

# Intercostal chest drains: a wake-up call from the National Patient Safety Agency rapid response report

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**ABSTRACT** Intercostal chest drains have been well established in the management of pneumothorax and pleural effusion, and explicit guidelines exist for the indications for inserting a chest drain. In May 2008 the UK's National Patient Safety Agency issued a rapid response report entitled *Risks of chest drain insertion*, highlighting significant complications directly related to intercostal chest drain insertions. A systematic search of the National Reporting and Learning System database for chest drain-associated patient safety incidents revealed 12 deaths and 15 cases of serious harm out of a total of 2,152 incidents between January 2005 and March 2008. In response to these alarming incidents the report called for six action points to be implemented by NHS hospitals and the independent sector by 17 November 2008. This review aims to summarise the National Patient Safety Agency recommendations and provide a brief review of the literature on chest drain-related complications.

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## REVIEW

Numerous indications require the removal of air or fluid from the pleural space through the placement of an intercostal drain (ICD) either by Seldinger technique or blunt dissection (Table 1). The Seldinger technique, originally described in 1953,<sup>1</sup> involves the use of an introducer needle to access the thoracic cavity with advancement of the guide wire and the use of dilators and chest tube over the wire. This technique is predominantly employed to insert small- and medium-bore chest tubes (up to 24F). The insertion of ICDs is generally carried out by trainee doctors in acute general and respiratory medicine, accident & emergency (A&E), intensive care and cardiothoracic units. The British Thoracic Society (BTS) guidance stipulates that operators should be adequately trained and supervised to minimise procedure-associated hazards.<sup>2</sup> The dangers of chest drain insertion were underlined in a rapid response report by the National Patient Safety Agency (NPSA).<sup>3</sup>

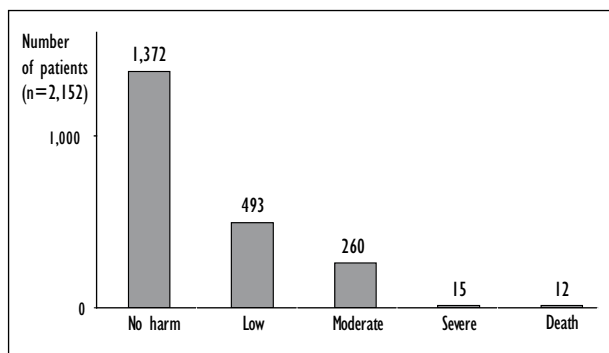
An interrogation of three databases revealed numerous fatalities that had occurred as a direct consequence of pleural tube placement. The National Reporting and Learning System (NRLS) is a database that has received notifications of patient safety incidents from NHS organisations in England and Wales since January 2005, including 2,152 incidents related to chest drains. Notification is voluntary and can be done by any healthcare staff when there 'is any unintended or unexpected incident which could have or did lead to harm for one or more patients receiving NHS care'.<sup>4</sup>

**TABLE 1** Indications for chest drain insertion\*

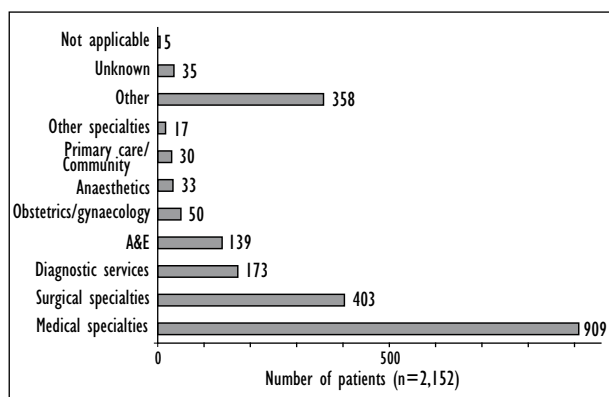
<b>Pneumothorax</b>
• In any ventilated patient
• Tension pneumothorax after initial needle relief
• Persistent or recurrent pneumothorax after simple aspiration
• Large secondary spontaneous pneumothorax in patients over 50 years
<b>Effusions/empyema</b>
• Malignant pleural effusion
• Empyema and complicated parapneumonic pleural effusion
• Traumatic haemopneumothorax
• Postoperative – for example, thoracotomy, oesophagectomy, cardiac surgery

\*Reproduced from Laws D, Neville E, Duffy J et al. BTS guidelines for the insertion of a chest drain. *Thorax* 2003; 58(Suppl II):ii53-ii59, with permission from BMJ Publishing Group Ltd.

The degree of harm is determined by those reporting the incident and is subsequently categorised as 'low' (patient required extra observation or minor treatment), 'moderate' (patient required further treatment or procedure), 'severe' (permanent or long-term harm) or 'death'. With regards to chest drains the degree of harm that occurred spanned from none to death (Figure 1), mostly in medical (42%) and surgical specialties (19%) (Figure 2). Generally, deaths and severe harm were related to incorrectly positioned chest drains puncturing solid organs such as lung, heart, liver and major vessels, causing haemorrhage. Many of the moderate harm adverse events



**FIGURE 1** Number of patient safety incidents by degree of harm (adapted from National Patient Safety Agency, *Rapid response report*<sup>3</sup>).



**FIGURE 2** Patient safety incidents involving chest drains by specialty (adapted from National Patient Safety Agency, *Rapid response report*<sup>3</sup>).

related to poor management of in-situ drains. Of 2,152 incidents reported to the NRLS database with regards to chest drains, 64% resulted in no extra treatment or observation required for the patient and were judged to cause 'no harm'.

Further evidence of harm was extracted from the NHS Litigation Authority dataset (17 deaths since 1995) and the Medicines and Healthcare products Regulatory Agency (MHRA) (nine incidents). The MHRA reports that all but one of its incidents related to drains inserted with Seldinger technique. Furthermore, 11 of the 12 deaths from the NRLS data refer to the insertion of drains using Seldinger technique (personal communication, NPSA).

The NPSA report also identified various themes that might have facilitated adverse events: inexperienced doctors undertaking the procedure, poor supervision of junior doctors, the site of insertion, inadequate imaging of the anatomical site, patients' anatomy and clinical condition, equipment used and lack of guidelines to support the procedure.

It concluded with six recommendations and requested their implementation by NHS and private healthcare providers by 17 November 2008:

**TABLE 2** Complications for intercostal chest drains

<b>Insertional</b>	Pain Placement outwith the pleural cavity: subcutaneous, intra-abdominal, solid organ Puncture of solid organ: liver, spleen, heart, lung, oesophagus Puncture of intercostal artery Insertion on incorrect side
<b>Positional</b>	Pain Drain failure (dislodgement/kinked/blocked) Re-expansion pulmonary oedema Bronchopleural fistula Pneumothorax
<b>Infective</b>	Wound infection Empyema

- Chest drains are only inserted by staff with relevant competencies and adequate supervision.
- Ultrasound guidance is strongly advised when inserting a drain for fluid.
- Clinical guidelines are followed and staff are made aware of the risks. Questions to be asked are: Do I need to do this? Does it need to be done as an emergency – can it wait? Have I had enough training to feel confident to do this? Are senior staff to hand? Am I familiar with this equipment? Is ultrasound available, with trained staff to position it safely?
- Identify a lead for training of all staff involved in chest drain insertion.
- Written evidence of consent is obtained from patients before the procedure, wherever possible.
- Local incident data relating to chest drains is reviewed, and staff are encouraged to report further incidents.

## OPINION

The insertion of an ICD clearly carries risks as pointed out by the NPSA, as is true with any clinical procedure. Accurate complication incidence rates are elusive as both the numerator (total number of all chest drain-related adverse events in the UK) and the denominator (total number of all chest drains inserted in the UK) are unknown. The NPSA and similar institutions rely on voluntary notification and any reports are therefore subject to bias such as systematic underreporting. A review of a literature search (Ovid MEDLINE®) limited to English using the keywords 'chest drains', 'chest tubes' or 'tube thoracostomy' and 'complication', reveals that published studies are often small, retrospective and vary in methodology. In particular, drain size and insertion technique differ widely depending on setting and specialty. Larger surgical drains that require blunt dissection and are still used by surgical specialties and trauma surgeons have largely been superseded by small-bore drains using Seldinger technique in medical specialties. This is partly due to the ease of insertion and enhanced patient

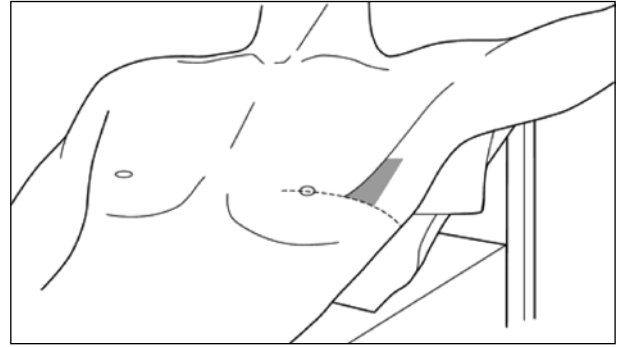
comfort of in-situ small-bore tubes compared with larger drains.<sup>2</sup> Their complication rates are comparable to large-bore drains, but both have never been directly compared in a prospective study.

Complications can be categorised into insertional, positional and infective, as shown in Table 2. Fortunately, serious or life-threatening adverse events are rare when small-bore drains are used and most incidents relate to drain blockage and displacement. A recent retrospective case note audit of 100 patients requiring a small-bore (12F) drain predominately for malignant or infected effusion and pneumothorax revealed a complication rate of 42% largely due to drain displacement (21%), drain blockage (9%) and pain (5%).<sup>5</sup> More severe complications were haemorrhage (1%), pneumothorax (4%) and drain misplacement (1%), none of which were life-threatening.

Mackenzie-Ross et al. performed a retrospective analysis of 156 medical patients with chest drains (size 16–32F, with 10% <16F), noting an 8% incidence for empyema, with a 15% immediate complication rate including pain, improper placement and failure of insertion.<sup>6</sup> High failure rates of 37% were reported for small-bore Seldinger-type drains by Horsley et al. (defined by the authors as drain failure [a failure of the resolution of the underlying condition], dislodgement or blockage). Only one patient (2%) developed an empyema as a result of drain insertion, and small-bore drains were less effective when used to treat empyema.<sup>7</sup>

These descriptions concur with our own experience documented in a recent retrospective audit of 41 medical small-bore drains (abstract submitted to European Respiratory Society conference 2009). Blockage or displacement of drains (eight patients) and pain (14 patients) occurred frequently. Less common, albeit concerning, were severe adverse events including haemorrhage (two patients), empyema (two patients) and re-expansion pulmonary oedema (two patients).

Adequate training of junior doctors is paramount to ensure safe procedural practice. Inexperience and poor supervision can be detrimental, as shown by Ball and colleagues, who reported an overall complication rate of 28% for junior doctors ranging from 40% in A&E to 7% in surgery.<sup>8</sup> When Griffiths et al. asked junior doctors to indicate on a photograph the correct insertion site for an ICD, only 55% picked the safe triangle as proposed by the BTS guidelines (Figure 3).<sup>9</sup> The BTS guidelines support the use of small (10–14F) drains for pneumothorax and malignant effusions, although there is justification to insert larger drains for haemothoraces to monitor blood loss. Debate remains as to the optimal drain size for complicated parapneumonic effusions/empyema,<sup>7,10</sup> but we feel that larger drains are justified for use in empyema.



**FIGURE 3** BTS guidelines 'safe triangle': anterior border of the latissimus dorsi, lateral border of the pectoralis major, line horizontal to the nipple and apex below the axilla. (Reproduced from Correction for Laws et al. 58 (Supplement 2): ii53. *Thorax* 2005; 60:152, with permission from BMJ Publishing Group Ltd.)

Using bedside real-time ultrasound can increase the accuracy of drain placement and prevent complications.<sup>11,12</sup> In its report the NPSA strongly advised physicians to employ ultrasound guidance when inserting a drain for pleural fluid. However, barriers to wider usage, such as high capital cost and training requirements, are recognised. Portable ultrasound devices with probes are priced from £25,000 upwards, although a recently marketed device costing under £10,000 provides adequate images. Operators are required to demonstrate competency by attending an approved ultrasound course and train to level 1 competency (under level 2 supervision) by performing 20 thoracic ultrasound scans (USS) on normal patients, 10 USS on pleural effusions and five drain placements or thoracocentesis.<sup>13</sup>

Forthcoming updated BTS guidance for ICD insertion is anticipated to incorporate the recommendations made by the NPSA. An interim statement by the BTS in November 2008<sup>14</sup> summarised advice on the implementation of the NPSA action points at hospital level within medical directorates. It acknowledged that local strategies will have to be tailored to individual circumstances and that solutions might differ from one health board to another. A named lead respiratory physician should act in an advising, training and monitoring role. Larger respiratory units may even wish to set up an 'on-call pleural team' to insert and manage chest drains. Training junior doctors to an adequate competency level requires practice on mannequins initially and close supervision and tutoring in clinical practice with log-book record keeping until the trainee is deemed proficient to insert a chest drain unsupervised. It might not be feasible to keep a list of junior doctors with proven competency as suggested by the BTS, given the high turnover rate of junior doctors that most units experience nowadays, but nevertheless the person inserting the chest drain should be deemed competent or be closely supervised if in training.

After obtaining written consent, all drains should preferably be placed in a suitable treatment room and

principles of sterility strictly adhered to at all times to reduce infection rates. Ideally, prepacked chest intubation sets containing a single drain type from a selected manufacturer should be standardised across the hospital to ensure familiarity with the equipment. The BTS concurred with the NPSA suggestion to apply real-time ultrasound imaging in all but the most acute emergencies, which is likely to become mandatory in the future. The authors' very positive experience in employing ward-based real-time ultrasound guidance rather than relying on often delayed departmental scans, particularly for small or loculated effusions, has led to the recent purchase of a portable device at our hospital.

It must be emphasised that few indications exist for emergency chest drain placement to remove fluid, and out-of-hours relief of immediate symptoms can be achieved by single drainage using a plastic cannula and three-way tap. Occasionally, a complicated parapneumonic effusion requires prompt drainage, but in most cases a referral to the specialist team can be made the following morning. Equally important is the care of in-situ drains either on respiratory or cardiothoracic wards, which should be undertaken by formally trained nursing staff. Specialist input to ongoing drain care will aid the appropriate use of suction and minimise unseemly clamping of drains. Specific drain care pathways should be implemented which incorporate the state of the drain site, function of the drain (if swinging/bubbling) and volumes of fluid draining. Utmost attention must be paid to the correct fixation of drains (drain suture without slack, gauze pillow behind drain to avert kinking, see-through dressing to allow an inspection of the drain site, omental tag fixation of the drain and the much larger connecting tube to prevent twisting, and the taping of the joint between the drain and the tube to avoid accidental disconnection).

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We recently overhauled the practice of chest drain insertion at our institution. All chest drains should now be placed and cared for in the respiratory wards (with the exception of the intensive care unit), under the care of respiratory physicians and nurses, with drain care pathways in place. Only in exceptional circumstances do we encourage out-of-hours drain placement (empyema or pneumothorax as per BTS guidance). Also newly implemented have been a patient information leaflet, the requirement for written consent, the use of a procedure room and standardised pre-packed kits and the employment of real-time ultrasound guidance. A sticky label with pertinent details in 'tick box' format for the medical notes acts as a checklist, facilitates standardisation and assists future audit cycles. Theoretical training sessions for all new junior doctors and nursing staff will be provided and a skills station employing a mannequin is being developed.

In summary, the insertion of chest drains is associated with morbidity and even mortality as highlighted by the timely NPSA alert. Recommendations aimed at improving clinical practice and safety include the naming of a lead clinician for training and advice, implementing structured training for junior doctors and nursing staff to raise competency levels, standardising equipment and operational procedures, strictly adhering to procedural guidance and developing an ultrasound service – all of which have been echoed in the recent BTS statement. Physicians and trusts are now called upon to implement the above recommendations speedily while monitoring current practice through audit to achieve better quality of care and patient safety.