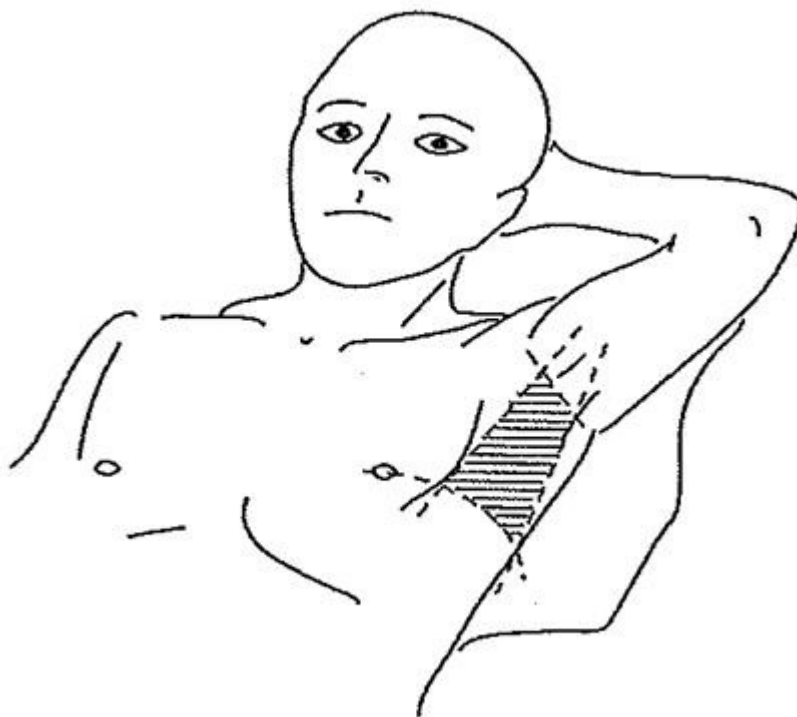


## How safe is the ‘safe triangle’?

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Flexible small-bore chest tubes are commonly used to drain large pleural effusions, as they are easy to insert by the Seldinger technique and comfortable for the patient. The commonly recommended site for insertion of a chest drain is the ‘safe triangle’, formed anteriorly by the lateral border of the pectoralis major, laterally by the lateral border of the latissimus dorsi, inferiorly by the line of the 5<sup>th</sup> intercostal space and superiorly by the base of the axilla (as shown in Figure 1). This position minimises the risk to blood vessels, muscle and breast tissue.

**Figure 1. ‘Safe Triangle’ (reproduced with permission from the BTS guidelines on pleural procedures 2010)<sup>11</sup>**



Perforation of internal organs is a rare but recognised complication after chest drain insertion. We present a report of a patient who developed myocardial perforation after insertion of a small-bore, flexible chest drain through the ‘safe triangle’ by the Seldinger technique, and we suggest improvements for safety.

## Case report

An 82-year-old man was admitted with congestive heart failure and bacterial endocarditis. He had dilated cardiomyopathy, mild renal impairment, chronic leg ulcers and *Staphylococcus* bacteraemia. A CT scan showed a large left sided pleural effusion with partial left lower lobe collapse and consolidation. The patient's chest X-ray is shown in Figure 2.

**Figure 2. Chest X-ray prior to the procedure showing evidence of pleural effusion and cardiomegaly**



The patient was breathless at rest, even after treatment with intravenous frusemide, spironolactone and bendrofluazide. The results of the diagnostic pleural tap were consistent with a para-pneumonic effusion. A chest drain was offered to the patient in an attempt to alleviate his breathlessness.

The 'safe triangle' was identified, and a 14F Rocket chest drain was inserted. Soon after insertion, blood was seen pulsing into the draining system. Cardiac perforation was suspected, and the tube was clamped. A CT chest scan revealed the chest drain in the left ventricle (Figure 3). The patient was transferred to the thoracic surgery unit and the drain was successfully removed by a mini-thoracotomy. The patient was discharged home 2 months later.

**Figure 3. Showing chest drain in the left ventricle and pleural effusion and partial collapse of the lung**



## Discussion

Chest tube insertion is a relatively common procedure, often carried out by junior medical staff, but it is associated with significant complications.<sup>1-9</sup> During a 3-year period, 12 deaths and 15 cases of serious harm were reported to the National Patient Safety Agency,<sup>1</sup> and the true incidence of significant complications is thought to be substantially higher.

The main complications associated with chest drain insertion include bleeding and haemothorax due to intercostal artery perforation, perforation of visceral organs and major vascular structures, intercostal neuralgia, subcutaneous emphysema, re-expansion pulmonary oedema, infection of drainage site, pneumonia and empyema.<sup>2</sup>

Only a few cases of cardiac perforation have been reported after insertion of small-bore chest drains; the insertion technique was not described in detail, and various types of drain tubes were used.<sup>3-5</sup> The drains were successfully removed by mini thoracotomy, and patients made a good clinical recovery. Contributing factors in the cardiac perforations were distorted anatomy of the chest, insertion below the 'safe triangle' and not using Doppler ultrasound. Kerger et al reported a case of left atrial perforation after insertion of a Matthy catheter through a right-sided chest drain.<sup>3</sup> In that case, neither ultrasound nor CXR picked up the extent of cardiomegaly.

Griffiths et al. conducted an audit to determine the ability of 55 junior doctors to insert a chest drain safely.<sup>6</sup> The doctors were asked to mark on a photograph where they would insert a chest drain for a pneumothorax in a non-emergency situation. An area outside the 'triangle of safety' was marked by 45% of the junior doctors surveyed. Ball et al. conducted a retrospective audit of complications from chest drains among trauma patients presenting to an Auckland hospital.<sup>7</sup> The overall complication rate was 40%; surgical residents had a lower complication rate than medical residents.

Two registrars who were involved in the procedure had inserted more than 10 chest drains each, which was higher than the average experience reported in a previous New Zealand study.<sup>8</sup> The registrar who performed the procedure had been unable to attend

a chest drain insertion tutorial. The tube was inserted in the fifth intercostal space over the anterior axillary line, within the boundaries of the “safe triangle” and the drain position was subsequently confirmed by 3D reconstruction. It is likely that the massive cardiomegaly and flabby ventricular wall contributed to the cardiac perforation. The extent of the cardiomegaly was not appreciated by the registrars performing the procedure.

An independent physician reviewed the case and identified some shortcomings, including failure to perform radiological imaging immediately before the procedure and lack of a system for monitoring attendance at a practical simulation session of chest drain insertion for medical registrars at the beginning of the rotation. It also advocated greater use of ultrasound and highlighted the trend toward routine use of pleural ultrasound internationally. The resulting recommendations were approved by the hospital patient safety group and implemented. The case was reported to the Ministry of Health as a sentinel event.

Cardiac perforation is a very rare complication of chest drain insertion, but the incidence may be higher with blind insertion than with blunt dissection. The Seldinger technique is not better than traditional methods, even though complications appear to be uncommon.

The most recent British Thoracic Society guideline advocates routine use of Doppler ultrasound before insertion of chest drains, and the National Patient Safety Agency has recommended ultrasound before inserting a drain for fluid.<sup>9</sup> The current Australasian guidelines make no recommendations for pre-procedural Doppler ultrasound. Bedside Doppler ultrasound can accurately identify fluid collection and blood vessels, resulting in a higher success rate and fewer complications.<sup>10</sup>

The best site for inserting a chest drain should be determined by real-time Doppler ultrasound rather than by adhering to the ‘safe triangle’. Each hospital should develop protocols and teaching for safe chest drain insertion. In our hospital, a lead chest physician is responsible for providing chest drain tutorials, and, since this case, we have made it mandatory for registrars to attend these tutorials. A national or regional strategy is needed to teach the skills for Doppler ultrasound for chest drain placement if this is to be the new standard of care.

In cases of severe cardiomegaly and distorted thoracic anatomy, blind insertion of a chest tube through the ‘safe triangle’ is not safe. Proper training and routine use of Doppler ultrasound for chest drain placement are the only effective means for reducing the risk for internal organ perforation.

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#### References:

1. Lamont T, Surkitt-Parr M, Scarpello J, et al. Insertion of chest drains: summary of a safety report from the National Patient Safety Agency. *BMJ*, 2009;339:b4923. doi: 10.1136/bmj.b4923.

2. Dev SP, Nascimento B Jr, Simone C, Chien V. Videos in clinical medicine. Chest-tube insertion. *N Engl J Med* 2007;357:e15.
3. Kerger H, Blaettner T, Froehlich C, et al. Perforation of the left atrium by a chest tube in a patient with cardiomegaly: management of a rare, but life-threatening complication. *Resuscitation* 2007;74:178-82. Epub 14 Feb 2007.
4. Asopa S, Iyenger S, Lloyd CT, et al. Accidental perforation of the left ventricle with a Bonanno catheter. *J Thorac Cardiovasc Surg* 2009;137:1023-4.
5. Legrand M, Lecuyer L, Van De Louw A, Thierry S. Pleural drain malposition. *Intensive Care Med* 2006;32:941-2.
6. Griffiths JR, Roberts N. Do junior doctors know where to insert chest drains safely? *Postgrad Med J* 2005;81:456-8.
7. Ball CG, Lord J, Laupland KB, et al. Chest tube complications: how well are we training our residents? *Can J Surg* 2007;50:450-8.
8. Wong CA, Lee O, Kennedy H, et al. The training, experience and confidence of junior doctors in performing pleural procedures. *NZ Med J* 2009;122:23-32.
9. National Patient Safety Agency. Rapid response report, chest drains: Risks associated with insertion of chest drains (2008) <http://www.nrls.npsa.nhs.uk/resources/patient-safety-topics/medical-device-equipment/?entryid45=59887&p=2>
10. Teoh R. The role of ward based pleural ultrasound, chest drain insertion–improving patient safety. BTS Winter Meeting, December 2008. <http://www.brit-thoracic.org.uk/ClinicalInformation/PleuralDisease/tabid/100/Default.aspx>
11. Havelock T, Teoh R, Laws , et al. Pleural procedures and thoracic ultrasound: BTS pleural disease guideline 2010. *Thorax* 2010;65(Suppl 2):ii61-eii76. doi:10.1136/thx.2010.137026