1) SUMMARY

This guideline provides a framework for the assessment and management of adult patients with rib fractures.

2) INTRODUCTION

Blunt chest-wall trauma, causing rib fractures, accounts for >15% of all trauma admissions to Emergency Departments (EDs) globally. Rib fractures may complicate up to two thirds of these injuries. St Mary’s Hospital admits, at a conservative approximation, at least 8-10 patients per month with multiple rib fractures.

Mortality associated with such injuries is variably estimated as 4-77% whilst 94% have associated injuries. Complications include pneumothorax, haemothorax, haemopneumothorax, lung contusion, flail segment, hypoventilation, lacerations of the liver, kidneys and spleen. Pain from rib fractures causes impaired coughing, voluntary splinting and muscle spasms and, in combination with lung contusion, impairs ventilatory function resulting in atelectasis, hypoxaemia and pneumonia (in 30% of cases). Eventually these result in respiratory failure with a requirement for mechanical ventilation. Patient age, number of rib fractures, presence of chronic lung disease, pre-injury anticoagulant use and oxygen saturation levels have been identified as risk factors that may predict complications after blunt chest-wall trauma. The incremental costs associated with rib fractures have not been evaluated, but can be considered in terms of ‘ICU bed days’, ‘ventilator days’ and ‘Major Trauma Ward days’, and are likely to be significant.

Gold standard pain relief for patients with multiple rib fractures at St Mary’s is achieved with thoracic epidural analgesia (TEA). Expertise in our hospital allows for timely epidural insertion by senior anaesthetists and appropriate management once sited. This approach is supported by evidence demonstrating clear benefit of thoracic epidurals over intravenous (IV) or intramuscular (IM) opioids. A recent meta-analysis found that although patients receiving TEA had more rib fractures, greater injury severity scores and greater physiological disturbance, they had better outcomes than less severely injured patients who received IV or IM opioid analgesia. Additionally the TEA group spent less time on mechanical ventilation, had greater improvement in tidal volumes in the first 24 hours and had a lower incidence of pneumonia and other pulmonary complications. Despite this, TEA has a low but significant complication rate and in some patients may be contra-indicated; there is also an inevitable failure rate. There are several alternatives to TEA including intercostal, interpleural and paravertebral blocks. Paravertebral analgesia is the most frequently cited alternative, but has disadvantages when compared with our gold standard at St Mary’s Hospital. These include:

- Difficulty instituting before rib fixation surgery.
- Risk of pneumothorax and haemothorax.
- Unreliable spread of analgesia: usually a segmental block is achieved and multiple level blocks are required.
- Finite duration of analgesia unless a catheter is sited and a local anaesthetic infusion is administered.
- Better efficacy when sited under direct vision during surgery rather than using a blind technique.
Surgical fixation and stabilisation of flail chest injuries is associated with reductions in duration of mechanical ventilation, ICU stay, total hospital stay, hospital acquired pneumonia and mortality rates\textsuperscript{5-9}. In the long term patients return to work sooner and have a reduced incidence of chronic pain and analgesic dependence\textsuperscript{7-9}. Studies have also shown similar beneficial outcomes in patients with multiple rib fractures\textsuperscript{10}. A multidisciplinary approach to patient selection for surgery is essential. The National Institute of Clinical Health and Excellence has approved and issued guidance on surgical fixation of flail chest injuries\textsuperscript{11}.

3) DEFINITIONS

- Rib fracture: a break in a bone making up the rib cage.
- Thoracic Epidural (TE): a fine catheter placed into the thoracic epidural space which is used to give analgesic drugs.
- Paravertebral block (PVB): regional anaesthetic technique providing analgesia to a segment of one hemithorax.
- Patient Controlled Analgesia (PCA): a method of allowing a patient to administer their own analgesia intravenously, usually opioid based.
- Sustained Maximal Inspiration (SMI): deep breathing exercises assessed with incentive spirometry.
- Non-invasive ventilation (NIV): facial Continuous Positive Airways Pressure (CPAP) or Bi-level Positive Airways Pressure (BIPAP) ventilation

4) SCOPE

These guidelines are for all staff involved in the care of adult trauma patients with rib fractures but are of particular relevance to those working in the Emergency Department, Theatres, Anaesthesia, Major Trauma Ward and other wards receiving trauma patients.
5) FULL GUIDELINE

**Rib fractures confirmed on CXR/CT**

- **Start regular analgesia:**
  - Paracetamol 1g PO/IV 6 hourly
  - Ibuprofen 600mg PO TDS (avoid in elderly)
  - Morphine sulphate 15-20mg PO 4 hourly (reduce dose in elderly)

### Risk factors for morbidity

- Chronic respiratory disease
- Pulmonary contusion
- Cardiovascular disease
- Smoker
- Low SpO₂ (CXR: ≥25% lung volume loss)
- Diabetes (NIV/ventilator dependent)
- Presence of ≥2 distant injuries
- Obesity
- Sleep apnoea

**If present in <65yo, consider invasive path**

**Early review for surgical rib fixation (<24hrs)**

- Flail chest
- ≥3 displaced rib fractures
- ≥65 years old
- Chest wall deformity
- CXR: ≥25% lung volume loss
- NIV/ventilator dependent

All admissions will be seen within 48hrs.

To refer to the service please e-mail: 
ribfracture@imperial.nhs.uk

**Contraindications to epidural analgesia**

<table>
<thead>
<tr>
<th>Absolute</th>
<th>Relative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient refusal</td>
<td>Unable to position patient</td>
</tr>
<tr>
<td>Spinal cord injury or haematoma</td>
<td>TBI with uncontrolled ICP</td>
</tr>
<tr>
<td>Epidural haematoma</td>
<td>Anatomical abnormalities</td>
</tr>
<tr>
<td>Thoracic vertebral body fracture</td>
<td>Previous thoracic spinal surgery</td>
</tr>
<tr>
<td>Clopidogrel within 7 days</td>
<td>Incomplete spinal evaluation</td>
</tr>
</tbody>
</table>

Platelets <80 x 10⁹/L

Extubation not anticipated within 5 days

INR >1.4

Prophylactic dose LMWH within 12hrs

Treatment dose LMWH within 24hrs

Figure 1: overview of the rib fracture pathway
Non-Invasive Pathway

Within 1 hour of diagnosis aim to:

- Start incentive spirometry
- Monitor oxygen saturation (SpO₂)
- Provide supplemental O₂ if needed
- Pain score using verbal rating scale

Prescribe regular analgesics:

- Paracetamol 1g PO/IV 6 hourly
- Ibuprofen 600mg PO TDS
- Regular PO morphine or opioid PCA
- Consider lidocaine 5% patches

SpO₂ reducing
O₂ needs increasing
SMI decreasing
Pain score increasing

Invasive pathway

SMI improving
Pain score improving

Sit in chair
Ambulate ASAP (spine & other injuries permitting)
Continue incentive spirometry 4 hourly

Figure 2: non-invasive pathway for rib fracture management
### Invasive Pathway

*(requires Major Trauma Ward admission)*

#### Within 1 hour of diagnosis aim to:
- Start incentive spirometry
- Monitor oxygen saturation (SpO₂)
- Provide supplemental O₂ if needed
- Pain score using verbal rating scale

#### Anaesthetic review for Thoracic Epidural (TE)
- **No contraindications**
- **TE contraindicated**

#### TE within 6 hours (must be booked on Cerner)

#### Regular follow up

#### Respiratory deterioration?
- SMI decreased
- SpO₂ reduced
- O₂ needs increased
- ABG deteriorating

#### Pain score worse
- Call anaesthetist for epidural trouble shooting. Re-site if necessary.

#### Pain controlled
- MTW HDU bed
- Contact ICU/ outreach
- Consider NIV/ IPPV

#### Candidate for surgical rib fixation

#### Pain worse?
- Respiratory decline?
- Pain & SMI improved
- Sit in chair
- Ambulate ASAP (spine & other injuries permitting)
- Continue incentive spirometry 4 hourly

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Figure 3: invasive pathway for rib fracture management
**Surgical Rib Fixation Pathway**

*(See Early Review for Surgical Rib Fixation candidates on page 2)*

### Decision making for potential candidates

Review by member of rib fracture fixation team.

**Discussion & Decisions**

- MDT may include: rib fracture fixation team, MTW consultant, anaesthetist, intensive care consultant, physiotherapist, occupational therapy & nursing staff.
- Decision for surgery made by 2 consultants.

Liaise with thoracic/trauma surgeons if suspicion of large air leak or visceral injury.

If ipsilateral clavicle fractured, have low threshold for ORIF clavicle.

### Pre-operative

**Book**

- Half day theatre session.

**Drugs**

- Give LMWH ≥12 hours before planned surgery.

**Equipment**

- MatrixRib fixation kit is sterile and available.

**Imaging**

- 3D CT reconstruction thorax complete.

**Blood results**

- FBC, renal profile (U&E & creatinine), clotting screen/TEG.

**Blood products**

- 2 units of packed red blood cells cross matched.

### Intra-operative

**Anaesthetic team**

1. Insert thoracic epidural prior to anaesthetic induction if not already in situ OR ensure the dressings are distant to the operative site.
2. Use single lumen ETViewVivaSight™ single lumen (video) endotracheal tube.
3. Ensure bronchial blocker available in theatre.
4. Insert arterial line if anticipating NIV or inability to extubate.

**All theatre team**

- Position patient laterally with rib fractures ‘up’.

**Surgical team**

1. Plan surgical incision(s) by identifying fractures clinically or with ultrasound.
2. If thoracic epidural not possible or contraindicated, insert paravertebral block/catheter under direct vision at the end of the procedure.

**Chest drains**

1. Replace any pre-existing chest drains prior to operative fixation.
2. Insert a minimum of 1 chest drain per operated hemi-thorax at the end of the procedure and connect it to an underwater seal.

**Mobile Chest X Ray at end of procedure (prior to desterilising).**

### Postoperative

**Post theatre destination**

1. Aim to extubate at end of procedure. Arrange Major Trauma Ward/Level 2 bed.
2. If intubated pre-op or significant respiratory compromise, to remain intubated and transfer back to ICU.

**Analgesia**

1. Administer epidural/paravertebral levobupivacaine/fentanyl mixture at 15mls/hr.
2. Remove epidural 5 days after insertion (7 days max, at discretion of anaesthetist & pain team).

**Rehabilitate**

1. Incentive spirometry four hourly.
2. Sit up and ambulate ASAP.
### Discharge planning

1. Continue incentive spirometry at home 4 hourly.
2. Wound review at 2 weeks.
3. Clinic review at 6 weeks.

Figure 4: rib fixation pathway
# NORTH WEST LONDON TRAUMA NETWORK
## RIB FRACTURE TERTIARY REFERRAL FORM

It is the policy of the North West London Major Trauma Centre to repatriate patients within 72 hours of rib fracture surgery if deemed medically fit.

### Referral details

<table>
<thead>
<tr>
<th>Referring clinician</th>
<th>Responsible Consultant:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Contact telephone (mobile):</td>
</tr>
<tr>
<td></td>
<td>Contact e-mail address:</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Hospital</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ward</td>
</tr>
<tr>
<td>Name:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Patient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date of birth:</td>
</tr>
<tr>
<td>NHS number:</td>
</tr>
<tr>
<td>Home address:</td>
</tr>
</tbody>
</table>

| General Practitioner: |

### Injury

**Mechanism:**

| Rib fractures: |

<table>
<thead>
<tr>
<th>Pneumothorax? YesNo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haemothorax? YesNo</td>
</tr>
<tr>
<td>Pulmonary contusion? YesNo</td>
</tr>
</tbody>
</table>

**Associated injuries:**

### Interventions

<table>
<thead>
<tr>
<th>Intercostal drain? YesNo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date of insertion: ...... / ...... / ......</td>
</tr>
<tr>
<td>Persistent air leak? YesNo</td>
</tr>
</tbody>
</table>

| Chest XR + CT chest (including 3D reconstruction rendered images) transferred by IEP: YesNo |

| Thoracic epidural in situ: YesNo |

<table>
<thead>
<tr>
<th>Ventilation:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-ventilating</td>
</tr>
<tr>
<td>Non-invasive ventilation</td>
</tr>
<tr>
<td>Intubated</td>
</tr>
</tbody>
</table>

**Details of any other treatment/surgery received:**

### Pre-morbid state

| Co-morbidities: |

| Previous thoracic/cardiac/thoracic spinal surgery: |

| Anticoagulant history: |

| Current VTE prophylaxis (medication/dose/ |
Please e-mail referral to ribfracture@imperial.nhs.uk

Figure 5: rib fracture tertiary referral form
6) IMPLEMENTATION

<table>
<thead>
<tr>
<th>Training required for staff</th>
<th>Yes</th>
<th>No</th>
</tr>
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<tbody>
<tr>
<td>If yes, who will provide training:</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>When will training be provided?</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Date for implementation of guideline:</td>
<td>1/9/2015</td>
<td></td>
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</table>

7) MONITORING / AUDIT

| When will this guideline be audited? | Ongoing currently (clinical governance reference number 1850) |
| Who will be responsible for auditing this guideline? | Mr Ian Sinha, Consultant Orthopaedic Surgeon  
Dr Sabeena Qureshi, Consultant Anaesthetist |
| Are there any other specific recommendations for audit? | None |

8) REVIEW

<table>
<thead>
<tr>
<th>Frequency of review</th>
<th>Please indicate frequency of review: 3-5 years</th>
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</table>
| Person and post responsible for the review:  
Mr Ian Sinha, Consultant Orthopaedic Surgeon  
Surgeon Commander Mansoor Khan, Consultant Trauma Surgeon  
Dr Sabeena Qureshi, Consultant Anaesthetist |

9) REFERENCES


### 10) GUIDELINE DETAIL

| Start Date: | Approved by Major Trauma Board January 2015 |
| Approval Dates |  |
| Name of Divisional group: | Anaesthetics and Major Trauma |
| Date of ratification: | January 2015 |
| Name of Directorate group: | Surgery, Cardiovascular and Cancer |
| Date of ratification: |  |
| Has all relevant legislation, national guidance, recommendations, alerts and Trust action plans been considered, and included as appropriate in the development of this guideline? | Please list ALL guidance considered: |
| Have all relevant stakeholders been included in the development of this guideline? | Please list all (name and role): |
| | Mr Chris Aylwin, Consultant trauma and vascular surgeon |
| | Mr Shehan Hettiarchty, Consultant plastic surgeon |
| | Surg Commander Mansoor Khan, Consultant trauma and vascular surgeon |
| | Mr Ian Sinha, Consultant Orthopaedic surgeon |
| | Dr Sabeena Qureshi, Consultant Anaesthetist |
| | Matron Michelle Elliott, Major Trauma Ward Matron |
| | Miss Nicola Batrick, Consultant Emergency Physician |
| | Dr Vanessa Garnelo Rey Consultant Intensivist & Trauma Lead |
| | Mr Simon Cunniffe, Theatre Manager |
| | Sister Ursula Garrett, Anaesthetics Clinical Co-ordinator |
| | Dr William Harrop-Griffiths, Consultant Anaesthetist & Service Director Theatres |
| Who will you be notifying of the existence of this guidance? | All clinical staff groups who are involved with the care of adult inpatients with rib fractures. |
| Related documents | Epidural Management Guideline for Anaesthetists |
| Author/further information | Name: Dr A Wickham, Mr I Sinha, Dr S Qureshi |
| | Title: Senior Clinical Fellow in Anaesthesia, Consultant Surgeon, Consultant Anaesthetist |
| | Division: Surgery, Cancer & Cardiovascular |
| | Site: St Mary’s Hospital |
| | Telephone/Bleep: 26162 |
| | Trust email address: Alexander.Wickham@imperial.nhs.uk, Ian.Sinha@imperial.nhs.uk, Sabeena.Qureshi@imperial.nhs.uk |
| Document review history | Next review due: 22/1/2018 |
| THIS GUIDELINE REPLACES: | Nil |
### 11) INTRANET HOUSEKEEPING

<table>
<thead>
<tr>
<th><strong>Key words</strong></th>
<th>Major Trauma, Rib Fracture, Epidural, Rib fixation</th>
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<tbody>
<tr>
<td><strong>Which Division/Directorate category does this belong to?</strong></td>
<td>Surgery, Cancer &amp; Cardiovascular</td>
</tr>
<tr>
<td><strong>Which specialty should this belong to when appearing on the Source?</strong></td>
<td>Major Trauma</td>
</tr>
</tbody>
</table>

### 12) EQUALITY IMPACT OF GUIDELINE

Is this guideline anticipated to have any significant equality-related impact on patients, carers or staff?

- **Yes**
- **No**