Online Appendix A4 BTS Guideline for Pleural Disease

Section A Spontaneous pneumothorax

Question A4 Evidence Review and Protocol

A4 For adults with pneumothorax, what is the optimal surgical approach when performing surgery?

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Question Evidence Review

A4 For adults with pneumothorax, what is the optimal surgical approach when performing surgery?

Background

Pneumothorax can be treated surgically, either acutely to treat a persistent air leak or prevent recurrence in patients whose initial pneumothorax has resolved. Surgery can be via thoracotomy, i.e. an open incision into the pleural cavity, or via video-assisted thoracoscopy surgery (VATS), whereby instruments are introduced into the pleural cavity via ports in the chest wall. Within these two categories, there is significant variation, particularly in the size of incision and number of ports. Both approaches allow access to the pleural space to perform bullectomy, pleurodesis or pleurectomy as required, but there may be significant differences in key outcomes. Hence, the aim of this review is to compare these two main surgical approaches for the treatment of adults with pneumothorax.

Outcomes

Pneumothorax recurrence, length of hospital stay, further treatment (pleural and surgical procedures), pain and breathlessness, duration of air leak, complications, quality of life and mortality

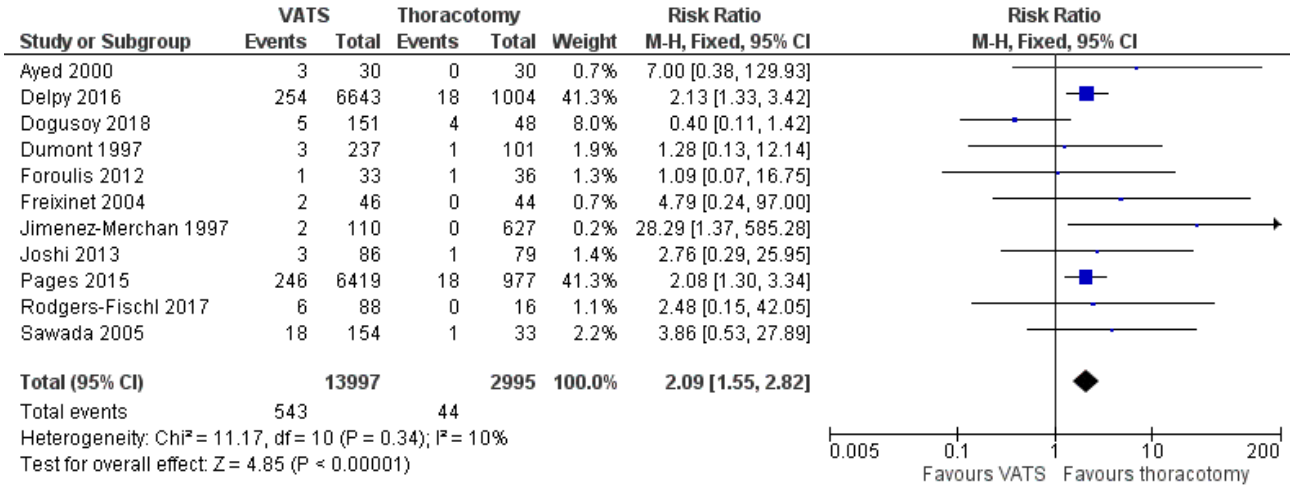
Evidence Review

Nineteen studies were initially identified in the literature search as being potentially relevant to the question and fifteen were deemed relevant to the review These included three randomised controlled trials studies[1-3], four prospective cohort studies[4-7] and eight retrospective cohort studies[8-15]. All studies compared thoracotomy and VATS, however, specific operations within these broad categories varied significantly between studies. In some studies thoracotomy included axillary mini-thoracotomy and the number of ports used in VATS studies varied.

Pneumothorax recurrence

Pneumothorax recurrence was reported in 12 studies[1-6,10-15], but one study reported no recurrence in either experimental arm (VATS and thoracotomy) and hence was excluded from the meta-analysis.[13] The resulting meta-analysis showed that risk of pneumothorax recurrence was slightly higher following VATS (31 per 1000 patients (23 to 41)) compared with thoracotomy (15 per 1000), but overall the recurrence rate was low using either surgical technique (Figure A4a).

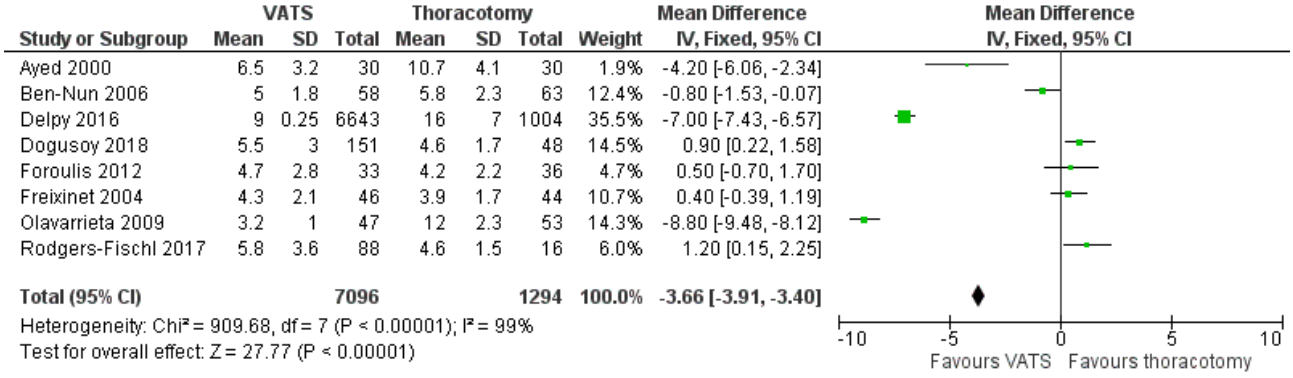
Figure A4a: Pneumothorax recurrence



Length of hospital stay

Length of post-operative hospital stay was reported in 10 studies.[1-3,5,7,9-11,13,14] Eight studies reported mean and SD data and meta-analysis showed that the length of hospital stay was 3.66 days shorter (3.40 to 3.91 days) following VATS when compared with thoracotomy for the treatment of pneumothorax in adults (Figure A4b).[1-3,9-11,13,14] Two further studies reported length of hospital stay as median data, but both studies showed no difference in length of hospital stay following VATS or thoracotomy treatment (4 days versus 6 days respectively, $p = 0.46$[5] and 4 days (range 1-26) versus 5 days (range 3-30) respectively[7]).

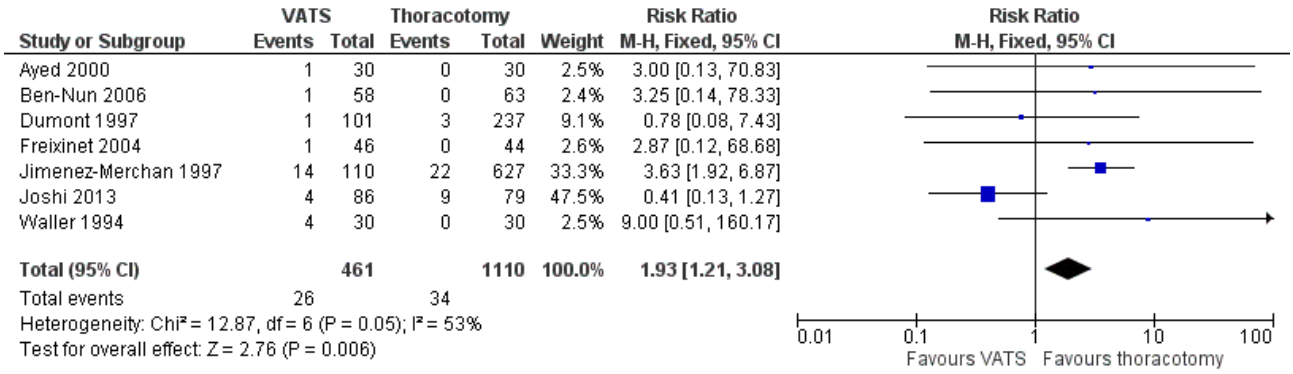
Figure A4b: Length of hospital stay



Further treatment (pleural and surgical procedures)

Seven studies reported on further treatment and meta-analysis showed that risk of need for further treatment was slightly higher for those undergoing VATS (59 per 1000 patients (37 to 94)) compared with those undergoing thoracotomy (31 per 1000) for the treatment of pneumothorax in adults.[1,3-5,7,9,12] (Figure A4c)

Figure A4c: Further treatment (pleural and surgical procedures)



Pain and breathlessness

Five studies reported on the use of post-operative analgesia and a summary of the results is shown in Table A4a.

No studies reported on breathlessness.

Duration of air leak

The duration of air leak was not reported in any study.

Table A4a: Comparison of post-operative analgesic use following video-assisted thoracoscopy surgery or thoracotomy for the treatment of pneumothorax in adults

Study	Analgesic	VATS	Thoracotomy	*p*
		Median (range)		
Waller 1994[7]	Morphine (mg)*	25 (6-65)	34 (10-60)	<0.05
Al-Qudah 1999[8]	Pethidine (mg)*	180 (120-240)	240 (180-300)	NS
		Mean ± SD		
Ayed 2000[1]	Pethidine (mg)*	67 ± 27	148 ± 24	<0.0001
Ben-Nun 2006[9]	Meperidine (mg)†	90 ± 18	265 ± 38	<0.05
Olavarrieta 2009[13]	Meperidine (mg)†	60 ± 18	295 ± 48	<0.05

* Within the first 12 hours of post-operative care

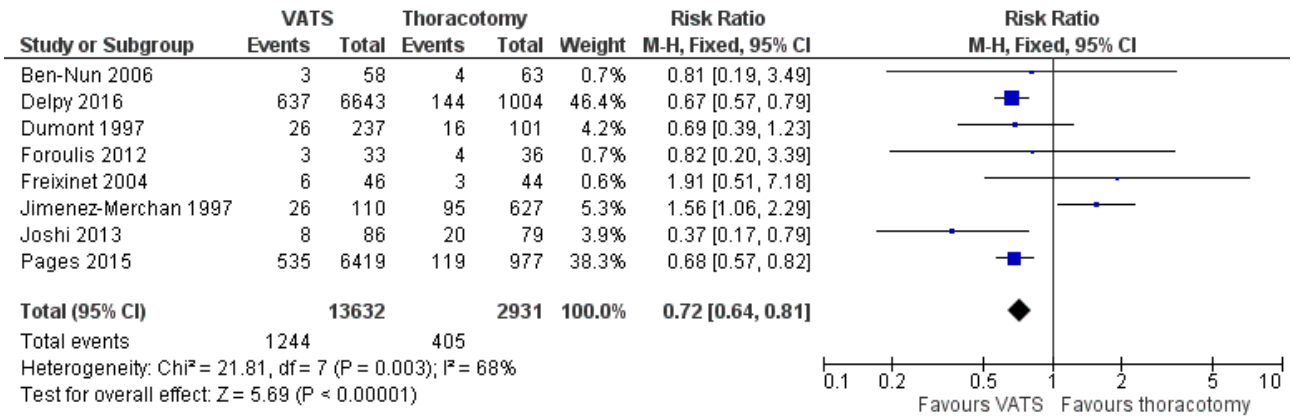
† Per day

NS – not significant; VATS – video-assisted thoracoscopy surgery

Complications

Post-operative complications were reported in nine studies[1-6,9,10,12], but again one study reported no complications in either experimental arm (VATS and thoracotomy) and was excluded from the meta-analysis[1]. Meta-analysis of the remaining eight studies showed that there was a reduced anticipated risk of complications following VATS (99 per 1000 patients (88 to 112) compared with thoracotomy (138 per 1000)). (Figure A4d)

Figure A4d: Complications



Quality of life

Quality of life was not reported in any study.

Mortality

Mortality was reported in nine studies[1,2,4,5,7,11-14], but only 1 study reported patient deaths, with 1/15 patients dying following VATS group and 2/15 patients dying following thoracotomy[7].

Evidence Statements

Pneumothorax recurrence (**Very low**) and the need for further procedures (**Very low**) appear to be slightly increased following video-assisted thoracoscopy surgery, when compared with thoracotomy, for the treatment of pneumothorax in adults, but the rate of both clinical outcomes appears to be very low following either surgical approach

Length of hospital stay (**Very low**), post-operative pain (**Ungraded**) and complications (**Very low**) appear to be reduced following video-assisted thoracoscopy surgery when compared with thoracotomy for the treatment of pneumothorax in adults

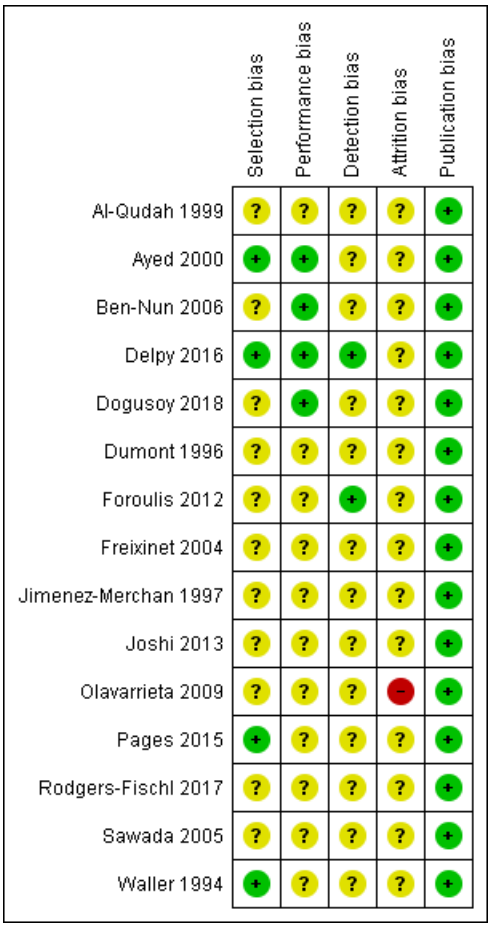
Recommendations

- Video-assisted thoracoscopy access can be considered for surgical pleurodesis in the general management of pneumothorax in adults (**Conditional**)
- Thoracotomy access and surgical pleurodesis should be considered for the lowest level of recurrence risk required for specific (e.g. high risk) occupations, but the risk of post-operative pain should be discussed with the patient (**Conditional**)

Research Recommendation

- Further research is needed to understand individual patient perceptions of recurrence risk with regards to acceptability of complications and outcomes associated with different forms of surgical access

Risk of bias summary



GRADE analyses

For adults with pneumothorax, what is the optimal surgical approach when performing surgery?

Population: Adults (18+) with pneumothorax

Intervention: Video-assisted thoracoscopy surgery (VATS)

Comparator: Thoracotomy

Outcome	Number of participants (studies)	Relative effect (95% CI)	Anticipated absolute effects		Quality of the Evidence (GRADE)
			Thoracotomy	VATS	
Recurrence	16992 (11 studies)	RR 2.09 (1.55 to 2.82)	**15 per 1000**	**31 per 1000** (23 to 41)	⨁◯◯◯ **VERY LOW** [a,b]
Further treatment	1571 (7 studies)	RR 1.93 (1.21 to 3.08)	**31 per 1000**	**59 per 1000** (37 to 94)	⨁◯◯◯ **VERY LOW** [a,b]
Complications	16563 (8 studies)	RR 0.72 (0.64 to 0.81)	**138 per 1000**	**99 per 1000** (88 to 112)	⨁◯◯◯ **VERY LOW** [a,b]

CI: Confidence interval

Explanations

a. High risk of bias across the studies
b. Serious inconsistency across the studies

For adults with pneumothorax, what is the optimal surgical approach when performing surgery?

Population: Adults (18+) with pneumothorax

Intervention: Video-assisted thoracoscopy surgery (VATS)

Comparator: Thoracotomy

Outcome	Number of participants (studies)	Estimate of effect	Quality of the Evidence (GRADE)
Length of hospital stay	8390 (8 studies)	3.66 days lower (3.44 lower to 3.91 lower) in the intervention group	⨁◯◯◯ **VERY LOW** [a,b]

Explanations

a. High risk of bias across the studies
b. Serious inconsistency across the studies

Recommendation Table

Question Details

POPULATION:	Adults (18+) with spontaneous pneumothorax undergoing surgery
INTERVENTION:	Thoracotomy (± bullectomy ± surgical pleurodesis)
COMPARISON:	Video Assisted Thoracoscopic Surgery (± bullectomy ± surgical pleurodesis)
OUTCOMES:	Pneumothorax recurrence; length of hospital stay; further treatment (pleural and surgical procedures); pain and breathlessness; duration of air leak; complications; quality of life; mortality

SUMMARY OF JUDGEMENTS

	JUDGEMENT						
PROBLEM	No	Probably no	**Probably yes**	Yes		Varies	Don't know
DESIRABLE EFFECTS	Trivial	Small	**Moderate**	Large		Varies	Don't know
UNDESIRABLE EFFECTS	Large	Moderate	**Small**	Trivial		Varies	Don't know
CERTAINTY OF EVIDENCE	**Very low**	Low	Moderate	High			No included studies
BALANCE OF EFFECTS	Favours the comparison	Probably favours the comparison	**Does not favour the intervention or the comparison**	Probably favours the intervention	Favours the intervention	Varies	Don't know

TYPE OF RECOMMENDATION

Strong recommendation against the intervention	Conditional recommendation against the intervention	**Conditional recommendation for either the intervention or the comparison**	Conditional recommendation for the intervention	Strong recommendation for the intervention
☐	☐	☒	☐	☐

CONCLUSIONS

Recommendation

Video-assisted thoracoscopy access can be considered for surgical pleurodesis in the general management of pneumothorax in adults

Thoracotomy access and surgical pleurodesis should be considered for the lowest level of recurrence risk required for specific (e.g. high risk) occupations

Justification

Pneumothorax recurrence (**Very low**) and the need for further procedures (**Very low**) appear to be slightly increased following video-assisted thoracoscopy surgery, when compared with thoracotomy, for the treatment of pneumothorax in adults, but the rate of both clinical outcomes appears to be very low following either surgical approach

Length of hospital stay (**Very low**), post-operative pain (**Ungraded**) and complications (**Very low**) appear to be reduced following video-assisted thoracoscopy surgery when compared with thoracotomy for the treatment of pneumothorax in adults

Subgroup considerations

There were no subgroups to consider

Research priorities

Further research is needed to understand individual patient perceptions of recurrence risk with regards to acceptability of complications and outcomes associated with different forms of surgical access

References

1. Ayed AK, Al-Din HJ. Video-assisted thoracoscopy versus thoracotomy for primary spontaneous pneumothorax: A randomized controlled trial. *Medical Principles and Practice.* 2000;9(2):113-118.
2. Foroulis CN, Anastasiadis K, Charokopos N, et al. A modified two-port thoracoscopic technique versus axillary minithoracotomy for the treatment of recurrent spontaneous pneumothorax: A prospective randomized study. *Surgical Endoscopy.* 2012;26(3):607-614.
3. Freixinet JL, Canalis E, Julia G, Rodriguez P, Santana N, De Castro FR. Axillary thoracotomy versus videothoracoscopy for the treatment of primary spontaneous pneumothorax. *Annals of Thoracic Surgery.* 2004;78(2):417-420.
4. Jimenez-Merchan R, Garcia-Diaz F, Arenas-Linares C, Giron-Arjona JC, Congregado-Loscertales M, Loscertales J. Comparative retrospective study of surgical treatment of spontaneous pneumothorax. Thoracotomy vs thoracoscopy. *Surgical Endoscopy.* 1997;11(9):919-922.
5. Joshi V, Kirmani B, Zacharias J. Thoracotomy versus VATS: is there an optimal approach to treating pneumothorax? *Annals of the Royal College of Surgeons of England.* 2013;95(1):61-64.
6. Pages PB, Delpy JP, Falcoz PE, et al. Videothoracoscopy versus thoracotomy for the treatment of spontaneous pneumothorax: A propensity score analysis. *Annals of Thoracic Surgery.* 2015;99(1):258-263.
7. Waller DA, Forty J, Morritt GN. Video-assisted thoracoscopic surgery versus thoracotomy for spontaneous pneumothorax. *Annals of Thoracic Surgery.* 1994;58(2):372-376; discussion 376-377.
8. Al-Qudah A. Video-assisted thoracoscopy versus open thoracotomy for spontaneous pneumothorax. *Journal of Korean Medical Science.* 1999;14(2):147-152.
9. Ben-Nun A, Soudack M, Best LA. Video-assisted thoracoscopic surgery for recurrent spontaneous pneumothorax: the long-term benefit. *World Journal of Surgery.* 2006;30(3):285-290.
10. Delpy JP, Pages PB, Mordant P, et al. Surgical management of spontaneous pneumothorax: Are there any prognostic factors influencing postoperative complications? *European Journal of Cardio-thoracic Surgery.* 2016;49(3):862-867.
11. Dogusoy I, Yildirim M, Ustaalioglu R, Demirbag H. A comparison of axillary thoracotomy versus video-assisted thoracoscopic surgery in the surgical treatment of primary spontaneous pneumothorax. *Turk Gogus Kalp Damar Cerrahisi Derg.* 2018;26(1):132-137.
12. Dumont P, Diemont F, Massard G, Toumieux B, Wihlm JM, Morand G. Does a thoracoscopic approach for surgical treatment of spontaneous pneumothorax represent progress? *European Journal of Cardio-Thoracic Surgery.* 1997;11(1):27-31.
13. Olavarrieta JR, Coronel P. Expectations and patient satisfaction related to the use of thoracotomy and video-assisted thoracoscopic surgery for treating recurrence of spontaneous primary pneumothorax. *Jornal Brasileiro De Pneumologia: Publicacao Oficial Da Sociedade Brasileira De Pneumologia E Tisilogia.* 2009;35(2):122-128.
14. Rodgers-Fischl PM, Martin JT, Saha SP. Video-assisted thoracoscopic versus open lobectomy: costs and outcomes. *Southern Medical Journal.* 2017;110(3):229-233.
15. Sawada S, Watanabe Y, Moriyama S. Video-assisted thoracoscopic surgery for primary spontaneous pneumothorax: evaluation of indications and long-term outcome compared with conservative treatment and open thoracotomy. *Chest.* 2005;127(6):2226-2230.

Question Protocol

Field	Content
Review Question	What is the optimal surgical approach when performing pneumothorax surgery?
Type of review question	Intervention review
Objective of the review	A question comparing surgical approach techniques (Video Assisted Thoracoscopic Surgery (VATS), open thoracotomy). Is VATS superior to open thoracotomy?
Eligibility criteria – population / disease / condition / issue / domain	Adults (18+) with spontaneous pneumothorax undergoing surgery
Eligibility criteria – intervention(s)	Thoracotomy (± bullectomy ± surgical pleurodesis)
Eligibility criteria – comparators(s)	Video Assisted Thoracoscopic Surgery (± bullectomy ± surgical pleurodesis)
Outcomes and prioritisation	Recurrence Length of hospital stay Further treatment (pleural and surgical procedures) Pain / breathlessness Duration of air leak Complications Quality of life Mortality
Eligibility criteria – study design	RCTs Prospective comparative studies Case series of >100 patients
Other inclusion /exclusion criteria	Non-English language excluded unless full English translation Conference abstracts, Cochrane reviews, systematic reviews, reviews Cochrane reviews and systematic reviews can be referenced in the text, but **DO NOT** use in a meta-analysis

Proposed sensitivity / subgroup analysis, or meta-regression	None
Selection process – duplicate screening / selection / analysis	Agreement should be reached between Guideline members who are working on the question. If no agreement can be reached, a decision should be made by the Guideline co-chairs. If there is still no decision, the matter should be brought to the Guideline group and a decision will be made by consensus
Data management (software)	RevMan5 Pairwise meta-analyses Evidence review/considered judgement. Storing Guideline text, tables, figures, etc. Gradeprofiler Quality of evidence assessment Gradepro Recommendations
Information sources – databases and dates	MEDLINE, Embase, PubMED, Central Register of Controlled Trials and Cochrane Database of Systematic Reviews 1966 - present
Methods for assessing bias at outcome / study level	RevMan5 intervention review template and NICE risk of bias checklist (follow instructions in '*BTS Guideline Process Handbook – Intervention Review'*)
Methods for quantitative analysis – combining studies and exploring (in)consistency	If 3 or more relevant studies: RevMan5 for meta-analysis, heterogeneity testing and forest plots (follow instructions in '*BTS Guideline Process Handbook – Intervention Review'*)
Meta-bias assessment – publication bias, selective reporting bias	GRADEprofiler Intervention review quality of evidence assessment for each outcome (follow instructions in '*BTS Guideline Process Handbook – Intervention Review'*)
Rationale / context – what is known	VATS is the standard of care for pneumothorax prevention surgery, but there is a slightly higher recurrence rate than those who undergo thoracotomy, but this is a larger procedure. What is the evidence that informs this practice?