EVIDENCE-BASED REVIEW

Simple aspiration versus chest-tube insertion in the management of primary spontaneous pneumothorax: a systematic review


Department of Respiratory and Critical Care Medicine, Singapore General Hospital, Outram Road, Singapore 169608, Singapore

Clinical Trials and Epidemiology Research Unit, 226 Outram Road, Block B, #02-02, Singapore

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Summary Background: The initial treatment of a primary spontaneous pneumothorax (PSP) is controversial. Guidelines of the British Thoracic Society recommend simple aspiration for all PSP requiring intervention. The placement of chest tubes is only advocated for patients who fail simple aspiration. However, the American College of Chest Physicians Delphi Consensus Statement found simple aspiration to be rarely appropriate in the management of PSP.

Aims: To compare simple aspiration with chest-tube drainage in the initial management of PSP.

Methods: Meta-analysis of randomized controlled trials (RCTs).

Outcome measures: Reductions in duration of hospital stay, recurrence rate and pain or dyspnoea score were classified as benefits, whereas reductions in successful events were classified as risks.

Data collection and analysis: For dichotomous data, the relative risk (RR) and 95% confidence intervals were calculated. For continuous data, weighted mean differences (WMD) were used.

Results: Three RCTs were identified with a combined total of 194 patients. Simple aspiration was associated with shorter hospitalization (WMD −1.30 days [−2.20 to −0.39]). The results for success rate could not be combined because of differences in outcome definitions. However, a pooled result for "success at 1 week or more" showed no significant difference between either intervention (RR 0.86 [0.67, 1.11]). Results of recurrence at 1 year were also not significantly different (RR 0.73 [0.39–1.38]). Different reporting systems for pain scores meant that data could not be pooled. Only one trial reported dyspnoea scores.

Conclusion: RCT evidence in this field is limited, and the total sample size is too small to make any firm conclusion. On the basis of current available evidence, simple aspiration is advantageous in the initial management of PSP because of shorter
hospitalization. There is no significant difference in recurrence at 1 year using either modality, and the efficacy data are inconclusive.

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Introduction

Kjaergard first described a primary spontaneous pneumothorax (PSP) occurring in an otherwise healthy individual in 1932. Its global incidence is estimated at 18–28 per 100,000 for men and 1.2–6 per 100,000 for women. For first episodes of PSP that cannot be managed by observation, both simple aspiration and chest-tube drainage are established treatment modalities. The choice of method, however, is still controversial.

The British Thoracic Society (BTS) guidelines recommend that simple aspiration should be the treatment option of choice for stable PSP requiring intervention (Grade A recommendation). This is advocated regardless of the size of the pneumothorax. However, reports and audits have shown that these guidelines are poorly complied, and that simple aspiration and chest tubes are inappropriately used. It is estimated that between 2000 and 7000 “unnecessary” chest tubes are being inserted in the UK annually.

The American College of Chest Physicians released a consensus statement on the management of PSP using the Delphi method in 2001. The Delphi method summarizes the level of consensus for each recommendation from an expert panel and identifies settings in which multiple opinions exist. It was designed to provide consensus recommendations in areas where there was insufficient clinical evidence. Chest tube or pleural catheters were recommended as the preferred interventions over simple aspiration. The level of consensus for this was graded as good. They advocated simple aspiration only for stable patients with small PSP that progressed with observation, but otherwise found it to be an inappropriate treatment modality.

Despite this consensus, the management of PSP varies significantly between pulmonologists and thoracic surgeons, both in the relative frequency of intervention in PSP and in the use of either chest tubes or simple aspiration.

Resolving this debate will standardize care and reduce confusion among clinicians about the best initial modality. Chest-tube drainage is the more invasive procedure. It typically involves the insertion of a 16–22F tube in the third or fifth intercostal space along the mid-clavicular line by blunt dissection. Simple aspiration, by contrast, involves pleural drainage through the second intercostal space in the mid-clavicular line via a 16–18 gauge cannula attached to a three-way tap and a 50cc syringe. If 2.5L or more of air is aspirated, an unsealed air leak would be suspected. Contraindications for simple aspiration are bilateral pneumothoraces, tension pneumothorax, multiple recurrent pneumothoraces and concurrent pleural effusion or haemothorax. In these situations, a chest tube is indicated.

This systematic review was undertaken to determine objective estimates of which is the better treatment option based on evidence from randomized controlled trials (RCTs) for the initial management of PSP. A stronger evidence base can strengthen future guidelines and potentially improve physician compliance with the recommendations.

Methods

Search strategy

We conducted a literature search, following established guidelines, using MEDLINE from 1966 to June 2003, EMBASE from 1974 to June 2003 and the Cochrane Central Database (Issue 3, 2003). We used the search terms spontaneous and pneumothorax, primary and pneumothorax, nontraumatic and pneumothorax, nontraumatic and pneumothorax, needle and aspiration, manual and aspiration, simple and aspiration, intercostal and tube, chest and tube, thoracic and tube, intercostal and drain, chest and drain, as well as, thoracic and drain. The search was limited to RCTs, and there was no language restriction. We reviewed the complete reference list of all studies identified through an electronic search and wrote to first authors of selected publications requesting assistance in clarifying data and identifying unpublished studies. No distinction was made between first occurrence of PSP and recurrent episodes.

Selection criteria

We selected RCTs with patients who had a PSP as defined by the study authors. Selected trials had to specifically compare simple aspiration with chest-tube drainage. Primary outcomes sought were...
duration of hospitalization, immediate success rate, recurrence rate and pain or dyspnoea scores.

**Study description and validity assessment**

Independently, and in duplicate, two of the authors extracted data from the identified trials. We developed a standard data collection form that included 10 validity criteria to evaluate internal and external validity (Table 1). Two independent reviewers extracted the data from the identified trials and assessed quality of trials from the level of concealment of allocation, degree of blinding used and losses to follow-up. Any difference in opinion was settled by consensus after consultation with the entire study group.

**Statistical analysis**

We used dichotomous and continuous variables that reflected each outcome. Analysis was not confined to intention-to-treat because of sparse information in the selected studies. Pooled effect estimates and heterogeneity between studies were tested with Rev Man 4.2.1 statistical package. When heterogeneity was significant with a fixed-effects model, we used a random-effects model. We calculated relative risk (RR) for dichotomous outcomes, weighted mean difference (WMD) for continuous outcomes and 95% CIs to estimate the treatment effects.

**Results**

**Study selection**

The electronic search identified four RCTs that were published between 1994 and 2002, of which three fulfilled our selection criteria. The excluded publication evaluated talc pleurodesis by medical thoracoscopy as an intervention for PSP and compared it against chest-tube drainage. We reviewed the abstracts of 53 publications from the bibliographies of these trials, but none of them were suitable for this meta-analysis. Therefore, the final result of our search was three RCTs (Fig. 1). There was complete agreement between the two reviewers on this selection.

**Study description and validity**

The studies presented data from three European countries and were all published in English (Table 2). Two of them were multi-centre studies. The study by Andrivet et al. was conducted in an intensive-care setting. The number of patients in the studies ranged from 60 to 96, but none of the studies justified the sample size by an explicit statement of the expected treatment effect, power and significance level.

Patients who received either simple aspiration or chest-tube drainage had comparable age, gender ratio and smoking history at baseline. All trials allowed repeated aspiration if simple aspiration failed the first time round.

None of the RCTs described concealment of allocation or blinding. Therefore, selection and performance bias had not been eliminated. Although it may not have been practical to blind either patient or healthcare provider when chest tube or simple aspiration was being carried out, blinding of assessors, especially in determining the success or recurrence rate, could have been possible. Given the objective nature of such end points, this ultimately may not have made a dramatic difference to the findings.

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**Table 1 Methodological quality of trials.**

<table>
<thead>
<tr>
<th></th>
<th>Harvey and Prescott&lt;sup&gt;17&lt;/sup&gt;</th>
<th>Andrivet et al.&lt;sup&gt;15&lt;/sup&gt;</th>
<th>Noppen et al.&lt;sup&gt;16&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Randomization</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Concealment of allocation</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Comparability at baseline</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Treatment protocol</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Outcome definitions</td>
<td>X</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>No co-interventions</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Extent of follow-up in months</td>
<td>12</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>Intention to treat</td>
<td>X</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Blinding</td>
<td>X</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>No confounding factors</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>

✓, Present; X, not explicitly reported.
The primary criticism of the study by Harvey and Prescott\textsuperscript{17} is that it did not describe critical design elements, such as outcome definitions and treatment protocol. A higher proportion of patients who had complete collapse of the lung was allocated to chest tube (18 out of 31 patients) than to simple aspiration (10 out of 29 patients). This may have a bearing on the generalizability of the result. Four patients had a small rim of pneumothorax and still received intervention when observation with oxygen therapy may have been more appropriate. Fourteen (23.3\%) patients also had a previous pneumothorax. It was not possible to separate the data on first episode of PSP from recurrent episodes based on what was published. There was no intention to treat analysis. However, attrition bias is unlikely to be a major issue, as 100\% of the patients were followed up for 12 months, and there was no mention of crossover between interventions.

Andrivet et al.\textsuperscript{15} did not limit their study to PSP. However, stringent exclusion criteria meant that 53 out of 61 (86.9\%) cases were PSP. This study also suffers from design heterogeneity compared with the two other trials.\textsuperscript{16,17} In order to facilitate healing of the air leak, simple aspiration was delayed arbitrarily for 72 h in patients who were identified to be clinically stable. The basis for this delay was a theoretical presumption and was not substantiated by evidence. Moreover, data show that the air leaks in PSP can heal rapidly.\textsuperscript{18} This trial design contrasts sharply to the other two trials in which simple aspiration was carried out immediately. Subsequently, in a non-randomized part of the study by Andrivet et al.,\textsuperscript{15} another group of 35 patients with similar baseline characteristics underwent immediate simple aspiration. This group showed similar results for success and recurrence rate, but hospitalization was cut by 2.1 days. These data were excluded from our meta-analysis because the study protocol was not randomized or case-controlled. Outcome definition for chest-tube success was defined by the absence of an air leak within 10 days of insertion, whereas successful simple aspiration required near complete (> 80\%) lung re-expansion with no recurrence within 24 h.
Table 2  Randomized controlled trials comparing simple aspiration with chest-tube drainage for the management of primary spontaneous pneumothorax.

<table>
<thead>
<tr>
<th>Country</th>
<th>Number</th>
<th>Location</th>
<th>Inclusion criteria</th>
<th>Exclusion criteria</th>
<th>Intervention (months of follow-up)</th>
<th>Outcome definitions</th>
<th>Outcomes (drop out rate)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harvey and Prescott17</td>
<td>UK  73</td>
<td>Not specified; used inpatient admissions</td>
<td>PSP size ranging from small rim to complete collapse</td>
<td>Tension pneumothorax, lung disease other than previous pneumothorax</td>
<td>Simple aspiration vs chest tubes (12)</td>
<td>Not stated</td>
<td>Hospital stay in days; success of procedure; recurrence at 12 months; risk of subsequent pleurectomy; pain scores during procedure, average daily pain score and total pain score (0%)</td>
</tr>
<tr>
<td>Andrivet et al.15</td>
<td>France 96*</td>
<td>Four MICU (three in university teaching hospitals)</td>
<td>First or first recurrence of a complete spontaneous pneumothorax</td>
<td>Iatrogenic, traumatic or bilateral pneumothorax; need for mechanical ventilation; underlying lung cancer, abscess or consolidated pneumonia; contralateral bullous emphysema; diffuse interstitial pneumonitis; temperature &gt; 38.5°C; moderate to severe haemostasis defect; prior ipsilateral thoracotomy; proven/suspected HIV; moderate to major pleural effusion or haemothorax</td>
<td>Chest tube vs aspiration. Aspiration immediately if signs of poor clinical tolerance present and delayed 72 h if signs absent. If aspiration failed, repeat allowed before chest-tube insertion (3)</td>
<td>Aspiration success defined as near-complete lung re-expansion (i.e. &gt; 80% with no recurrence within 24 h). Chest-tube success defined by absence of air leak within 10 days and no requirement for second chest tube</td>
<td>Hospital stay in days; success of procedure; recurrence at 3 months; daily pain scores; daily dyspnoea scores (13.2%)</td>
</tr>
<tr>
<td>Noppen et al.16</td>
<td>Belgium 60</td>
<td>Five hospitals, including one tertiary and four general units</td>
<td>First episode of PSP that was either symptomatic or &gt; 20% in size</td>
<td>Underlying lung disease, previous pneumothorax, tension pneumothorax</td>
<td>Aspiration vs chest tubes. If aspiration unsuccessful it was repeated at discretion of pulmonologist and if still unsuccessful then chest tube inserted (12)</td>
<td>Aspiration success defined as complete or near-complete and persistent lung expansion. Chest-tube success defined as complete lung re-expansion with no air leak and chest tube removal within 72 h. Aspiration and chest tube success at 1 week defined as complete and persistent lung expansion at 7 days</td>
<td>Hospital stay in days; need for hospitalization; immediate success; success at 1 week; recurrence at 12 months (0)</td>
</tr>
</tbody>
</table>

*35 patients were excluded from analysis because they were not randomized. MICU, medial intensive care unit; PSP, primary spontaneous pneumothorax.
Sixteen (26.2%) patients had a previous history of pneumothorax (i.e., recurrent pneumothorax). Andrivet et al.\(^\text{15}\) assessed recurrence at 3 months, and follow-up was 86.8%.

Noppen et al.\(^\text{16}\) defined chest-tube success as complete re-expansion of lungs with no air leak and subsequent removal of chest tube within 72 h of insertion. Simple aspiration success required complete or near complete and persistent lung re-expansion. Data were available for immediate success and for continued successful resolution at 1 week. Only patients with first occurrence of PSP were recruited. Follow-up was for 12 months and was 100%.

**Effect of simple aspiration versus with chest-tube drainage on primary spontaneous pneumothorax**

When the data from the three trials were pooled with a fixed-effects model, patients treated with simple aspiration had a shorter duration of hospitalization (WMD \(-1.30\) days [95% CI \(-2.20\) to \(-0.39\)]) (Fig. 2). This was despite the 72-h delay in simple aspiration in 26 out of 33 (78.8%) patients in the study by Andrivet et al.\(^\text{15}\) A sensitivity analysis was conducted by excluding these data. A similar result was obtained but, as expected, the pooled statistic moved further in favour of simple aspiration (WMD \(-1.47\) days [95% CI \(-2.41\), \(-0.52\)]).

Treatment success was assessed at different time points in the selected studies, and this made it difficult to combine the data. A subgroup analysis of immediate success and success at 1 week or more was carried out. Although the outcome definitions were different, and ideally the data should not be combined, we decided to explore the overall effectiveness of treatment in the studies by the pooled statistic for "success at 1 week or more" (Fig. 3). It showed no significant statistical difference between simple aspiration and chest-tube insertion; RR 0.86 (95% CI 0.67–1.11). When reviewing the data from the individual trials, chest-tube drainage achieved a higher success rate in two studies,\(^\text{15,17}\) and no difference was found between either modality in the third study by Noppen et al.\(^\text{16}\) The success rate in studies ranged from 84.8% to 100% for chest tubes compared with simple aspiration, which varied from 66.7% to 92.6%.

Two RCTs reported recurrence at 1 year. The combined data seemed to favour simple aspiration, but this did not achieve statistical significance (RR 0.73 [95% CI 0.39–1.38]). Andrivet et al.\(^\text{15}\) reported 3-month recurrence with similar results (RR 0.71 [95% CI 0.28–1.83]) (Fig. 4).
### Simple Aspiration vs Chest Tube drainage for primary spontaneous pneumothorax

**Comparison:** Simple Aspiration vs Chest Tube drainage

**Outcome:** Success

<table>
<thead>
<tr>
<th>Study or sub-category</th>
<th>SA</th>
<th>CT</th>
<th>RR (random)</th>
<th>Weight</th>
<th>RR (random)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n/N</td>
<td>n/N</td>
<td>95% CI</td>
<td>%</td>
<td>95% CI</td>
</tr>
<tr>
<td><strong>01 Immediate success</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Noppen 2003</td>
<td>16/27</td>
<td>21/33</td>
<td>100.00</td>
<td>0.93 [0.62, 1.40]</td>
<td>100.00</td>
</tr>
<tr>
<td>Subtotal (95% CI)</td>
<td>27</td>
<td>33</td>
<td>100.00</td>
<td>0.93 [0.62, 1.40]</td>
<td></td>
</tr>
<tr>
<td>Total events: 16 (SA), 21 (CT)</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Test for heterogeneity: not applicable</td>
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</tr>
<tr>
<td>Test for overall effect: Z = 0.34 (P = 0.73)</td>
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<tr>
<td><strong>02 Success at 1 week or more</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Andrivet 1995</td>
<td>22/33</td>
<td>26/28</td>
<td>27.98</td>
<td>0.72 [0.55, 0.93]</td>
<td></td>
</tr>
<tr>
<td>Harvey 1994</td>
<td>28/35</td>
<td>38/38</td>
<td>36.63</td>
<td>0.80 [0.68, 0.94]</td>
<td></td>
</tr>
<tr>
<td>Noppen 2003</td>
<td>25/27</td>
<td>28/33</td>
<td>35.38</td>
<td>1.09 [0.91, 1.31]</td>
<td></td>
</tr>
<tr>
<td>Subtotal (95% CI)</td>
<td>95</td>
<td>99</td>
<td>100.00</td>
<td>0.86 [0.67, 1.11]</td>
<td></td>
</tr>
<tr>
<td>Total events: 75 (SA), 92 (CT)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Test for heterogeneity: (\text{Chi}^2 = 9.41, \text{df} = 2) (P = 0.009), (\text{I}^2 = 78.7%)</td>
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<td></td>
<td></td>
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<tr>
<td>Test for overall effect: Z = 1.15 (P = 0.25)</td>
<td></td>
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</tbody>
</table>

#### Figure 3
Successful treatment of primary spontaneous pneumothorax as expressed by relative risk and the combined results for "success at 1 week or more" as pooled RR.
### Review: Simple Aspiration vs Chest Tube drainage for primary spontaneous pneumothorax

#### Comparison: Simple Aspiration vs Chest Tube Drainage

#### Outcome: Recurrence

<table>
<thead>
<tr>
<th>Study or sub-category</th>
<th>SA n/N</th>
<th>CT n/N</th>
<th>RR (fixed) 95% CI</th>
<th>Weight %</th>
<th>RR (fixed) 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>01 Recurrence at 3 months</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Andrivet 1995</td>
<td>6/29</td>
<td>7/24</td>
<td>0.71 [0.28, 1.83]</td>
<td>100.00</td>
<td>0.71 [0.28, 1.83]</td>
</tr>
<tr>
<td>Subtotal (95% CI)</td>
<td>29</td>
<td>24</td>
<td></td>
<td>100.00</td>
<td></td>
</tr>
</tbody>
</table>

Test for heterogeneity: not applicable
Test for overall effect: Z = 0.71 (P = 0.48)

| **02 Recurrence at 1 year** | | | | | |
| Harvey 1994 | 5/35 | 10/38 | 0.54 [0.21, 1.43] | 54.21 | 0.54 [0.21, 1.43] |
| Noppen 2003 | 7/27 | 9/33 | 0.95 [0.41, 2.22] | 45.79 | |
| Subtotal (95% CI) | 62 | 71 | | 100.00 | 0.73 [0.39, 1.38] |

Test for heterogeneity: Chi² = 0.73, df = 1 (P = 0.39), I² = 0%
Test for overall effect: Z = 0.97 (P = 0.33)

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**Figure 4** Recurrence rates at 1 year and 3 months as expressed by relative risk for the individual trials and the combined results for recurrence rate for 1 year as pooled relative risk.
Pain and dyspnoea scores could not be combined because of different definition criteria. Harvey and Prescott\(^{17}\) found less average daily pain and total pain scores in patients receiving simple aspiration (total pain score \(WMD -4.00 [95\% CI -5.58 \text{ to } -2.42]\)). However, Andrivet et al.\(^{15}\) found no difference in daily pain scores. The daily dyspnoea scores presented favoured chest-tube drainage over patients with delayed simple aspiration.

**Discussion**

The strength of this meta-analysis is the systematic and methodological review of data limited to only RCTs. Its weakness is a reflection of the quality of the trials reviewed. The RCTs were all relatively small and not adequately powered. Significant differences were found in the definitions of primary outcomes. Recurrent pneumothoraces were included in two trials,\(^{15,17}\) and it was not possible to analyse these data independently on the basis of what was published. Thirty (15.5\%) of the 194 patients had a previous pneumothorax, and 14 of them were assigned to simple aspiration, resulting in an almost even allocation. In addition, the inclusion of a small number of secondary pneumothoraces in the study by Andrivet et al.\(^{15}\) resulted in a heterogeneous study population. Follow-up for recurrence also varied from 3 to 12 months. These differences and inconsistencies made it difficult to pool all the data and provide summarized outcomes. Where possible, data were combined to provide clarification on what appropriate treatment should be given while awaiting stronger data.

We found that the use of simple aspiration instead of chest tube resulted in shorter hospitalization. The attractiveness of simple aspiration is its potential for an outpatient treatment. However, the risks of discharging a patient after simple aspiration in the emergency room are unknown and cause apprehension among attending physicians. Tension pneumothorax is an extremely rare occurrence in PSP, and there were no such events in any of the three RCTs even when simple aspiration failed. However, in recurrent episodes of PSP, risk of failure of treatment increased,\(^{19}\) as did subsequent recurrence rate.\(^{20}\) The reported success rate for intercostal tube drainage for PSP dropped from 90.7\% for first episodes to 52.4\% for second episodes to 15.4\% for third episodes.\(^{19}\) Recurrence rate increased from 57\% after initial PSP to 62\% and 83\% for second and third episodes, respectively.\(^{20}\) Therefore, hospital admission for recurrence prevention may be advisable even if the recurrent PSP can be adequately treated by the emergency department.

No significant difference was found in recurrence rate of PSP at both 3 and 12 months using either simple aspiration or chest tubes. This disputes the theory that the irritation caused by the inserted chest tube promotes symphysis between the visceral and parietal pleura, and consequently reduces recurrence.\(^{16}\) This conclusion is likely to be valid for only first episodes of PSP, and should not be extended to recurrent PSP or secondary pneumothoraces given the likelihood of persistence of the air leak and higher incidence of further recurrence.\(^{19-21}\)

Issues that remain to be resolved are the efficacy of simple aspiration compared with chest tubes, and how well patients tolerate each procedure as measured by pain and dyspnoea. Efficacy data are conflicting and we struggled to reconcile this because pooling of data was difficult. The two trials\(^ {15,17}\) that reported better success rates with chest-tube drainage were the ones that included either recurrent or secondary pneumothoraces in their data. Noppen et al.,\(^ {16}\) who studied solely first episodes of PSP, found no significant difference in efficacy. Furthermore, the study by Andrivet et al.\(^ {15}\) was far more “demanding” in the definition of simple aspiration success, requiring near-complete re-expansion of the lungs and cessation of any air leak within 24h. In chest-tube insertion, the air leak was allowed to persist for up to 10 days before it was determined to have failed. This may have skewed the success rate in favour of chest tubes. Moreover, the difference in success rate of chest tubes compared with simple aspiration that was reported by the two trials\(^ {15,17}\) was small but still statistically significant: Harvey and Prescott\(^ {17}\) (RR 0.80 [95\% CI 0.68–0.94]) and Andrivet et al.\(^ {15}\) (RR 0.72 [95\% CI 0.55–0.93]). The clinical significance of this difference is doubtful. The pooled result for “success at 1 week or more” further suggests that simple aspiration may not be less effective (RR 0.86 [95\% CI 0.67–1.11]).

Total pain scores reported by Harvey and Prescott\(^ {17}\) were lower in the simple aspiration group. Chest-tube insertion has been known to be associated with high levels of pain and anxiety.\(^ {22}\) Therefore, the BTS guidelines on insertion of a chest tube emphasize the role of either benzodiazepine or opioid pre-medication, as well as local anaesthesia before the procedure to establish effective pain control.\(^ {23}\)

It was difficult to interpret the pain and dyspnoea data reported by Andrivet et al.\(^ {15}\) The scores were
reported on an analogue scale from 0 to 10, on a daily basis, up until 5 days after diagnosis of pneumothorax. The data are skewed by the 72-h delay in the group assigned to simple aspiration. It would be inappropriate to conclude that the simple aspiration group experienced as much pain and more dyspnoea than the chest-tube group when most of the participants in this group were left untreated for 72 h. In fact, we could as easily conclude that patients with pneumothoraces left untreated experienced just as much pain as those who had a chest tube in situ.

The advantage of simple aspiration is its availability, low procedure-related morbidity and low cost. Also, less training and dependence on skilled operators is required. Complication rates are reported at about 1%. Of 800 cases who had simple aspiration, significant complications that occurred include six vaso-vagal reactions, two episodes of subcutaneous emphysema, two retained catheter tips and one haemothorax. Failure of aspiration can, however, result in patient frustration and distress. The need to return to hospital for a repeat procedure or for the extra procedure of the subsequent chest tube, the persistence of symptoms such as pain and dyspnoea from an unresolved pneumothorax, and the inevitable increased morbidity from the failed initial procedure will lead to anxiety and poor patient satisfaction. Furthermore, aspiration, if unsuccessful the first time, is less likely to succeed if repeated. This will suggest a need to review the practice of attempting repeat aspiration should simple aspiration fail and instead proceed immediately to chest-tube insertion.

In contrast to simple aspiration, chest-tube insertion has a higher reported complication rate. In non-trauma patients, the rate for early complications is 3% and the rate for late complications is 8% (i.e. complications occurring 24 h after insertion). The most common complication is a non-functioning tube due to kinking, clotting or dislodgement. Complications associated with the insertion procedure include lung or diaphragm perforation, intercostal vessel laceration, direct abdominal placement, chylothorax, acute diaphragmatic paralysis, partial aortic obstruction, avulsion injury to the lesser curve of the stomach and subcutaneous placement. Positional problems include Horner’s syndrome, arterio-venous fistula formation and re-expansion pulmonary oedema. Pulmonary infarction, subcutaneous emphysema, and infections, such as empyema and exit site sepsis, are other possible complications. Chest tubes also may result in poor cosmetic results from scarring.

While simple aspiration requires only a 16–18 gauge cannula, a 50 cc syringe, a three-way tap and local anaesthetic, chest-tube insertion necessitates a far longer equipment list, which adds to cost. This includes sterile gowns and drapes, instruments for skin incision and blunt dissection of chest wall, chest tubes, connecting system, closed underwater drainage system, local anaesthetic and pre-medication.

This paper does not address the role of small-bore 8–14 F pleural catheters. These have been proven to be an attractive alternative to chest tubes and also allow outpatient management. However, they remain alternatives for chest tubes and are not indicated for simple aspiration and so will not replace the role of aspiration in the management of PSP. Future debate may be centered on the relative merits of simple aspiration versus pleural catheters. The use of pleural catheters may not necessarily result in a narrowing of the difference in hospitalization period and costs. A concern regarding pleural catheters is the higher complication rates (36%), which may be due to physician inexperience and inappropriate patient selection.

Future research in the form of larger, adequately powered RCTs is needed to provide conclusive evidence for the preferred treatment modality in the initial treatment of PSP. This should address the issues that weaken the trials used in this meta-analysis, such as design and outcome heterogeneity, small sample size, and lack of concealment of allocation and blinding. Further outcomes that have yet to be evaluated include quality of life and cost effectiveness.

Given the current data, and taking into consideration the substantial risks involved in chest-tube insertion, we favour the practice of simple aspiration in the initial management of first episodes of PSP. This is provided that there are no contraindications such as bilateral or tension pneumothoraces. The evidence for simple aspiration in recurrent PSP is far more limited, and management decisions have to be carefully evaluated in the appropriate clinical context. Any upgrading of the level of evidence of the BTS guidelines from 1b to 1a will only come about after more RCT data are available. These data will diminish the need for expert-based consensus recommendations. With the evidence in this systematic review, it is hoped that simple aspiration in the management of PSP will be used more appropriately,
and consequently improve patient outcome and care.

**Practice points**

- US and UK guidelines give conflicting advice on the initial management of PSP.
- Only three RCTs have compared simple aspiration and chest-tube insertion for the initial management of PSP.
- These studies show that, provided there are no contraindications such as bilateral or tension pneumothoraces, simple aspiration seems to be as effective as chest-tube insertion in the initial management of first episodes of PSP.
- Simple aspiration results in a shorter duration of hospital stay.
- The role of simple aspiration for second or recurrent episodes is less clear.

**Research directions**

- To fully resolve the debate larger, adequately powered RCTs that address the weaknesses of the current trials (i.e. design and outcome heterogeneity, small sample size, lack of concealment of allocation and blinding) are required.
- Outcomes that have yet to be evaluated are quality of life and cost effectiveness.
- Other areas for exploration include comparative trials between small bore pleural catheters and simple aspiration, stratification of risk factors for outcomes in PSP and long-term clinical outcomes of individuals with pneumothoraces treated with observation compared with those having an interventional procedure.

**References**

