PAPER

Evaluation of small-bore wire-guided chest drains for management of pleural space disease

Objectives: To evaluate the efficacy and practicality of a small-bore wire-guided chest drain for management of pleural space disease in dogs and cats.

Materials and Methods: A 14 gauge chest drain was placed using a modified Seldinger technique in animals requiring ongoing management of pleural space disease. A questionnaire was used immediately after placement to collect data regarding the ease of placement, reliability and function of the drain.

Results: Twenty animals were enrolled in which 29 drains were placed. The most common pleural space disease encountered was pyothorax (10 of 20). Sixteen animals required sedation for placement, and 25 of 29 chest drains were inserted at the first attempt. Most drains were placed in less than 10 minutes. The median length of time of catheter use was three days. Few complications were noted during the insertion and throughout the use of the drains. Clinicians rated drain placement as "easy" in 27 of 29 times and the drain function as "good" in 24 of 29 times.

Clinical Significance: Small-bore wire-guided chest drains are an effective alternative to larger gauge drains. Only minor complications were seen during insertion of the chest drains, and their performance was deemed satisfactory in most cases.

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INTRODUCTION

Chest drain placement is commonly performed for the removal of air or fluid from the pleural space in order to relieve respiratory compromise. Typically, pleural space disease is initially managed with needle thoracocentesis, which can be repeated several times (Laws and others 2003, Sigrist 2008). If needle thoracocentesis fails to stabilise or manage the animal's clinical signs, then chest drain placement is recommended. Indications for chest drain placement in veterinary practice include pneumothoraces, particularly if tension pneumothorax is present or there is persistent or recurrent pneumothorax; malignant pleural effusions; pyothorax; penetrating thoracic injuries and in postoperative situations (Tillson 1997a, Laws and others 2003, Sigrist 2008).

There are few guidelines in the veterinary literature regarding the insertion of chest drains (Tillson 1997a and b, Dugdale 2000), and only a small number of studies reviewing morbidity associated with chest drain insertion and use (Demetriou and others 2002, Waddell and others 2002, Barrs and others 2005, Tattersall and Welsh 2006, Moores and others 2007).

Many practitioners currently use trocar-type drains inserted using pressure to place them within the pleural space. This technique is no longer recommended in human medicine because of its high complication rate (Hyde and others 1997, Laws and others 2003, Horsley and others 2006, Ball and others 2007). The use of trocar-type drains is discouraged in cats and small dogs because of their high thoracic wall compliance and associated increased risk of complications (Tillson 1997a, Dugdale 2000). Other methods include a "mini-thoracotomy" method in which blunt dissection performed using a pair of haemostats places a non-styletted chest drain grasped in the jaws of the haemostats into the pleural space (Tillson 1997b, Dugdale 2000, Khan 2007). Anaesthesia or heavy sedation is required for these techniques in most instances, which may be undesirable in cardiovascularly unstable or dyspnoeic animals (Demetriou and others 2002, Barrs and others 2005, Khan 2007, Sigrist 2008).

In human medicine, the reported complication rate associated with insertion and use of large-bore chest drains is between 5 and 35 per cent, and complications are categorised as insertional, positional or infectious (Chan and others 1997, Collop and others 1997, Horsley and others 2006, Ball and others 2007). In veterinary medicine, use of large-bore chest drains has been linked to insertional and mechanical complications in up to 58 per cent of cases. Reported complications include pneumothorax, lung trauma, arrhythmias, haemorrhage from laceration of intercostal vessels, misplacement, failure to drain and fluid leakage around the catheter (Tillson 1997b, Dugdale 2000, Demetriou and others 2002, Waddell and others 2002, Barrs and others 2005, Moores and others 2007).

The use of small-bore catheters (10 to 14 French) inserted using a modified Seldinger technique is recommended in human medicine for the treatment of pneumothoraces and malignant effusions as they are associated with fewer insertional and infectious complications (Parulekar and others 2001, Laws and others 2003, Horsley and others 2006, Davies and others 2008) and they are considered more comfortable for the patients (Clementsen and others 1998).

In veterinary medicine, the Seldinger technique is commonly used for the placement of central venous and peripherally inserted central catheters, but its use for insertion of chest drains has not been evaluated.

This study describes the use of the modified Seldinger technique for chest drain placement and evaluates the efficacy and practicality of a 14 gauge chest drain in dogs and cats requiring insertion of a chest drain for management of pleural space disease.

MATERIALS AND METHODS

The study was carried out at The Queen Mother Hospital for Animals, Royal Veterinary College, over a six month period. Animals were considered eligible for enrolment in this study if they required non-surgical placement of a chest drain for ongoing management of pleural space disease. Cases were enrolled consecutively.

A 14 gauge small-bore wire-guided chest drain (Chest Drain; MILA International Inc.) (Fig 1) was placed using a modified Seldinger technique. This is a 20 cm long polyurethane, multi-fenestrated catheter. Patients were restrained in sternal or lateral recumbency depending on operator preference. Sedation or anaesthesia was provided as required depending on the animal's temperament and on the severity of their clinical compromise. Patients were clipped on the lateral side of the affected hemithorax from the last rib to the caudal margin of the scapula and from the spine to the sternum before sedation to shorten the time of the procedure. The skin was aseptically prepared before drain placement (Fig 2).

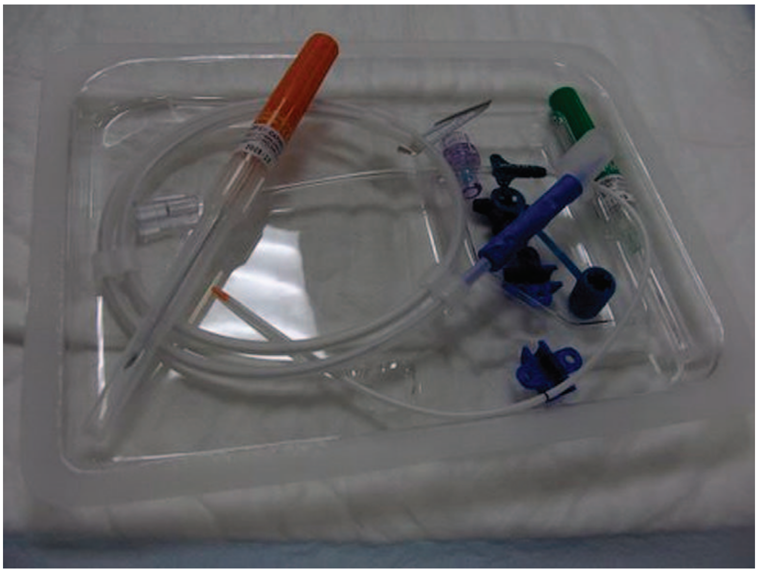

FIG 1. MILA Chest Drain kit

A small skin incision was made with a scalpel blade at the level of the ninth intercostal space, approximately one third of the way down from the top of the thorax for pneumothoraces and approximately one third of the way up from the bottom in the case of pleural effusion to facilitate placement. The introducer catheter was tunnelled subcutaneously to the seventh or eighth intercostal space, and then, the catheter was inserted into the thoracic cavity (Fig 3). The introducer entered the pleural space at the cranial edge of the rib to minimise the risk of injuring the neurovascular bundle, situated at the caudal aspect of the rib. The introducer was advanced fully into the thorax over the stylet, and a J-wire threaded through the catheter and advanced cranio-ventrally approximately 12 to 20 cm or until resistance was encountered. The catheter was removed over the guide wire, leaving the latter in place. The small-bore tube was then advanced into the thoracic cavity over the guide wire (Fig 4). Accurate placement of the drain was assessed by gentle aspiration of either fluid (Fig 5) or air depending on the underlying disease. If air or fluid could not be easily retrieved, thoracic radiographs were taken to visualise the position of the

FIG 2. Dog restrained in sternal recumbency. Patient is clipped on the lateral side of the affected hemithorax, and the skin is aseptically prepared

FIG 3. Introducer catheter after being tunnelled is introduced in the pleural space

drain. The chest drain was secured to the skin through the suture holes on the catheter (Fig 6) using three metric nylon (Ethilon; Ethicon and Johnson & Johnson). In small patients where the drain could not be fully inserted, the remainder of the tube was secured to the skin using a Chinese finger-trap suture. A sterile non-woven adhesive dressing (Primapore™; Smith and Nephew) was applied over the entrance site, and a netting vest was used to secure and protect the chest drain against the body wall.

Patients were monitored 24 hours a day in the intensive care unit while the chest drain was in place and managed as necessary for their underlying condition.

Upon placement of the drain, a questionnaire (Appendix 1) was used to evaluate the ease of placement, reliability and function of the catheter. Data collected included the reason for drain placement, whether sedation/anaesthesia was required, the number of attempts and duration for placement, complications during insertion and during use of the chest drain and the length of time in use. Clinicians were also asked to subjectively rate the ease of placement and overall function (including both immediately after placement and during use) of the catheter.

At the end of the study period, the questionnaires were collated and reviewed.

RESULTS

Twenty animals were included in the study, 10 dogs and 10 cats (Table 1). A total of 29 drains were placed (16 in cats and 13 in dogs). Six cats and two dogs had bilateral chest drain placed at the same time. Twelve animals had a unilateral chest drain placed. One dog required replacement of a unilateral chest drain because of recurrence of the underlying disease. There were seven domestic shorthair cats, two Persian cats and one domestic longhair cat. Four were female neutered, four male neutered and two male entire. Their median age was 6·25 years (range 0·75 to 12 years), and median weight was 3·8 kg (range 2·8 to 5·7 kg). A number of different dog breeds were represented; golden retriever (2), crossbreed (2) and one each of border collie, Jack Russell terrier, Labrador retriever, flat coated retriever, bichon frise and German shorthair pointer. Four were female neutered, one female entire, two male neutered and three male entire; the median age was 2·8 years (range 0·75 to 12 years), and median weight was 16·8 kg (range 4·2 to 25·8 kg).

The underlying disease process was pyothorax in 10 (50 per cent) animals, pneumothorax in five (25 per cent) animals, chylothorax in two (10 per cent) animals, haemothorax in two (10 per cent) animals and malignant pleural effusion in one (5 per cent) animal. Needle thoracocentesis was performed in all cases requiring stabilisation before drain placement.

Sedation was required for placement in 16 animals. In six cats, a combination of ketamine (Ketaset®; Fort Dodge Animal Health Ltd) and midazolam (Hypnovel®; Roche) and in two cats, a combination of ketamine and butorphanol (Torbugesic®; Fort Dodge Animal Health Ltd) were used to provide sedation. Intravenous butorphanol was used in five dogs and intravenous methadone (Synastone™; Auden Mckenzie (Pharma Division) Ltd) and midazolam in three dogs to provide sedation. General anaesthesia was performed in two cats and one dog to allow concurrent surgical or diagnostic procedures including castration (one cat), placement of an oesophageal tube (one cat) and computed tomography (one dog). One dog was manually restrained without sedation on two separate occasions to allow the placement of a chest drain, which was tolerated very well. Local anaesthesia was not used in any patients for placement.

Chest drains were placed by a number of different veterinary surgeons with varying

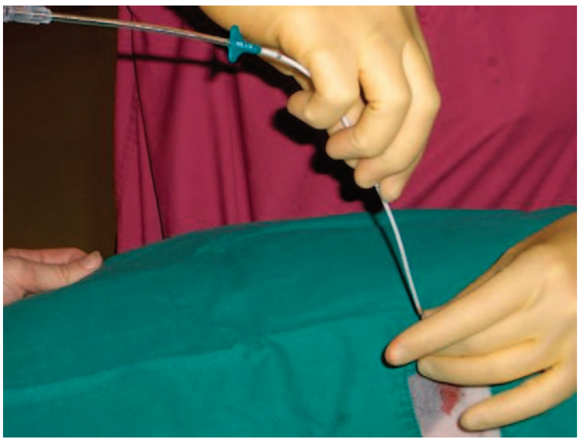

FIG 4. Insertion of the chest drain into the thoracic cavity over the guide wire

FIG 5. Accurate placement of the drain is assessed by gentle aspiration of fluid

levels of experience and training (including new graduated interns). Twenty-five of 29 chest drains were inserted at the first attempt. Two chest drains required a second attempt at placement as they were malpositioned in the thorax, one needed three attempts as there was soft tissue scarring and swelling associated with a previous thoracotomy incision and one needed replacement as the soft tissue tunnel created by the 14 gauge insertion needle was not large enough to allow introduction of the drain.

Eleven drains took less than five minutes for their insertion, 13 took between five and 10 minutes and five took greater than 10 minutes.

Complications were encountered during chest drain placement in eight animals. Pneumothorax was seen in eight animals that had not been presented for pneumothorax (mild in seven cases and moderate in one). The diagnosis of pneumothorax was made in the majority of cases by aspiration of air through the chest drain after placement. In one case, thoracic radiographs confirmed the presence of a moderate unilateral pneumothorax on the same side as the chest drain was placed. The pneumothoraces resolved after the first drainage in seven animals; the remaining case showed complete resolution without further intervention in two days.

Complications were reported during use of five drains. In four drains, the complications were functional; kinking (two) and malpositioning (two), both pointing caudally rather than cranially, leading to an inability to evacuate the pleural space, and one drain was accidentally removed by the animal.

The median length of time the drain was in use was three days (one to 13 days) (Fig 7).

Of the 29 drains that were placed, six chest drains were removed after one day because of functional complications including malpositioning (2 of 29 drains) and kinking (1 of 29 drains) of the drains; two of them were removed from one patient as the animal was euthanased because of poor prognosis of the underlying disease (idiopathic chylothorax) (one of these two drains was also malpositioned) and one drain was accidentally removed by the animal. Three of the 29 drains were removed after one day because the animals underwent surgical investigation for their underlying disease processes and the small-bore chest drain was changed for a wide-bore surgically placed drain at this time. The timing for the other chest drains' removal (20 of 29 drains) was dependant on clinician preference but was usually because of resolution of the underlying disease.

The clinicians' opinion on placement was rated as "easy" for 27 drains and "not easy" for two drains. The overall function was assessed to be "good" in 24 drains, "acceptable" for one drain and "poor" for four drains.

DISCUSSION

This study demonstrates that small-bore chest drains are effective for the management of pleural space disease.

In human medicine, the use of small-bore chest drains has gained interest recently. Despite the lack of randomised controlled trials evaluating the efficacy of small-bore tubes, there has been a movement towards the use of smaller catheters inserted by a modified Seldinger technique from placement by blunt dissection (Parulekar and others 2001, Laws and others 2003, Horsley and others 2006).

We found that the modified Seldinger technique was straightforward and allowed clinicians with different levels of veterinary experience to successfully insert a chest drain to address pleural space disease.

Few complications were noted at insertion, pneumothorax being the most

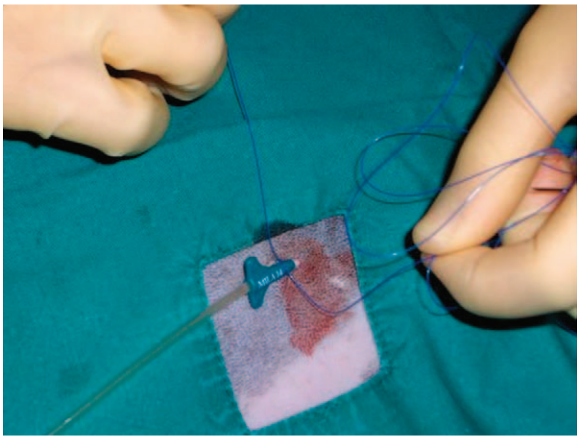

FIG 6. The chest drain is secured to the skin through the suture holes on the catheter

Table 1. Summary of clinical data for the cases included in the study

	Signalment	Number of drains	Diseases	Complications during placement	Complication during use	Opinion on placement	Opinion on function	Outcome
Case 1	DSH, Fn 5 years	2	Pyothorax	Pneumothorax	Kinked and unable to drain	Easy	Poor	Resolution of pleural space disease
				None	None	Easy	Good	
Case 2	DSH, Fn 3 years	2	Pyothorax	Pneumothorax	None	Easy	Good	Resolution of pleural space disease
				None	None	Easy	Good	
Case 3	DSH, Mn 2 years	2	Pyothorax	None	Removed by animal	Easy	Acceptable	Resolution of pleural space disease
				None	None	Easy	Good	
Case 4	DSH, Mn 9 years	2	Pyothorax	Pneumothorax	None	Easy	Good	Resolution of pleural space disease
				None	None	Easy	Good	
Case 5	DSH, Mn 8 months	1	Pyothorax	None	None	Easy	Good	Exploratory thoracotomy
Case 6	Persian, Me 5 years	2	Pyothorax	Pneumothorax	None	Easy	Good	Resolution of pleural space disease
				None	Malpositioned and unable to drain	Easy	Poor	
Case 7	Persian, Fn 9 years	2	Pyothorax	None	None	Easy	Good	Resolution of pleural space disease
				Pneumothorax	None	Easy	Good	
Case 8	DSH, Fn 5 years	1	Chylothorax	Pneumothorax	Marked skin scar around eighth to ninth IC, so difficult to place it in the correct IC	Not very easy	Good	Resolution of pleural space disease
Case 9	DLH, Mn 12 years	1	Pleural effusion of malignancy	None	None	Easy	Good	Resolution of pleural space disease
Case 10	DSH, Mn 12 years	1	Pyothorax	None	Kinked and unable to drain	Not very easy	Poor	Non-resolution of pleural space disease
Case 11	Border collie, Fn 12 years	1	Haemothorax	None	None	Easy	Good	Resolution of pleural space disease
Case 12	Crossbreed, Me 2 years	1	Pneumothorax (traumatic)	None	None	Easy	Good	Resolution of pleural space disease
Case 13	Jack Russell, Fn 2 years	1	Spontaneous pneumothorax	None	None	Easy	Good	Exploratory thoracotomy
Case 14	Labrador, Fn 2·5 years	2	Pyothorax	None	None	Easy	Good	Resolution of pleural space disease
				None	None	Easy	Good	
Case 15a	Flat coated retriever, Me 10 months	1	Pyothorax after surgery	None	None	Easy	Good	Resolution of pleural space disease
Case 15b	Flat coated retriever, Me 10 months	1	Pyothorax after surgery	Pneumothorax	None	Easy	Good	Resolution of pleural space disease
Case 16	Crossbreed, Fn 10 years	1	Pneumothorax following lung biopsy	None	None	Easy	Good	Resolution of pleural space disease
Case 17	Bichon frise, Me 10 months	2	Chylothorax	Pneumothorax	None	Easy	Good	Resolution of pleural space disease
				None	Malpositioned and unable to drain	Easy	Poor	
Case 18	German shorthaired pointer, Mn 2 years	1	Traumatic pneumothorax	None	None	Easy	Good	Resolution of pleural space disease
Case 19	Golden retriever, Fn 1year	1	Haemothorax	None	None	Easy	Good	Resolution of pleural space disease
Case 20	Golden retriever, Mn 4 years	1	Spontaneous pneumothorax	None	None	Easy	Good	Exploratory thoracotomy

DSH Domestic short hair, Fn Female neutered, Mn Male neutered, Me Male entire, DLH Domestic long hair, IC Intercostal space

commonly encountered. Pneumothorax was observed in eight animals but was typically mild; it was drained immediately through the chest drain in situ and did not require further intervention. The finding of a mild pneumothorax is not unexpected after placement of a chest drain (either large bore or small bore) and is probably secondary to air entry during the placement.

These minor complications are in contrast to those seen reported with the use of large-bore chest drain inserted through blunt dissection (lung laceration, laceration of the coronary vessels and development of pericardial effusion) (Dugdale 2000).

Our findings are similar to those seen with the use of this technique in human medicine where most complications are mild (mild pneumothorax, emphysema and wound site bleeding) when compared with the use of large-bore chest drains (Horsley and others 2006, Davies and others 2008).

In human medicine, small-bore-modified Seldinger-placed chest drains are also associated with lower rates of infectious complications when compared with large-bore chest drain (Chan and others 1997, Horsley and others 2006, Ball and others 2007, Davies and others 2008). No cases of iatrogenic pyothorax secondary to drain placement were noted in our study, although this may be a reflection of the low numbers of animals included.

The use of small-bore chest drains to treat pleural space disease is a relatively new concept in veterinary practice. Previous recommendations on the use of thoracostomy tubes state that the tube should be

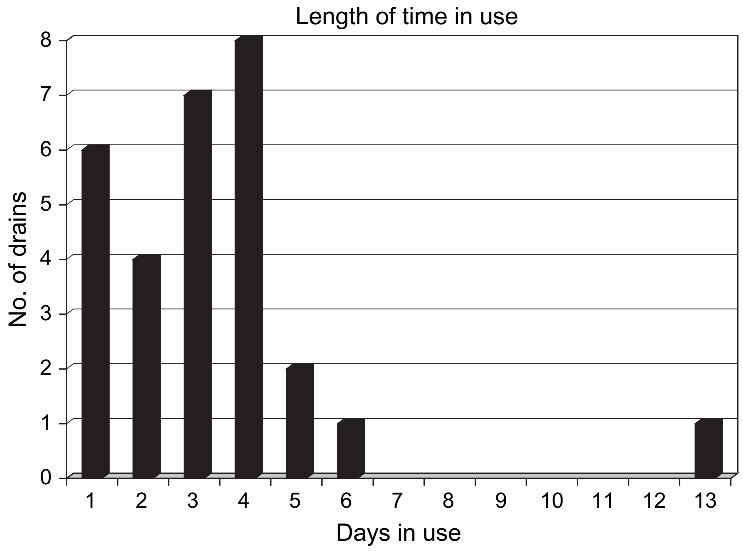

FIG 7. Length of time of chest drain use

approximately equal in diameter to the main stem bronchus and that the underlying disease should also be considered, with malignant and infectious effusions requiring larger chest drains (Tillson 1997b). Typically, 16 to 24 French drains are recommended for dogs and cats. The literature regarding morbidity and mortality associated with the use of chest drains is limited in veterinary medicine.

The main problems associated with use of small-bore chest drains in human medicine are a failure to drain, secondary to dislodgement and blockage of the drain (Horsley and others 2006). This occurs in 21 per cent of cases compared with 0·2 to 6 per cent rate in large-bore chest drains (Davies and others 2008). Regular flushing of the drain with sterile saline has been shown to decrease the incidence of drain blockage (Davies and others 2008).

In our study, the most common complication reported was failure of the chest drain to drain as a result of kinking or malpositioning. Obstruction of the drain by fluid or fibrin clot was not encountered, despite the fact that many of the drains were used to manage pyothorax.

In this case series, no cases had a chest drain replaced following removal of a drain for poor function. In one of these cases, there was lack of resolution of the pleural space disease, but for financial reasons, the owner decided to treat the cat with antibiotics and not to replace the drain. Another case was euthanased the same day because of his underline disease and in two other cases the presence of a functioning drain in the other hemithorax allowed ongoing management and resolution of the pleural space disease.

An interesting difference when comparing these data with those published in the human literature was the efficacy of these drains in animals with pyothorax (Horsley and others 2006, Davies and others 2008). In people, larger bore chest drains (14 to 24 French) are recommended in cases of empyema as small-bore chest drains have been reported to be associated with the highest rate of complication because of blockage (Laws and others 2003). In one study, if empyema cases were excluded, the rate of drain blockage dropped from 15 to 9·5 per cent (Horsley and others 2006). Ten animals with pyothorax were treated in this study, totalling 18 chest drains, and obstruction of these drains was not encountered. It is likely that the low "blockage" rate in this study was related to management strategies used in animals with pyothorax within our hospital. Typically, animals with pyothorax have their thoracic cavities lavaged two to six times a day with sterile saline depending on the severity of the pyothorax. This is probably sufficient to avoid blockage of the drain.

No serious complications were encountered during placement or use of these drains, although only a relatively low number of animals were included. As the complication rate was low, it was not possible to evaluate for risk factors for complications such as the experience of the veterinary surgeon performing the technique, although this information was collected in the data collection sheet.

Direct comparison of the use of small-bore chest drains with large-bore chest drains in veterinary practice is hindered by a lack of comparable studies. A limitation of this study is the lack of a direct comparison group. The aim of this study was to prospectively evaluate the use of a small-bore wire-guided chest drain in a patient population requiring chest drain placement. These animals often have a higher anaesthetic risk as a result of their underlying disease process, and as such, we were interested in evaluating a technique that was easy to use in these animals without the requirement for anaesthesia. As such, it was difficult to argue for a comparison group of patients having large-bore chest drains placed as these typically require anaesthesia for placement.

This technique and catheter have several advantages over the other techniques for placement and types of drains in use. Anaesthesia was not required unless other procedures were required and most animals tolerated placement with sedation, minimally trained personnel were able to place the drain without problems, insertion was quick even with inexperienced operators and the drain worked well in a number of disease processes.

Observational data in human patients suggest that smaller bore drains are less painful and better tolerated by patients (Clementsen and others 1998). Although not directly evaluated in the questionnaire, retrospective review of patient's records revealed that animals with small-bore chest drains required less opioid analgesia and subjectively appeared more comfortable than those with large-bore chest drains placed for management of non-surgical disease.

There is no simple method of predicting whether pleural space disease will be successfully managed through a small-bore catheter. Our experience with these chest drains suggests that they are associated with few insertional complications, they are easy to insert and effective in a variety of pleural space diseases and they are also well tolerated by patients. Small-bore wire-guided chest drains are quick to place, and because of their relatively larger size and multiple fenestrations, thoracic evacuation is quick compared with needle thoracocentesis; they can therefore be used as initial therapy to stabilise dyspnoeic patients and for ongoing management of pleural space disease. If the technique fails to achieve resolution of the disease or if any complications arise, then an alternative approach may be used.

Conclusions

Small-bore drains are safe to insert, and the modified Seldinger technique offers a low rate of complications associated with insertion and use. The procedure is well tolerated by animals and requires only minimal sedation. Small-bore guide-wire chest drains should be considered as an alternative to large-bore chest drains in the treatment of pleural space disease.

References

Ball, C. G., Lord, J., Laupland, K. B., Gmora, S., Mulloy, R. H., King, A., Schieman, C. & Kirkpatrick, A. W. (2007) Chest tube complications: how well are we training our residents? *Canadian Journal of Surgery* **50**, 450-458

Barrs, V. R., Allan, G. S., Martin, P., Beatty, J. A. & Malik, R. (2005) Feline pyothorax: a retrospective study of 27 cases in Australia. *Journal of Feline Medicine and Surgery* **7**, 211-222

Chan, L., Reilly, K. M., Henderson, C., Khan, F. & Salluzzo, R. F. (1997) Complication rates of tube thoracostomy. *American Journal of Emergency Medicine* **15**, 368-370

Clementsen, P., Evald, T., Grode, G., Hansen, M., Jacobsen, K. G. & Faurschou, P. (1998) Treatment of malignant pleural effusion: pleurodesis using a small percutaneous catheter. A prospective randomized study. *Respiratory Medicine* **92**, 593-596

Collop, N. A., Kim, S. K. & Sahn, S. A. (1997) Analysis of tube thoracostomy performed by pulmonologists at a teaching hospital. *Chest* **112**, 709-713

Davies, H. E., Merchant, S. & McGown, A. (2008) A study of the complications of small bore 'Seldinger' intercostal chest drains. *Respirology* **13**, 603-607

Demetriou, J. L., Foale, R. D., Ladlow, J., McGrotty, Y., Faulkner, J. & Kirby, B. M. (2002) Canine and feline pyothorax: a retrospective study of 50 cases in the UK and Ireland. *Journal of Small Animal Practice* **43**, 388-394

Dugdale, A. (2000) Chest drains and drainage techniques. *In Practice* **22**, 2-15

Horsley, A., Jones, L., White, J. & Henry, M. (2006) Efficacy and complications of small bore, wire guided chest drains. *Chest* **130**, 1857-1863

Hyde, J., Sykes, T. & Graham, T. (1997) Reducing morbidity from chest drains. *British Medical Journal* **311**, 914-915

Khan, S. A. (2007) Thoracostomy tube placement in the dog. *Laboratory Animals (NY)* **36**, 21-24

Laws, D., Neville, E. & Duffy, J. (2003) BTS guidelines for the insertion of a chest drain. *Thorax* **58**, 53-59

Moores, A. L., Halfacree, Z. J., Baines, S. J. & Lipscomb, V. J. (2007) Indications, outcomes and complications following lateral thoracotomy in dogs and cats. *Journal of Small Animal Practice* **48**, 695-698

Parulekar, W., DiPrimo, G., Matzinger, F., Dennie, C. & Bociek, G. (2001) Use of small-bore vs large-bore chest tubes for treatment of malignant pleural effusions. *Chest* **120**, 19-25

Sigrist, N. E. (2008) Thoracostomy tube placement and drainage. In: Small Animal Critical Care Medicine. Eds D. Silverstein & K. Hopper, Elsevier Saunders, St. Louis, MO, USA. pp 134-137

Tattersall, J. A. & Welsh, E. (2006) Factor influencing the short-term outcome following thoracic surgery in 98 dogs. *Journal of Small Animal Practice* **47**, 715-720

Tillson, D. M. (1997a) Thoracostomy tubes. Part I. Indications and anesthesia. *Compendium Continuing Education for the Practising Veterinarian* **19**, 1258-1263

Tillson, D. M. (1997b) Thoracostomy tubes. Part II. Placement and maintenance. *Compendium Continuing Education for the Practising Veterinarian* **19**, 1331-1337

Waddell, L. S., Brady, C. A. & Drobatz, K. J. (2002) Risk factors, prognostic indicators, and outcome of pyothorax in cats: 80 cases (1986–1999). *Journal of the American Veterinary Medical Association* **221**, 819-824

APPENDIX 1

Questionnaire for prospective evaluation of thoracic catheter placed through modified Seldinger technique

Date and time ______________________________

Animal's name______________________________

Hospital number ________________________

Disease or condition_____________________

Reason for placing		**Removal date**	
Where placed	☐ ICU ☐ Theatre ☐ Wards ☐ Endoscopy	**Why removed**	☐ Accidental ☐ Planned ☐ Animal improved ☐ Animal dead
The animal requires	☐ Sedation (which drugs______________________ ______________) ☐ Anaesthesia ☐ Manual restrained	**Opinion on placement of the catheter**	☐ Easy ☐ Difficult Comments:
Number of attempt of placement			
Time for the placement		**Opinion on function of the catheter**	☐ Good ☐ Poor Comments:
Complication during the insertion	☐ Pneumothorax ☐ Haemothorax ☐ Other______________		
Length of time in use		**Any other comments**	
Complication during its use	☐ Accidental removal ☐ Dislodgement ☐ Haemothorax ☐ Pneumothorax ☐ Patient uncomfortable ☐ Catheter is kinked ☐ Unable to drain ☐ Pyrexia		