Treatment of primary spontaneous pneumothorax

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Purpose of review
Initial treatment of primary spontaneous pneumothorax poses dilemmas for clinicians as size classification systems and current treatment guidelines differ in their approaches, and underlying evidence is weak. The purpose of this review is to summarize recent evidence and highlight remaining evidence gaps.

Recent findings
Recent studies confirm significant variation in practice. New evidence suggests that conservative management may be a viable option in a wider range of patients than previously thought (including some large pneumothoraces), with a reported clinical success rate of 79%. New data regarding aspiration report similar treatment success rates and shorter hospitalizations than chest tube drainage; however, methodological issues challenge these findings. There are conflicting data about the prognostic implications of computed tomography-identified pulmonary dystrophia.

Summary
Initial management of primary spontaneous pneumothorax is controversial, and there remains little high-quality evidence to guide decision-making. International differences in classification systems and management recommendations make meaningful pooling of clinical trials difficult. This makes a strong case for international agreement about study methodology in order to facilitate meaningful comparisons. Recent evidence suggests that conservative management may be a viable option and argues for its place in much needed randomized trials.

Keywords
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Introduction

By definition, primary spontaneous pneumothoraces (PSPs) arise in otherwise healthy people without lung disease and without any apparent precipitating event. Reported incidence is 18–28/100 000 per year for men and 1.2–6/100 000 per year for women [1,2]. Many patients do not seek medical advice for several days, 46% waiting more than 2 days before presentation despite symptoms [3].

A range of initial therapeutic options are available including conservative therapy (observation as an inpatient or more commonly as an outpatient), aspiration and chest tube drainage. There is a paucity of appropriately sized and constructed, prospective randomized trials to inform practice. Although there are some consensus guidelines, the paucity of data and the number of clinical specialties with an interest in pneumothorax management contribute to ongoing uncertainty as to the optimal initial management strategy.

The purpose of this review is to summarize recent evidence and highlight remaining evidence gaps in the initial treatment of PSP.

Size classification

Although there is general agreement that patients with respiratory compromise or clinical evidence of tension require decompression, most treatment guidelines base their recommendations on the size of the pneumothorax. They divide pneumothoraces into 'large' and 'small'; however, the definition of what constitutes a 'large' pneumothorax varies. A recent article compared three of the size classification approaches (as described by the British Thoracic Society [4], the American College of Chest Physicians [5] and the Belgian Society of Pulmonology [6]), reporting that they agreed in their classification of pneumothoraces as 'small' or 'large' only 47% of the time and that the proportion of pneumothoraces classified as 'large' varied from 10 to 49% [7••]. This has serious implications. In particular, it implies that

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Table 1 Comparison of guideline recommendations (clinically stable patients)

Guideline	Definition of 'large'	Management recommendation for large pneumothorax
BTS [4]	Presence of a visible rim of >2 cm between the lung margin and the chest wall	Simple aspiration
ACCP [5]	>3 cm apical interpleural distance	Pleural catheter insertion (small bore or ICC) and drainage
BSP [6]	Where there is a pleural gap along the entire length of the lateral chest wall	Aspiration or pleural catheter insertion (small bore or ICC) and drainage

ACCP, American College of Chest Physicians; BSP, Belgian Society of Pulmonology; BTS, British Thoracic Society; ICC, intercostal catheter.

studies comparing outcomes of patients with 'large' or 'small' PSP classified according to different guideline methods are not comparing like groups. As these classification systems have been used for patient selection in research studies, it further implies that integration of studies (e.g. for reviews, meta-analyses) may be seriously flawed if classification system differences are not taken into account. This is a real challenge to the progress of research in management of PSP. It makes a strong case for international agreement on methodological requirements for measuring and reporting size estimates of pneumothoraces included in research samples.

Current guidelines

There are a number of published guidelines on the management of PSP. All agree that small pneumothoraces (with the definition caveat discussed above) in stable patients can be treated conservatively and that patients with respiratory compromise, hypoxia or clinical evidence of tension require evacuation of air from the pleural space. Unfortunately, they differ with respect to definitions of and treatment recommendations for larger pneumothoraces. The intercontinental selection shown in Table 1 highlights this issue.

Variation in practice

Several recent studies have identified wide variation in practice with respect to management of PSP [8–11]. This is further evidence of a lack of consensus or evidence regarding optimal management strategies or both.

Therapeutic options

The options for initial treatment of PSP are conservative management (inpatient or outpatient observation without intervention), aspiration, insertion of a small bore thoracostomy catheter or insertion of a traditional larger bore intercostal catheter (ICC). As mentioned above, there is agreement about the treatment of small pneumothoraces in clinically well patients and of those with respiratory compromise. As evidenced by the variation in guideline recommendations, the group defined as 'large' poses the challenge.

The relative effectiveness of treatment strategies is summarized in a recent review [12] (Table 2). Of note, a recent study of 121 pneumothoraces reported that, on multivariate analysis, pneumothorax size as measured using the average interpleural distance method was the only factor with a statistically significant association with treatment failure ($P = 0.02$) [13]. That study is, however, weakened as it was based on retrospective medical record review, with its well known limitations regarding data quality.

Conservative management

Conservative management was the mainstay of therapy until the 1940s. The rate of resolution/reabsorption of pneumothoraces was previously estimated as 1.25–1.8% of the volume of hemithorax every 24 h [14]. A recent study, based on a computed tomography (CT) volumetric-derived formula for estimating pneumothorax size, reported the rate of reexpansion as 2.2% (95% confidence interval 1.4–3.0%), with significant between and within-patient variation in reexpansion rate (−7.5 and 13.4%/day) [15]. It also found a tendency for larger pneumothoraces to reexpand at a faster rate.

A recent uncontrolled Australian study [16••] comparing outcomes for patients with PSPs included 91 patients treated conservatively as outpatients, including some with large pneumothoraces. Reported success rate (lack of further intervention) was 79%, but for the majority of those who had an intervention the reason for intervention was unclear. Importantly, there were no emergency interventions required, suggesting that this approach is safe in selected patients. It makes a strong case for the inclusion of conservative therapy arms in future research trials.

Table 2 Summary of success rates for management strategies for primary spontaneous pneumothorax

Strategy	Success rate (%)
Conservative	79–90
Aspiration	50–83
ICC	66–97
Small bore/pigtail catheter	74–100

ICC, intercostal catheter. Modified from [12].

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Although yet to be studied, conservative management before planned surgical intervention might be a viable therapeutic option in clinically well patients presenting with pneumothorax recurrence. It theoretically avoids the risk, albeit small, associated with aspiration or tube drainage. It also allows a planned approach to admission, optimizing use of hospital beds.

Aspiration

Successful reexpansion of the lung after simple aspiration is of the order of 50–83% [12]. Systematic reviews [17,18,19•] have reported similar treatment success rates and shorter length of stay compared with immediate chest tube drainage. That said, the reviews acknowledge that variations in the definition of clinical success and its time frame of measurement make pooling this data challenging. The effectiveness of aspiration is further supported by the findings of another randomized controlled trial [20]. That study, of 137 episodes of first episode PSP, used 'immediate success' as its primary endpoint. Unfortunately, the definition of immediate success was different between the groups. Immediate success for the aspiration group was defined as complete, or nearly complete, lung expansion following aspiration whereas immediate success for a tube thoracostomy was defined as absence of air leak, complete lung expansion and chest tube removal within 3 days of the insertion of the tube. These are clearly not equivalent endpoints. They reported immediate success of 62% for aspiration compared with 68% for chest tube drainage.

The issues with endpoint selection and definitions highlighted in the systematic reviews and recent studies again argue strongly for international consensus on methodology for pneumothorax management studies.

Traditionally, when aspiration is unsuccessful, patients are managed with placement of a chest drain [ICC]. This has recently been challenged. A small uncontrolled study compared thoracoscopic surgery to chest tube drainage for patients with failed aspiration [21•]. They found that surgery resulted in a shorter hospital stay (4.8 vs. 6.1 days) and lower recurrence at 16 months (1/30 vs. 5/22).

One-year recurrence rates after successful simple aspiration have been shown to be approximately 15% [22]. Given this recurrence rate, some researchers have questioned whether additional interventions after successful aspiration can reduce this. An uncontrolled before and after study explored the impact of instillation of minocycline after successful aspiration on recurrence rate [23]. Minocycline was associated with higher analgesia requirements, but no difference in hospitalization rates or length of stay was seen. A trend toward lower recurrence rates was observed in the minocycline group [13 vs. 22%; odds ratio 0.3, 95% confidence interval (CI) 0.08–1.06]. This finding awaits validation in a prospective controlled trial.

Intercostal catheter drainage

ICCs (chest tubes), traditionally between 10 and 40 F in size, may be inserted by an anterior, axillary or postero-apical approach. For practical and cosmetic reasons, an axillary approach is the most favored currently. Primary success rates of 66–97% have been reported [12]. Reported duration of hospital admission ranges from 7 to 9 days [24]. A recent cohort study including 64 patients treated with chest tubes reported 73% treatment success [16••]. The remaining patients (23%) required surgical intervention.

In some centers, smaller pleural catheters (usually 8–16 F) have been combined with the use of one-way valves with good results. A variant of small bore catheter drainage is the use of a pigtail catheter. A recent study from France reports clinical success rates (defined as complete or nearly complete persistent lung expansion, without the need for any additional procedure and without recurrence) at 24 h of 61% and at 1 week of 85% with an average length of stay of 2.3 days [25]. This approach opens the possibility of outpatient management for a selected cohort; however, there has been no research defining this cohort or robustly comparing outcomes to other strategies, including conservative management.

Imaging, dystrophia and therapeutic implications

Pulmonary dystrophia (subpleural blebs or bullae) is widely believed to play a role in the occurrence of PSP, being frequently identified on CT scans of affected patients. It has been suggested that if it is identified at CT, either on admission or after treatment of the index visit, there might be a case for elective surgical intervention to prevent recurrence. Data to date are conflicting. One study has reported an increased risk of recurrence (48 vs. 20%) if blebs are identified at CT [26]. Others have found no relationship between the amount and characteristics of dystrophia on recurrence rate [27,28].

Conclusion

Initial management of PSP is controversial, and there remains little high-quality evidence to guide decision-making. Most studies are small and of low methodological quality. International differences in classification systems, treatment and endpoints make meaningful pooling of small studies very difficult. This makes a strong case for international agreement regarding study methodology and reporting in order to facilitate comparisons. Recent evidence suggests that conservative management may be a viable option in a wider range of patients than

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previously thought and argues for its place as a therapeutic arm in future randomized trials. The therapeutic importance of the identification and potential treatment of pulmonary dystrophia in the prevention of recurrent pneumothorax is unclear at this time.

References and recommended reading

Papers of particular interest, published within the annual period of review, have been highlighted as:
• of special interest
•• of outstanding interest

Additional references related to this topic can also be found in the Current World Literature section in this issue (p. 395).

1 Melton LJ, Hepper NCG, Offord KP. Incidence of spontaneous pneumothorax in Olmsted County, Minnesota: 1950–1974. Am Rev Respir Dis 1979; 29:1379–1382.

2 Bense L, Wiman LG, Hedenstierna G. Onset of symptoms in spontaneous pneumothorax: correlations to physical activity. Eur J Respir Dis 1987; 71: 181–186.

3 O'Hara VS. Spontaneous pneumothorax. Milit Med 1978; 143:32–35.

4 Henry M, Arnold T, Harvey J, Pleural Diseases Group, Standards of Care Committee, British Thoracic Society. BTS guidelines for the management of spontaneous pneumothorax. Thorax 2003; 58 (Suppl 2):ii39–ii52.

5 Baumann MH, Strange C, Heffner JE, *et al.* Management of spontaneous pneumothorax: an American College of Chest Physicians Delphi consensus statement. Chest 2001; 119:590–602.

6 De Leyn P, Lismonde M, Ninana V, *et al.* Guidelines Belgian Society of Pulmonology. Guidelines on the management of spontaneous pneumothorax. Acta Chir Belg 2005; 105:265–267.

7 Kelly AM, Druda D. Comparison of size classification of primary spontaneous
•• pneumothorax by three international guidelines: a case for international consensus? Resp Med 2008; 102:1830–1832.

This study compares the size classification of PSP using the methods described by the British Thoracic Society (BTS), American College of Chest Physicians (ACCP) and Belgian Society of Pulmonology (BSP) guidelines, finds they agree in a minority of cases and discusses the implications of these findings for evaluation of evidence on treatment.

8 Kelly AM, Clooney C, Spontaneous Pneumothorax Australia Study Group. Deviation from published guidelines in the management of primary spontaneous pneumothorax in Australia. Intern Med J 2008; 38:64–67.

9 Stolz AJ, Simonek J, Pafko P. Variations of primary spontaneous pneumothorax management. Rozhl Chir 2008; 87:5–9.

10 Ragusa M, Martelli M, Breda C, *et al.* Management of spontaneous pneumothorax: nation-wide fact-finding survey among Italian thoracic surgery units. Chir Ital 2007; 59:627–634.

11 Mendis D, El-Shanawany T, Mathur A, Redington AE. Management of spontaneous pneumothorax: are British Thoracic Society guidelines being followed? Postgrad Med J 2002; 78:80–84.

12 Kelly AM. Management of primary spontaneous pneumothorax: is the best evidence clearer fifteen years on? Emerg Med Australas 2007; 19:303–308.

13 Paolini R. Management and outcome of spontaneous pneumothoraces at three urban EDs. Emerg Med Australas 2007; 19:449–457.

14 Kircher LT Jr, Swartzel RL. Spontaneous pneumothorax and its treatment. JAMA 1954; 155:24–29.

15 Kelly AM, Loy J, Tsang AY, Graham CA. Estimating the rate of re-expansion of spontaneous pneumothorax by a formula derived from computed tomography volumetry studies. Emerg Med J 2006; 23:780–782.

16 Kelly AM, Kerr D, Clooney M. Outcomes of emergency department patients
•• treated for spontaneous pneumothorax. Chest 2008; 134:1033–1036.

This uncontrolled study includes one of the largest reported groups of patients treated conservatively for PSP. It also identifies that 16% of patients require surgery.

17 Zehtabchi S, Rios CL. Management of emergency department patients with primary spontaneous pneumothorax: needle aspiration or tube thoracostomy? Ann Emerg Med 2008; 51:91–100.

18 Chan SS. The role of simple aspiration in the management of primary spontaneous pneumothorax. J Emerg Med 2008; 34:131–138.

19 Wakai A, O'Sullivan RG, McCabe G. Simple aspiration versus intercostal tube
• drainage for primary spontaneous pneumothorax in adults. Cochrane Database Syst Rev: CD004479.

This is a well conducted systematic review comparing aspiration to chest tube drainage.

20 Ayed AK, Chandrasekaran C, Sukumar M. Aspiration versus tube drainage in primary spontaneous pneumothorax: a randomised study. Eur Respir J 2006; 27:477–482.

21 Chen JS, Hsu HH, Tsai KT, *et al.* Salvage for unsuccessful aspiration of
• primary pneumothorax: thoracoscopic surgery or chest tube drainage? Ann Thorac Surg 2008; 85:1908–1913.

This is the first study to suggest progression to surgery rather than chest tube drainage for failed aspiration.

22 Chan SS, Rainer TH. Primary spontaneous pneumothorax: 1-year recurrence rate after simple aspiration. Eur J Emerg Med 2006; 13:88–91.

23 Chen JS, Tsai KT, Hsu HH, *et al.* Intrapleural minocycline following simple aspiration for initial treatment of primary spontaneous pneumothorax. Respir Med 2008; 102:1004–1010.

24 Hock Ong M, Chan YH, Shern Kee TY, *et al.* Spontaneous Pneumothorax Outcome Study (SPOT phase I): a 2-year review. Eur J Emerg Med 2004; 11:89–94.

25 Marquette C, Marx A, Leroy S, *et al.* Simplified stepwise management of primary spontaneous pneumothorax: a pilot study. Eur Resp J 2006; 27:470–476.

26 Hirai S, Hamanaka Y, Mitsui N, *et al.* Therapeutic strategy for spontaneous pneumothorax. Kyobu Geka 2007; 60:175–179.

27 Ouanes-Besbes L, Golli M, Knani J, *et al.* Prediction of recurrent spontaneous pneumothorax: CT scan findings versus management features. Respir Med 2007; 101:230–236.

28 Martinez-Ramos D, Angel-Yepes V, Escrig-Sos J, *et al.* Usefulness of computed tomography in determining risk of recurrence after a first episode of primary spontaneous pneumothorax: therapeutic implications. Arch Bronconeumol 2007; 42:304–308.

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