Survey of major complications of intercostal chest drain insertion in the UK

Ann Harris, B Ronan O’Driscoll, Peter M Turkington

ABSTRACT

Background Following reports from the National Patient Safety Agency of deaths and serious harm from intercostal chest drains (ICD) we conducted a national survey among chest physicians of their experience of harm associated with ICD.

Methods A questionnaire was sent to 198 UK chest physicians at 148 acute hospital trusts, enquiring about current practice and any adverse incidents related to chest drains from 2003 to 2008.

Results 101 of 148 trusts (68%) replied. 67 trusts reported at least one major incident involving ICD insertion. 31 Cases of ICD misplacement were reported with seven deaths. Misplaced drains were inserted in liver (10), peritoneal space (6), heart (5), spleen (5), subclavian vessels (2), colon (1), oesophagus (1) and inferior vena cava (1). 47 cases of serious lung or chest wall injuries with eight deaths and six cases of ICD placement on the wrong side with two deaths were reported. The guidewire was lost in the pleural cavity in three cases. 22 of 101 trusts required written patient consent before ICD insertion. 11 trusts had a training policy. 16 trusts had patient information literature for this procedure. The seniority of doctors permitted to insert ICDs was as follows: 30% any doctor; 27% at least 1 year post qualification; 32% at least 2 years; 11% at least 4 years.

Conclusions 67% of responding trusts had encountered major complications of ICD. The survey raised concerns about training and consent. The National Patient Safety Agency has made recommendations to address these risks which are also addressed in the 2009 update of the British Thoracic Society Pleural Disease Guideline.

BACKGROUND

Intercostal chest drains are widely used throughout the medical, surgical and critical care specialties. Incorrect placement or management of intercostal chest drains can lead to significant morbidity and even mortality. In 1997 Collop et al reported a 3% early complication rate including misplacement and pneumothorax, and an 8% late complication rate including dislodgement, infection and kinking. However, of the 126 chest drains used 91% were large calibre Argyle drains (>24F) and 9% were small Cook drains (<14F) (Cook drains range from 8 to 36F). The British Thoracic Society (BTS) now recommends the use of small-bore (10–14F) wire guided (Seldinger) chest drains for the treatment of pneumothoraces and malignant pleural effusions. As a result Seldinger chest drains are being used more frequently in hospital practice.

Seldinger chest drains do not come without risks. In a prospective assessment of Seldinger drain use by Horsley et al, four of 52 insertions resulted in minor complications; three surgical emphysema, one bleeding wound site, and one case of iatrogenic empyema. However, a retrospective case note audit by Davies et al found very few complications following 100 Seldinger chest drain insertions. 21% fell out and 9% of drains became blocked, but no other complications occurred. A recent study by Benton and Benfield showed a statistically significant higher complication rate with Argyle chest drains and a tendency to longer drainage times than Seldinger chest tubes when used to treat spontaneous pneumothorax.

Nevertheless, there have been a number of more serious misplacements—for example, perforation of the left atrium with a Mattheys 6F catheter and perforation of the liver with a large bore chest tube. It is not known how the risks of Seldinger drains compare with the risks of Argyle drains.

The UK National Patient Safety Agency (NPSA) received reports of 12 deaths and 15 cases of serious harm from chest drains between 2005 and 2008, highlighting a more serious problem. In total another 2125 incidents were reported which were a result of poor management of chest drains with outcomes ranging from ‘no harm’ to ‘moderate harm’. In contrast, the Medicines and Healthcare Products Regulatory Agency (MHRA) received reports of just nine incidents since 2003. Such a low number may be a result of incidents not being reported. Of the nine incidents, eight were related to the use of Seldinger type intercostal drains.

The NPSA and MHRA have reviewed these incidents and several issues were common between them. Common problems included failure to follow manufacturer’s instructions, excessive insertion of dilator, inadequate imaging, anatomical anomalies, and the patient’s clinical condition.

The NPSA and MHRA reported evidence of poor supervision of junior doctors and low levels of experience among clinicians inserting chest drains. A third year trainee in the UK (ST3) is now expected to be competent at Seldinger intercostal drain insertion by the end of their core training. However, very few hospitals have a formal training programme. James et al surveyed the competence of medical registrars (trainees with at least 4 years of clinical experience) in the West Midlands deanery. The median number of ICD which each doctor had inserted was 10–15 (range 0–50); 69% had inserted fewer than 10 large bore ICD in their whole careers and 53% of non-respiratory trainees were not confident in the procedure. The authors concluded that non-respiratory trainees are inadequately trained and lack confidence in ICD insertion.

Griffiths and Roberts surveyed junior doctors in Sheffield as to the correct anatomical landmarks...
when inserting an intercostal drain. Their audit showed that 45% of junior doctors did not know the correct position for insertion. Those juniors with cardiothoracic experience were all correct; however, of the 15 juniors with respiratory experience only 6 (40%) were correct. This highlights poor postgraduate education, especially in the medical specialties. Another survey of junior doctors by Mazumdar et al. found similar evidence of lack of experience and training. Only 65% of trainees had inserted an ICD by the third year after qualification and only 50% had inserted more than five by the end of their training; 62% of those supervising other doctors had inserted only 1–4 ICDs themselves before guiding more junior colleagues, and 79% were unaware of the BTS guidelines on ICD insertion, including those who had acted in a supervisory role to less experienced doctors.

We have conducted a survey of current practice in the UK to determine which major complications have been encountered by chest physicians in UK hospitals when inserting intercostal drains and what training and patient safety measures were in place in 2008.

METHODS

Study design and participants

We undertook a postal questionnaire survey in spring 2008. The questionnaire was sent to one consultant physician in adult respiratory medicine at each acute hospital in the UK. Respiratory consultants were identified by the BTS national directory 2007. The questionnaire was sent to 198 consultant respiratory physicians representing 148 acute hospital trusts (some trusts comprised more than one acute hospital). This was sent twice to their hospital address during a period of 3 months from January to March 2008. A stamped addressed envelope was included with each questionnaire.

Measurements

The brief questionnaire (web appendix i) asked responders to comment on hospital size, type of trust, type of intercostals drain used, and grade of physician permitted to insert the intercostals drain to try to establish common themes between incidents. The questionnaire included questions about current practice at each hospital, patient information literature about the procedure and complications, and whether they obtain written consent from patients for this procedure. The questionnaire asked participants to comment retrospectively on any major adverse incidents related to intercostal drains that they were aware of in the past 5 years (2003–2008), to provide a total number as well as details of the event.

Analysis of the data

Data were extracted from the responses and entered into Microsoft Excel 2008 spreadsheet. The questionnaire asked for one representative to respond on behalf of the Trust, including all specialties to reduce duplication. The results were then collated and expressed as numbers of events. Each recorded adverse event was analysed independently: the grade of doctor involved in the insertion, the type of drain, and the nature of injury. If a procedure took place under the supervision of a more senior colleague, the responsibility was attributed to the supervising clinician rather than the more junior trainee.

RESULTS

One hundred and eleven replies were received, representing 101 of 148 acute hospital trusts in the UK (68% response rate). Sixty-nine per cent of responses were from district general hospitals, 25% were from teaching hospitals, and 6% were from tertiary hospitals. A number of duplicate responses were received as a result of some acute hospital trusts being on split sites. In addition, many responders remembered that there had been incidents but could not provide specific details. This was counted as reporting an incident, but not counted in the total number of events observed.

Types of intercostal drains

Most trusts used more than one type of drain. Seventy-seven trusts reported using small bore (10–14F) Portex Seldinger drains (Smiths Medical UK), 29 trusts used small bore (10–14F) Rocket Seldinger drains (Rocket Medical UK), and some trusts used both brands. Twenty-one trusts reported using the Cook seldinger drains (8–36F) (Cook Medical, USA) and 57 reported using the Argyle intercostal drains (various suppliers).

Adverse incidents

Sixty-seven trusts reported at least one major incident involving ICD insertion. In total, 87 adverse clinical incidents were reported which included 17 deaths (see table 1). There were 37 incidents of chest drains inserted in the wrong anatomical location or on the wrong side as shown in table 2. Thirty-five trusts reported serious lung or chest wall injuries affecting 47 patients with eight deaths. Of these 47 patients, 18 (38%) suffered lung penetration or laceration, 11 (23%) had serious haemorrhage, and eight (17%) developed surgical emphysema. The remaining nine cases involved injury to the chest wall, infection and persistent air leak. The guide wire was lost in the pleural cavity in three cases.

A Seldinger type drain was implicated in 52 of the 87 adverse events including 10 fatal cases. An Argyle intercostal drain was used in 20 of the reported cases which included five deaths, and the reporter was unable to confirm the type of drain involved in the other cases. Five of the eight fatalities due to chest wall injuries and five of the nine fatalities due to intercostal drain insertion into the wrong side or into an organ involved Seldinger drains (see table 5). The proportion of Seldinger drains and Argyle drains used in these hospitals is not known.

Grade of physician permitted to insert chest drains

The seniority of doctors permitted to insert ICDs at the 101 trusts is as follows: 50% any grade of doctor including newly qualified; 27% at least 1 year of clinical experience; 52% at least 2 years of clinical experience; and 11% at least 4 years of clinical experience.

Grade of physician and speciality involved in adverse incidents

Of the 87 reported incidents, fully trained consultant physicians were involved in 10 cases (11%), trainees with at least 4 years of clinical experience were involved in 36 cases (41%), trainees with 2–4 years of experience were involved in 23 cases (26%), and trainees with 0–2 years of clinical experience were involved in four cases (5%) (see table 4).

Respiratory physicians were responsible for the care of 35 cases, 16 were under general medical care, and eight were treated by emergency department staff, but the proportion of cases cared for by each of these specialties in unknown (see table 5).

Table 1 Types of adverse incidents associated with chest drain use at 101 acute hospital trusts

<table>
<thead>
<tr>
<th>Nature of injury</th>
<th>No. of trusts</th>
<th>No. of deaths</th>
<th>No. of cases</th>
<th>Percent fatal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lung or chest wall injury</td>
<td>35</td>
<td>8</td>
<td>47</td>
<td>17%</td>
</tr>
<tr>
<td>Wrong side</td>
<td>5</td>
<td>2</td>
<td>6</td>
<td>33%</td>
</tr>
<tr>
<td>Lost wire</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>Wrong location</td>
<td>24</td>
<td>7</td>
<td>31</td>
<td>23%</td>
</tr>
<tr>
<td>Total</td>
<td>67</td>
<td>17</td>
<td>87</td>
<td>20%</td>
</tr>
</tbody>
</table>
Physician training, patient information and informed consent

Eleven trusts had a training policy including supervision and formal instruction for trainee operators, and 16 trusts had patient information literature for this procedure. Only 22 of the 101 trusts required written consent from the patient before ICD insertion at the time of the survey.

DISCUSSION

Insertion of an intercostal drain is commonly assumed to be an easy and quite minor bedside procedure. However, the results of this survey would suggest that this is a false assumption because we identified 87 serious incidents including 17 fatalities at 67 acute hospital trusts over a 3 year period. Following the NPSA rapid response report, UK trusts are being encouraged to develop local policies to reduce the risks involved (see boxed text).

This study has several limitations. Our response rate was 68%, and this was a retrospective survey based on the memory of consultants in a single specialty, therefore the reported incidents are likely to be underestimated. Furthermore, the survey was dependent upon reporter interpretation of what was meant by a serious adverse event. For example, some chest wall injuries that have caused no harm might not have been thought of as a ‘serious adverse event’. As the number of drains inserted in each trust is unknown, the risk per procedure or for each type of drain cannot be estimated, which is a further limitation of this study. This study was restricted to chest physicians and relied on physicians sharing information across spilt hospital sites within the same trust and between specialities. It is therefore likely that adverse incidents that occurred in other departments of a hospital would not have been picked up by this survey. Therefore, the true number of serious adverse events is likely to be much higher than that documented in our survey. This suggests that a large proportion of incidents are not being reported to the NPSA which documented only 27 serious incidents in a 3 year period.

In addition, it is impossible to know the nature of the survey (sent to respiratory physicians). A higher proportion of chest wall injuries may have occurred in the same trust and between specialities. It is therefore likely that adverse incidents that occurred in other departments of a hospital would not have been picked up by this survey. Therefore, the true number of serious adverse events is likely to be much higher than that documented in our survey. This suggests that a large proportion of incidents are not being reported to the NPSA which documented only 27 serious incidents in a 3 year period.

In addition, it is impossible to know the total number of intercostals drains inserted throughout the UK so it is not possible to calculate the total number of incidents and deaths due to chest drains each year.

Thirty-seven adverse incidents were due to misplaced of a chest drain into an organ or on the wrong side of the body. This accounted for nine deaths. The most common organ injuries involved the spleen, liver and the peritoneal space. These events can only be explained by inserting the intercostal drains too far or not within the ‘safe triangle’. Furthermore, there were 47 reported cases of chest wall injuries, 18 of which were due to lung penetration or laceration probably caused by over-insertion of the dilator. The dilators for Seldinger drains were 24 cm in length before a recent re-design which was prompted by some of the incidents reported in this survey.

One in five of the chest wall injuries was secondary to haemorrhage. One of the particular hazards about intercostal artery haemorrhage is that it occurs into a negative pressure space of effectively unlimited capacity which is hidden from view (the hemithorax). This is unlike any other major internal haemorrhage and makes this injury particularly dangerous and potentially lethal. It is a matter of special concern that there were six cases of chest drain insertion into the wrong side. It could be hypothesised that the chest radiograph was not seen or clinical signs were not elicited before drain insertion in these cases and the use of ultrasound guidance should prevent any such events in the future.

Of the incidents where the drain type was documented, Seldinger type drains and Argyle drains were implicated in 68% and 26%, respectively. This probably reflects the higher proportion of Seldinger drains in use in UK hospitals. We cannot calculate the relative risk (RR) of each type of drain as the proportional use of each drain type is not known.

All grades of physician were involved in the reported incidents. The largest proportion (41%) involved trainees with 1–4 years of training (medical registrars). This is partly because of the large proportion of drains inserted by this group of trainees. In addition, the number of incidents among the consultants and senior trainees may be artificially high as they could have been acting as a supervisor for a more junior colleague when the event occurred. The respiratory team inserted 40% of drains in the reported incidents. This may reflect the large number of intercostal drains inserted by respiratory teams and the tendency for these patients to be more complicated, or it may be due to the nature of the survey (sent to respiratory physicians).

Although this current study and previous research have established that intercostal drain insertion has substantial risks, it is surprising that only 22% of trusts required written consent in 2008 and only 16 trusts had patient information literature available for this procedure. This finding was particularly unexpected given that informed consent is required in most hospitals for diagnostic procedures such as endoscopy, which are safer than chest drain insertion, and patient consent is advocated in the national guideline for chest drain insertion. This guideline also states that all operators should have completed appropriate training; however, only 11 trusts had a formal training policy including teaching sessions, formal supervision and DOPS (directly observed procedures) assessment. Thirty per cent of trusts allowed first year trainees to insert intercostal

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Table 2 Location of misplaced drains

<table>
<thead>
<tr>
<th>Location of misplaced drains</th>
<th>Number of cases</th>
<th>Number of deaths</th>
<th>Per cent fatal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liver</td>
<td>10</td>
<td>1</td>
<td>10%</td>
</tr>
<tr>
<td>Intrapleural space</td>
<td>6</td>
<td>0</td>
<td>–</td>
</tr>
<tr>
<td>Spleen</td>
<td>5</td>
<td>1</td>
<td>20%</td>
</tr>
<tr>
<td>Heart</td>
<td>5</td>
<td>3</td>
<td>60%</td>
</tr>
<tr>
<td>Subclavian vessels</td>
<td>2</td>
<td>1</td>
<td>50%</td>
</tr>
<tr>
<td>Colon</td>
<td>1</td>
<td>0</td>
<td>–</td>
</tr>
<tr>
<td>Inferior vena cava</td>
<td>1</td>
<td>1</td>
<td>100%</td>
</tr>
<tr>
<td>Oesophagus</td>
<td>1</td>
<td>0</td>
<td>–</td>
</tr>
<tr>
<td>Drain inserted into</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>wrong side</td>
<td>6</td>
<td>2</td>
<td>33%</td>
</tr>
<tr>
<td>Total</td>
<td>37</td>
<td>9</td>
<td>24%</td>
</tr>
</tbody>
</table>

Table 3 Type of intercostal drain involved in each type of incident

<table>
<thead>
<tr>
<th>Nature of injury</th>
<th>Number of cases (deaths)</th>
<th>Seldinger</th>
<th>Argyle</th>
<th>Not recorded</th>
<th>Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wrong location/side</td>
<td>20 (5)</td>
<td>11 (3)</td>
<td>6 (1)</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Lost wire</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Lung/chest wall injury</td>
<td>33 (5)</td>
<td>9 (2)</td>
<td>5 (1)</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Mortality</td>
<td>10</td>
<td>5</td>
<td>2</td>
<td>17 total</td>
<td></td>
</tr>
</tbody>
</table>
drains. Given that this a high risk procedure, it may not be appropriate to delegate this complex procedure to such junior staff. We would suggest that postgraduate deaneries should not require this skill as a ‘tick box’ exercise for all medical trainees because there are not enough cases available to train junior doctors at all levels in a wide range of medical specialities.¹³

This study, along with the NPSA rapid response report, raises several issues. First, hospital trusts will need to ensure those people who wish to insert intercostal drains are trained appropriately and their knowledge and experience is maintained. Trusts and deaneries will have to decide whether they will attempt to train all their medical trainees or only those in specific grades in specific specialities, who are likely to have the opportunity to learn the procedure properly by placing a number of drains under senior supervision. In the latter instance trusts may have to institute further on-call measures to offer an acute chest drain service (very few chest drains are genuine emergencies because tension pneumothorax can be treated initially by using a large intravenous cannula). In addition, new doctors joining the trust each year may need supervision or repeat training before they are permitted to insert chest drains. The chest team at Sandwell Hospital used a porcine model to train and assess doctors in the insertion of an intercostal drain in the acute setting that was found to be an effective training tool.¹¹

The NPSA guidance and the new BTS guideline both recommend ultrasound guidance for inserting an intercostal drain for fluid.⁹ Trusts should therefore consider the training of their medical staff in thoracic ultrasonography and supplying a portable ultrasound machine for the medical specialties. Slack et al¹² conducted a telephone survey to elicit whether ultrasound machines were available and whether they were used by accident and emergency (A&E) and respiratory teams in the Thames area in 2008. They discovered that portable ultrasound was available to 60% of A&E departments, but they were used to assist in guidance of an ICD in just 9% of departments. Medical juniors had access to a portable ultrasound in 20% of hospitals in the Thames region, but they were used for intercostal drain insertion in just 7% of hospitals. The mere presence of ultrasound equipment does not imply that physicians have been trained in its use and the report of the Royal College of Radiologists (RCR) suggests that extensive training is required before non-radiologists can safely use ultrasound guidance for inserting an ICD (RCR report). Otherwise the procedure should be undertaken by a trained radiologist.

This current survey, together with previous surveys and the NPSA and MHRA, suggest that intercostal drain insertion is a risky procedure in UK hospitals at present.⁹ ¹¹ ¹⁵ This survey highlights the extent of the problem; however, prospective data need to be collected nationally to assess accurately the complication rate of intercostal drainage and to eliminate the bias which affects this survey. This could be done through a central web registry.

To ensure patient safety there needs to be a move towards formal postgraduate training in chest drain insertion and the use of ultrasound. Indeed a pre-drain checklist would enhance safety to ensure basics have been checked—for example, clotting and chest x-ray review. More specifically, junior doctors need to be trained as to when an intercostal drain is absolutely necessary and the timescale with which it needs to be done because, with the exception of major trauma, it is very rare for a chest drain to require urgent insertion without waiting for senior advice or assistance. UK trusts should encourage physicians to choose carefully the area and equipment they use, including brand of chest drain, to minimise risk. Finally, the issues of consent and patient information need to be addressed more effectively in UK hospitals as recommended in the NPSA guidance in 2008.⁹

Table 5 Speciality involved

<table>
<thead>
<tr>
<th>Specialty</th>
<th>No. of cases</th>
<th>Wrong location</th>
<th>Lost wire</th>
<th>Wrong side</th>
<th>Lung/ chest wall injury</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiratory</td>
<td>12</td>
<td>2</td>
<td>3</td>
<td>18</td>
<td>35</td>
<td>87</td>
</tr>
<tr>
<td>General medicine</td>
<td>9</td>
<td>0</td>
<td>1</td>
<td>6</td>
<td>16</td>
<td>30</td>
</tr>
<tr>
<td>General surgeons</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Intensive therapy unit / anaesthetics</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Radiology</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Accident and emergency</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>6</td>
<td>8</td>
<td>18</td>
</tr>
<tr>
<td>Not recorded</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>12</td>
<td>17</td>
<td>32</td>
</tr>
<tr>
<td>Total</td>
<td>31</td>
<td>3</td>
<td>6</td>
<td>47</td>
<td>87</td>
<td>158</td>
</tr>
</tbody>
</table>

National patient safety association advice 2009

Following the evidence of harm, the NPSA issued a rapid response report.⁸ This encourages acute hospital trusts to develop local policies to ensure that:

- 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 made aware of the risks.
- 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 encouraged to report further incidents.

Main messages

- The UK National Patient Safety Agency (NPSA) received reports of 12 deaths and 15 cases of serious harm from chest drains between 2005 and 2008 and released a rapid response report in 2008 to improve clinical care.
- Our UK survey found that clinicians at 67% of responding trusts have encountered major complications of chest drains.
- 17 fatal cases were reported in this survey (2003—2008), mostly due to misplacement of the chest drain.
- As the number of drains inserted in each trust is unknown, the risk per procedure cannot be estimated.
- Despite the risks involved, only 22% of trusts required written consent for this procedure and only 11% of trusts had a formal training policy in early 2008.
- Only 16% of trusts had patient literature about the procedure in early 2008.
- 30% of trusts allowed FY1 physicians to insert ICDs in 2008.
- The BTS Standards of Care Committee are assisting the NPSA with plans to reduce these risks and a prospective national study of chest drain complications is planned. This will allow clinicians to assess the risk of each procedure and the RR from different types of chest drain.
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REFERENCES
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