Clinical audit

A regional survey of chest drains: evidence-based practice?

Augustine Tang, Timothy Hooper, Ragheb Hasan

Department of
Cardiothoracic
Surgery, Wythenshawe
Hospital, Manchester
M23 9LT, UK
A Tang
T Hooper

Department of
Cardiothoracic
Surgery, Manchester
Royal Infirmary,
Oxford Road,
Manchester M13 9WL,
UK
R Hasan

Correspondence to
Mr Augustine Tang,
Department of
Cardiothoracic Surgery,
Wessex Regional Thoracic &
Cardiac Unit, Southampton
General Hospital, Tremona
Road, Southampton SO16
6AQ, UK

Accepted 16 April 1999

Summary

Although the use of chest drains is common in medicine, there appear to be wide variations in practice. A survey was therefore conducted to establish the current status of chest drain management in the Northwest region. A questionnaire targeted consultants practising in the specialties of chest medicine, general surgery, accident & emergency and cardiothoracic surgery. The questionnaire consisted of five sections encompassing aspects of the insertion, day-to-day care and removal of chest drains. With an overall response rate of 75.3% (110/146), important variations in every major aspect of the practice of chest drains were found between the specialties and to a large extent within each specialty. We have made a number of recommendations which aim to encourage good practice and reduce unnecessary complications, including the adoption of standardised protocols for inserting and managing chest drains.

Keywords: chest drains; clinical audit

Intercostal chest drains are commonly used to manage a variety of thoracic conditions by doctors working in different specialties. Safe practice requires an understanding of the anatomy, physiology, and pathology of the pleural space and a working knowledge of the physics of vacuum and air flow.¹ Complications are more likely to develop if chest drains are used without appropriate knowledge and skill. Among the patients referred to our cardiothoracic surgical practice for management of complications arising from pre-existing chest drains, we have observed wide variations in many aspects of the management of such drains prior to referral. This may reflect the different spectrums of thoracic conditions encountered by clinicians in different specialties, and varying levels of experience in intercostal drainage. However, random observations made in our everyday practice suggested that even when a chest drain was used for a common indication such as drainage of closed pneumothorax, there seemed to be no consensus on the major issues regarding management of the drain. Furthermore, there appeared to be a general lack of unified guidance on the techniques of inserting chest drains. Consequently, many decisions on the practice of chest drains tend to be based more on personal factors than sound clinical evidence. We have therefore conducted a survey of current practice amongst consultants working in different specialties in the Northwest region.

Materials and methods

A questionnaire on various aspects of the insertion and management of chest drains (box 1) was sent to all consultants practising in the specialties of Chest Medicine (CM), General Surgery (GS), Accident & Emergency (A&E) and Cardiothoracic Surgery (CTS) in the Northwest region. Closed-ended questions with the options of yes (Y), no (N), and abstention (A) were used whenever possible to simplify subsequent analysis of collated data. Questions were carefully worded so as to minimise misinterpretations.

Results were collated, analysed and presented according to the specialties. Each category of responses is expressed as a percentage of the total number of responders. For close-ended questions, analysis was performed using Pearson Chi Square test to compare the proportions of positive replies (Y). Statistical significance was considered when $p < 0.05$. Data from open-ended questions were tested

Survey on the management of chest drains

Name: _____ Hospital: _____ Specialty: _____

A Indications for using a chest drain:

1 Do you have a unit/hospital policy or guidelines on the use of chest drains?	Y/N
2 If a drain is indicated for a pneumothorax, do you routinely place it apically?	Y/N
3 If a drain is required to evacuate pleural fluid, do you routinely place it basally?	Y/N
4 Have you found ultrasound guidance helpful in draining loculated fluid collection?	Y/N

B Techniques of inserting a chest drain:

1 Do you bluntly dissect through chest wall and pleura before inserting a drain?	Y/N
2 Do you create a subcutaneous tunnel for the passage of the drain?	Y/N
3 Do you puncture the pleura using the drain-trocar?	Y/N

C Care of an indwelling chest drain:

1 Do you routinely prescribe prophylactic antibiotics for an indwelling drain?	Y/N
2 Do you routinely apply suction drainage to evacuate a pneumothorax?	Y/N
3 What is your preferred suction pressure (in cm water)?	—

D Indications for removing an indwelling chest drain:

1 When air leak stops, would you remove a drain for pneumothorax without further confirmation of lung re-expansion?	Y/N
2 Do you routinely confirm lung re-expansion on chest X-ray before removing a drain for pneumothorax?	Y/N
3 What duration of persistent air leak will prompt you to take further action?	Y/N
4 How much daily drainage (ml) will you allow before removing a drain for fluid?	—

E Techniques of removing a chest drain:

1 Do you routinely apply suction to a drain while it is being removed?	Y/N
2 Do you routinely instruct the use of the Valsalva manoeuvre whilst removing a drain?	Y/N

Figure Response rates for different specialties. Dark columns represent the percentage of responders and white columns represent the total number surveyed. There was no difference between the specialties ($p > 0.05$)

for the pattern of distribution and assessed accordingly using Kruskal-Wallis test. Computations were done using statistical software (GLIM 3.77, Royal Statistical Society, London, UK) on a 486 IBM-compatible personal computer.

Results

A total of 110 consultants responded, giving a response rate of 75.3% (110/146). There was a similar response rate between the various specialties (figure). Not all responders answered every question, and some of the

results reported, mainly those requiring an open response, are based on fewer than 110 people.

INDICATIONS FOR USE

More consultants in CM and A&E had adopted formal guidelines for the management of chest drains than those in GS and CTS ($p = 0.0065$) (table 1). Consultants in CTS and GS preferred to place apical chest drains for pneumothorax more often than their counterparts in CM and A&E ($p = 0.0243$). Similarly, more consultants in CTS, GS and CM would place a basal drain to evacuate intrapleural fluid than those in A&E ($p = 0.0254$) (table 1). Consultants in CM and CTS had more experience in using ultrasound to guide the drainage of intrapleural fluid ($p = 0.00516$).

TECHNIQUES OF INSERTION

There seemed to be no major differences in the technical aspects of inserting chest drains between the four specialties (table 1), with the exception that fewer A&E consultants employed the trocar to penetrate the pleura than consultants from other specialties ($p = 0.0206$).

CARE OF CHEST DRAINS

Very few consultants prescribed prophylactic antibiotics to cover an indwelling chest drain, regardless of specialty (table 1). CTS

Table 1 Specialties of the consultant responders. Responses to sections A to C of the survey

	CTS			CM			A&E			GS				
Questions	Yes	No	Abstain	Yes	No	Abstain	Yes	No	Abstain	Yes	No	Abstain	p value	
Section A - use of drain														
Guideline on chest drains?	21.4	78.6	0.0	52.0	48.0	0.0	46.2	46.2	7.7	10.7	80.7	8.8	0.0065	
Apical drain for air?	92.9	0.0	7.1	48.0	52.0	0.0	46.2	53.8	0.0	71.4	25.0	3.6	0.0243	
Basal drain for fluid?	78.6	7.1	14.3	80.0	12.0	8.0	38.5	61.5	0.0	73.2	17.9	8.9	0.0254	
Ultrasound guidance helpful?	78.6	14.3	7.1	88.0	8.0	4.0	30.8	46.2	23.1	50.0	31.6	17.5	0.0052	
Section B - drain insertion														
Blunt dissection?	78.6	14.3	7.1	80.0	16.0	4.0	76.9	23.1	0.0	64.3	30.4	5.4	0.4	
Subcutaneous tunnel?	28.6	64.3	7.1	12.0	80.0	8.0	7.7	92.3	0.0	16.1	80.4	3.6	0.4	
Trocar puncture of pleura?	57.1	35.7	7.1	68.0	28.0	4.0	23.1	76.9	0.0	41.1	55.4	3.6	0.0206	
Section C - care of indwelling drain														
Prophylactic antibiotics?	14.3	78.6	7.1	0.0	100.0	0.0	0.0	100.0	0.0	7.1	89.5	3.5	0.183	
Suction for pneumothorax?	64.3	28.6	7.1	0.0	100.0	0.0	0.0	92.3	7.7	3.6	92.9	3.6	<0.001	
Suction pressure (cm water)*	18.3 +/- 3.9 (64.3%)			5 (4%)			No response (0%)			20 (1.8%)			NA	

Results are expressed as percentages of those who responded per specialty. CTS = Cardiothoracic Surgery, CM = Chest Medicine, A&E = Accident and Emergency, GS = General Surgery.

*Results are expressed as mean +/- SEM per specialty and numbers in brackets indicate the response rates; NA = not applicable. The p values relate to comparisons of positive responses (Yes) between the specialties.

Table 2 Specialties of the consultant responders. Responses to sections D and E of the survey

	CTS			CM			A&E			GS				
Questions	Yes	No	Abstain	Yes	No	Abstain	Yes	No	Abstain	Yes	No	Abstain	p value	
Section D - drain removal														
Further confirmation after air leak stops?	35.7	57.1	7.1	28.0	72.0	0.0	0.0	53.8	46.2	7.1	87.5	5.4	0.009	
Routine chest radiograph?	14.3	78.6	7.1	36.0	64.0	0.0	38.5	7.7	38.5	78.6	17.9	3.6	<0.001	
Duration (days) of air leak to prompt further action?*	9.6 +/- 1.5 (78.6%)			5.8 +/- 0.6 (96.0%)			1+/-1 (15.4%)			4.7 +/- 0.4 (70.2%)			0.001	
Daily drainage (ml) allowed before drain removal*	98.9 +/- 22.5 (85.7%)			83.4 +/- 11.5 (68%)			86.7 +/- 41 (23.1%)			69+/-8.6 (63.2%)			0.35	
Section E - drain removal technique														
Suction during removal?	28.6	57.1	14.3	4.0	96.0	0.0	0.0	46.2	53.8	10.7	83.9	5.4	0.05	
Valsalva manoeuvre?	57.1	28.6	14.3	36.0	64.0	0.0	23.1	23.1	53.8	69.6	26.8	3.6	0.02	

Results are expressed as percentages of those who responded per specialty. CTS = Cardiothoracic Surgery, CM = Chest Medicine, A&E = Accident and Emergency, GS = General Surgery.

*Results are expressed as mean +/- SEM per specialty and numbers in brackets indicate the response rates. The p values relate to comparisons of positive responses (Yes) between the specialties.

consultants applied suction to evacuate a pneumothorax much more readily than their colleagues in the other specialties ($p < 0.001$) and the most frequently used suction pressure was between 15 and 20 mmHg (table 1).

INDICATIONS FOR REMOVAL

Most consultants chose not to remove an indwelling chest drain for pneumothorax purely on the basis of cessation of bubbling through the underwater seal, regardless of specialty (table 2), although, unlike their counterparts, most GS consultants preferred routine chest X-ray confirmation of resolution before removing the drain ($p < 0.001$). Consultants in CTS and CM allowed for a longer duration of air-leak before considering further intervention compared to those in GS and A&E ($p = 0.001$) (table 2). There was no difference between the specialties in terms of the maximum volume of daily drainage which the consultants would allow before removing a drain for fluid (table 2).

REMOVAL TECHNIQUES

The majority of consultants did not employ suction routinely while removing a drain although there was a tendency for suction to be more popular among those in CTS ($p = 0.05$) (table 2). More consultants in CTS and GS preferred the Valsalva manoeuvre during drain removal than their counterparts in CM and A&E ($p = 0.02$) (table 2).

Discussion

Guidelines are normally composed by experts to enable the less experienced to adopt a good and safe standard of practice. With regard to the use of chest drains, the various specialties targeted in the survey have adopted unit policy or guidelines to different extents. This may reflect local and individual differences in the attitude towards medicolegal, training and case-load implications arising from the use of such guidelines.

There has been much debate over the importance of siting an 'apical' chest drain to evacuate air and a 'basal' one for fluid as reflected by the findings of this survey. In general it is accepted that a drain of appropriate calibre (28 French gauge or larger for blood and 24 French gauge or larger for air and effusion) placed in any position in the pleural cavity should restore negative pressure and re-expansion of the lung, expelling excess intrapleural air or fluid.² However, accurate positioning of the tip of the drain following insertion may expedite the process, particularly for loculated collections. Therefore it is often suggested that chest drains should be directed cephalad for the evacuation of free air and postero-basally for the drainage of fluid. During thoracotomy, there is additional opportunity for a right-angled drain to be directed toward the costophrenic angle so long as one avoids possible occlusion by diaphragmatic movements.¹ Our findings indicated that radiologically guided drainage of the pleural space was valued more by specialists in CM and

CTS. This may reflect their greater experience in managing patients with loculated intrapleural collections, such as localised empyema and malignant effusion, which can be drained more effectively under the guidance of fluoroscopy, ultrasound or computed tomography scanning.^{3,4}

There is still much disagreement over which technique is ideally suited for inserting a chest drain. This perhaps indicates that any chosen technique has its inherent advantages and shortcomings and a didactic approach would not satisfy every clinical scenario.¹ It has been suggested that using a trocar to gain access to the pleural cavity can render the procedure dangerous.⁵ Perhaps a safer approach is to make a thoracostomy through an incision and with blunt dissection to create a tract large enough to admit a finger so that the pleural cavity can be palpated prior to the passage of a drain through the opening. This minimises the likelihood of iatrogenic complications such as penetration of various thoracic⁶⁻¹⁰ and abdominal structures¹¹ and is especially useful in trauma situations. Consequently this technique has been advocated by the advanced trauma life support course¹² and may account for the lower preference of using trocar penetration of the pleura among consultants practising in A&E. However, the dissection involved in this approach can produce more pain and since the tract is larger than the drain, leakage of pleural content may occur and nosocomial infection may result.¹ An astute clinician must therefore consider both the positive and negative attributes of a technique in every case. It has recently been highlighted that using appropriate equipment, including a pair of metal artery forceps, would further reduce morbidity from inserting chest drains.² This may apply particularly to hospital wards and accident and emergency departments where such fundamental items may not be available.

Intrathoracic infections, including empyema and pneumonia, are known to be encouraged by the presence of an indwelling chest drain.^{13,14} However, the efficacy of antibiotics given as prophylaxis against such complications has not been substantiated,^{13,15,16} although there is some evidence of benefits in patients who presented with penetrating chest trauma.¹³ It is perhaps not surprising therefore that very few responders to our survey routinely prescribed prophylactic antibiotics while a chest drain was in place.

There are significant differences between individuals and specialties in the use of suction drainage to evacuate intrapleural air. Our findings may reflect a greater experience of suction in cardiothoracic surgical practice. The advantages of closed suction drainage have been demonstrated, including quicker resolution of pneumothorax, shorter duration of chest drainage and hence hospital stay.^{17,18} However, there is no agreement as to how much suction should be used. Some proposed high-pressure suction (-40 cmH₂O)¹⁹ whereas others favoured a more conservative approach (-10 cmH₂O).²⁰ The most commonly used suction pressure has been reported as -20 cmH₂O,¹ which agrees

with our findings. We wish to emphasize the importance of avoiding potential pitfalls in suction drainage relating to either inadequate²⁰ or excessive air flow²¹ through the system. If there is not enough flow through the system preventing lung expansion, the patient may be prone to developing atelectasis, tension pneumothorax, fluid accumulation or infection.²⁰ On the other hand, too much flow may perpetuate existing air leaks, increase air stealing leading to hypoxia²¹ and excessive suction may on rare occasions trap portions of lung in the drain.²² These problems may be compounded by the inexperience of the users.

Our findings exposed significant variations in the criteria used by different individuals and specialties for removing an indwelling chest drain inserted to evacuate intrapleural air. This may reflect the different emphasis being placed on the relative importance of the clinical, radiological and drainage signs of a resolved pneumothorax. There were also important differences in what was being regarded as persistent air leakage which requires further intervention. Although early intervention has been shown to benefit those with serious underlying lung pathology,²³ persistent air leakage *per se* is not an absolute indication for surgery. The essence of managing pneumothoraces is to ensure progressive and adequate lung re-expansion with regular monitoring by chest radiographs. The mere presence of a chest drain and bubbling in the water seal are not sufficient indicators of adequate treatment. Prolonged lung deflation in the presence of an indwelling chest drain provides the ideal environment in which complications such as empyema and cortex formation of the deflated lung may supervene.

A not infrequent complication which may follow the removal of an indwelling chest drain is recurrent pneumothorax caused by move-

Learning/summary points

- chest drains are used frequently and widely but not always correctly, thus risking the development of serious complications
- to minimise complications, we recommend safe standards of practice: insert drain without trocar after adequate dissection; use radiological guidance to drain loculated collections; provide antimicrobial prophylaxis in penetrating trauma; evacuate pneumothorax with high-volume, low-pressure (-20 cmH₂O) continuous suction; closely monitor re-expansion of lung and remove drain with Valsalva manoeuvre applied
- if in doubt, seek specialist advice early

Box 2

ment of atmospheric air into the pleural cavity.¹⁸ This is more likely to occur if the patient breathes in while a drain is being removed. Both the Valsalva manoeuvre and the use of continuous suction during drain removal may minimise the risk of air entering the pleural cavity. Although evidence suggests that most recurrent pneumothoraces spontaneously resolve without complications,²⁴ one cannot reliably identify those who may need further intervention. Therefore we advocate the above manoeuvres as effective measures to minimise the risk of an avoidable complication following drain removal.

In conclusion, the findings of this study demonstrate a diversity of views about the management of chest drains. Standardised protocols may minimise unnecessary complications, particularly for specialists less familiar with intercostal tube drainage.

We are grateful to Rocket Medical plc, Sherwood Davis & Geck, and SIMS Portex Limited for providing financial support.

- Munnell ER. Thoracic drainage. *Ann Thorac Surg* 1997;**63**:1497–502.
- Hyde J, Sykes T, Graham T. Reducing morbidity from chest drains. *BMJ* 1997;**314**:914–5.
- Silverman SG, Mueller PR, Saini S, et al. Thoracic empyema: management with image-guided catheter drainage. *Radiology* 1988;**169**:5–9.
- Klein JS. Thoracic intervention. *Curr Opin Radiol* 1992;**4**:94–103.
- Treasure T, Murphy JP. Pneumothorax. *Surgery* 1989;**75**:1780–6.
- Casillas JA, de la Fuente A. Right atrium perforation by a pleural drain. Report of a case with survival. *Thorac Cardiovasc Surg* 1983;**31**:247–8.
- De la Fuente A, Sanchez R, Suarez J, Sarraj A, Moriones I. Left ventricular perforation by a pleural tube. *Tex Heart Inst J* 1994;**21**:175–6.
- Eriksson A. Fatal iatrogenic exsanguination from pleural drain insertion into the inferior vena. *Thorac Cardiovasc Surg* 1982;**30**:191–3.
- Koutras P, Kwon V, Holland RH, Webb WR. An unusual cause of perforation of the aorta. *Ann Thorac Surg* 1969;**8**:575–9.
- Moessinger AC, Driscoll JMJ, Wigger HJ. High incidence of lung perforation by chest tube in neonatal pneumothorax. *J Pediatr* 1978;**92**:635–7.
- Symbas PN. Chest tube drainage. *Surg Clin North Am* 1989;**69**:41–6.
- Trauma ACoSCo. *Thoracic trauma. Advanced trauma life support program for physicians: instructor manual*. Chicago: American College of Surgeons, 1993.
- Nichols RL, Smith JW, Muzik AC, et al. Preventive antibiotic usage in traumatic thoracic injuries requiring closed tube thoracostomy. *Chest* 1994;**106**:1493–8.
- Simpson AJ, Das SS, Tabaqchali S. Nosocomial empyema caused by *Clostridium difficile*. *J Clin Pathol* 1996;**49**:172–3.
- Demetriades D, Breckon V, Breckon C, et al. Antibiotic prophylaxis in penetrating injuries of the chest. *Ann R Coll Surg Engl* 1991;**73**:348–51.
- LeBlanc KA, Tucker WY. Prophylactic antibiotics and closed tube thoracostomy. *Surg Gynecol Obstet* 1985;**160**:259–63.
- Howe BEJ. Evaluation of chest suction with artificial thorax. *Surg Forum* 1952;**2**:1–7.
- Davis JW, Mackersie RC, Hoyt DB, Garcia J. Randomized study of algorithms for discontinuing tube thoracostomy drainage. *J Am Coll Surg* 1994;**179**:553–7.
- Roe BB. Physiological principles of drainage of the pleural space. *Am J Surg* 1958;**96**:246–53.
- Perkins R. Early management of the pleural space following partial pulmonary resection. *Am Surg* 1957;**23**:555–67.
- Pierson DJ. Persistent bronchopleural air leak during mechanical ventilation: a review. *Respir Care* 1982;**27**:408–15.
- Stahley TL, Tench WD. Lung entrapment and infarction by chest tube suction. *Radiology* 1977;**122**:307–9.
- Schoenenberger RA, Haefeli WE, Weiss P, Ritz R. Evaluation of conventional chest tube therapy for iatrogenic pneumothorax. *Chest* 1993;**104**:1770–2.
- Schmidt A, Mouton W, Ris HB. [Residual postoperative pneumothorax: harmless radiological finding or complication-prone diagnosis?]. *Schweiz Med Wochenschr* 1995;**125**:1391–5.