Rib fractures are breaks in the bones of the rib cage. They are very common and account for 10-15% of all hospital admissions as a result of trauma globally (Peek et al., 2020), and are associated with significant pain and mortality, particularly in older patients.

Ribs are sturdy structures that require considerable force to break. The most common cause of breakage is a direct blow to the chest, often from a car accident or a fall. When this happens, it is likely that other, more fragile, organs in the body will also be injured. Age, frailty and conditions, such as osteoporosis, can make patients more prone to rib fractures through relatively minor mechanisms of injury, such as a fall from standing; as such, older people are more vulnerable to rib fractures and their complications than the general population.

After a rib fracture, pain and altered mechanics of how patients breathe can lead to an inability to take deep breaths and cough, resulting in reduced lung volume and impaired gas exchange. These factors can lead to the development of pneumonia and a need for oxygen therapy and help with breathing. Other complications include:

- Pneumothorax (air in the pleural cavity);
- Haemothorax (blood in the pleural cavity);
- Atelectasis (collapsed lung);
- Lung contusion (bruising) (Baiu and Spain, 2019).

**Anatomy and physiology**

The human skeleton has 24 individual ribs, set as 12 pairs. They are divided into three main categories:

- True ribs (ribs 1-7);
- False ribs (ribs 8-12);
- Floating ribs, which are part of the false ribs (ribs 11-12).

They form the protective cage of the thorax, where many vital organs...
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- including the heart and lungs - are located. Although fixed into place, ribs do allow for some outward movement, and this helps to stabilise the chest during inhalation and exhalation. The ribs are anchored posteriorly to the 12 thoracic vertebrae. True ribs then attach anteriorly to the sternum via costal cartilage (Fig 1).

The space between each rib is called the intercostal space; there are 11 intercostal spaces in the thoracic cage filled with intercostal muscles, arteries, veins and nerves (Fig 2). Intercostal spaces are important landmarks for nurses and other health professionals when they are assessing lung and heart sounds, performing needle decompression, and managing and placing chest drains.

Injury characteristics
Generally, the ribs that are most vulnerable to injury are ribs 7-10 because they are less mobile than the 11th and 12th. But any rib can be broken. Rib fractures can be:
● Simple – hairline fractures or fractures that are not displaced;
● Complex – multiple fractures or many displaced fragments in one or more ribs.

When many adjacent ribs are broken into multiple pieces, a segment can become free floating because it is separated from the chest wall. This is called a ‘flail segment’ and is a serious injury, often resulting in difficulty breathing and significant lung contusion.

Jagged rib edges or dislodged ribs can pierce the lung (causing a pneumothorax) and other organs, as well as disrupting the intercostal vessels, causing haemothorax and shock (Su et al, 2019).

Complications
Pneumothorax
A pneumothorax happens when air, either from the damaged lung or an open wound on the chest wall, is drawn into the pleural cavity, causing the lung to collapse (Fig 3). A tension pneumothorax is a life-threatening emergency that occurs when the accumulated air displaces the mediastinal structures resulting in cardiovascular collapse (Jalota Sahota and Sayad, 2022). Diagnosis is made clinically or by chest X-ray, and treatment requires the immediate insertion of a chest drain.

Haemothorax
A haemothorax is similar to a pneumothorax but instead of air, it is blood that collects in the pleural cavity (Fig 3). Haemothorax can be diagnosed with a chest X-ray and treated with a large-bore chest

drain. Very occasionally, surgical intervention may be required to stop the bleeding.

Haemopneumothorax
When both air and blood collect simultaneously in the pleural cavity, this is called a haemopneumothorax (Fig 3). Treatment is the same, but two chest tubes might be needed: one towards the apex or top section of the lung to drain the air, and one on the lower section to drain the fluid.

Cardiac tamponade
Cardiac tamponade happens when fluid, such as blood from chest trauma, accumulates around the heart, impairing its ability to contract; it can lead to cardiac arrest if not treated promptly. Treatment with pericardiocentesis or a thoracotomy is usually done in the emergency department or at the bedside (Stashko and Meer, 2022).

Lung contusions
A lung contusion is a bruise that happens at the time of impact but continues to evolve over hours and days. Contusions can be especially bad if patients have clotting disorders or are taking anticoagulants for underlying conditions. Although not as immediately life threatening as the complications already noted, lung contusions often interfere with gas exchange and lead to respiratory failure requiring oxygen therapy and/or mechanical ventilation. Effective pain control is important for optimising the function of the remaining good lung by allowing deep breathing and lung expansion.

Breathing mechanics
Displaced rib fractures or flail segments are likely to interfere with normal chest movements or breathing mechanics, hindering lung expansion and eventually gas exchange (Fig 4).

The position and condition of the broken ribs can also worsen underlying lung bruising and lead to chronic pain due to nerve entrapment. In these cases, surgical rib fixation can be indicated to stabilise the chest and promote recovery.

Medical management
In most cases, rib fractures will heal by themselves and pain will settle over time. However, some patients, such as those with multiple fractures or flail chest, will experience severe breathing problems and might even need advanced respiratory support. Others will remain at risk of developing complications that may cause impaired gas exchange and hypoventilation, particularly those with altered breathing mechanics or patients experiencing severe pain.

Surgical rib fixation is becoming more common in major trauma centres due to...
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the development of new, less-invasive surgical techniques and metal implants. However, this is only performed in a minority of patients and, overall, treatment options are mainly conservative. Both nursing and medical treatments are focused on preventing and managing the three main problems resulting from rib fractures:

- Hypoventilation due to pain;
- Impaired gas exchange in a damaged lung underlying the fractures;
- Impaired breathing due to altered chest wall mechanics (seen in flail chest, Fig 4).

Nursing care

Nurses have a central role in the management of patients with rib fractures. Many patients can be safely managed on the ward with good nursing care. This involves effective respiratory management, pain assessment and analgesia, to aid physiotherapy treatment and help prevent admissions to critical care. Recent studies suggest that patient outcomes are improved if these interventions take place as part of protocolised care (Witt and Bulger, 2017; Sahr et al, 2013). Bundles of care for patients with rib fractures include algorithms that feature nurses, physiotherapists and medical staff prescribing analgesics and aiding mobilisation, and following standardised observations that may trigger escalation of care automatically.

Most patients with significant rib fractures are admitted to general wards or trauma units at their local hospital. Those with more severe injuries are transferred to major trauma centres for management of their chest injuries and other concomitant injuries.

Older patients can sustain serious injuries, including rib fractures, through low-energy falls, and make up an increasing number of admissions to hospitals (Kehoe et al, 2015). What may seem to be a minor injury to a young person can have profound effects on older patients. The less severe mechanisms of injury on older patients can influence triage at the scene; as a result, they are usually taken to their local hospitals rather than to a major trauma centre by paramedics.

Assessment and care will depend on the patient presentation and concomitant injuries, but it will always be focused on close monitoring of respiratory function and effective pain control. It is also important to understand the potential for deterioration and be able to identify and escalate red-flag symptoms, including:

- Respiratory distress – characterised by shallow or fast breathing using accessory muscles;
- A drop in oxygen saturation;
- Tracheal deviation;
- Unresolved chest pain that leaves the patient unable to take deep breaths;
- Tachycardia;
- Low blood pressure (Cathala and Moorley, 2020; Munroe and Curtis, 2011).

Respiratory assessment

Nurses need to be able to carry out a comprehensive respiratory assessment as part of a routine patient assessment; they should follow a standardised, structured approach, such as the A-G (airway, breathing, circulation, disability, exposure, further information, goals) method, as outlined by Cathala and Moorley (2020). The key is to address problems as they are identified, before moving to the next letter.

Respiratory rate and pulse oximetry are key parameters, not only to titrate oxygen therapy, if it is needed, but also to increase monitoring and escalate concerns, as dictated by early warning scoring systems.

Normal oxygen saturation levels are 94-98%; if the patient has chronic obstructive pulmonary disease, the normal range is 88-92% (O’Driscoll et al, 2011). It is important to document whether the patient is receiving supplemental oxygen and how much, alongside the saturation readings. Oxygen-flow rates should be adjusted to maintain target saturation levels; care must be taken to avoid administering excess oxygen. Nurses should be mindful of the factors that can lead to inaccurate oxygen saturation readings, such as bright lights, false nails, nail polish or reduced peripheral perfusion.

The chest should be observed for unequal expansion and increased work of breathing, which is usually manifested by the use of accessory muscles. Pursing of
Pain management

Even minor rib fractures can be very painful because of the large number of nerves surrounding the ribs. Pain control is the cornerstone of effective management of rib fractures as it enables the patient to cough, breathe deeply and withstand physiotherapy to prevent chest infections. As ribs move with every breath, it is impossible to rest the injured area, making rib pain difficult to manage. Patients in pain tend to take shallow breaths, increasing the risk of developing atelectasis and pneumonia, which have been directly correlated with the number of rib fractures and severity of pain (Galvagn et al, 2016).

The key objective is to achieve full pain control, with a safe, simple method and no unwanted side-effects. This is challenging in patients with severe chest injuries so, often, a combination of methods is needed. This is known as multimodal analgesia and outlined in the World Health Organization’s (1996) analgesic ladder. Multimodal analgesia incorporates:

- Simple analgesics – such as paracetamol and non-steroidal anti-inflammatory medications, including ibuprofen and diclofenac;
- Opiates – intravenous infusions or enteral preparations;
- Local or regional analgesia – epidural catheters or nerve blocks.

Hospitals might use different versions of the pain ladder, depending on local preferences and medicine supply but, in general, all follow similar principles. Table 1 shows the analgesic management algorithm used by the Royal London Hospital’s critical care team.

In severe chest injuries with multiple fractures, a thoracic epidural is the most effective way to treat pain. However, this approach requires advanced medical and nursing management to avoid complications. Patients with thoracic epidurals need close monitoring and frequent observations to identify potential complications, so they must be nursed in critical care areas or specific trauma ward environments with sufficient numbers of trained staff. Paravertebral blocks and serratus plane blocks are all valid alternatives, with better safety profiles, although none are likely to cover the full anatomical extent of the fractures.

As a result of the risks and limitations of regional pain management methods, systemic analgesics are often used, either as adjuncts to regional analgesia or as a first-line treatment. Opioids are effective at controlling pain but can cause respiratory depression, which can be counterproductive when the goal is to prevent respiratory complications.

Pain assessment

Effective pain management relies on accurate and timely pain assessments to ensure early escalation along the ladder. When assessing pain, it is important to do so both when the patient is at rest and moving (known as dynamic pain assessment) to ensure analgesia is effective enough to enable deep breathing and physiotherapy treatment. It is also essential to use a pain

Table 1. Analgesic management algorithm used by the Royal London Hospital’s critical care team (specific to the management of chest trauma or rib fractures)

<table>
<thead>
<tr>
<th>Level of pain</th>
<th>Analgesics</th>
<th>Side-effects</th>
<th>Nursing management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tier 1 Mild</td>
<td>✷ Paracetamol given regularly</td>
<td>✷ NSAIDs – risk of gastric ulcer and bleed, kidney injury</td>
<td>✷ Regular pain assessment and documentation, both at rest and with movement</td>
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<tr>
<td></td>
<td>✷ NSAIDs given regularly</td>
<td>✷ Opioids – drowsiness and respiratory depression, nausea, vomiting</td>
<td>✷ Use standard scoring system to allow for comparison between assessors</td>
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<tr>
<td></td>
<td>✷ Weak opioid: codeine/tramadol (oral) if kidney function is normal</td>
<td></td>
<td>✷ Regional anaesthesia requires trained nursing staff to provide hourly observations</td>
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<tr>
<td></td>
<td>✷ Strong opioid: oral morphine (5-20mg) every 2-4 hours or oxycodone 5-10mg every 4 hours (oral), as required for breakthrough pain</td>
<td>✷ Pain relief is adequate when:</td>
<td>✷ The patient can take deep breaths and cough</td>
</tr>
<tr>
<td>Tier 2 Moderate</td>
<td>✷ Refer to the acute pain team</td>
<td>✷ Drowsiness with higher risk of falls/less mobility</td>
<td>✷ The patient is comfortable mobilising in bed</td>
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<td></td>
<td>✷ Paracetamol with or without NSAIDs plus:</td>
<td>✷ Nausea – all meds listed should always be prescribed with antiemetics</td>
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<tr>
<td></td>
<td>✷ Intravenous morphine: 1-2mg boluses or PCA</td>
<td>✷ Respiratory depression and risk of atelectasis through poor lung expansion</td>
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<td></td>
<td>✷ PCA morphine with background infusion or fentanyl if renal impairment</td>
<td>✷ Constipation</td>
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<td></td>
<td>✷ Gabapentin or pregabalin as adjuncts for neuropathic pain</td>
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<tr>
<td>Tier 3 Severe</td>
<td>✷ Refer to the acute pain team</td>
<td>✷ Hypotension and bradycardia (related to thoracic epidural only)</td>
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<td></td>
<td>✷ Paracetamol with or without NSAIDs plus regional anaesthesia with:</td>
<td>✷ Itching</td>
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<tr>
<td></td>
<td>✷ Thoracic epidural (gold standard)</td>
<td>✷ Headache, dizziness</td>
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<td></td>
<td>✷ Paravertebral or chest-wall nerve blocks</td>
<td>✷ Numbness</td>
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<tr>
<td></td>
<td>✷ Intrapleural block if no other option available and chest drain present</td>
<td>✷ Systemic toxicity (very rare)</td>
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<td></td>
<td>✷ Regional anaesthesia with:</td>
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<td></td>
<td>✷ Pain scores &gt;4/10</td>
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Source: Parjam Zolfaghari
Rib fractures are common in trauma. The number of ribs fractured is directly related to the risk of complications and mortality, particularly in older people.

Nurses have an important role in the management of patients with rib fractures. Continuous respiratory and pain assessment identifies patients who are deteriorating or at risk of doing so. Nursing interventions include titration of analgesia, encouragement of frequent coughing and deep-breathing exercises, and early mobilisation – all of which are key to achieving a good outcome in such patients.

Prompt and effective analgesia, early mobilisation, close observation and respiratory support are important when managing patients with rib fractures and preventing complications. Local protocols can help to establish early, appropriate interventions and escalate analgesia requirements without delays.

Conclusion

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References

Cathala X, Moorley C (2020) Performing an A-G scoring tool to standardise the assessment and ensure objectivity.

Pain scales are often numerical because using numbers is an effective way of measuring the response to treatment. In areas such as critical care, where patients are unconscious or unable to communicate, pain scales include a range of physiological and observed parameters, such as heart rate, respiratory rate, facial tension and calmness.

Pain assessments should also include monitoring for unwanted effects of the analgesic therapies being given, particularly in older people or those who are frail. Many non-steroidal anti-inflammatory drugs are contraindicated or must be used with caution in patients with underlying renal impairment. These drugs can increase the risk of bleeding and can be contraindicated in trauma patients who have head injuries or severe haemorrhage. Opioids are linked to impairment. These drugs can increase the risk of respiratory depression.

Continued use of opioids is not worsening any respiratory complications in the patient.

Nurses need to increase the frequency of respiratory assessments to make sure the use of opioids is not worsening any respiratory complications in the patient. They should also actively observe to check whether there is a need for antiemetics and/or laxative medication.

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