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Original Research Article

A storm or a storm in a teacup? A retrospective review of spontaneous pneumomediastinum at a tertiary Australian Hospital

Georgia T. Cox*, Madison B. Bowles, Jessica Ng, Philip Townend, Leigh Rutherford, David Parker

Department of Surgery, Gold Coast University Hospital, Queensland, Australia

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***Correspondence:**
Dr. Georgia T. Cox,
E-mail: Georgia.cox@health.qld.gov.au

ABSTRACT

Background: Spontaneous pneumomediastinum (SP) is defined as the presence of free air in the mediastinum without a clear precipitating cause. Whilst uncommon and with a relatively benign course, SP is often thoroughly investigated by surgeons as spontaneous oesophageal perforation (Boerhaave's syndrome) must be identified early due to high morbidity and mortality. This study aimed to evaluate current practice in the investigation and management of SP at our institution.
Methods: All patients with imaging-confirmed pneumomediastinum at a tertiary hospital from 2014 to 2022 were reviewed. Those with precipitating trauma, recent surgery or aerodigestive instrumentation were excluded.
Results: 70 patients were included; 4 (5.7%) patients were diagnosed with Boerhaave's syndrome based on computed tomography (CT) evidence of oesophageal injury alone and were treated with immediate surgery. The remaining 66 patients were diagnosed with SP. In this group, common predisposing factors were young age, smoking, illicit drugs and alcohol. The lead presenting symptoms were dyspnoea, chest pain, vomiting and cough. Of the 13 different admitting specialties, respiratory and upper gastrointestinal surgery were most common. Of those patients diagnosed with SP, 37 (54%) patients underwent imaging to exclude oesophageal injury; 30 (43%) were assessed using CT with oral contrast, 16 (23%) had a fluoroscopic contrast oesophagram, and 9 were investigated with both modalities.
Conclusions: SP is uncommon, benign and does not require operative intervention. Multiple specialities manage SP at our institution and the use of imaging modalities differs between teams. We propose a management algorithm to assist clinicians unfamiliar with SP, risk-stratify patients for oesophageal injury and avoid unnecessary investigation.

Keywords: Spontaneous pneumomediastinum, Hamman's syndrome

INTRODUCTION

Spontaneous pneumomediastinum (SP) is defined as the presence of free air in the mediastinum without a clear precipitating cause.[1-3] It can be referred to as Hamman's syndrome, after being first described in 1939 by clinician Louis Hamman.[1,3] The pathophysiology is believed to be a result of alveolar rupture, secondary to the pressure gradient between the pulmonary interstitium and the alveoli. Escaped air in the interstitium then flows along the pressure gradient to the mediastinum and hilum.[1-3]

Whilst uncommon and with a relatively benign course, it is imperative that it is differentiated from more sinister conditions such as spontaneous oesophageal perforation (Boerhaave's syndrome) which often presents with pneumomediastinum on imaging. This study aimed to evaluate current practice in the investigation and management of SP at our institution.

METHODS

A retrospective chart review of patients with imaging-confirmed pneumomediastinum at Gold Coast University Hospital (GCUH) from January 2014 to December 2022 was performed. GCUH is a tertiary hospital located in Queensland, Australia. The study was approved by the GCUH Human Research and Ethics Committee (EX/2023/QGC/89762).

A list of patients with interstitial emphysema or spontaneous pneumomediastinum from 2014 to 2022 were identified in the electronic medical record (EMR) under the data code J98.2. The local imaging platform (inteleconnect) was searched to determine if patients from this list had pneumomediastinum on imaging at presentation. Confirmation of pneumomediastinum required reporting radiologist to comment on its presence. All patients with pneumomediastinum confirmed through chest X-ray or computerised tomography (CT) were included. Exclusion criteria were as follows: precipitating trauma, recent surgery or aerodigestive instrumentation. Information required for the study was obtained from the patient's EMR. Demographic information, presenting symptoms, admitting speciality, risk factors, diagnostic imaging modalities and management strategies were collected and tabulated using Microsoft excel. Percentages of each data field were calculated. No other statistical software was utilised for this study.

RESULTS

A total of 70 patients were included in the study. 4 (5.7%) patients were diagnosed with Boerhaave's syndrome. All 4 of these patients presented to the emergency department (ED) clinically unwell and urgent CT revealed evidence of oesophageal injury without the need for oral contrast. These 4 patients were treated with immediate surgery, booked within hours of presentation.

The remaining 66 patients were diagnosed with SP and further analysis was taken of this cohort (Figure 1).

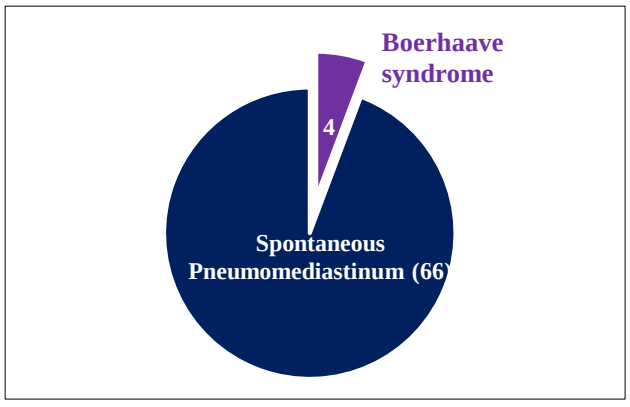

Figure 1: Pneumomediastinum cohort without clear precipitating cause.

Of those diagnosed with SP, 47 (71%) were male. The median age of presentation was 22 years with a range of 5-83 years (Table 1). The lead presenting symptoms were dyspnoea (39%), chest pain (24%), vomiting (23%) and cough (23%) (Figure 2). Other less common symptoms included sore throat, syncope and dysphagia.

Table 1: General characteristics (total patients=66).

Characteristics	Frequency (%)
Age (years)	
Mean	24.8
Median	21.5
Gender	
Male	47 (71.0)
Female	19 (29)
Length of hospital stay	
Average (days)	2.71

Common predisposing factors were young age, smoking, illicit drugs, alcohol intoxication and pre-existing lung disease (Figure 3).

13 different specialities admitted SP patients at our institution. Respiratory and upper gastrointestinal (UGI) surgery was the most common with 24% and 18% of the cohort respectively (Figure 4).

Other treating teams included general medicine, cardiothoracic surgery (CTS) and the acute surgical unit (ASU). 15 (23%) of patient were assessed in the ED and discharged home without hospital admission. 28 (41%) patients did not receive any surgical consultation throughout their hospital stay.

All patients were initially diagnosed with pneumomediastinum on a chest X-ray or CT. 37 (54%) patients underwent further diagnostic imaging to exclude oesophageal injury. 30 (43%) were assessed using CT with oral contrast, 16 (23%) had a fluoroscopic contrast oesophagram, and 9 were investigated with both modalities. Only 3 (4.3%) patients underwent an endoscopy (Table 2).

Table 2: Investigations subsequent to chest X-ray.

Investigation	Number	Percentage
Ct oral contrast	28	42.42
Ct oral contrast and barium swallow	9	13.64
Barium swallow only	7	10.61
Endoscopy	3	4.55
No subsequent imaging	31	46.97

The average length of inpatient hospital stay was 2.71 days with a range of 0-40 (Table 1). There was no mortalities or representations within 7 days of discharge.

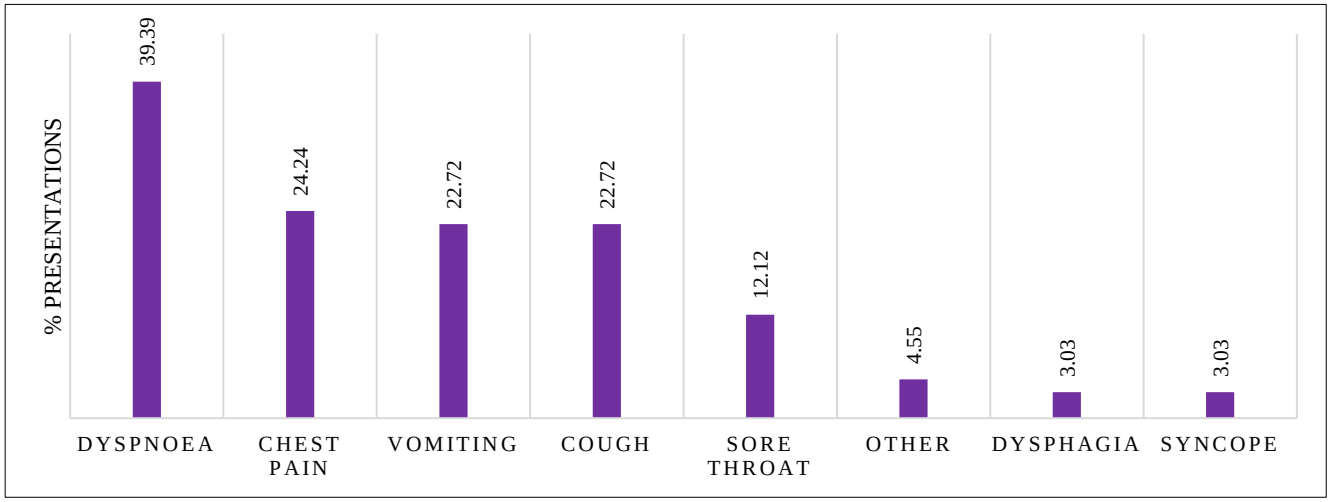

Figure 2: Spontaneous pneumomediastinum presenting symptoms.

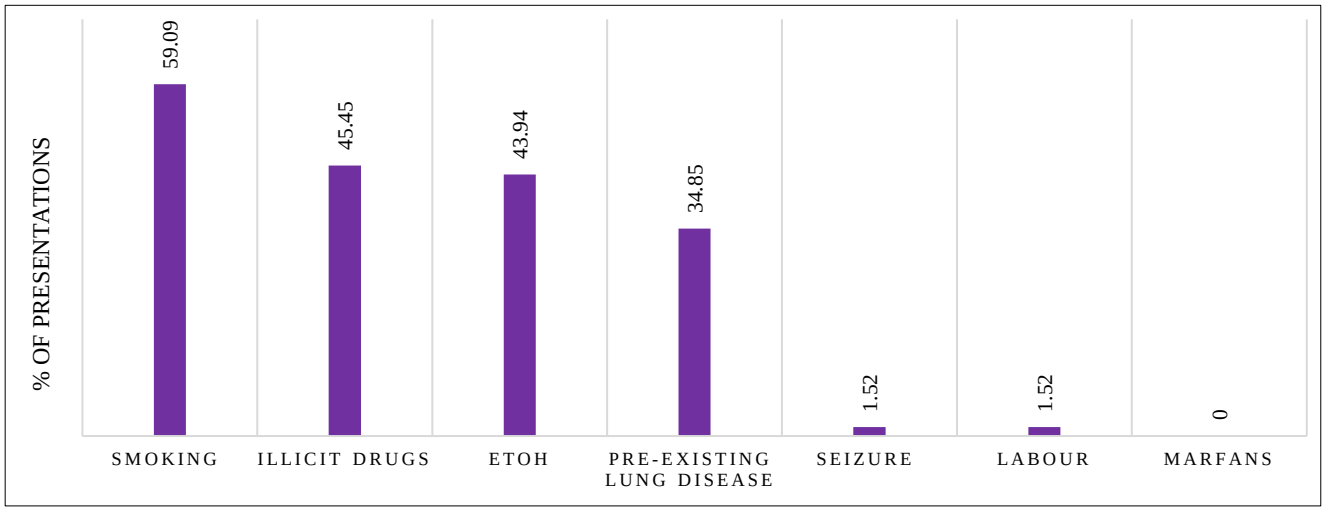

Figure 3: Spontaneous pneumomediastinum predisposing factors.

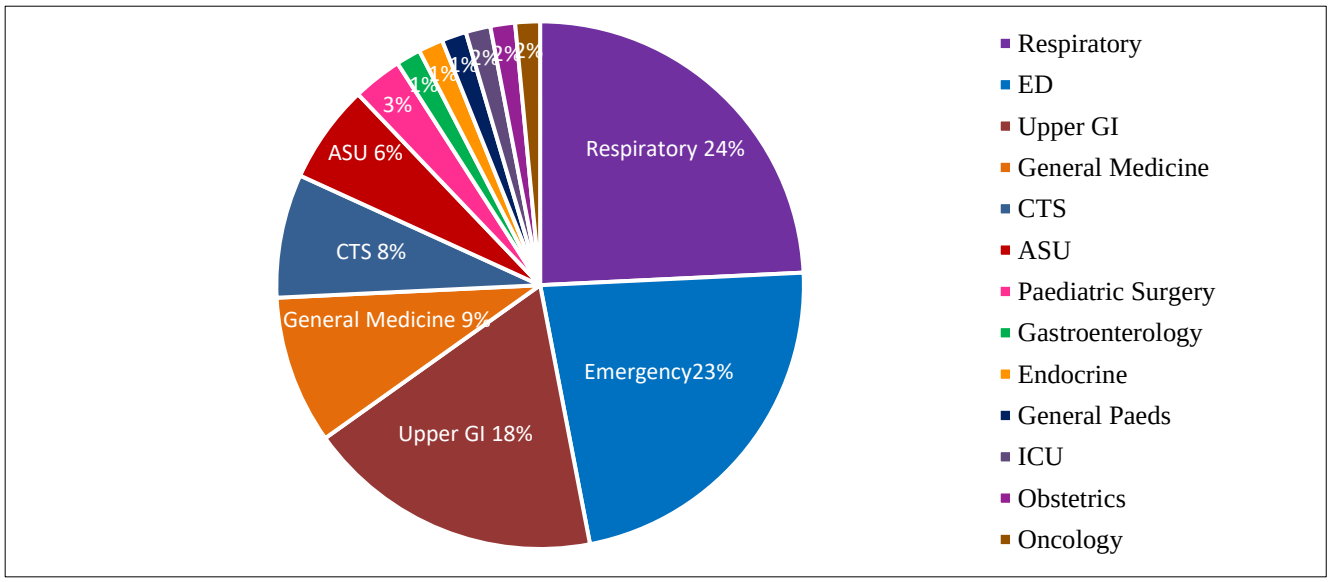

Figure 4: Admitting team.

DISCUSSION

Pneumomediastinum is an uncommon condition in which free air is present within the mediastinum.[1,4,5] The mediastinal cavity is the area within the chest which is demarcated by the thoracic inlet superiorly, diaphragm inferiorly and pleural cavities laterally.[4]

The condition can be categorised according to its aetiology into secondary pneumomediastinum or spontaneous pneumomediastinum (SP).[1,4,5] Secondary mediastinum is that which occurs as a result of physical trauma, infection surgery or iatrogenically during procedures like endoscopy.[4,5] This occurs either from a mediastinal infection containing gas-producing organisms, or via rupture of the mucosal barriers of the tracheobronchial tree or oesophagus.[4,5]

SP encompasses cases in which no clear causative factor is identified.[1,4,5] The pathophysiology is believed to be secondary to alveolar rupture, also known as the Macklin phenomenon.[1,4,5,8] This rupture is thought to occur as a result of high intra-alveolar pressure or low peri-vascular pressure, or both.[8] The subsequent escaped air flows into the mediastinum during the breathing cycle as the pressure within the mediastinal cavity is reduced relative to the pulmonary parenchymal pressure.[8]

Precipitating factors of SP reported in the literature include asthma, inhalation of toxic agents or illicit substances or the valsalva manoeuvre that occurs with straining or vomiting. The frequency of precipitating smoking, illicit drug use and recent alcohol intake is particularly evident in our cohort. Existing literature reports labour and seizures however the incidence of these precipitating events in our cohort was low (Figure 3).

SP most frequently affects young males in our study which agrees with current data.[1,2,4-6] It primarily presents with symptoms such as chest or neck pain, dyspnoea, cough, or dysphagia.[1-5] Clinical signs include the presence of subcutaneous emphysema or Hamman's sign. This sign can be detected via auscultation, in which crackles synchronised with cardiac contraction are heard.[2,3] Despite Hammans sign being highly suggestive of this condition, it is present in under half of cases.[2,3] The detection of Hamman's sign in our cohort is unknown.

Spontaneous pneumomediastinum is rare with some case series reporting an incidence of 1 in 44,500.[3,5] Many however believe SP occurs more frequently but is under diagnosed due to patients either not seeking medical attention or being misdiagnosed given the multiple other cardiopulmonary pathologies that can cause chest pain or dyspnoea.[4,5]

The diagnosis can be made through various imaging modalities. Chest X-rays remain an inexpensive, accessible and quick investigation with a high sensitivity if both postero-anterior and lateral views are performed.[2] The main diagnostic features include linear images of gas in the mediastinum which typically extends to the neck, in addition of collections of air delineating the upper airways, mediastinal blood vessels, heart and oesophagus.[2] Chest X-ray and non-contrast CT imaging however are usually insufficient in differentiating between SP and oesophageal perforation.[8]

Both CT with oral contrast and barium swallow studies (also known as fluoroscopic contrast oesophagram) are viable options in assessing oesophageal perforation. Whilst barium swallow has traditionally been regarded as the gold-standard diagnostic modality for diagnosis of oesophageal perforation (sensitivity 77.8%, specificity 98.9%, PPV 87.5%, and NPV 97.9%), there is a growing body of literature suggesting that CT with oral contrast has a higher sensitivity (100%) and a similar negative predictive value (100%) to that of a barium swallow.[8,9] In addition, CT with oral contrast is more widely accessible out of hours and in other institutions.[8] Evidence has also shown that barium swallow studies do not provide additional information that changes clinical management beyond the information that is provided by CT with oral contrast.[9]

UGI endoscopy is another investigation that could be considered to assess for oesophageal injury in patients with pneumomediastinum, endoscopy has a sensitivity of 100% and specificity of 80% in detecting Boerhaave's.[10]

Endoscopies are more invasive than imaging modalities and carry a risk of enlarging the oesophageal rupture and subsequently worsening the pneumomediastinum. This modality of investigation has a limited role in investigation pneumomediastinum in patients who has not had recent surgery, endoscopy or other instrumentation like intubation. It may be considered in patients with a high suspicious of perforation with negative radiography, or when swallowing a contrast agent is impossible for technical reasons.[11]

As seen in this data, SP follows a relatively benign course and does not require operative management. Therapies should be directed towards symptom relief such as analgesia and rest.[1,2,5,8] Administration of oxygen may increase gas absorption by sixfold and therefore may be considered.[5] There is no evidence supporting the use of antibiotics unless there is diagnostic uncertainty with concern for other possible aetiologies.[8] Patients can be safely discharge home, without routine follow-up, if they are well and do not have a co-existing significant pneumothorax.[8] There were no mortalities or 7-day recurrences identified in our study, which corresponds with the literature where there have no reported mortalities following spontaneous pneumomediastinum and approximately 1% chance of recurrence.[3,5,8]

The question then becomes; which patients require further investigation to assess for oesophageal perforation? The rare incidence of this condition and the paucity of data

makes this question difficult to answer. Nevertheless, it is clear there is a diversity of specialists involved in the care of these patients and significant variations in practice amongst different teams. Certain patients will be investigated with multiple modalities whilst others have none and are discharged home the same day. The UGI surgery team at our institution propose an algorithm to assist clinicians' hospital wide to ensure patient safety whilst avoiding the over-investigation of well patients. We recommend the algorithm seen in Figure 5 which suggests that if a patient, who has CT confirmed pneumomediastinum, has any concerning signs for oesophageal injury, (clinically unwell, vomiting or free fluid is seen in the mediastinum) further investigation with CT with oral contrast should be considered. In the absence of these sinister features, we suggest symptomatic management alone (Figure 5).

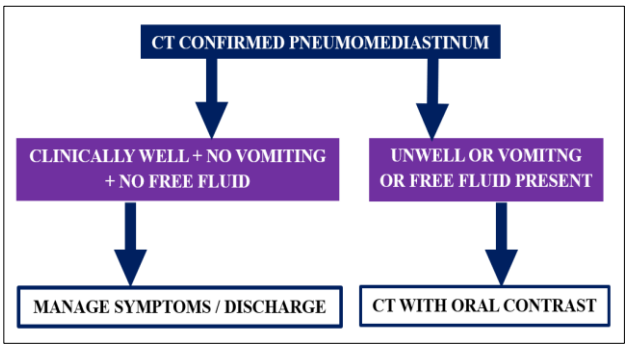

Figure 5: Investigation algorithm proposed for pneumomediastinum in the absence of a clear precipitating cause.

*If ongoing high clinical suspicion despite reassuring CT with oral contrast, can consider barium swallow

There are several limitations to this study. Possibly the most apparent is its retrospective nature. By design, it relies on accurate recordkeeping with the inherent risk of missing or inaccurate data. Therefore, presenting symptoms and risk factors may have been underestimated if detailed history and documentation was not performed. Secondly, the size of our cohort was small. All patients who met the inclusion and exclusion criteria during the defined time period were included, and therefore, the cohort size could not be increased. Data codes recorded in EMR were used to identify patients with pneumomediastinum. Given the EMR was only implemented at our institution in 2014, we were unable to collect data prior. Nevertheless, there are in fact very few studies in the literature that include a cohort of SP patients greater than 100. Furthermore, the limited number of Boerhaave syndrome presentation to GCUH between 2014 and 2022 resulted in the inability to extrapolate definitive conclusions from this data. As only four Boerhaave syndrome cases were identified, it was not possible to compare their risk factors to those patients diagnosed with SP in order to service a more detailed and evidence-based management algorithm. Despite its limitations, this study contributes to the paucity of current Australian articles on this topic and provides insights into the investigation and management of SP amongst different specialities within the hospital.

CONCLUSION

SP is uncommon, benign and does not require operative intervention. However, it needs early differentiation from Boerhaave syndrome. Multiple specialities, both surgical and medical, manage SP at our institution and the use of imaging modalities differs between teams. We propose a management algorithm to assist clinicians unfamiliar with the condition, risk-stratify patients for oesophageal injury and avoid unnecessary investigation.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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