functional analgesia, can help to identify patients most likely to need regional analgesia before they deteriorate.

NUH Adult blunt chest wall trauma and rib fracture management. Rattenberry, Morgan, Turner. 2020.

STUMBL Score

274 patients, 2009-2011
Composite "Complications"

Variable	Score
Age	+1 per additional 10-year increase starting at 10 years of age
Number of rib fractures	+3 per rib fractured
Chronic lung disease	+5 if present
Pre-injury anticoagulant use	+4
Peripheral oxygen saturation levels	+2 per 5% decrease in peripheral oxygen saturation levels starting at 94% at time of assessment

Final risk score	Probability mean ± standard deviation of developing complications
0–10	13 ± 6%
11–15	29 ± 8%
16–20	52 ± 8%
21–25	70 ± 6%
26–30	80 ± 6%
31 and upwards	88 ± 7%

- <11 discharge from ED
- 11-25 admit to L0 or L1
- >26 admit to critical care

Battle CE. Critical Care. 2014; 18:R98

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Risk assessment

- SRMA
- 2010-2022
- 73 observational studies
- Up to 160,123 patients

Age >65 (OR 2.11; 53,612 patients)
3 ribs # (OR 2.86; 160,123 patients)
Cardiopulmonary disease (OR 2.86; 249 patients)

Battle C. Emerg Med J. 2023; 40: 369-78.

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- Flail
- Bilateral injuries
- 1st rib fracture
- Degree of fracture displacement
- Pulmonary contusions
- BMI > 25
- Reduced vital capacity
- Frailty
- Treatment in low volume centres or outside established pathway

Witt CE. Trauma Surg Acute Care Open. 2017; 2e000064

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Case – Risk assessment

- Age 35 (2 points)
- 6 ribs, 4 radiological flail (18 points)
- No chronic lung disease (0 points)
- No anticoag (0 points)
- Sats 88% (2 points)

- Total 22 points (~70% risk of complications)

A tool to assist ED decision-making regarding destinations of care…

… repurposed to help determine analgesic regimes

4. Further management based on STUMBL score

Score 0-10	Score 11-15	Score 16-30	Score >30
Unlikely to require Major Trauma admission	Consider escalation if score 11-15 OR	Patient at risk of respiratory decompensation	Assess for ventilatory support
Consider discharge if safe with simple analgesia	Unable to deep breathe and cough OR	Refer to Major Trauma fellow (784-3422) or MT Consultant (switchboard) and Adult Inpatient Pain Team	**Early liaison with critical care**
	Other risk factors for morbidity	Likely to need regional analgesia (see RA flowchart)	

Other risk factors for morbidity	
Pulmonary contusion	≥2 distant injuries
Cardiovascular disease	Smoker
Obesity / OSA	Frailty

NUH Adult blunt chest wall trauma and rib fracture management. Rattenberry, Morgan, Turner. 2020.

Functional assessment

"Give me a big cough!"

"Can you take a deep breath?"

"What are the % Sats doing?"

? Thresholds for action

? Inter-rater agreement

? Temporal reliability

? Assessor bias

? Impact of confounders

PIC Score

1 2 3 4 5 6 7 8 9 10

Pain Patient-reported, 0-10 scale	Inspiration Inspiratory spirometer; goal and alert levels set by respiratory therapist	Cough Assessed by bedside nurse
3 - Controlled (Pain intensity scale 0-4)	4 – Above goal volume	3 - Strong
2 - Moderate (Pain intensity scale 5-7)	3 – Goal to alert volume	2 - Weak
1 - Severe (Pain intensity scale 8-10)	2 – Below alert volume	1 - Absent
	1 – Unable to perform incentive spirometry	

Witt CE. Trauma Surg Acute Care Open. 2017;

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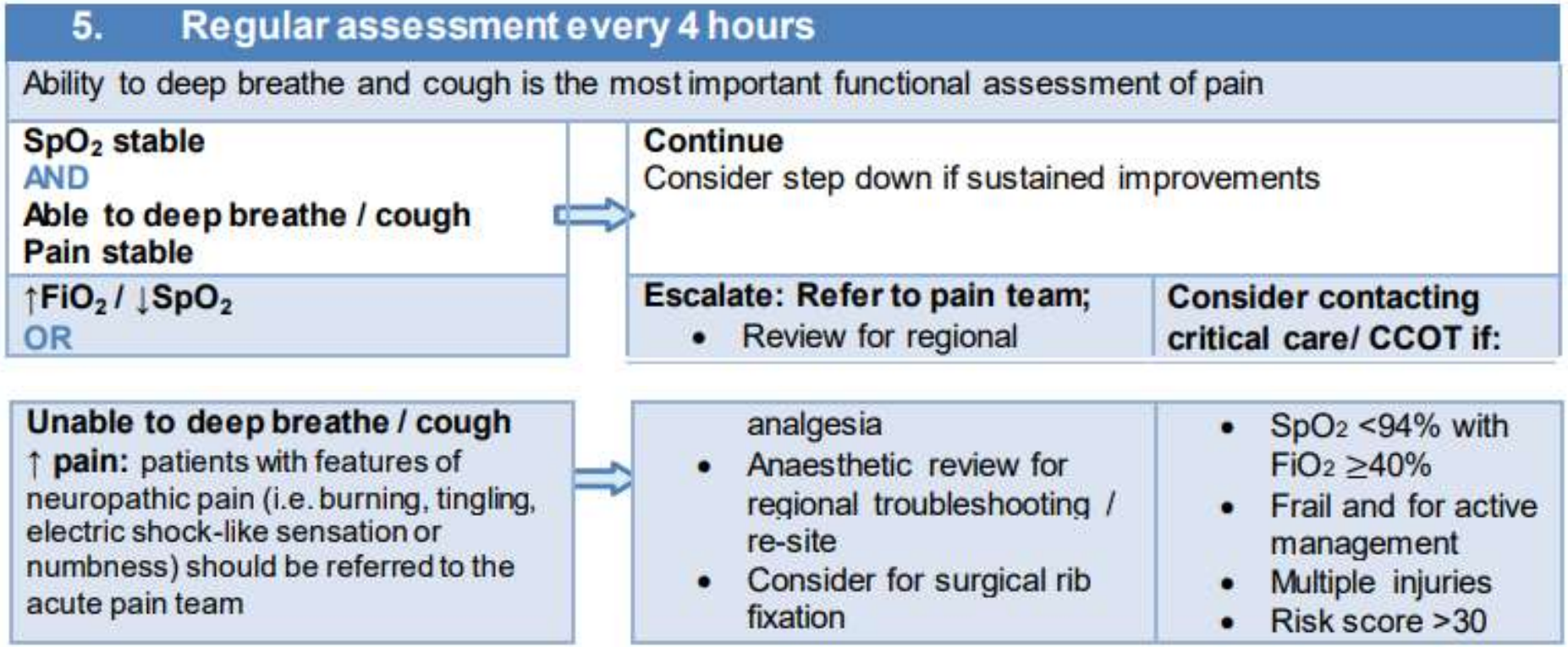


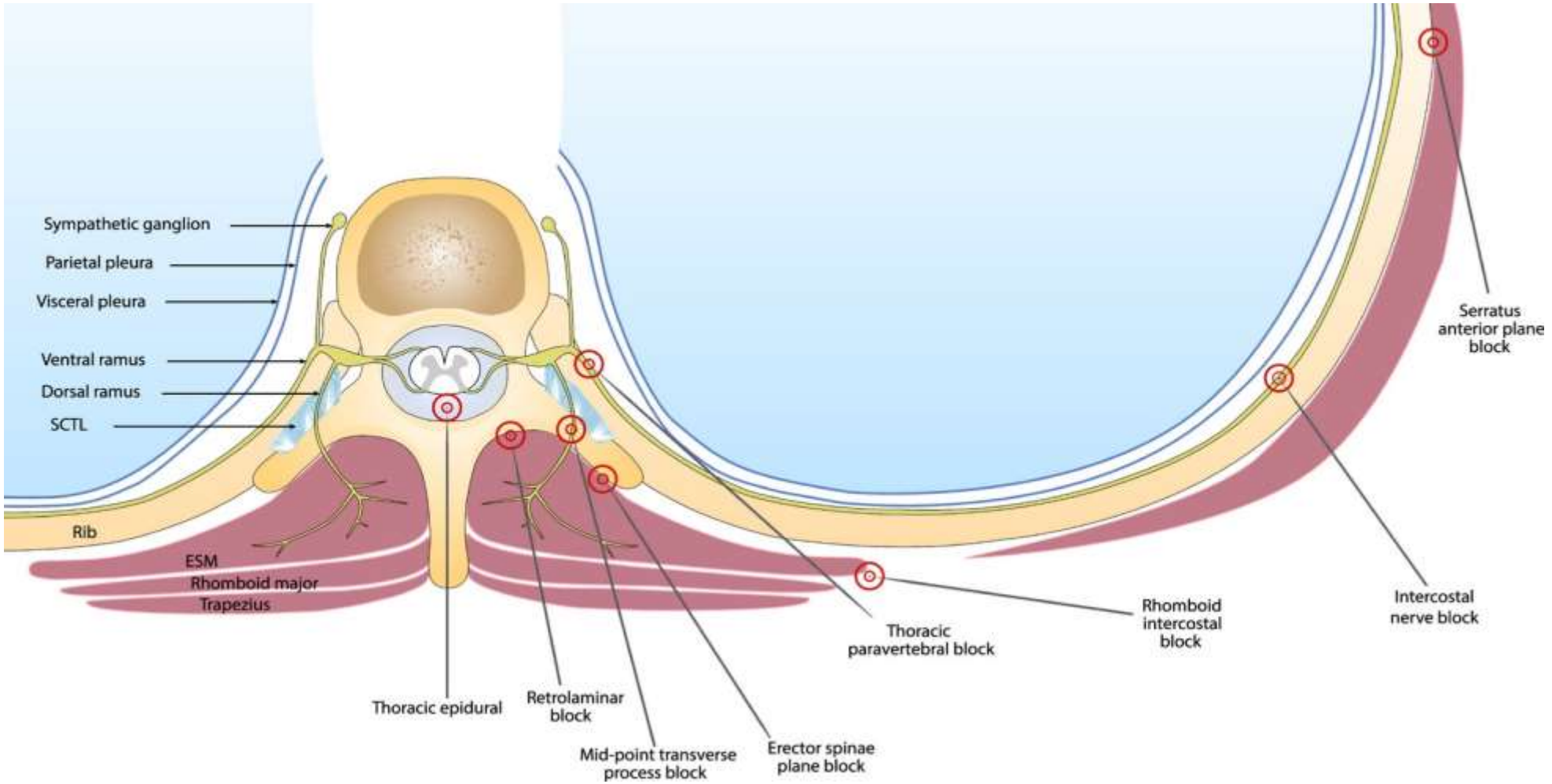
NUH Adult blunt chest wall trauma and rib fracture management. Rattenberry, Morgan, Turner. 2020.

Case continued

- Day 2, Trauma ward
- 35F, 6 x ribs (left), 3 flail
- Left ICD in situ, some bubbling
- Paracetamol, ibuprofen, omeprazole, Longtec 10mg bd, Shortec 5-10mg 2hrly, ketamine 20mg qds, lidocaine patch
- Refusing to cough, won't sit out
- FiO2 4l NC -> .40 humidified

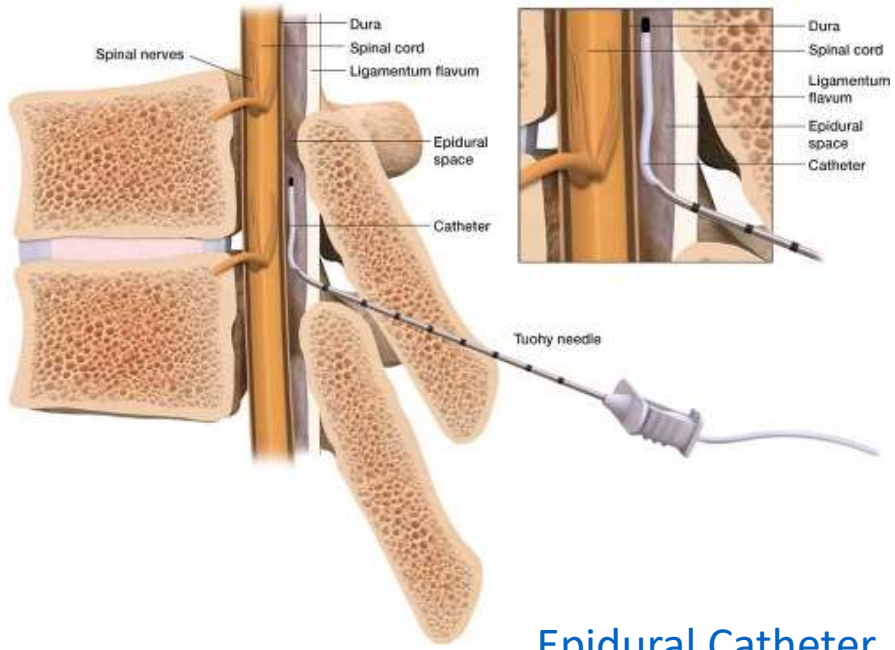
- Interventions?
- Analgesia?
- Thoughts on oxycodone?

Which regional technique?



Thoracic epidural analgesia

- Profound and reliable functional analgesia
- Definite procedural endpoint
- Established in anaesthetic practice
- Simple dosing
- Easy(ish) to ‘troubleshoot’
- Familiar to nurses and therapists

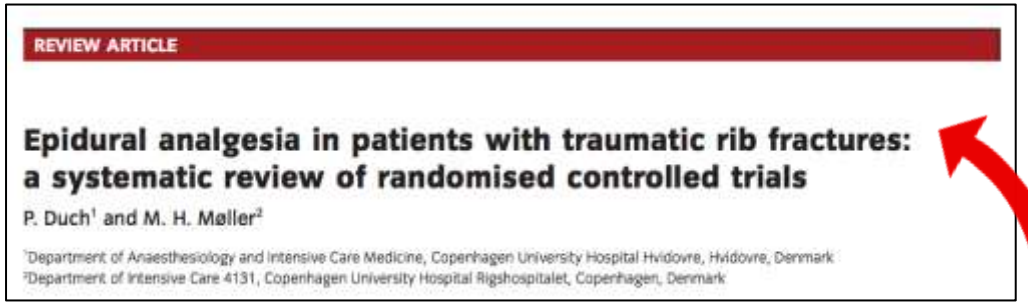


Epidural Catheter Analgesia | Anesthesia Key (aneskey.com)

PROF HEWSON'S TAKE-HOME MESSAGE

It is readily observable that epidural analgesia provides the most profound pain relief for people with rib fractures

2015



REVIEW ARTICLE

Epidural analgesia in patients with traumatic rib fractures: a systematic review of randomised controlled trials

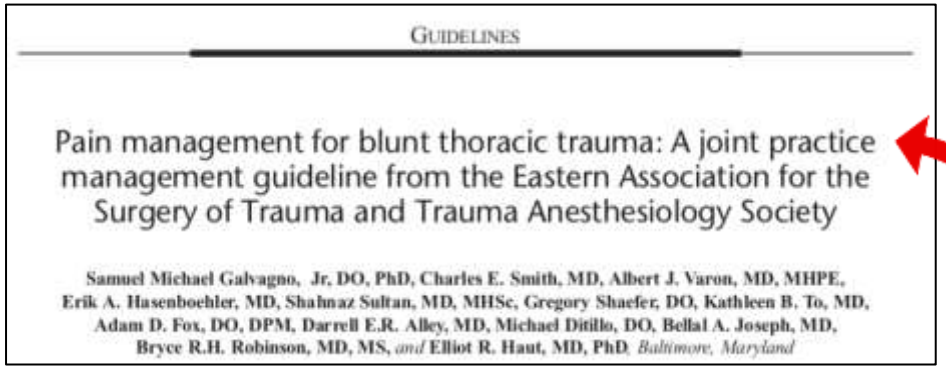
P. Duch[1] and M. H. Møller[2]

[1]Department of Anaesthesiology and Intensive Care Medicine, Copenhagen University Hospital Hvidovre, Hvidovre, Denmark
[2]Department of Intensive Care 4131, Copenhagen University Hospital Rigshospitalet, Copenhagen, Denmark

"No firm evidence for benefit or harm duration of mechanical ventilation or pneumonia."

6 RCTS, 223 pts

2016



GUIDELINES

Pain management for blunt thoracic trauma: A joint practice management guideline from the Eastern Association for the Surgery of Trauma and Trauma Anesthesiology Society

Samuel Michael Galvagno, Jr, DO, PhD, Charles E. Smith, MD, Albert J. Varon, MD, MHPE, Erik A. Hasenboehler, MD, Shahnaz Sultan, MD, MHSc, Gregory Shaefer, DO, Kathleen B. To, MD, Adam D. Fox, DO, DPM, Darrell E.R. Alley, MD, Michael Ditillo, DO, Bellal A. Joseph, MD, Bryce R.H. Robinson, MD, MS, *and* Elliot R. Haut, MD, PhD *Baltimore, Maryland*

"Conditionally recommend for treatment of pain. Very low-quality evidence."

285 – 1,636 pts

2018

ORIGINAL ARTICLE

Comparison of analgesic interventions for traumatic rib fractures: a systematic review and meta-analysis

Jesse Peek[1] · Diederik P. J. Smeeing[1,2] · Falco Hietbrink[1] · Roderick M. Houwert[1,2] · Marije Marsman[3] · Mirjam B. de Jong[1]

"Provides better pain relief (but no meta-analysis) but no differences in secondary endpoints."

19 studies, RCTs and observational, 2,801 pts

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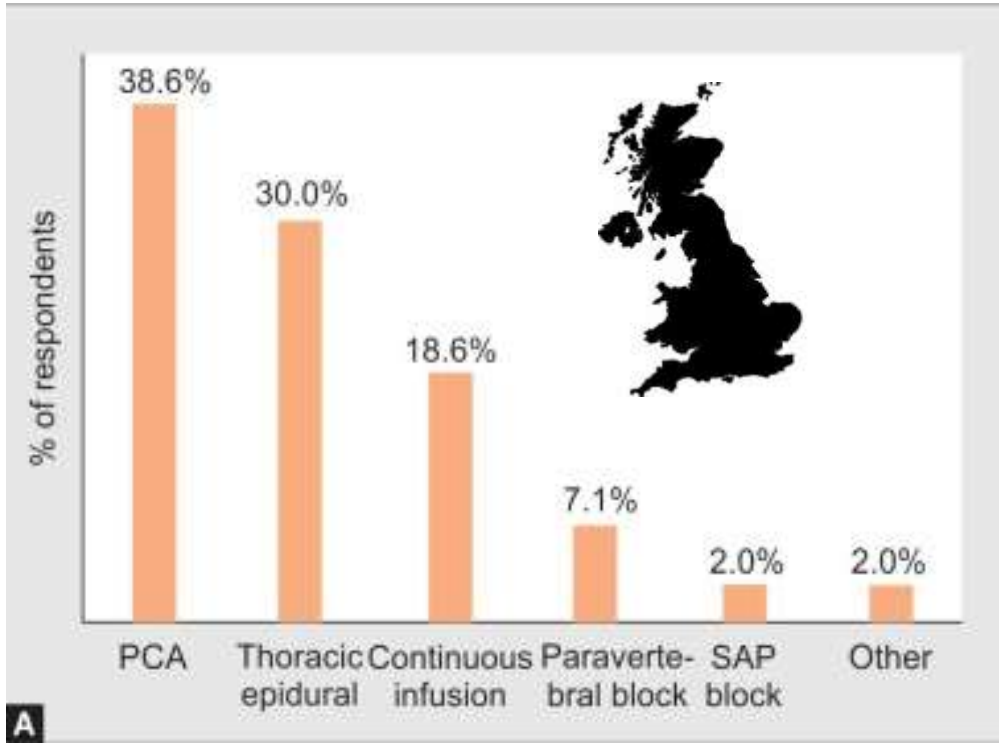
PROF HEWSON'S TAKE-HOME MESSAGE 2

The literature does not support any specific regional analgesic technique having significant impact on important outcomes (beyond pain) in management of people with rib fractures



"Thoracic epidural rates typically 9.9 – 18.4%"

NUH = 40% epidural rate

Epidural is 'first line' RA therapy for 30% of UK clinicians … but TEA is only sited in a small minority of cases

Beard L. Ind J Crit Care Med. 2020; 24: 184-189

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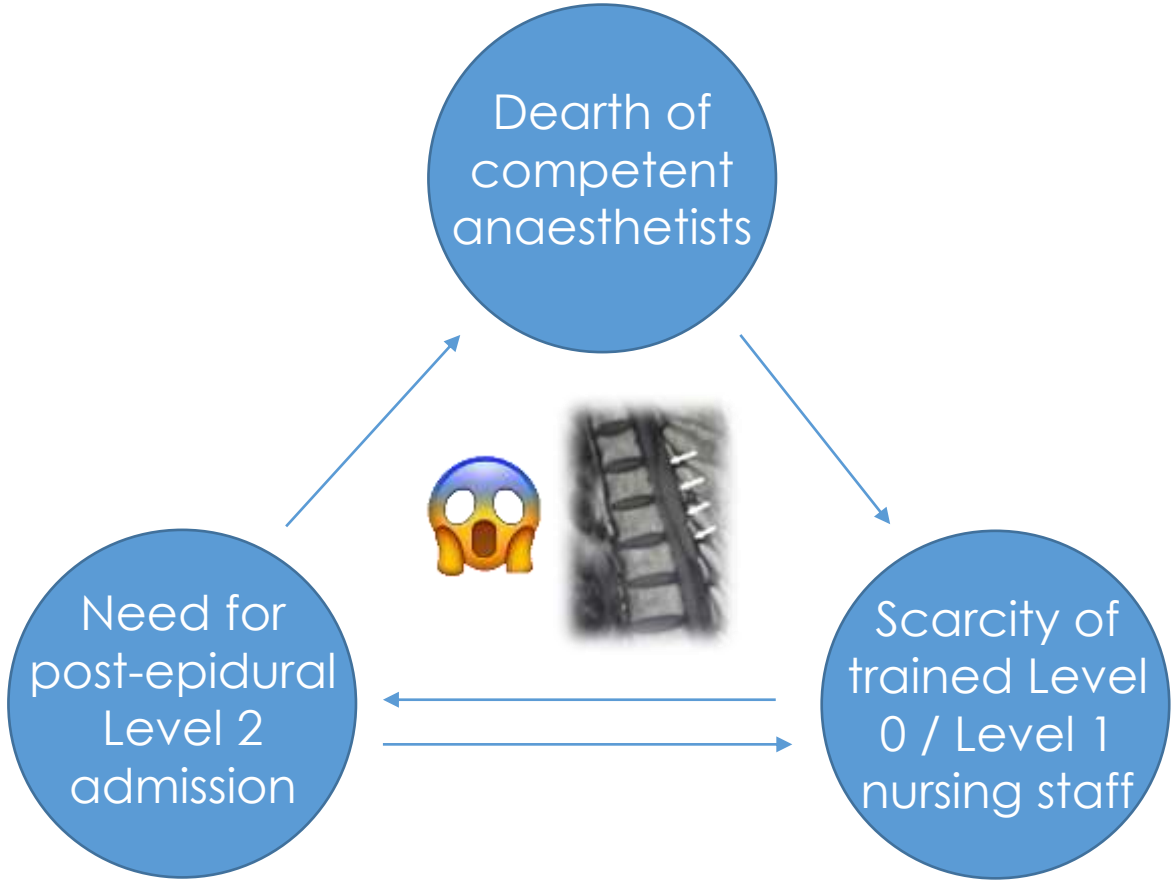
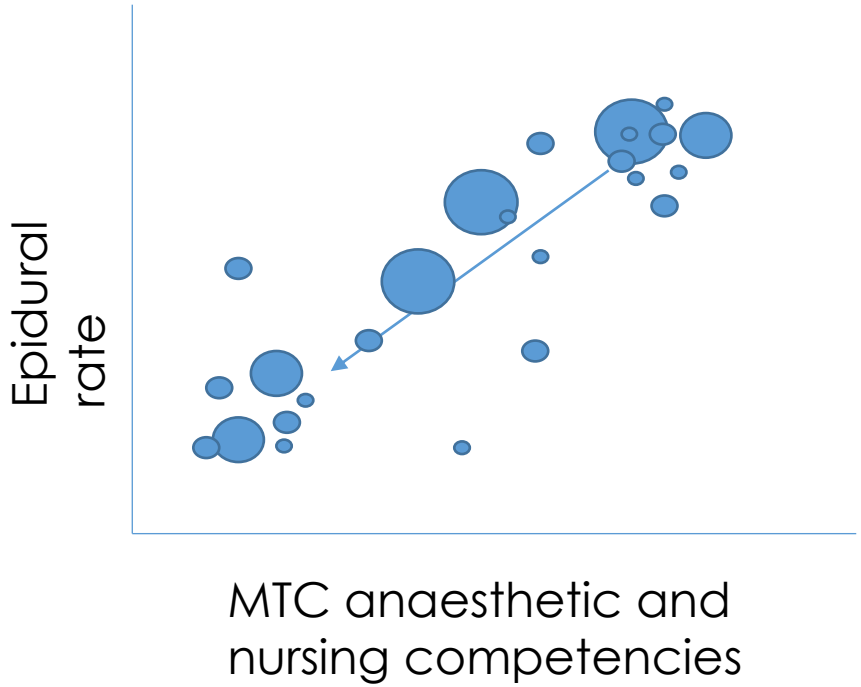




What else can I offer patients?

Epidural analgesia for rib fractures is not without harms…

- Delay (NUH 17 [7-28] hours)
- Failure (20% re-site rate at NUH)
- Hypotension
- Sedation
- Cardiac arrest
- Vertebral canal haematoma

And some contraindications…

Coagulopathy

- Traumatic 2.2%
- Warfarin 4.4%
- DOAC 7.2%
- Clopidogrel 6.1%

Spinal cord injuries 8%

Catastrophic injury 3.6%

Refusal 1.1%

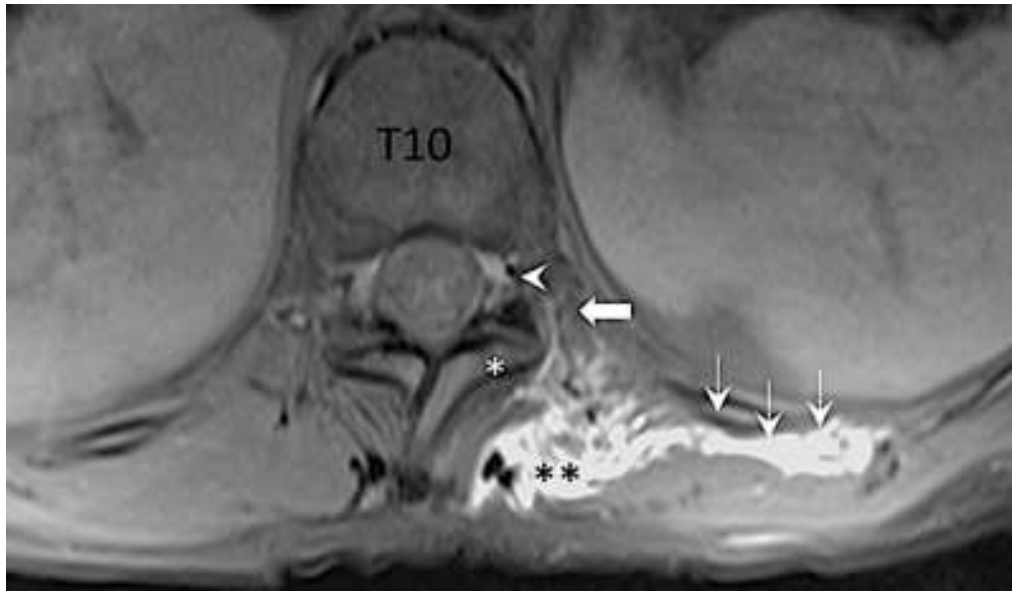
Haemodynamic instability ?

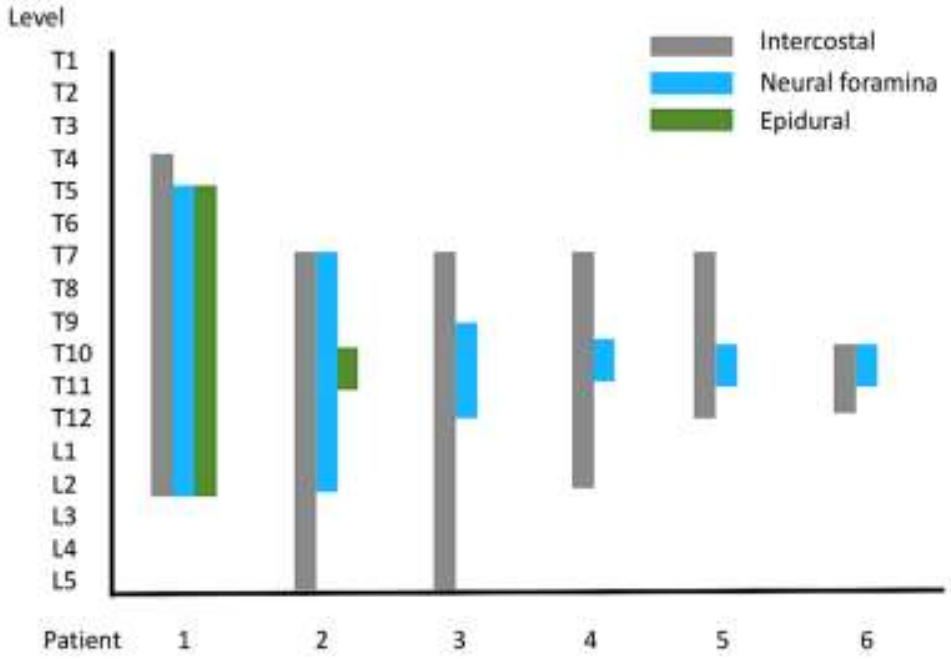
1 in 5 patients

Correctable

Risk : benefit

Erector spinae plane block…





Schwartzmann A. Can J Anesth. 2020; 67: 942-948

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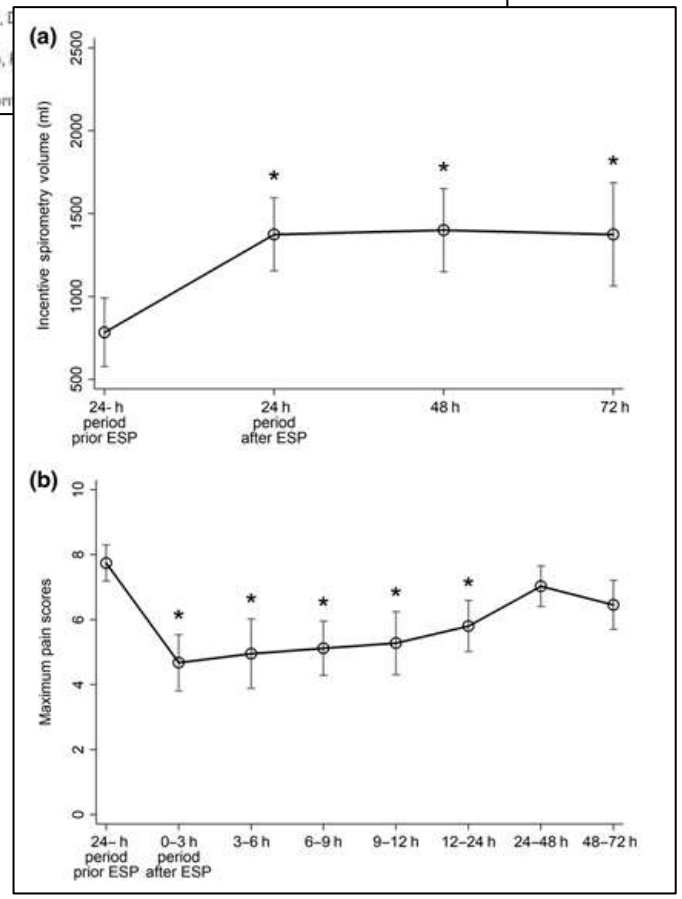
Anaesthesia 2019, 74, 585-593 doi:10.1111/anae.14579

Original Article

The effect of erector spinae plane block on respiratory and analgesic outcomes in multiple rib fractures: a retrospective cohort study*

S. D. Adhikary,[1] W. M. Liu,[2] E. Fuller,[3] H. Cruz-Eng[4] and K. J. Chin[5]

1 Professor, 3 Resident Physician, 4 Assistant Professor, D
Penn State College of Medicine, Hershey, PA, USA
2 Associate Professor and Deputy Director of Research,
Acton, CA, Australia
5 Associate Professor, Department of Anesthesia, Toron



Open access Protocol

BMJ Open

Erector Spinae Plane Blocks for the Early Analgesia of Rib Fractures in Trauma (ESPEAR): protocol for a multicentre pilot randomised controlled trial with feasibility and embedded qualitative assessment

David W Hewson ,[1,2] Jessica Nightingale,[3] Reuben Ogollah,[4] Benjamin J Ollivere,[2,3] Matthew L Costa,[5] Simon Craxford ,[2] Peter Bates,[6] Nigel M Bedforth[1]

- MMA & ESP vs MMA alone
- Large volume, PIB regime
- Manchester Royal Infirmary, Royal London, Queen's Medical Centre

Hewson DW. BMJ Open. 2022; 12: e062935

Adhikary SD. Anaesthesia. 2019; 74: 564-568

Fascia iliaca for hips…
ESP for ribs

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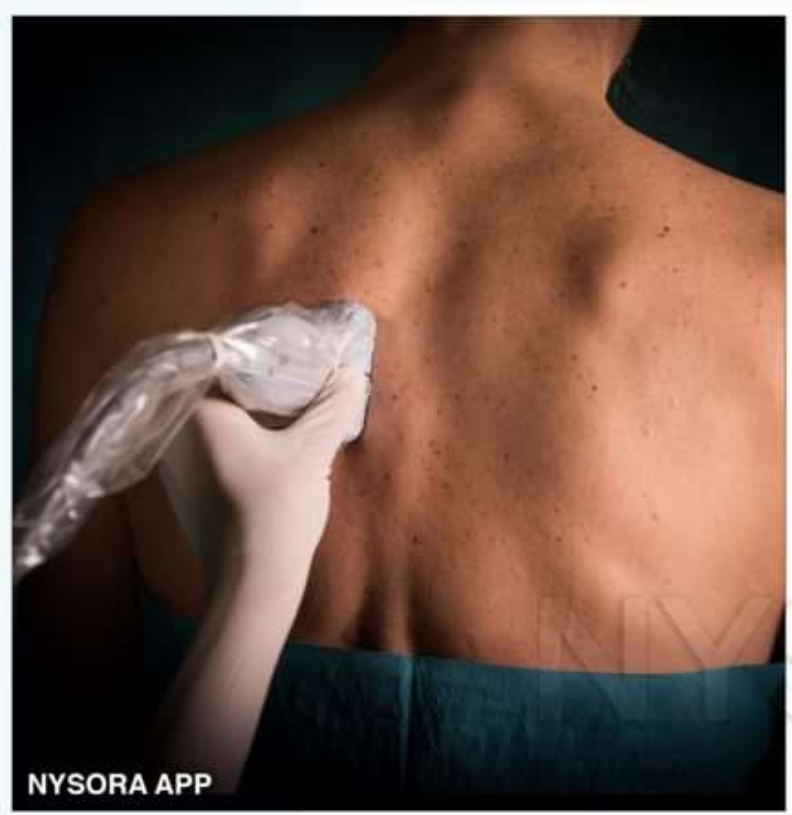
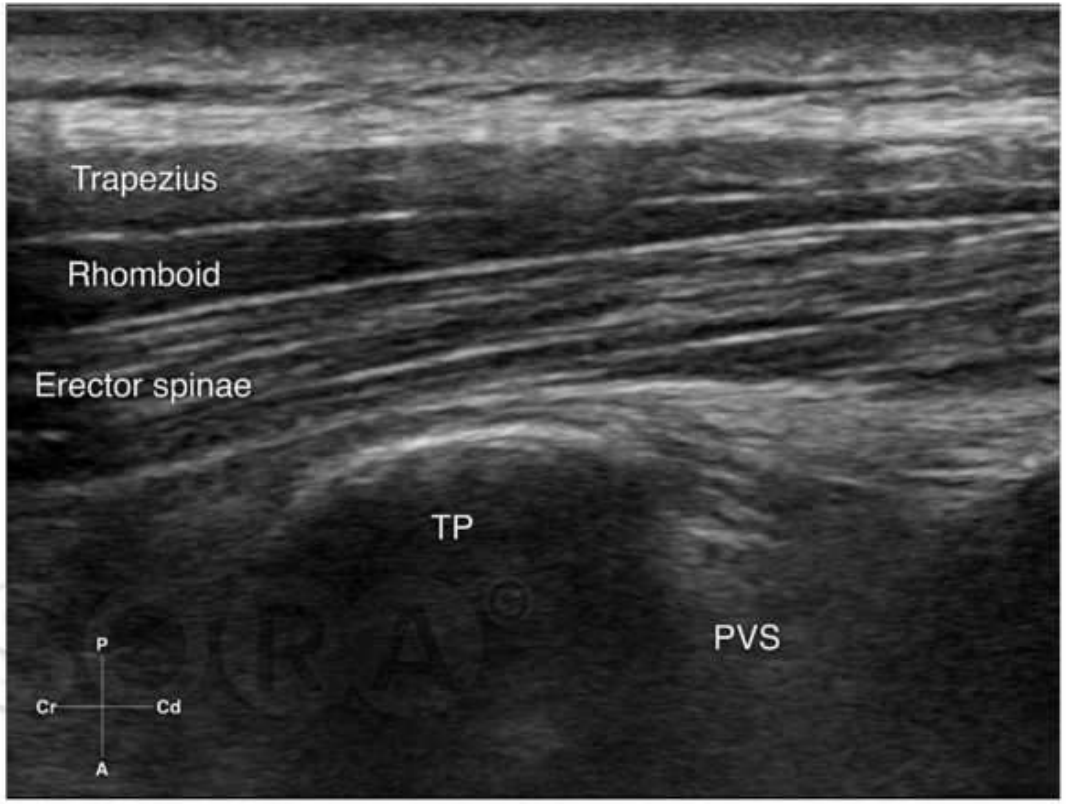
US guided erector spinae plane block



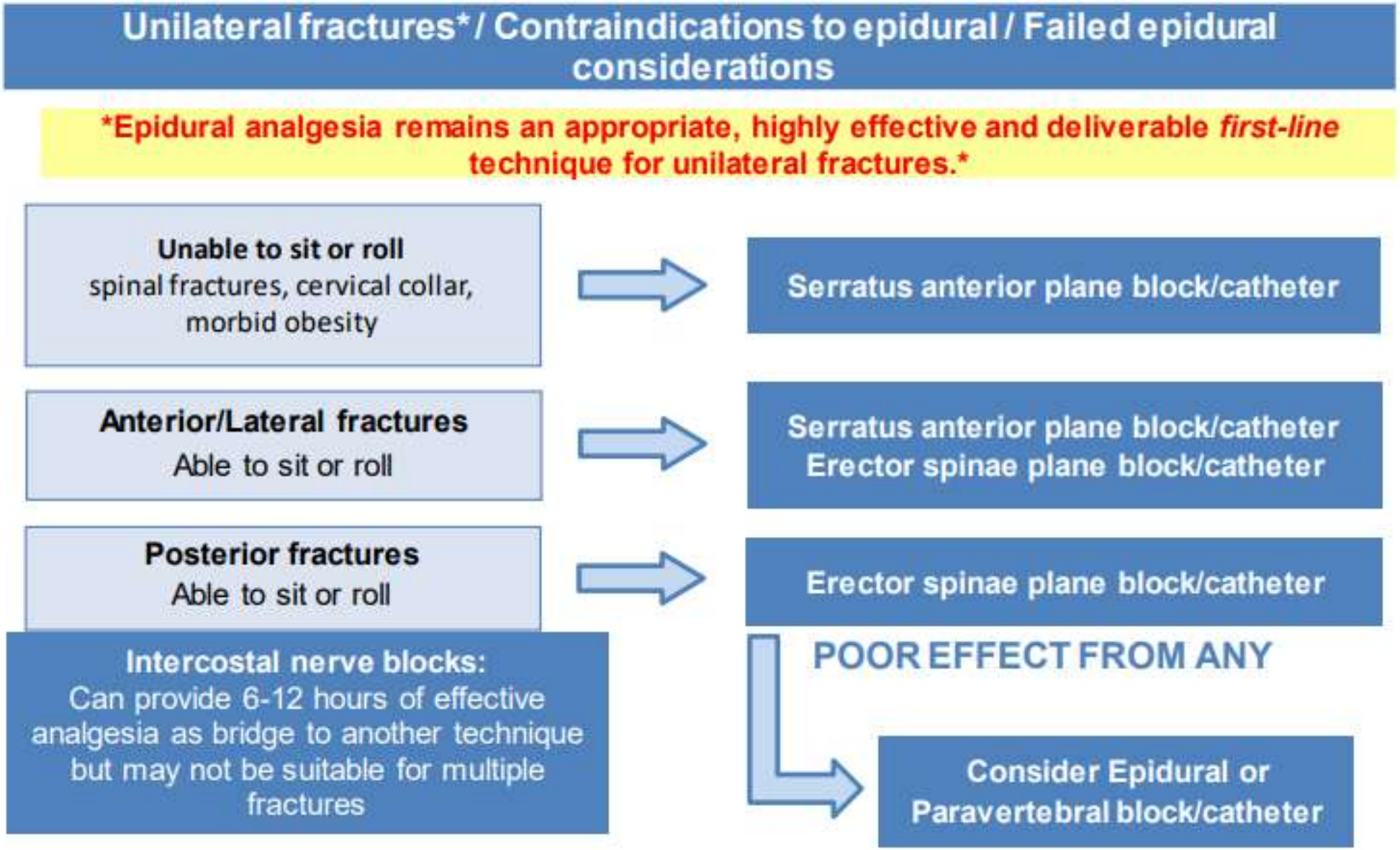


NYSORA

Erector spinae plane blocks

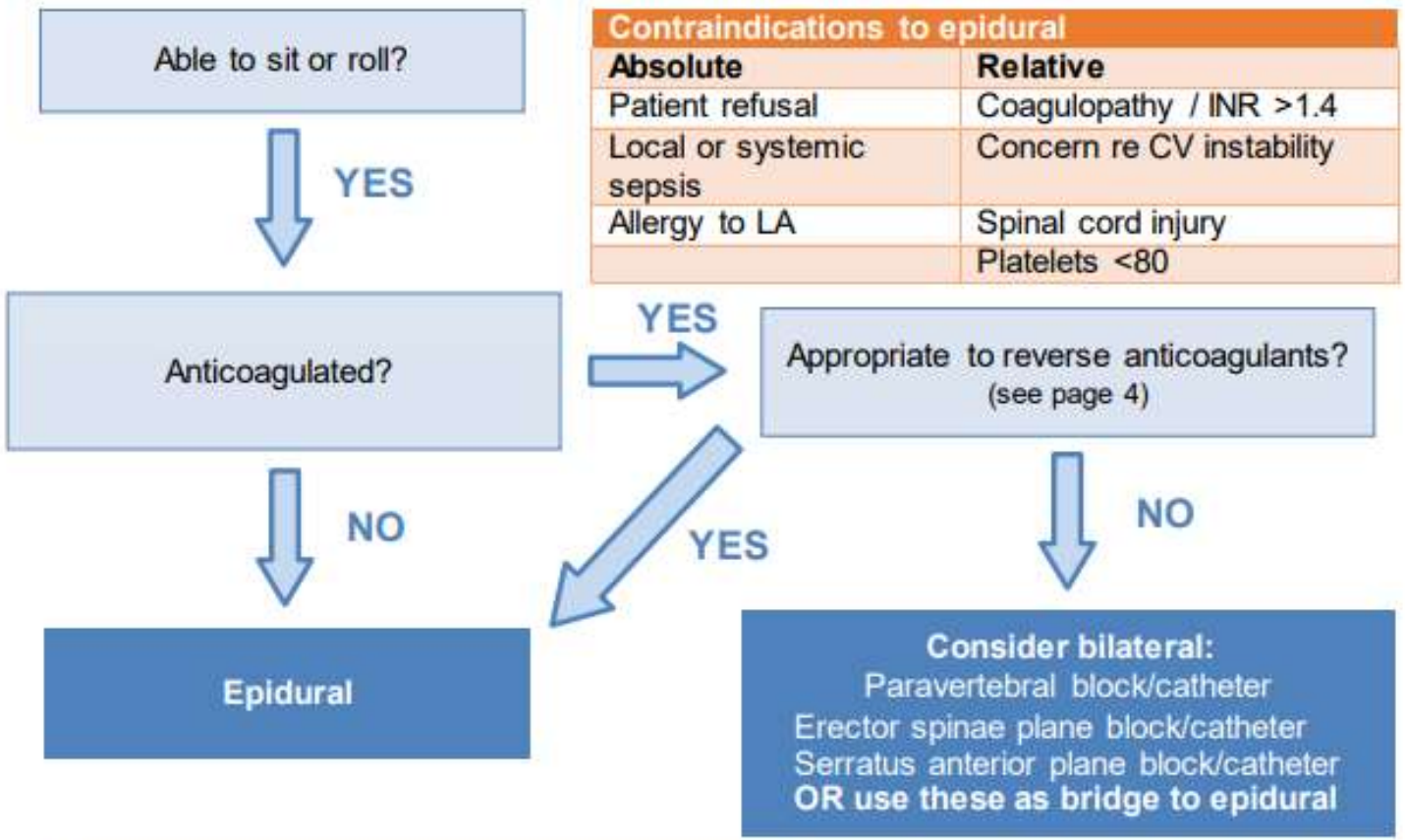
- Effectively reduces pain scores
- Low risk of complications
- ‘Safe’ in the anticoagulated
- Catheters can be inserted (advanced technique)

- Small risks of
  - PTX
  - Nerve injury
  - Vascular puncture
  - Infection
  - Total spinal
  - LAST
- Requires repositioning



NUH Adult blunt chest wall trauma and rib fracture management. Rattenberry, Morgan, Turner. 2020.

Bilateral fractures



Contraindications to epidural	
Absolute	**Relative**
Patient refusal	Coagulopathy / INR >1.4
Local or systemic sepsis	Concern re CV instability
Allergy to LA	Spinal cord injury
	Platelets <80

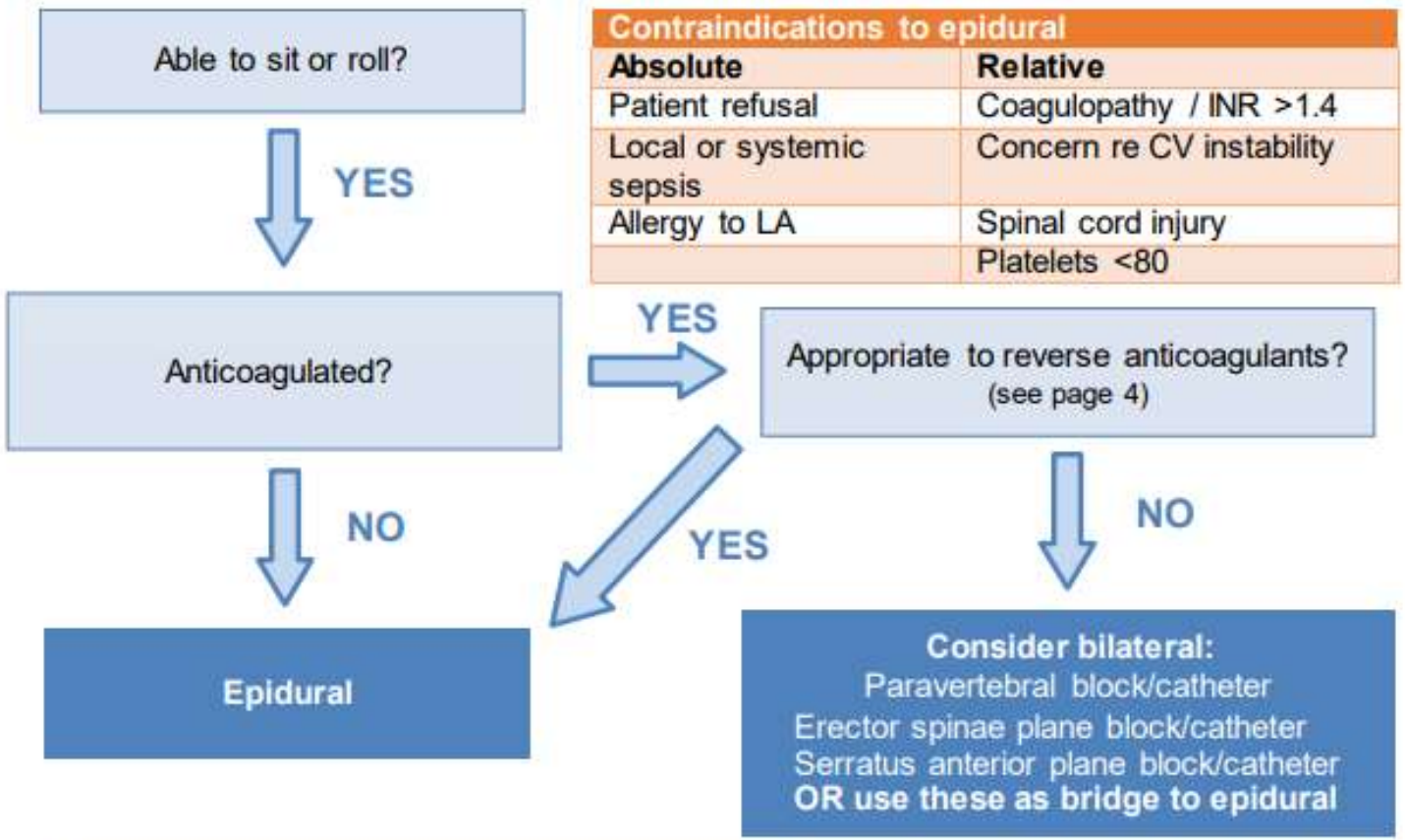
Unlike the elective surgical population, patients with rib fractures are at particularly high risk of epidural induced hypotension and sedation. This can be contributed to by other injuries and their resuscitation status. It is advisable to consider loading the epidural space with 0.125% levobupivacaine (following test dose) and to avoid epidural opioids, if already given by an alternate route.

NUH Adult blunt chest wall trauma and rib fracture management. Rattenberry, Morgan, Turner. 2020.

Challenging case 1

- 68 M, Car vs Car, driving under the influence of alcohol
- Bilateral 6-10 rib fractures, bilateral chest drains, contusions ++
- On clopidogrel for previous CVA
- Bilateral subsegmental PE on Trauma scan
- eGFR 68
- Day 1: describes severe pain, cannot cough, escalating O2 requirement (Sats 96% on 50% humidified), RR 10, Pupils 3+/3+, struggling to stay awake
- Paracetamol, ibuprofen, omeprazole, ketamine, lidocaine patch, pregabalin, longtec 10mg bd, shortec 5-10mg 2hrly
- What now???

Bilateral fractures



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NUH Adult blunt chest wall trauma and rib fracture management. Rattenberry, Morgan, Turner. 2020.

Anticoagulation and epidurals

Drug		Acceptable time after drug for epidural performance
Heparins	UFH	4hrs or normal APTTR
	LMWH prophylaxis	12hrs
	LMWH treatment	24hrs
Antiplatelets	Aspirin / NSAIDs	No precautions
	Clopidogrel / Prasugrel	7 days
	Ticagrelor	5 days
Oral anticoagulants	Warfarin	INR <1.5
	Rivaroxaban	48hrs
	Dabigatran	48-96hrs depending on Creatinine Clearance
Thrombolytic drugs	e.g Alteplase	10 days

NUH Adult blunt chest wall trauma and rib fracture management. Rattenberry, Morgan, Turner. 2020.

Opioids

Current NUH sedation scoring tool	Proposed sedation scoring tool
Sedation 0 Awake 1 Mild Drowsiness, easy to rouse 2 Drowsy, difficult to rouse 3 Unrousable	0 — Wide awake 1 — Easy to rouse (and can stay awake) 2 — Easy to rouse but unable to remain awake 3 — Difficult to rouse

- Monitor for opioid induced ventilatory impairment
  - Consider amending EWS sedation score
- Monitor for AKI
- Avoid oxycodone unless age>70, eGFR <50, and/or intolerant of morphine
- Opioid stewardship – education, avoid MR preparations(?), appropriate dosing, discharge planning

Challenging case 2

- 88F, Nursing home resident
- Advanced dementia, moderate COPD, community DNACPR, can walk few steps with frame
- Fall out of bed
- Bilateral 4-10 rib fractures with unilateral 3 segment flail, extensive pulmonary contusions
- Sats 92% on 60% humidified
- Small subdural -> not for neurosurgical intervention
- Has had paracetamol IV and 10mg IV morphine
- Very drowsy, GCS E3 V3 M5, cries and groans when moved
- What now???

Take-homes

1. The **intercostal nerve** and **collateral intercostal branch** cause rib pain, but not all pain after chest trauma comes from these nerves

2. Subjective ad hoc assessments of respiratory performance should be **replaced** by semi-structured tools

3. **Epidural analgesia** provides the most profound pain relief for people with rib fractures

4. Published evidence does not **support any specific regional analgesic** technique having significant impact on important outcomes

5. In UK practice epidural usage for rib fractures is **increasingly restricted** to specialist centres and 'special occasions'

6. Research into regional techniques is interesting … but the **gains are to be made by quality improvement**

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Key message

- Early effective analgesia by a multidisciplinary team saves lives

NICHE

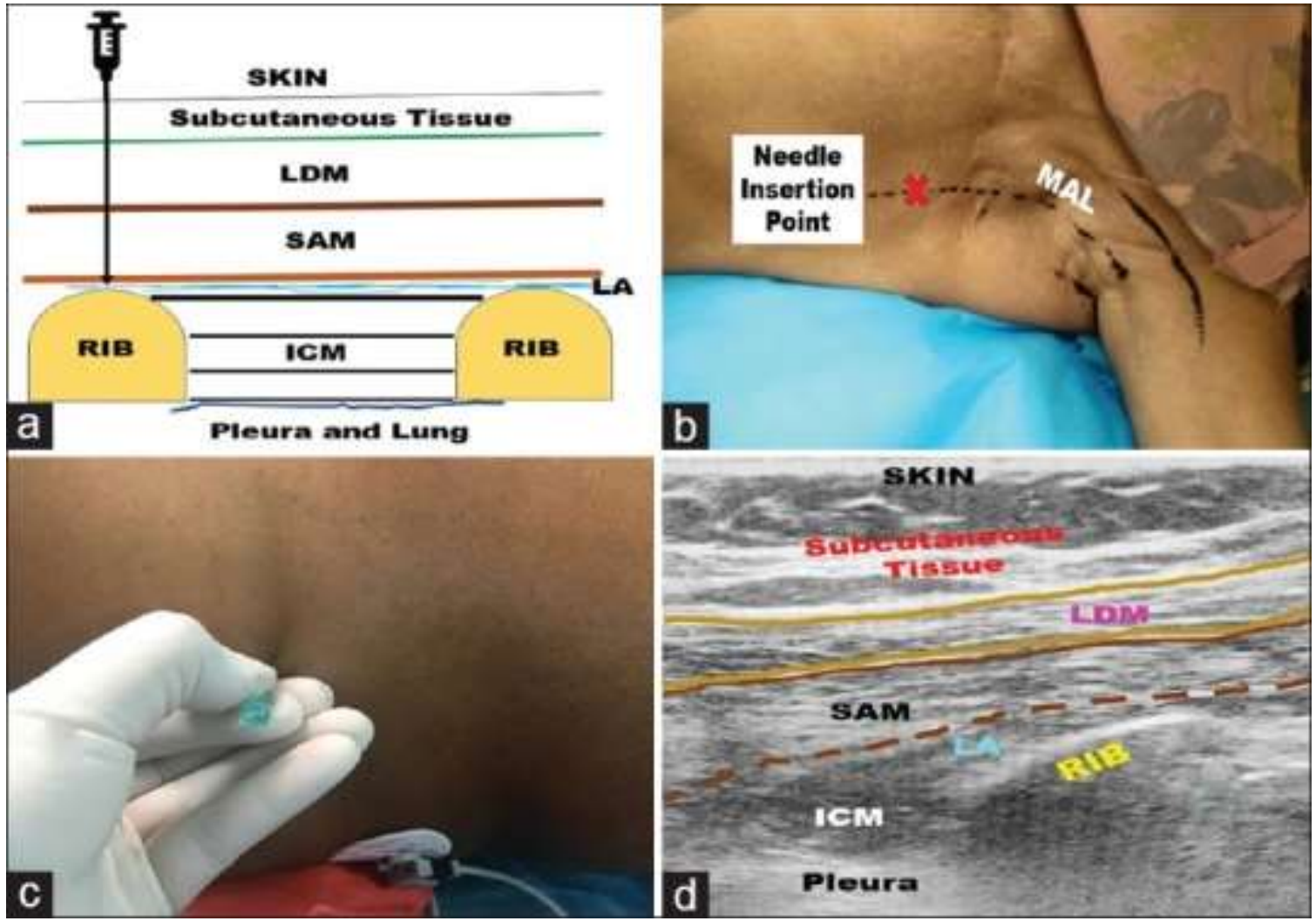
A role for pre-hospital regional analgesia?

- Serratus plane block can be performed easily in the supine position with ultrasound
- McLean et al. 2019 – case description of an ‘in flight’ block
- Harrington et al. 2022 – 13 out of 2004 chest wall injuries in NSW, Ausralia received SAP between 2018 and 2021.

McLean et al. Air medical journal. 2019

Harrington et al. Prehosp Emerg Care. 2022

NICHE



Vadera et al. 2020

Anatomical serratus plane block???

- Could be useful in prehospital and ED setting
- Vadera et al – letter to journal, including two cases
- 5th rib, mid axillary line, infiltrate onto rib
- Risk of thoracodorsal vessel injury/intravascular injection
- Not recommended at this time

Vadera et al. 2020