ORIGINAL ARTICLE

Management of patients admitted with pneumothorax: a multi-centre study of the practice and outcomes in Hong Kong

CME

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Objective To examine the management practice of pneumothorax in hospitalised patients in Hong Kong, especially the choice of drainage options and their success rates, as well as the factors associated with procedural failures.

Design Retrospective study.

Setting Multi-centre study involving 12 public hospitals in Hong Kong.

Patients All adult patients admitted as an emergency in the year 2004 with a discharge diagnosis of 'pneumothorax' were included. Data on the management and outcomes of the various types of pneumothoraces were collected from their case records.

Results Altogether these patients had 1091 episodes (476 primary spontaneous pneumothoraces, 483 secondary spontaneous pneumothoraces, 87 iatrogenic pneumothoraces, and 45 traumatic pneumothoraces). Conservative treatment was offered in 182 (17%) episodes, which were more common among patients with small primary spontaneous pneumothoraces (71%). Simple aspiration was performed to treat 122 (11%) of such episodes, and had a success rate of 15%. Aspiration failure was associated with having a pneumothorax of size 2 cm or larger (odds ratio=3.7; 95% confidence interval, 1.2-11.5; P=0.03) and a smoking history (4.1; 1.2-14.3; P=0.03). Intercostal tube drainage was employed in 890 (82%) episodes, with a success rate of 77%. Failure of intercostal tube drainage was associated with application of suction (odds ratio=4.1; 95% confidence interval, 2.8-5.9; P<0.001) and presence of any tube complications (1.55; 1.0-2.3; P=0.03). Small-bore catheters (<14 French) were used in 12 (1%) of the episodes only. Tube complications were encountered in 214 (24%) episodes.

Conclusion Notwithstanding recommendations from international guidelines, simple aspiration and intercostal tube drainage with small-bore catheters were not commonly employed in the management of hospitalised patients with the various types of pneumothoraces in Hong Kong.

Introduction

Despite the presence of guidelines for the management of pneumothorax,[1-4] considerable variations in practice have been reported in studies carried out in various countries.[5-13] Many such studies were either simple surveys,[5,7,9-11] or small retrospective single-centre audits.[6,7,12] In addition, most studies only described the practice for managing primary spontaneous pneumothorax (PSP).[7-9,13] Despite the advocacy of less invasive interventions such as simple aspiration (SA)[1,3,4] and intercostal tube drainage (ITD), and use of small-bore catheters[2-4] in the management of spontaneous pneumothorax (SP) and especially for PSP, many studies have revealed suboptimal adherence to such guidelines.[5-13] In this study, we aimed to examine the management practice of pneumothorax in hospitalised patients in Hong Kong, especially regarding the choice of drainage options and their success rates, as well as the factors associated with procedural failures.

Methods

Study design and patients

A multi-centre retrospective study was carried out in 12 public hospitals in Hong Kong,

治療氣胸的方法和效果：香港多間醫院參與的研究結果

目的 探討香港治療氣胸的方法，尤其是對於不同引流方法的選擇和其成功率，以及失敗的原因。

設計 回顧研究。

安排 香港十二間公營醫院。

患者 於2004年因「氣胸」這診斷而經急症入院的成年病人，都會成為本研究的對象。從他們的病歷紀錄中，用搜集到的數據（如治療氣胸的方法及結果）作進一步分析。

結果 2004年共有1091次住院紀錄（476次原發性自發性氣胸、483次繼發性自發性氣胸、87次醫源性氣胸、45次外傷性氣胸）。其中有182次（17%）採取保守治療，而細小的原發性自發性氣胸較多採用這種處理方法（71%）。在122次（11%）採用刺針吸引法的病例中，成功率只有15%。2 cm或以上的氣胸（比數比=3.7；95%置信區間：1.2-11.5；P=0.03）和有吸煙史（4.1；1.2-14.3；P=0.03）與刺針吸引法失敗有關。在890次（82%）採用胸腔導管引流的病例中，成功率有77%。採用吸力引流（比數比=4.1；95%置信區間：2.8-5.9；P<0.001）和胸腔導管併發症的發生（1.55；1.0-2.3；P=0.03）與胸腔導管引流失敗有關。在胸腔導管引流的病例中，只有12個（1%）採用較小的導管（<14 F），而導管併發症則在214個病例中（24%）出現。

結論 儘管國際指引推介刺針吸引法和採用較小的導管作胸腔引流來治療氣胸，這兩種方法在香港仍未被普遍採用於因氣胸而需入院治理的病人。

including two university-affiliated institutions. The case records of adult patients with emergency admissions between 1 January 2004 and 31 December 2004 with a discharge diagnosis of 'pneumothorax' were retrieved and studied. Cases with the International Classification of Diseases 9th revision (ICD9) diagnostic codes of 512, 011.7 and 860 were identified by Clinical Data Analysis and the Reporting System of the Hong Kong Hospital Authority. Cases were subsequently excluded if (a) the actual diagnosis upon review was not pneumothorax; (b) the age was less than 18 years; (c) the patient had been transferred from another hospital or electively admitted for procedures related to the pre-existing pneumothorax; and (d) the record could not be retrieved despite repeated attempts. Data such as demographic information, type of pneumothorax, smoking status, underlying respiratory diseases, co-morbid conditions, previous pneumothoraces, management, outcomes, and length of stay were also collected. Secondary spontaneous pneumothorax (SSP) was defined as a pneumothorax associated with underlying lung diseases, and without these, it would be regarded as a PSP. Those with iatrogenic or traumatic aetiologies (ie non-spontaneous) were categorised as iatrogenic pneumothorax (IP) and traumatic pneumothorax (TP), respectively, regardless of any pre-existing respiratory diseases. The size of the pneumothorax was categorised as 'small' (<2 cm) or 'large' (≥2 cm), depending on the maximal distance between the lung margin and chest wall,[3] by reviewing case notes and, if necessary, any available chest radiographs. Successful resolution following SA and ITD was defined as complete lung expansion without the need for further interventions (SA, ITD, or surgery) during the same admission. Approval from the ethics committees of participating hospitals was obtained prior to the study.

Statistical analysis

Results were expressed as mean and standard deviation (SD) or median and interquartile range (IQR) values for continuous variables, or numbers (percentages) for categorical data. Student's *t* test or the Mann-Whitney *U* test were used to compare the differences between continuous variables as appropriate, while the Pearson χ^2 or Fisher's exact test were used to compare categorical data. Missing values were imputed using the maximisation method. Multiple logistic regression was used to determine the independent factors affecting the management outcomes. Results were reported as adjusted odds ratios with 95% confidence intervals. All tests of statistical significance were two-sided, unless otherwise stated. A P value of less than 0.05 was considered statistically significant. The analysis was performed using the Statistical Package for the Social Sciences (Windows version 11.0; SPSS Inc, Chicago [IL], US).

Results

Among the 1119 episodes of 'pneumothorax' identified using the ICD9 diagnostic codes, 28 were subsequently excluded (10 were in patients aged <18 years, seven did not have pneumothorax after case record review, two were electively admitted for surgery, and for nine episodes hospital records were missing). Altogether 1091 episodes (1057 patients) were included in the analysis. The mean age of the patients was 51 (SD, 24) years, and 935 (86%) of the episodes were in males. Almost 90% of the episodes were SPs (Fig). For most of the episodes (825, 76%), the patients were admitted to general medical wards, but to surgical wards for 128 (12%) and respiratory medical wards for 117 (11%) of the episodes. The pneumothorax was right-sided in 576 (53%), left-sided in 489 (45%), and bilateral in 26 (2%) instances. Smoking status of the patient was available for 993 of

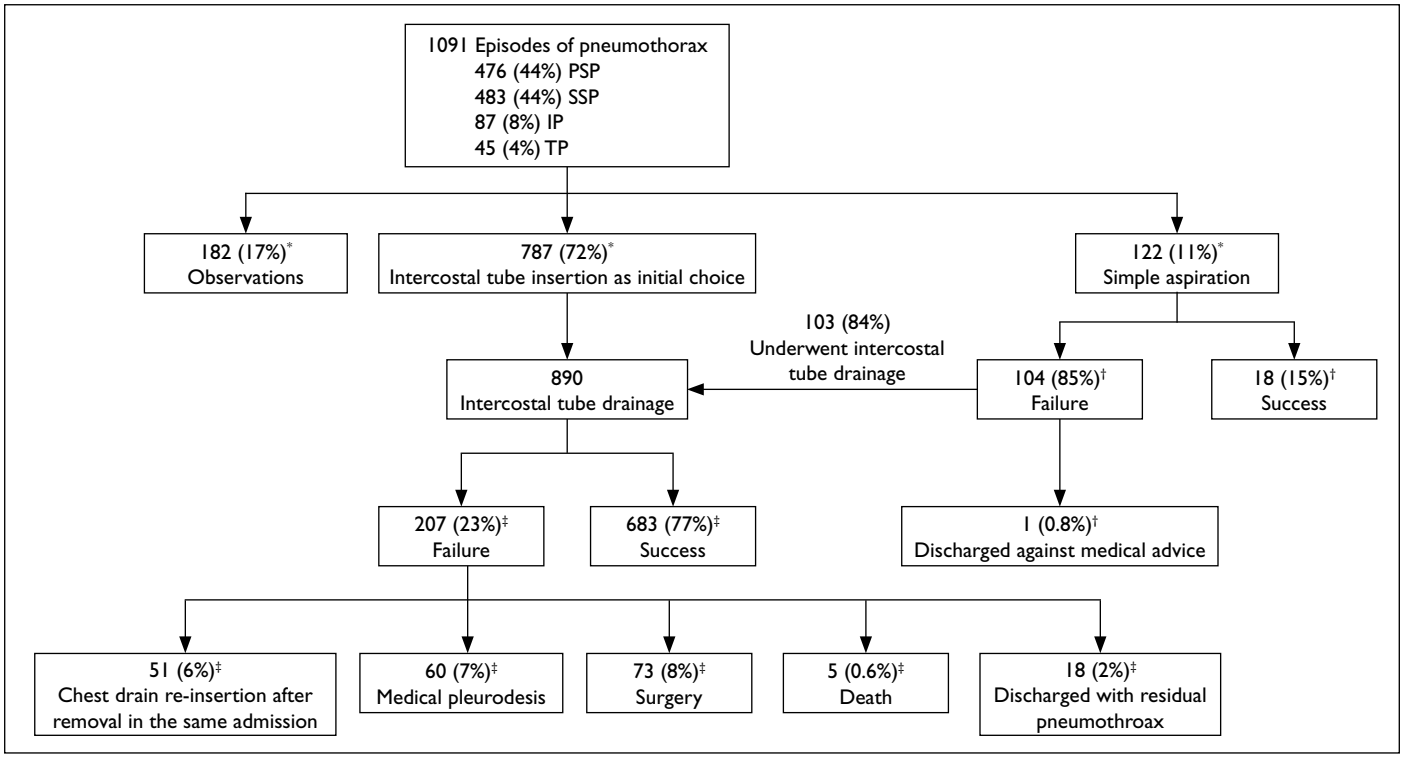

FIG. Management and outcomes of the 1091 episodes of pneumothorax

PSP denotes primary spontaneous pneumothorax, SSP secondary spontaneous pneumothorax, IP iatrogenic pneumothorax, and TP traumatic pneumothorax

* % based on all episodes of pneumothorax (n=1091)

† % based on all episodes of initial simple aspiration (n=122)

‡ % based on all episodes of intercostal tube drainage (n=890)

the episodes; for 713 (65%) they were either current or ex-smokers. The most common underlying respiratory diseases in patients with SSP were chronic obstructive pulmonary disease (287 episodes, 59%), old pulmonary tuberculosis (194 episodes, 40%) and malignancy (37 episodes, 8%), and in 154 (32%) more than one respiratory disease was present. Other medical co-morbidities were encountered in patients in the course of 285 (26%) episodes, and included diabetes mellitus, cardiovascular and cerebrovascular diseases. In 327 (30%) of the episodes, the patients gave a history of pneumothorax, ranging from once (218, 20%) to 8 times (1, 0.1%). Size categorisation was possible in 1003 (92%) episodes; 289 (27%) being 'small' and 714 (65%) 'large'. Chest pain or breathlessness were associated with 964 (88%) of the episodes. For the diagnosis of pneumothorax, a posteroanterior chest X-ray was the sole investigation used in 940 (86%) episodes. Additional expiratory, lateral, and decubitus radiographs were obtained for 77 (7%), 68 (6%), and 6 (0.5%) of the episodes, respectively. Computed tomography was used for 42 (4%) of the episodes.

The management of the 1091 episodes is summarised in the Figure and the choice of initial options selected are shown in Table 1. Oxygen was prescribed to patients in the course of 897 (82%) episodes. Simple observation only was employed in 182 (17%) of the episodes, including 76 (16%) of PSP, 70 (14%) of SSP, 30 (34%) of IP, and 6 (13%) of TP. The commonest categories of pneumothorax for which the patients were monitored conservatively were small PSPs, small SSPs, and IPs (Table 1).

TABLE 1. Choice of initial management options for the various types of pneumothorax

Types of pneumothorax	Initial choice (%)		
	Observation	Aspiration	Chest drain
Primary SP*			
Overall (n=476)	16	17	67
Size <2 cm (n=95)	71	10	20
Size ≥2 cm (n=351)	2	18	80
Secondary SP			
Overall (n=483)	14	7	73
Size <2 cm (n=145)	43	6	52
Size ≥2 cm (n=290)	2	9	89
Iatrogenic pneumothorax (n=87)	34	6	60
Traumatic pneumothorax (n=45)	13	2	84

* SP denotes spontaneous pneumothorax

TABLE 2. Multivariate logistic regression analyses of factors associated with outcomes of simple aspiration (n=122)

Factor	No. (%)		Adjusted odds ratio (95% confidence interval)	P value
	Successful aspiration (n=18)	Failed aspiration (n=104)		
Male sex	15 (83)	92 (88)	1.39 (0.29-6.63)	0.68
Age >50 years	4 (22)	33 (32)	0.78 (0.17-3.60)	0.75
Smoking history (ex- or current smokers)	6 (33)	66 (63)	4.11 (1.20-14.31)	0.03
Secondary spontaneous pneumothorax	2 (11)	33 (32)	6.34 (0.72-55.61)	0.10
Pneumothorax size ≥2 cm	10 (56)	83 (80)	3.65 (1.16-11.46)	0.03
Presence of >1 respiratory co-morbidity	1 (6)	11 (11)	0.33 (0.02-6.94)	0.47

Simple aspiration

Simple aspiration was performed for 122 (11%) of the episodes; 80 (66%) by doctors in the emergency departments, 32 (26%) in general medical wards, and 5 (4%) each in respiratory medical and thoracic surgical wards. The success rate was only 15%, with subsequent ITD being undertaken in 103 cases, including one after failure of repeated SAs (Fig). In all, SA was performed for 81 (17%) of PSP episodes, 35 (7%) of SSP episodes, 5 (6%) of IP episodes, and 1 (2%) episode of TP yielded success rates of 19%, 6%, 20% and 0%, respectively. No complications were encountered. A past or current smoking history, and a 'large' pneumothorax (≥2 cm) were associated with procedural failures (Table 2). Only a smoking history was associated with aspiration failures, when PSP episodes were analysed separately (P=0.03).

Intercostal tube drainage

Intercostal tube drainage was carried out for 890 (82%) of the episodes. In the 655 (74%) episodes in which the catheter sizes were documented, a size larger than 24-French (F) was the most popular (293 episodes, 33%), followed by 20-24F (275 episodes, 31%) and 14-18F (75 episodes, 8%). Catheters of smaller than 14F were used for 12 (1%) episodes only. Patients admitted to surgical wards had larger tubes (>20F) than those managed by physicians (87% vs 74%, P<0.01), while those under the care of general physicians had larger tubes than those managed by respiratory physicians (94% vs 85%, P=0.03). More than one drain was used in 86 (10%) episodes. Suction was applied to chest tube in 446 (50%) episodes. The timing in relation to tube insertion was available in 437 instances. Suction was commenced immediately, 24 hours, and 48 hours after tube insertion in 162 (37% of ITD with suction), 88 (20%) and 187 (43%) episodes, respectively. Clamping before tube removal was practised in 382 (43%) episodes. Complications of ITD were identified in 214 (24%) episodes (Table 3). The overall success rate of ITD was 77%. Subsequent surgery or chemical pleurodesis was carried out for 133 (15%) episodes, because of persistent leakage and failure of lung expansion. Successful ITD for PSP, SSP, IP and TP were noted in 283 (74%), 314 (77%), 51 (91%), and 35 (90%) of the episodes, respectively. Presence of any intercostal tube complication and application of suction were independently associated with ITD failure (Table 4). However, 'early' application of suction (within 24 hours of tube insertion) was not associated with a higher failure rate; respective early and late suction failure rates being 39% and 32% (P=0.19). When analysed separately, application of suction remained the only factor associated with ITD failure for PSP (P<0.001) and SSP (P<0.001) episodes.

TABLE 3. Complications associated with intercostal tubes (n= 890)

Complication	No. (%)
Aberrant placement of chest drain	18 (2)
Penetration of internal organs	20 (2)
Haemorrhage	19 (2)
Surgical emphysema	99 (11)
Exit site infection	16 (2)
Empyema thoracis	2 (0.2)
Kinking or blockage of chest tubes	29 (3)
More than 1 complication	26 (3)
No complication	678 (76)

Referrals to respiratory physicians were made for 312 (29%) of the episodes, at a mean interval of 3.6 (SD, 3.7) days, while referrals to thoracic surgeons were made for 388 (36%) at a mean interval of 5.2 (SD, 6.7) days after admission. For 30 (3%) episodes, the patients received intensive care, of whom 29 also received mechanical ventilation. Their median length of stay in hospital was 10 (IQR, 6-18) days, although other co-morbidities also contributed to the length of hospitalisation in 227 (21%) of these episodes. The median length of stay for patients whose episodes were managed by observation alone was 5 (IQR, 3-7) days. Patients undergoing SA only had a significantly shorter median length of stay compared to those having ITD only (9 [IQR, 5-16] days vs 12 [IQR, 7-20] days; P<0.01).

TABLE 4. Multivariate logistic regression analyses of factors associated with outcomes following intercostal tube drainage (n=890)

Factor	No. (%)		Adjusted odds ratio (95% confidence interval)	P value
	Successful chest drain management (n=683)	Failed chest drain management (n=207)		
Male sex	589 (86)	184 (89)	0.861 (0.51-1.46)	0.58
Age >50 years	367 (54)	109 (53)	0.911 (0.59-1.41)	0.67
Smokers	450 (66)	148 (72)	1.447 (0.98-2.15)	0.07
More than 1 underlying respiratory disease	112 (16)	29 (14)	0.757 (0.45-1.28)	0.30
Secondary spontaneous pneumothorax	314 (46)	97 (47)	1.023 (0.67-1.57)	0.92
Pneumothorax size >2 cm	529 (78)	160 (77)	1.140 (0.76-1.71)	0.52
Need more than 1 intercostal tube	53 (8)	33 (16)	1.318 (0.78-2.24)	0.31
Application of suction	288 (42)	158 (76)	4.087 (2.82-5.92)	<0.001
Clamping chest drain before removal	306 (45)	76 (37)	0.81 (0.57-1.14)	0.23
Presence of any tube complications	143 (21)	69 (33)	1.55 (1.04-2.32)	0.03
Simple aspiration attempted before tube insertion	72 (11)	31 (15)	1.15 (0.71-1.88)	0.57
Not managed in respiratory wards	625 (92)	190 (92)	0.94 (0.51-1.72)	0.84

Discussion

To the best of our knowledge, this is one of the largest studies assessing the management practice of adult subjects hospitalised with pneumothorax,[5-13] and also the first study of its kind in Hong Kong. In contrast to previous surveys that employed hypothetical scenarios,[9-11] this study assessed the actual clinical management provided. Since the study involved a majority of public hospitals in Hong Kong, it provides representative data reflecting current local practice.

The finding that most patients with 'small' PSPs were offered simple observation is in line with the guidelines.[1-4] Our study also revealed that SA was not commonly performed by Hong Kong doctors, including respiratory physicians. Previous studies also revealed that SA was not a favoured strategy,[7,8,12] especially among the general physicians,[6] and for SSPs and PSPs of 'intermediate' size.[9,10] Such findings appear strange in the light of comparable studies[14-17] and systematic reviews[18,19] that have demonstrated similar immediate success rates for SA and ITD in patients with PSP. Additional advantages of SA include: shorter hospital stays,[14,17,18] less pain,[14] and fewer patients requiring hospitalisation.[16,17] However, the role of SA itself also differs between different guidelines. While the British Thoracic Society (BTS) proposes SA as first-line treatment for all PSPs, small SSPs and IPs deemed to need intervention,[3] the American College of Chest Physicians (ACCP) Delphi Consensus Statement (2001) stated that SA is only rarely appropriate in usual clinical circumstances.[2] In our study, a low immediate success rate was noted for SA, in contrast to previously reported rates of 59 to 80%.[14-17] Since earlier studies from emergency medicine specialists in Hong Kong had reported an immediate success rate of 51% and a 1-year recurrence rate of 18%,[20,21] our low success rate was possibly due to subject selection criteria. As we only recruited hospitalised patients; those successfully treated by aspiration in the Emergency Department without admission to hospital were not captured. Owing to shorter hospital stays[14,17,18] and impressive success rates in countries where SA is widely practised, this simple intervention deserves more local attention in the future. The finding that a 'large' pneumothorax was associated with failure of SA was in line with BTS guidelines,[3] whereas we did not find similar associations with the other two known risk factors, namely SSP and age exceeding 50 years. Although smoking has been associated with the development and recurrence of SP,[22,23] the exact explanation for this association with SA failure is unclear.

Notably, tubes of relatively large size (>20F) were more commonly selected for ITD. In the absence of evidence supporting the use of larger tubes (20-24F), the BTS guidelines recommend the initial use of small-bore tubes in SP, except when there was a persistent air leak.[3] There was also 'good consensus' about using small-bore catheters (≤14F) in clinically stable patients with large PSPs, and according to ACCP guidelines this preference could also be extended to accommodate patient preference for those with small SSPs.[2] A high success rate has been reported with the use of small-bore catheters for SP and IP.[24] Although there were concerns about occlusion with these catheters,[2] recent studies reported that the risk was small,[25,26] though other complications such as catheter displacement were quite frequent.[25,27] In our study, the complication rate (24%) of intercostal tubes was similar to that reported elsewhere for in-patients.[28] The observation that tube complications could predict failure of drainage is not surprising, since optimal function of the catheters becomes compromised.

Arguably, suction could have been confined to the more 'difficult' cases, yet its immediate application after tube insertion was noted in 36% of the episodes. For SP, IP and post-lobectomy patients, earlier studies have shown that suction was not associated with better outcomes compared to using underwater seal drainage.[29-31] In view of the reported complications of suction such as maintenance of air leaks, infections and reperfusion pulmonary oedema,[3,31] it is advisable to reserve its use for pneumothoraces with persistent air leaks or failure of re-expansion.[2-4,31] Although the BTS guidelines advised against clamping of tubes,[3] this was practised in more than 40% of the episodes. Diversity of views towards clamping was also evident in the ACCP Delphi Consensus Statement,[2] whilst Belgian Guidelines suggest clamping for a few hours with X-ray control before tube removal.[4] Pending resolution of this controversy by randomised controlled studies, clamping should be practised with caution and close monitoring of patients is advisable.[3]

In contrast to the situation for patients developing SP, there were no international guidelines for those suffering IP and TP.[32] While there is controversy as to whether ITD is always necessary in TP,[33,34] our study revealed a high preference for this treatment modality. While we did not assess the causes of IP, a previous study reported transthoracic lung biopsy, subclavian vein catheterization and thoracocentesis to be the commonest explanations.[35] Although a conservative approach was adopted in more than 30% of our patient cohort with IP, it seems prudent to consider the size of the pneumothorax, as well as the clinical stability and symptoms of the patient before deciding on the management option.[32]

As in the previous reports,[5-12] our patient cohort management practices for pneumothorax varied from the recommendations in guidelines. Possible reasons include: lack of awareness, perceived ineffectiveness of certain procedures, lack of confidence about existing evidence, and resistance to change.[7,8,10,11] Other reasons might entail patient preferences, availability and costs of devices. All of these might explain the difference between results obtained from various surveys and case record reviews.[7] In the absence of sufficient evidence from randomised controlled studies on which to base guidelines, it is likely that variations in practice will continue.

The major limitation of our study was its retrospective nature, with all its inherent weaknesses. Information about the size of pneumothorax, the size of intercostal tubes employed, the experience of the doctor performing the procedures, and the level of suction applied were not available for all the episodes. Moreover, we did not include patients discharged from the Emergency Department, which might have provided useful information concerning the practice of SA. Also, no follow-up data were collected to assess the subsequent outcomes of the various management options adopted.

Conclusion

This study revealed management practices for hospitalised patients with various types of pneumothoraces in Hong Kong. Patients with small PSPs were commonly managed by simple observation. Where drainage was considered necessary (as in most patients presenting with an SSP or large PSP), ITD was the preferred drain option. Simple aspiration and ITD with small-bore catheters was not commonly practised. More studies are needed to clarify optimal management options for patients presenting with pneumothorax.

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