

The Medical Management of Spontaneous Pneumothorax: A Concise Review

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Abstract

Spontaneous pneumothorax is an increasingly common clinical presentation, the management of which, until recent years, had remained unchanged for decades. A recent surge in pneumothorax research has produced the largest randomised controlled trials in the field yet and has revolutionised the management of spontaneous pneumothorax. The body of evidence supporting the introduction of conservative and ambulatory care in appropriate patients in recent guidelines now allows these patients, many of whom would otherwise have been admitted to hospital, to be managed in the outpatient setting and reduces their risk of complications compared to conventional chest drain insertion. In this review, we discuss recent advances in the management of pneumothorax and the evidence underpinning contemporary guidelines. We aim to equip physicians with the knowledge to engage their patients in the decision-making process regarding their pneumothorax, whilst keeping patient safety and patients' own preferences at the centre of their care.

Key words: pneumothorax; ambulatory; conservative; patient preference

Submitted: 7 February 2024 **Revised:** 28 July 2024 **Accepted:** 31 July 2024

Introduction

Spontaneous pneumothorax (SP), in which an air leak develops from the lung into the pleural space seemingly without provocation and causes the lung to collapse down, is a common medical problem (Gupta et al, 2000; Hallifax et al, 2018). Analysis of Hospital Episodes Statistics (HES) data suggests an annual admission rate of 14.1/100,000 population in 2016, with the incidence increasing over time (Hallifax et al, 2018). These pneumothoraces are commonly classified into primary spontaneous pneumothoraces (PSP), occurring in the absence of underlying lung disease, or secondary spontaneous pneumothorax (SSP), which the British Thoracic Society (BTS) classifies as occurring in patients with a known or suspected underlying lung disease or those over the age of 50 with a significant smoking history (Roberts et al, 2023). These categories are reflected in epidemiological data, which show a bimodal distribution of incidence, with the first peak between 15–30 years of age and a second increase in incidence over the age of 60, thought to reflect the presence of underlying lung disease increasing patients' risk of developing SP (Hallifax et al, 2018).

How to cite this article:

Barton EC, Walker SP. The Medical Management of Spontaneous Pneumothorax: A Concise Review. *Br J Hosp Med.* 2024. <https://doi.org/10.12968/hmed.2024.0047>

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Debate between an observational or interventional approach has been ongoing since the 1960s (Beumer, 1964; Hyde, 1963). Until recently, an interventional approach has dominated, due to perceived more rapid radiographic and symptomatic resolution with single use aspiration catheters and drainage kits (Baumann and Strange, 1997). In the last 5 years there have been multiple, well-designed randomised controlled trials which have fundamentally changed how we manage SP (Brown et al, 2020; Hallifax et al, 2020).

In this review, we will explore evolving research in the medical management of SP and how this evidence has shaped current guidance.

The Acute Management of Spontaneous Pneumothorax

The latest international BTS Pleural disease guidelines 2023 (Roberts et al, 2023), and the Joint ERS/EACTS/ESTS spontaneous pneumothorax guideline 2024 (Walker et al, 2024) mark an evolution in our approach to pneumothorax management. There is increasing recognition that SP represents a spectrum of disease; whilst most patients conform to one of the two established phenotypes, there are many patients who fit in the grey area between (Bintcliffe et al, 2015). These guidelines are considerably more patient-centred, and advise clinical evaluation of a patient's symptom burden to be the initial factor guiding management, followed by the presence of adverse features, including haemodynamic instability, significant hypoxia, presence of bilateral pneumothoraces or a haemopneumothorax, or if the patient meets the criteria to be diagnosed as a SSP. Although size of the pneumothorax remains a consideration, this is purely in assessing safety for intervention, rather than an indiscriminate guide to intervene if the pneumothorax exceeds a specified size. Patients exhibiting any high-risk characteristics should be managed with intercostal chest drain (ICD) insertion if safe to do so, or their pneumothorax further characterised with computed tomography (CT) imaging (Roberts et al, 2023).

For symptomatic patients without any adverse features, needle aspiration is no longer the only option available to clinicians and patients, with ambulatory and conservative care now placed on an equal footing with conventional management (Roberts et al, 2023). Patient choice is the main factor influencing decision making, provided local services can support all options. As clinicians, it is therefore important that we are equipped with sufficient information to empower our patients to be involved in this decision-making process. The evidence underpinning each treatment strategy will be explored in more detail throughout this review.

Needle Aspiration in SP

Although needle aspiration (NA), in which a bespoke aspiration kit (Fig. 1) or cannula with a 3-way tap is inserted under local anaesthetic via the 2nd intercostal space in the midclavicular line or within the safe triangle in the midaxillary line and up to 2.5 L of air aspirated, was first described in 1804 (Emerson, 1903), it was nearly 200 years later before an RCT comparing this with chest tube drainage was undertaken (Andrivet et al, 1995; Harvey and Prescott, 1994). Needle aspiration has

subsequently become a cornerstone of PSP management, with ICD insertion usually reserved for those who fail NA or exhibit physiological instability. Studies have shown immediate success rates of 60–67% (Andrivet et al, 1995; Carson-Chahhoud et al, 2017; Harvey and Prescott, 1994; Noppen et al, 2002), which allows up to two thirds of patients to be managed with a single procedure and a shorter hospital admission. These studies have also demonstrated lower complication rates (Andrivet et al, 1995; Harvey and Prescott, 1994; Noppen et al, 2002) and better patient tolerability (Ayed et al, 2006; Harvey and Prescott, 1994) with NA compared to ICD insertion.



Fig. 1. A Rocket™ pleural aspiration kit used for needle aspiration for pneumothorax.

It is important to make patients aware that NA is not necessarily a definitive procedure and that there is a reasonable risk that they will need further intervention should this fail. It can be difficult to predict in which patients NA is less likely to be successful. Studies have not found associations between either size or laterality of pneumothorax and success rates, although there was a trend towards larger aspiration volumes in patients whose aspiration was unsuccessful (1.59 L (SD 0.72) vs 2.52 L (SD 0.91)) (Harvey and Prescott, 1994). Whether this is representative of the presence of a persistent underlying visceral defect through which air is being aspirated at larger volumes is unclear, but guidelines have subsequently advised aspiration be limited to 2.5 L (Roberts et al, 2023). Patients should be advised on the potential need for further intervention.

NA has not been widely adopted in the SSP cohort. These patients are often more frail and co-morbid, and report a higher symptom burden than PSP patients,

both in terms of breathlessness and hypoxia (Tanaka et al, 1993). They are therefore generally considered less suitable for outpatient or ambulatory management of their pneumothorax. The aversion to NA in the SSP cohort largely stems from two small studies dating back more than 30 years, which found patients aged >50 (39% vs 19%) and those with underlying lung disease were more likely to fail NA than those <50 (39% vs 19%) and those without underlying lung disease (33.3% vs 21%) (Archer et al, 1985; Ng et al, 1994). These studies were performed in small cohorts of 30–35 patients, yet have shaped our practice for decades since.

In 2017, Thelle et al (2017) published a randomised controlled trial (RCT) comparing NA with ICD insertion in a mixed cohort of SP patients (79 PSP and 48 SSP). They found shorter hospital stays and lower complication rates with NA, even within the SSP cohort, and although success rates were lower with NA in SSP compared to PSP (59.1% vs 73.8%), higher rates of immediate success with NA were recorded in the SSP patients compared to those managed with an ICD (59.1% vs 23.1%) (Thelle et al, 2017). Given the diverse nature of the SSP cohort, with 50 year old smokers being grouped indiscriminately with 80 year old patients with interstitial lung disease (ILD), this raises the question of whether there are subgroups of SSP patients for whom NA may offer a less invasive management strategy associated with a shorter length of hospital stay and reduced complications. A national multicentre RCT is currently ongoing (PRINCE-SSP, NIHR204137) comparing NA with standard care in SSP patients to address this question.

Ambulatory Management in SP

Ambulatory care has been at the forefront of many areas of medicine over recent years as hospital services come under increased pressure and pneumothorax management is no exception to this. Prior to 2020, data on the safety and efficacy of ambulatory management in PSP was limited to inadequately powered RCTs and case series (Choi et al, 2007; Ho et al, 2011; Marquette et al, 2006; Rögglä et al, 1996), until a large, multicentre RCT randomised 236 patients to either ambulatory management with a self-contained one-way valve (Rocket Pleural Vent™, Fig. 2) or standard care (Hallifax et al, 2020) 64% of those managed with the pleural vent were discharged on the same day compared to 34% of those receiving standard care, with a shorter mean length of stay (LoS) in the ambulatory care arm than standard care (0 days vs 4 days, $p \leq 0.0001$). Ambulatory patients also underwent fewer total interventions (1.2 vs 1.4, $p = 0.0327$) with 33% of those managed with standard care requiring a further procedure.

Duration to completion of treatment was slightly longer in the ambulatory care arm, which the authors speculate may relate to clinicians' unfamiliarity with the device and longer intervals between clinical reviews than patients who were admitted and receiving daily review. Higher complication rates were also noted in the ambulatory care group (55% vs 39%), which mostly related to the device itself, such as device malfunctioning, dislodging, blocking or leaking. This study provides new, compelling evidence that ambulatory management of PSP is both safe, effective and reduces LoS whilst providing most patients with a single, definitive intervention.



Fig. 2. A Rocket™ Pleural Vent insertion kit for the ambulatory management of pneumothorax.

Similarly to NA, ambulatory care has often been avoided in favour of ICD insertion and admission in SSP patients, due to concerns about instability and their high risk of deterioration. A prospective case series at a UK single centre examined the use of an ambulatory pathway with an Heimlich type one-way flutter valve (Atrium Pneumostat™) (Fig. 3) (Khan et al, 2019). This allows unidirectional air egress, without the need for an under-water seal unit. All patients with PSP were eligible for ambulation. Patients with SSP were deemed eligible if they were cognitively intact, had a WHO performance status 0–1, were able to attend follow-up and no co-existing condition requiring hospital admission. In total, 49.5% of SSP patients were felt to be suitable for ambulatory management compared to 96.8% of PSPs (Khan et al, 2019). The average length of hospital stay for SSP patients was 0.74 (± 0.17) days. Whilst complications were not common, one drain was dislodged as an outpatient, and two patients developed empyema. The time to resolution and complication rates were similar in both the SSP and PSP groups. This raises the possibility that ambulatory management could be safe and effective in SSP patients, although this study is subject to selection bias due to its non-randomised design.

A subsequent RCT recruited 41 patients with SSP to either standard care or ambulatory management with a Rocket Pleural Vent™ or the Atrium Pneumostat™ attached to an ICD, depending whether ICD had already been inserted at the time of randomization (Walker et al, 2021). Although the initial LoS was shorter with ambulatory care, there was ultimately found to be no difference in mean LoS at



Fig. 3. Atrium Pneumostat™ for the ambulatory management of pneumothorax.

30 days between the two groups. High treatment failure rates were reported with the Rocket Pleural Vent™ (6/13 patients), leading to its removal from the study. Authors postulated that this treatment failure may relate to the narrower gauge (8 Fr) of the vent compared to a 12 Fr ICD being insufficient to manage the high flow air leaks often seen in SSP. There was, however, a trend towards shorter LoS with no early treatment failure in patients in the ambulatory care arm managed with the Atrium Pneumostat™, suggesting that success of ambulatory management may not only be patient- but also device-specific.

There are many contributing factors that make ambulatory care in SSP more challenging, therefore this should only be considered on a case-by-case basis, depending on the patients' clinical condition, physiological reserve, functional status and social support network.

Conservative Management of SP

Another significant change in the management of pneumothorax is the increased credibility given to conservative management of SP, which is now recommended for all asymptomatic patients or for PSPs with minimal symptoms. Retrospective case series dating back to the 1960s provide supporting evidence that conservative management is successful for mixed cohorts of SP patients (Beumer, 1964) yet conservative management fell out of favour with the development of bespoke, single use aspiration kits and ICD insertion kits, alongside a desire for rapid radiographic and symptom resolution.

Many since then have queried whether conservative management ought to be re-explored, with [Walker et al \(2022\)](#) questioning whether, by intervening, we actually create an intrathoracic pressure gradient which encourages flow through the visceral pleural defect and perpetuates the issue and [Simpson \(Simpson, 2010; Simpson et al, 2012\)](#) suggesting that the relatively low incidence of tension pneumothorax, especially in the PSP cohort, may indicate that visceral defects actually close spontaneously within a short space of time. These theories are supported by tracer gas experiments, which found that chlorofluorocarbons inhaled by SP patients during needle aspiration were unable to be detected in 35% of PSP and 20% of SSP, a finding that was strongly predictive of treatment success and potentially suggests that the visceral defect had already sealed and the leak resolved at the time of NA ([Kiely et al, 2001; Seaton et al, 1991](#)).

Until recently, there was a paucity of high-quality evidence to support conservative management of PSP. A multicentre, Australian RCT by [Brown et al \(2020\)](#) randomised 316 PSP patients to either conservative care or ICD insertion with a primary outcome of radiographic resolution at 8 weeks. Full lung re-expansion was evident at 8 weeks in 98.5% of those managed with ICD compared to 94.4% of those managed with conservative care ($p = 0.02$). Of perhaps more relevance is that only 15.4% of those managed conservatively required further intervention, suggesting that many patients may not require any intervention at all for their pneumothorax. This study also identified a lower recurrence rate with conservative care (8.8% vs 16.8%), a finding that has not been replicated in a subsequent systematic review of 8 studies including nearly 12,000 PSP patients ([Lee et al, 2020](#)). [Brown's study \(Brown et al, 2020\)](#) demonstrated lower complications rates with conservative care. The only complications reported was a skin infection of a subsequently inserted chest drain. There were 3 haemothoraces documented as present prior to intervention.

Both studies noted lower complication rates in those managed conservatively and no difference in resolution rates between conservative and standard care ([Brown et al, 2020; Lee et al, 2020](#)).

[Brown's study \(Brown et al, 2020\)](#) was not without its limitations, which has curbed the widespread adoption of conservative care to an extent. This study reported a high screen failure rate (88%). The reasons for exclusion were not detailed in the paper but it may be due to the exclusion of patients with prior episodes of PSP and it is suspected that patients with a high symptom burden were selected out. Pneumothorax recurrence is known to be common with significant variation in recurrence rates reported (8–74%) ([Walker et al, 2018](#)), therefore excluding those with prior episodes of PSP raises the question of whether conservative management is truly generalisable to the whole PSP population. In addition, symptom scores in this study were lower than those reported in other PSP studies ([Hallifax et al, 2020](#)), with an mean Borg dyspnoea score of 1.7 (SD 1.4) and chest pain score of 2.1 (SD 2.1) out of 10 in the conservative group ([Brown et al, 2020](#)). These findings are only truly generalisable to PSP patients with a low symptom burden. Furthermore, the lack of a patient-focussed primary outcome, when radiographic resolution at 8 weeks was never really in doubt, and that the comparator

arm (ICD) is not considered standard care in many countries have also come under scrutiny. As a result, current guidance recommends conservative management only be considered in minimally symptomatic or asymptomatic patients, irrespective of pneumothorax size (Roberts et al, 2023; Walker et al, 2024). A practical approach is to ambulate patients in the emergency department to determine symptoms burden. An ongoing multicentre RCT comparing conservative care with standard care seeks to address issues around which there remains clinical equipoise, including the role of conservative care in PSP patients with a higher symptom burden and a history of prior pneumothorax, with number of pleural procedures as the primary outcome (CONCEPT study, NIHR133653).

The safety and efficacy of conservative management in SSP has not been so extensively explored. In a single retrospective case series of 82 patients presenting to a single centre with SSP, 39% were successfully managed conservatively without need for further intervention (Gerhardy and Simpson, 2021). But by virtue of its retrospective design, this study is subject to inevitable selection bias; patients managed conservatively had significantly smaller pneumothoraces than those managed with an intervention, although all pneumothoraces met the BTS guidance at the time for intervention. This raises the possibility that conservative care could be suitable for a carefully selected group of patients with SSP, but further exploration in adequately-powered RCTs are required to define what that population may be.

The Right Procedure in the Right Patient

With such a wealth of options now available to clinicians, weighing up which procedure to perform on which patient takes some consideration. It is important to consider several factors which may influence a clinician or a patient's decision including availability of local services and experience, an individual's symptom burden and their priorities for care.

Management of SSPs and unstable PSPs remains relatively straightforward; the majority of these patients will be deemed to have adverse features according to the new BTS guidelines, for which ICD insertion is recommended (Roberts et al, 2023). Conservative management is only advised for asymptomatic SSPs, and even then the guidelines recommend a period of inpatient observation prior to discharge. For stable PSPs, decisions regarding management are more nuanced. Symptom burden is an important factor; patients with no or minimal symptoms are more suitable for conservative management, irrespective of the size of their pneumothorax, whilst patients with a higher symptom burden will benefit from intervention with either an ambulatory device or NA to relieve their symptoms.

Ambulatory devices require experience with both their insertion and ongoing management, and although their use is becoming more widespread, there may be centres in which the clinicians have less familiarity with the devices, which ought to be taken into account when offering this treatment to patients. Both ambulatory and conservative care require a responsive service run by physicians with pleural experience to provide robust regular follow-up for patients at short notice. The

availability of these services locally needs to be considered when explaining treatment options to patients with PSP.

The more invasive an intervention, the more likely the patient is to experience a complication. The Joint ERS/EACTS/ESTS clinical practice guidelines on adults with spontaneous pneumothorax outlined comparative complications rates between conservative care, NA, ambulatory care and ICD (Walker et al, 2024). Both ICD and ambulatory care had the most complications, with comparative fewer reported for patients managed with NA and conservative care.

Patient priority is also given significant weight in the new guidelines. Patients should be provided with balanced information on all treatment options available locally to empower them to be involved in the decision. For patients who are keen to avoid a procedure, conservative management may be their choice, but they need to be aware that their symptoms and radiographic findings will take longer to resolve without intervention, and that intervention may be required in the event of deterioration. Patients who wish for rapid resolution of their symptoms or radiographic findings, for example to enable them to fly in the near future, should be encouraged to consider ambulatory care or needle aspiration, with the knowledge that their risk of needing a further procedure and being admitted to hospital is higher with NA. Fig. 4 provides a summary of which patients with PSP are more likely to be suitable for which intervention. The West Midlands Academic Health Science Network has produced a useful resource—My Pneumothorax Journey—which can help support patients in deciding what their priority for treatment is (West-midlands-academic-health-science-network, 2024).

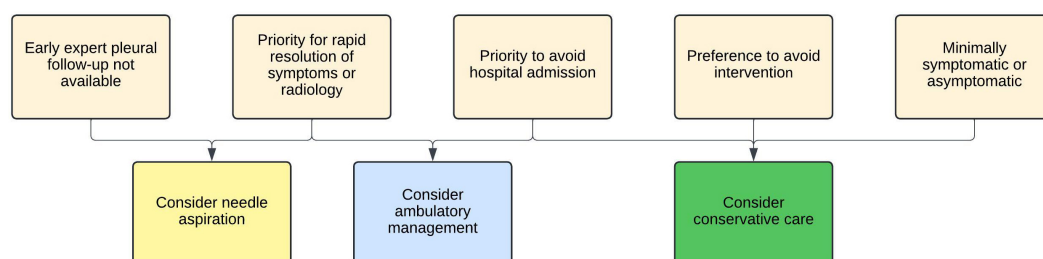


Fig. 4. Decision tree for management of primary spontaneous pneumothoraces (PSP) in absence of adverse features (authors opinion).

Conclusion

Pneumothorax research has made great strides over the last decade, with robust evidence to support both ambulatory and conservative care in PSP. From the result of Brown's study (Brown et al, 2020), a conservative approach in patients with PSP can now be considered, regardless of size of pneumothorax. In this study population, with a low symptom burden who were physiologically well, it was a safe and effective approach. For a more symptomatic or unstable patients, ambulatory management with a flutter valve is an attractive approach for PSP. It can shorten

length of hospital stay compared to a standard approach of NA or ICD, providing there are ambulatory services to support follow-up and manage complications.

NA still has a role for PSP, in patients in whom conservative approach isn't appropriate due to symptom burden and an ambulatory approach isn't appropriate due to patient wishes or lack of supportive infrastructure.

ICD management for PSP should be reserved for patients that don't respond to other initial care or when there are features of cardio-respiratory compromise (tension).

The management of SSP is more challenging, with high rates of treatment failure with an ambulatory approach. Whilst there is supportive data for NA, ICD remains the principal treatment approach.

Key Points

- Conservative management is safe and effective in patients with moderate to large PSP. Due to patient selection in largest RCT, international guidelines could only make recommendations for minimally symptomatic PSP.
- NA is a minimally invasive approach to PSP. However approximately 40% will fail initial aspirations and require an ICD. The evidence for patients with SSP is still exploratory.
- Ambulatory management for PSP is an effective method for minimising length of hospital stay. RCTs on initial ambulatory management for SSP have shown high rates of treatment failure. It is unclear if this is device-specific.
- Clinicians should be alert for the presence of adverse features in patients with SP; haemodynamic instability, significant hypoxia, the presence of bilateral pneumothoraces or a haemopneumothorax, or patients with underlying lung disease/smokers over the age of 50. Any of these factors are an indication for ICD insertion.

Availability of Data and Materials

All the data of this study are included in this article.

Author Contributions

ECB and SPW designed the research study. ECB and SPW drafted the manuscript. Both authors contributed to important editorial changes in the manuscript. Both authors read and approved the final manuscript. Both authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

Not applicable.

Acknowledgement

Not applicable.

Funding

This research received no external funding.

Conflict of Interest

The authors declare no conflict of interest.

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