Healing the Lungs
Non-Surgical Solutions for Pneumothorax

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Pneumothorax

VS

Current consensus & guideline for pneumothorax

consensus conference

Management of Spontaneous Pneumothorax*

An American College of Chest Physicians Delphi Consensus Statement

Management of spontaneous pneumothorax: British Thoracic Society pleural disease guideline 2010

Andrew MacDuff,[1] Anthony Arnold,[2] John Harvey,[3] on behalf of the BTS Pleural Disease Guideline Group

Video-assisted thoracic surgery for pneumothorax: republication of a systematic review and a proposal by the guideline committee of the Japanese Association for Chest Surgery 2014

Delphi technique

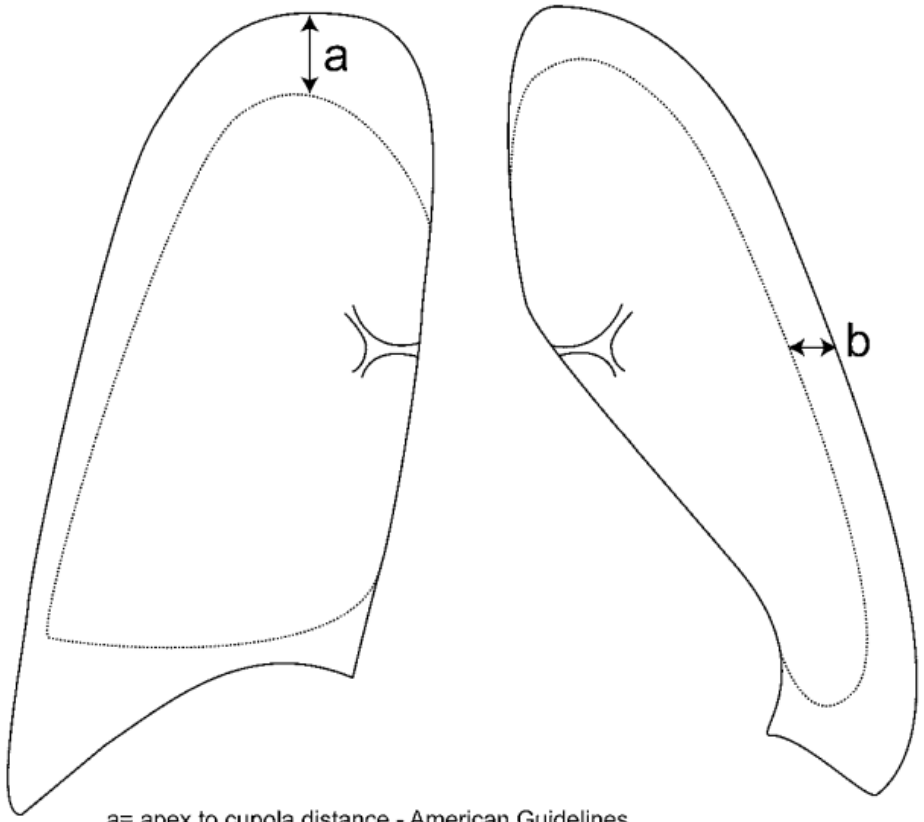
Structured communication method used to gather expert opinions and achieve consensus on complex issues.

- several rounds of questionnaires
- summary of the experts' responses
- revise their earlier answers after feedback

Factors for decision-making

- Type of pneumothorax – primary or secondary
- Amount of pneumothorax – small or large
- Symptom
- Clinical stability : RR, HR, BP, saturation
- Risk of recurrence
- Patient preference
- Ability to tolerate a surgical procedure
- Accessibility to the healthcare facility

Small vs Large amount



a= apex to cupola distance - American Guidelines
b= interpleural distance at level of the hilum - British Guidelines

ACCP guideline

Apex to cupola

Small < 3cm

Large ≥ 3cm

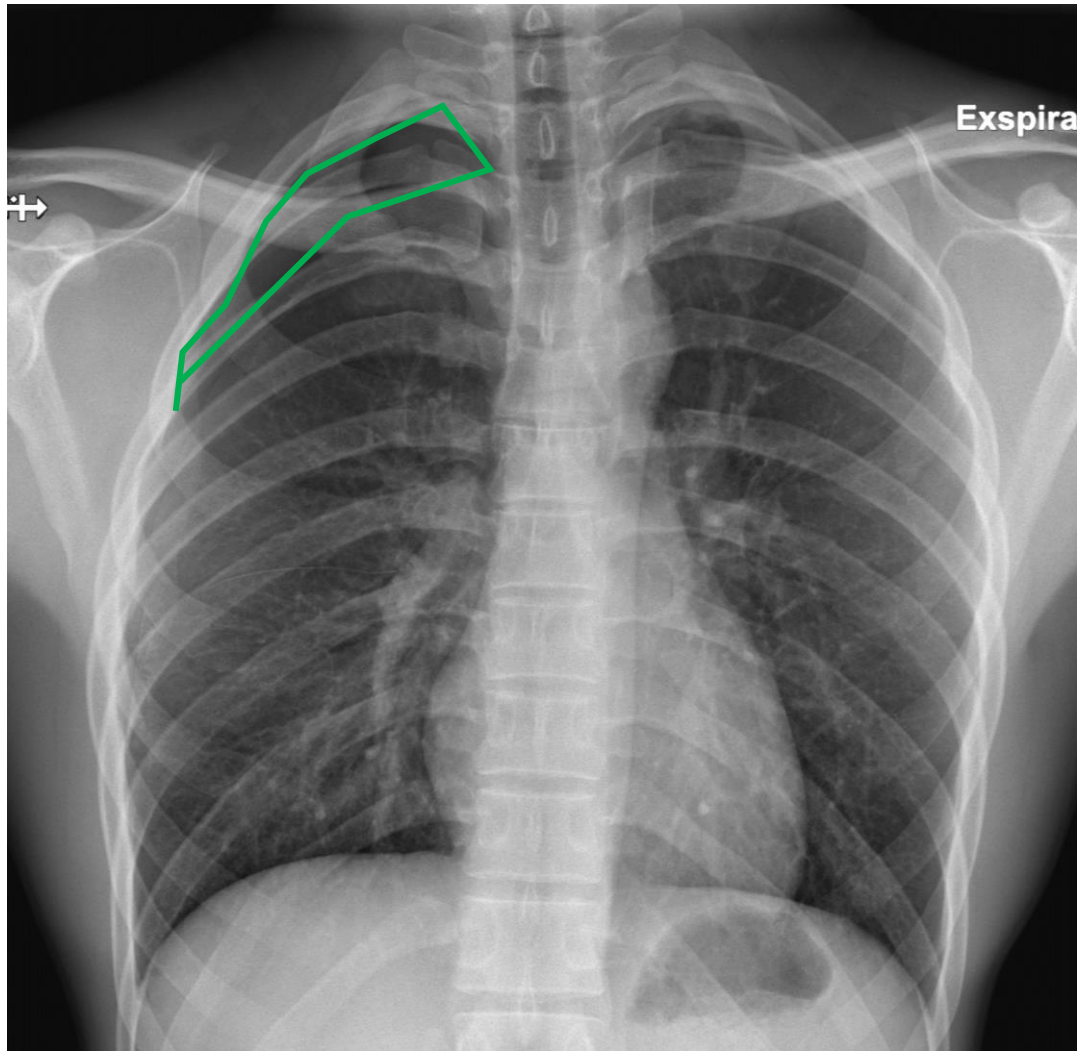
BTS guideline

Lung margin to chest wall at the level of hilum

Small < 2cm

Large ≥ 2cm

Clinically Stable Primary Spontaneous Pnx with a Small Amount



M/22
Dyspnea (2 days ago)
V/S stable
H/O VATS wedge resection, Lt d/t pnx

A. Admission and catheter or tube insertion
B. Observation and Repeat CXR to exclude progression

Clinically Stable Primary Spontaneous Pnx with a Small Amount

ACCP guideline

- Observed in ER for 3 to 6 hr and repeat chest X-ray
- Follow-up within 1-2 days after discharge
- Patient may be admitted if the live distant from hospital

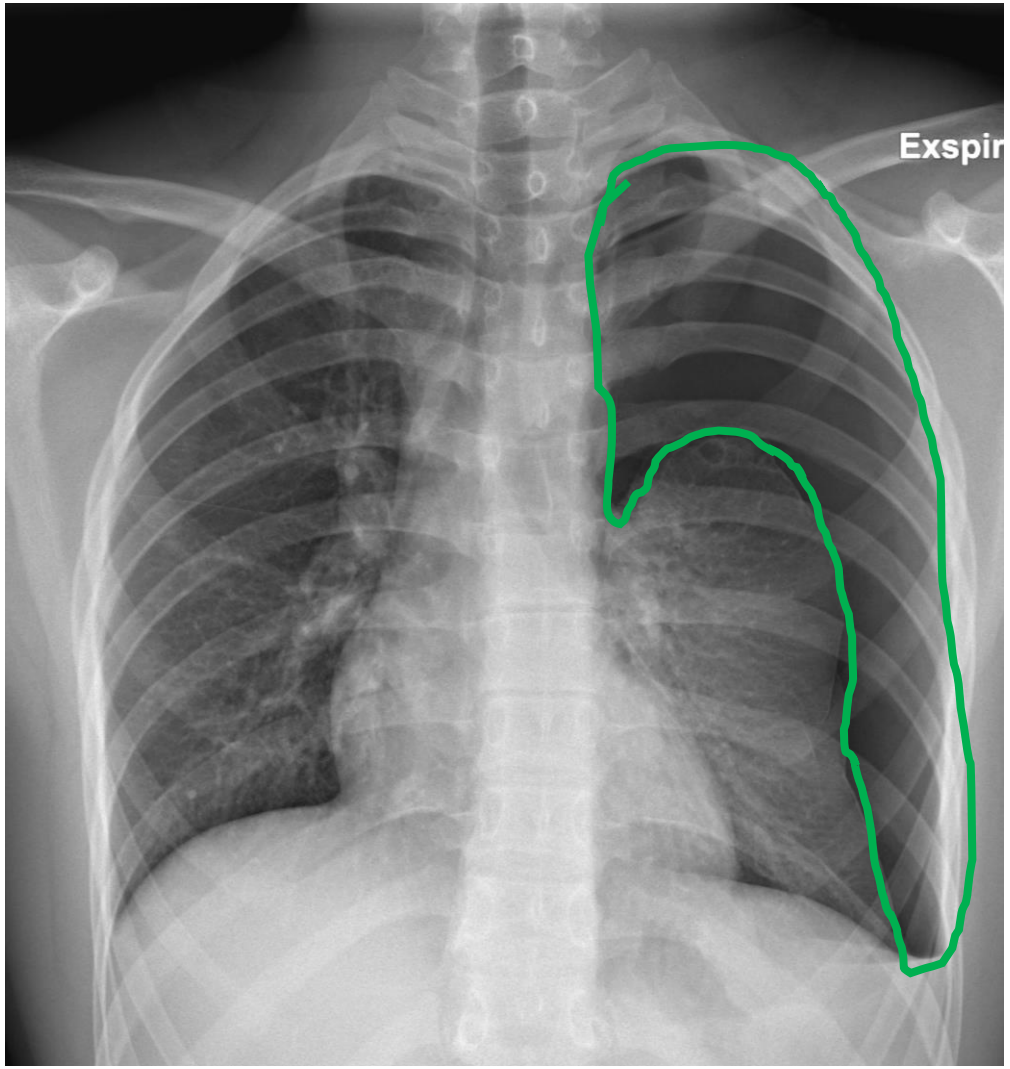
Baumann et al Chest 2011

BTS guideline

- The presence of breathlessness influences the management strategy. (D)
- Patients with significant breathlessness (any size of pnx) should undergo active intervention. (A)
- Observation is the treatment of choice for small PSP without significant breathlessness. (B)
- Patients with a small PSP without breathlessness should be considered for discharge with early outpatient review.

Macduff et al Thorax 2010

Clinically Stable Primary Spontaneous Pnx with a large Amount



M/16
Chest discomfort (1 day ago)
V/S stable

⇩

A. Admission and Drainage
B. Admission and Aspiration
C. Discharge with Small Bore Catheter and Heimlich Valve

Clinically Stable Primary Spontaneous Pnx with a large Amount

ACCP guideline

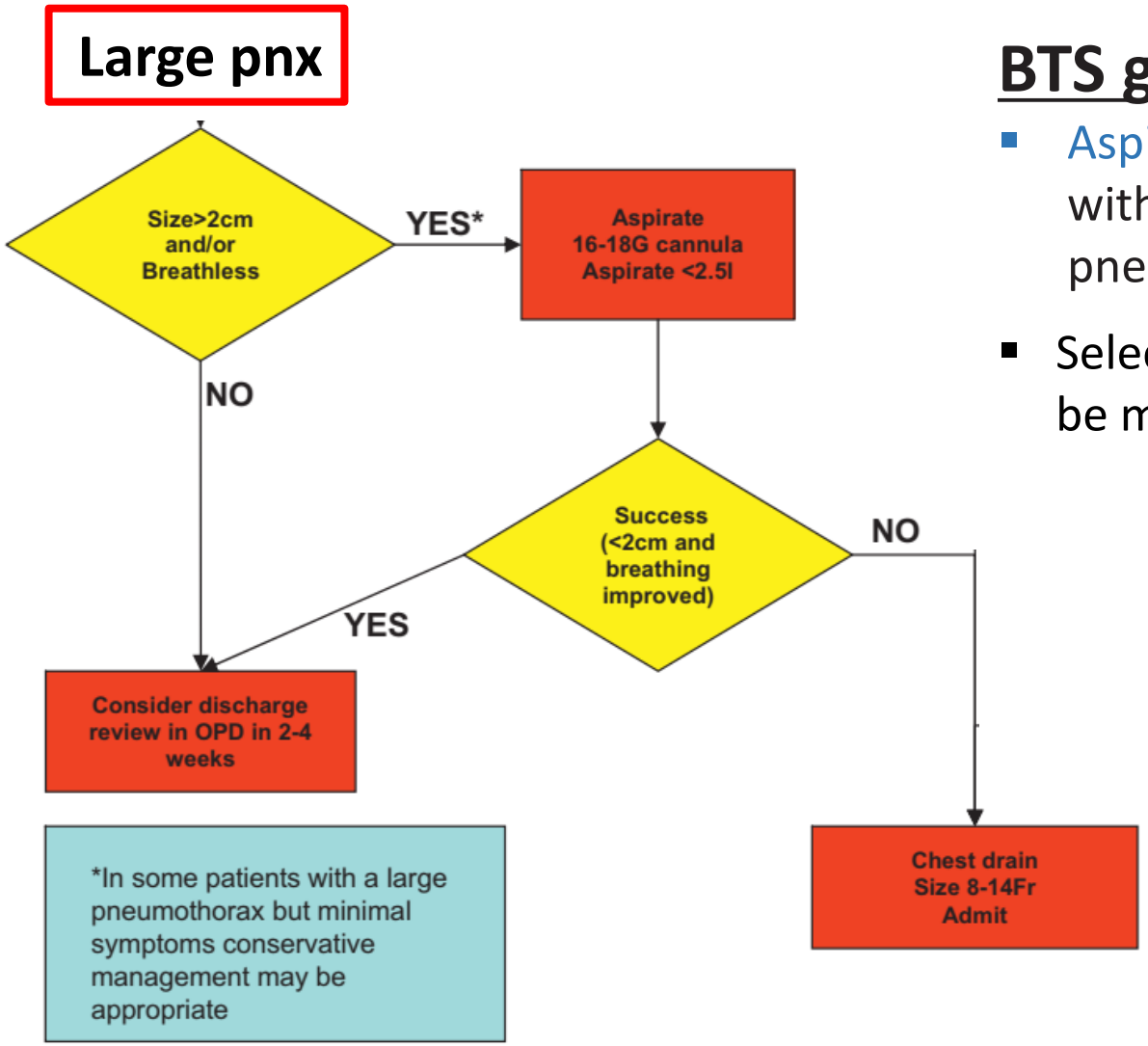
- **Hospitalization and undergo drainage (very good consensus)**

  : Small bore catheter or medium sized bore chest tube

- **Drainage may be attached to Heimlich valve or water seal chest bottle**
- **Suction apply (some consensus)**
- **Discharge with small bore catheter and Heimlich, if lung has been expanded**

Baumann et al Chest 2011

Clinically Stable Primary Spontaneous Pnx with a large Amount



BTS guideline

- Aspiration as an initial intervention in patients with a large or symptomatic primary pneumothorax
- Selected asymptomatic patients with a large PSP may be managed by observation alone. (A)

Macduff et al Thorax 2010

Aspiration vs Drainage?

Outcomes	Illustrative comparative risks (95% CI)		Relative effect (95% CI)	No. of partici-pants (studies)	Quality of the evidence (GRADE)
	Intercostal tube drainage	Simple aspiration			
Immediate success rate Follow-up: 3 days to 24 months	**714 per 1000**	**557 per 1000** (493 to 635)	**RR 0.78** (0.69 to 0.89)	435 (6 studies)	⊕⊕⊕⊖ **moderate**[a]
One-year success rate Follow-up: 12 to 24 months	**766 per 1000**	**820 per 1000** (735 to 904)	**RR 1.07** (0.96 to 1.18)	318 (4 studies)	⊕⊕⊕⊖ **moderate**[a]
Hospitalization rate Follow-up: 3 days to 24 months	**862 per 1000**	**517 per 1000** (215 to 1000)	**RR 0.60** (0.25 to 1.47)	245 (3 studies)	⊕⊖⊖⊖ **very low**[a,b,c]
Duration of hospital stay Follow-up: 12 to 24 months	Mean duration of hospital stay ranged across control groups from **4.04 to 7 days.**	Mean duration of hospital stay in the intervention groups was **1.66 lower** (-2.28 to -1.04).	—	387 (5 studies)	⊕⊕⊕⊖ **moderate**[a]

Immediate success rate : Chest tube > Aspiration

1-yr success rate (recurrence) : No difference

Cochrane Database Syst Rev 2017

Aspiration vs Drainage?

Simple Aspiration versus Drainage for Complete Pneumothorax
A Randomized Noninferiority Trial

Tania Marx[1], Luc-Marie Joly[4], Anne-Laure Parmentier[2], Jean-Baptiste Pretalli[3], Marc Puyraveau[2], Jean-Claude Meurice[5], Jeannot Schmidt[6], Olivier Tiffet[7], Gilbert Ferretti[9], Dominique Lauque[10], Didier Honnart[11], Faraj Al Freijat[12], Alain Eric Dubart[13], Romain Genre Grandpierre[14], Alain Viallon[8], Dominique Perdu[15], Pierre Marie Roy[16], Toufiq El Cadi[17], Nathalie Bronet[18], Grégory Duncan[19], Gilles Cardot[20], Philippe Lestavel[21], Frédéric Mauny[2], and Thibaut Desmettre[1]

2009-2015, 31 hospital
Prospective open-label randomized noninferiority trial
Aspiration vs drainage (chest tube) ; 402 pt
First episode and complete of primary spontaneous pneumothorax

Primary outcomes : pulmonary expansion 24 hr after procedure
Secondary outcomes : tolerance of treatment, adverse event, recurrence within 1 yr

Marx et al AJRCCM, 2023

Aspiration vs Drainage?

Treatment failure

: 29% vs 18% (difference in failure rate, 0.113; 95% CI , 0.026–0.200).

Recurrence

: 20 % vs 27% (frequency difference, 20.07; 95% CI, 20.16, 10.02)

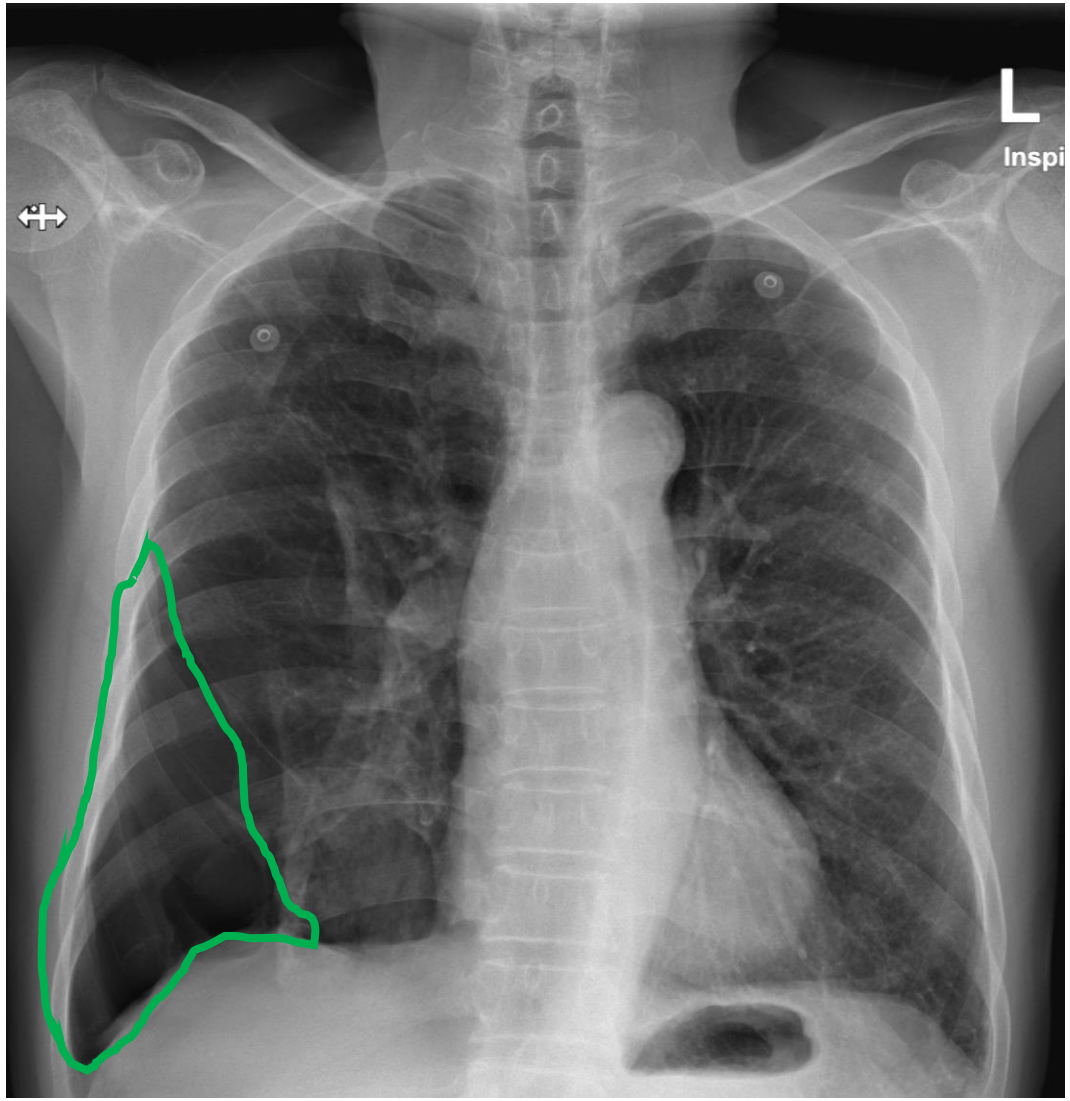
The aspiration group experienced

Less pain overall (mean difference, 21.4; 95% CI, 21.89, 20.91)

Less pain limiting breathing (frequency diff, 20.18; 95% CI,20.27, 20.09)

Less kinking of the device (frequency diff, 20.05; 95% CI, 20.09, 20.01).

Clinically Stable Secondary Spontaneous Pnx with a Large Amount



M/65
Dyspnea (1 day ago)
V/S Tachycardia (HR=108)
History of pneumothorax (4 yr ago)

⇩

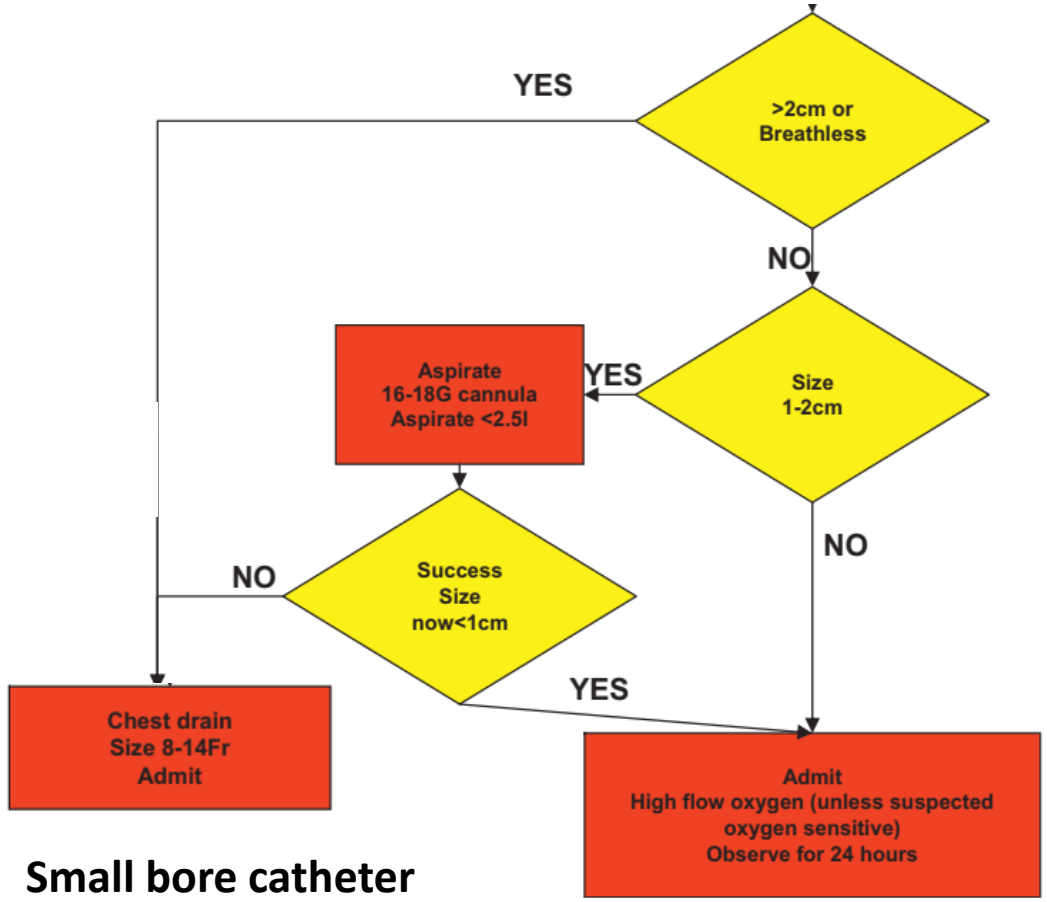
Admission and Drainage
A. Small bore catheter (≤ 14Fr)
B. Moderate bore chest tube (16-22Fr)
C. Large bore chest tube (24-36Fr)

Clinically Stable Secondary Spontaneous Pnx with a large Amount

ACCP guideline

- Hospitalization and undergo placement of chest tube (very good consensus)
- 16-22Fr (moderate bore)
- Small bore maybe acceptable

BTS guideline



Small bore catheter

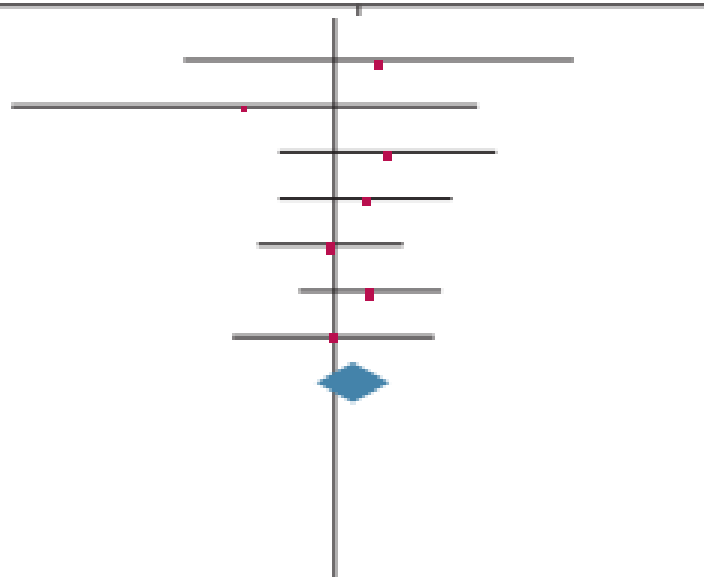
Baumann et al Chest 2011

Macduff et al Thorax 2010

Small or Large? Size does matter?

Study or Subgroup	Pigtail Events	Pigtail Total	Chest tube Events	Chest tube Total	Weight	Risk Ratio IV, Random, 95% CI
1.1.2 Success (Spontaneous)						
Hussein et al[9] 2017	8	11	7	11	1.1%	1.14 (0.64-2.03)
Kuo et al[12] 2013	5	10	15	23	0.8%	0.77 (0.39-1.53)
Lee et al[14] 2010	18	23	24	36	3.6%	1.17 (0.86-1.61)
Liu et al[15] 2003	37	50	35	52	5.7%	1.10 (0.86-1.41)
O'Rourke and Yee[16] 1989	6	6	96	102	8.0%	0.99 (0.80-1.22)
Riber et al[3] 2017	46	60	51	74	8.3%	1.11 (0.90-1.37)
Tsai et al[17] 2006	50	69	16	22	4.1%	1.00 (0.74-1.34)
Subtotal (95% CI)		**229**		**320**	**31.6%**	**1.06 (0.95-1.18)**
Total events	170		244			

Heterogeneity: $Tau^2 = 0.00$; $\chi^2 = 2.17$, df = 6 ($P = .90$); $I^2 = 0\%$
Test for overall effect: $z = 1.08$ ($P = .28$)



Success rate, pigtail vs chest tube

170 of 229 (74.2%) vs 244 of 320 (76.2%)

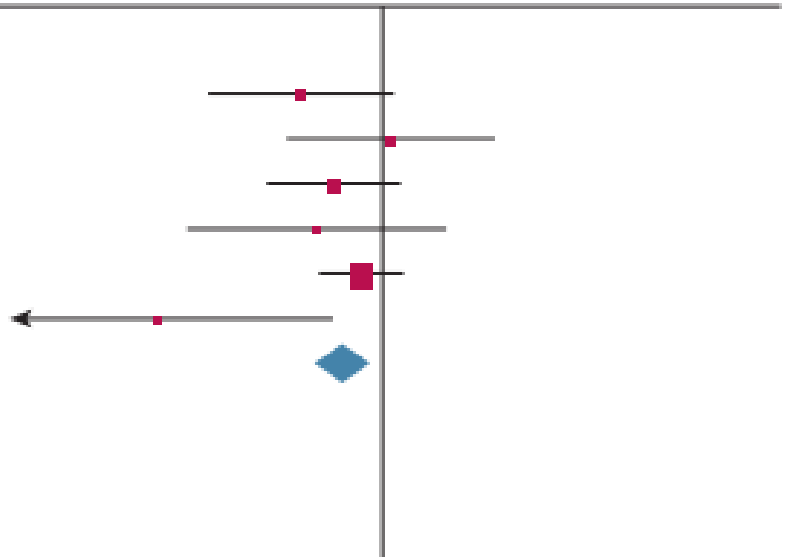
RR was 1.06 (95% CI 0.95-1.18)

Chang et al Chest 2018

Small bore or Large bore? Size does matter?

Study or Subgroup	Pigtail Events	Pigtail Total	Chest tube Events	Chest tube Total	Weight	Peto Odds Ratio Peto, Fixed, 95% CI
1.3.2 Complications (Spontaneous)						
Hussein et al[9] 2017	2	11	6	11	8.1%	0.22 (0.04-1.22)
Kuo et al[12] 2013	2	10	4	23	6.5%	1.19 (0.18-7.89)
Lee et al[14] 2010	5	18	12	24	15.5%	0.41 (0.12-1.39)
O'Rourke and Yee[16] 1989	0	6	15	102	4.2%	0.30 (0.03-3.16)
Riber et al[3] 2017	14	60	23	74	40.7%	0.68 (0.32-1.45)
Tsai et al[17] 2006	0	69	2	22	2.2%	0.02 (0.00-0.40)
Subtotal (95% CI)		**174**		**256**	**77.2%**	**0.49 (0.28-0.85)**
Total events	23		62			

Heterogeneity: $\chi^2 = 7.01$, df = 5 ($P = .22$); $I^2 = 29\%$
Test for overall effect: $z = 2.54$ ($P = .01$)



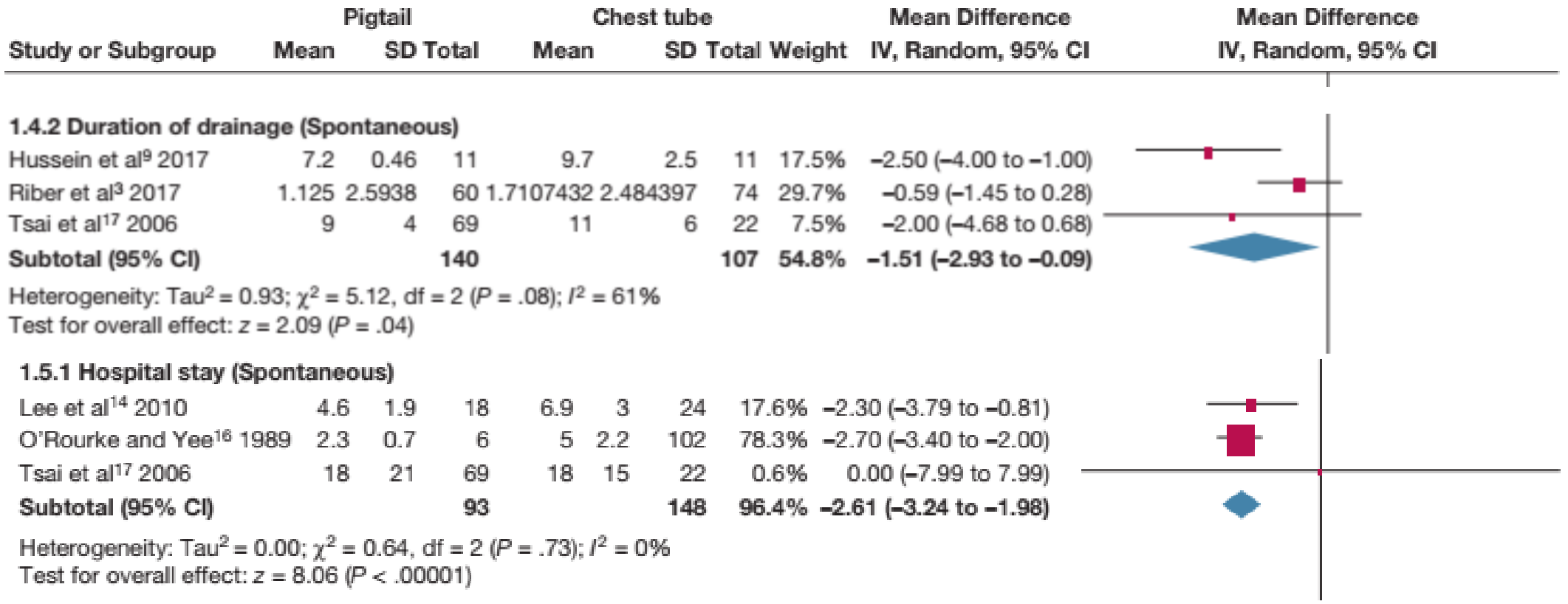
Pigtail group had a lower complication rate than the chest tube group

23 pf 174 (13.2%) vs 62 of 256 (24.2%)

Peto OR was 0.49 (95% CI 0.28-0.85)

Chang et al Chest 2018

Small bore or Large bore? Size does matter?

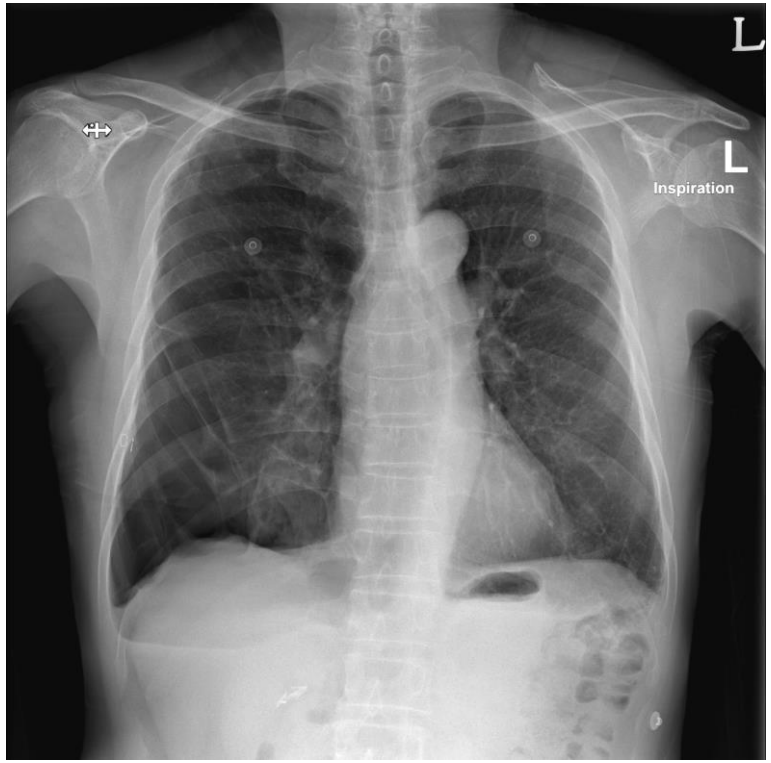


Study or Subgroup	Pigtail Mean	Pigtail SD	Pigtail Total	Chest tube Mean	Chest tube SD	Chest tube Total	Weight	Mean Difference IV, Random, 95% CI
1.4.2 Duration of drainage (Spontaneous)								
Hussein et al[9] 2017	7.2	0.46	11	9.7	2.5	11	17.5%	−2.50 (−4.00 to −1.00)
Riber et al[3] 2017	1.125	2.5938	60	1.7107432	2.484397	74	29.7%	−0.59 (−1.45 to 0.28)
Tsai et al[17] 2006	9	4	69	11	6	22	7.5%	−2.00 (−4.68 to 0.68)
Subtotal (95% CI)			**140**			**107**	**54.8%**	**−1.51 (−2.93 to −0.09)**
Heterogeneity: $Tau^2 = 0.93$; $\chi^2 = 5.12$, df = 2 ($P = .08$); $I^2 = 61\%$								
Test for overall effect: $z = 2.09$ ($P = .04$)								
1.5.1 Hospital stay (Spontaneous)								
Lee et al[14] 2010	4.6	1.9	18	6.9	3	24	17.6%	−2.30 (−3.79 to −0.81)
O'Rourke and Yee[16] 1989	2.3	0.7	6	5	2.2	102	78.3%	−2.70 (−3.40 to −2.00)
Tsai et al[17] 2006	18	21	69	18	15	22	0.6%	0.00 (−7.99 to 7.99)
Subtotal (95% CI)			**93**			**148**	**96.4%**	**−2.61 (−3.24 to −1.98)**
Heterogeneity: $Tau^2 = 0.00$; $\chi^2 = 0.64$, df = 2 ($P = .73$); $I^2 = 0\%$								
Test for overall effect: $z = 8.06$ ($P < .00001$)								

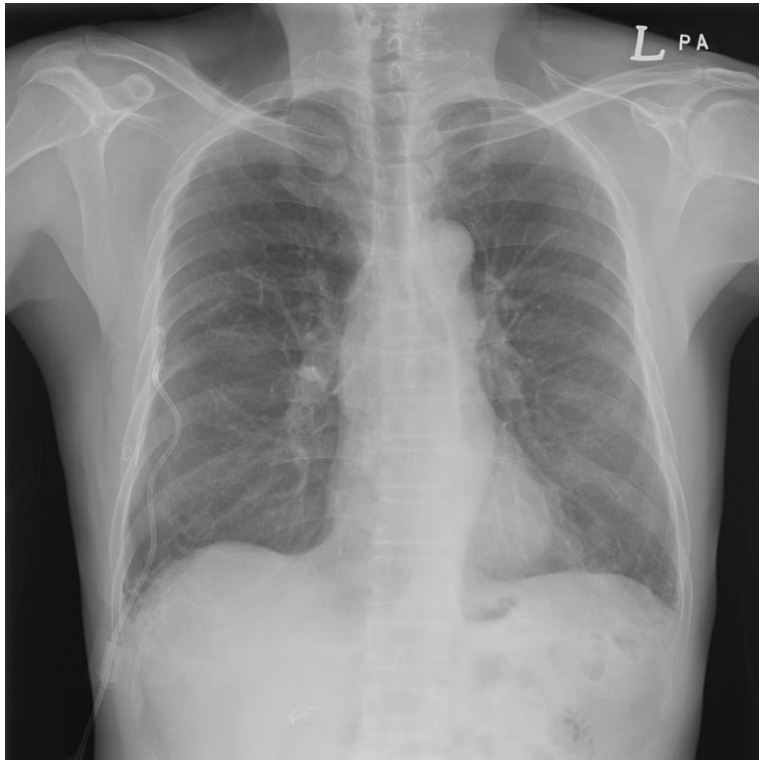
Pigtail group had a shorter drainage duration (-1.5) and hospital stay (MD -2.61)

Chang et al Chest 2018

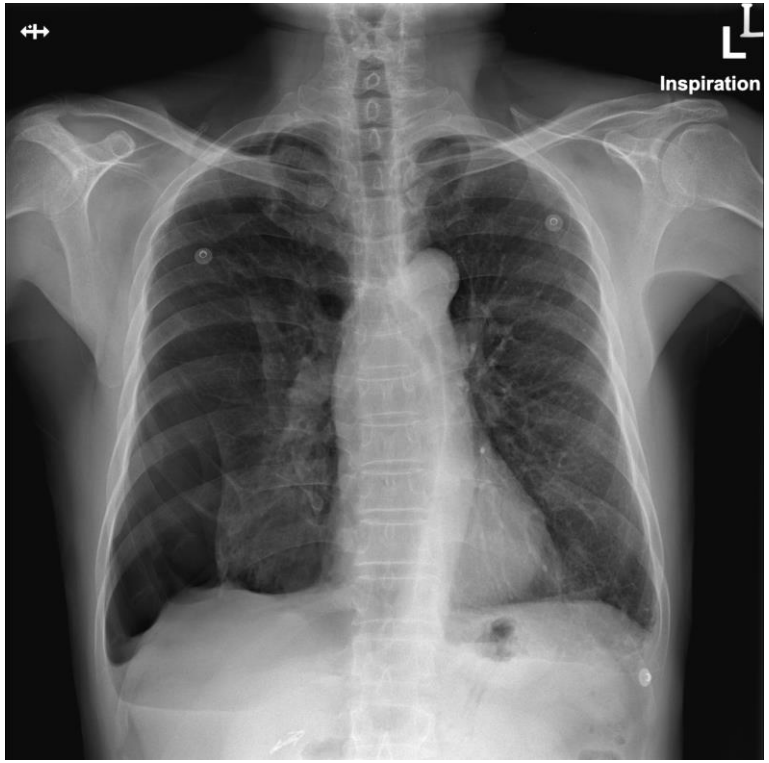
Moderate-sized chest tube (20Fr)
Hospital stay : 3 days



1st OPD after discharge



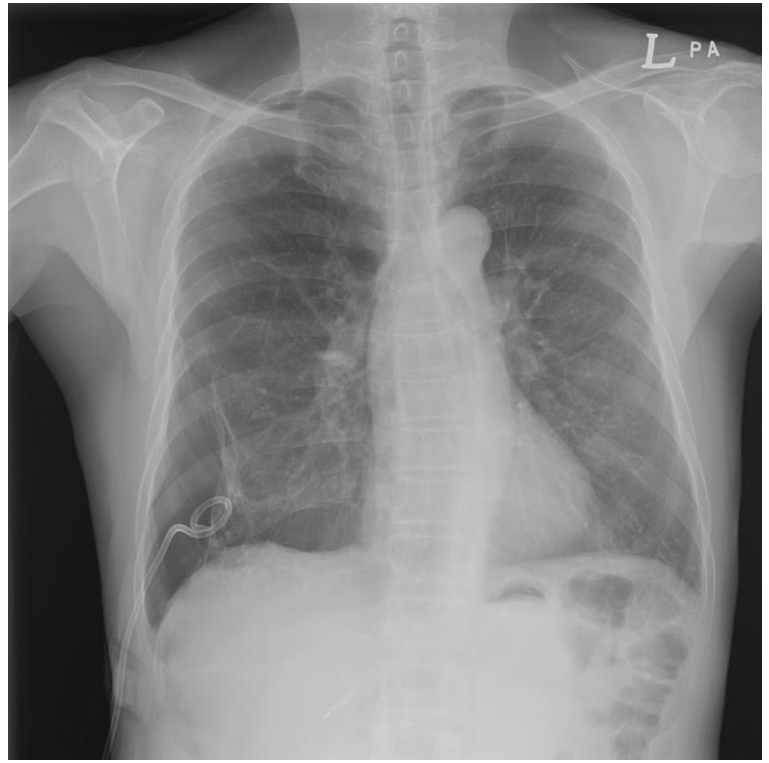
Small percutaneous catheter
Hospital stay : 4 days



After 2 week

4th recurrence

Small percutaneous catheter



Prolonged air leak (HD 6)

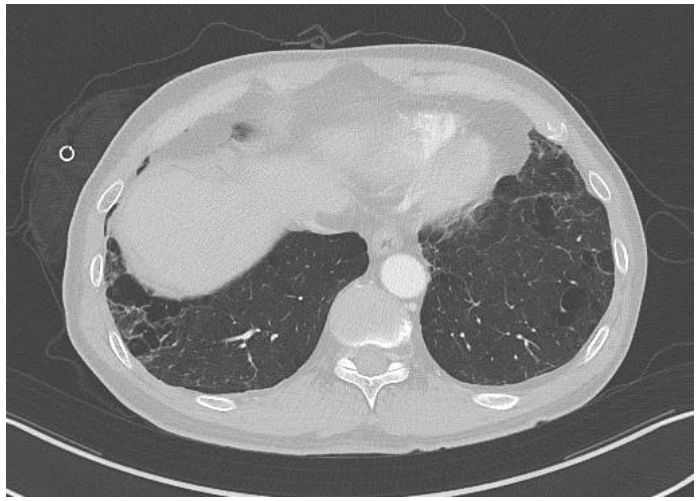
Prolonged Air Leaks – how to manage?

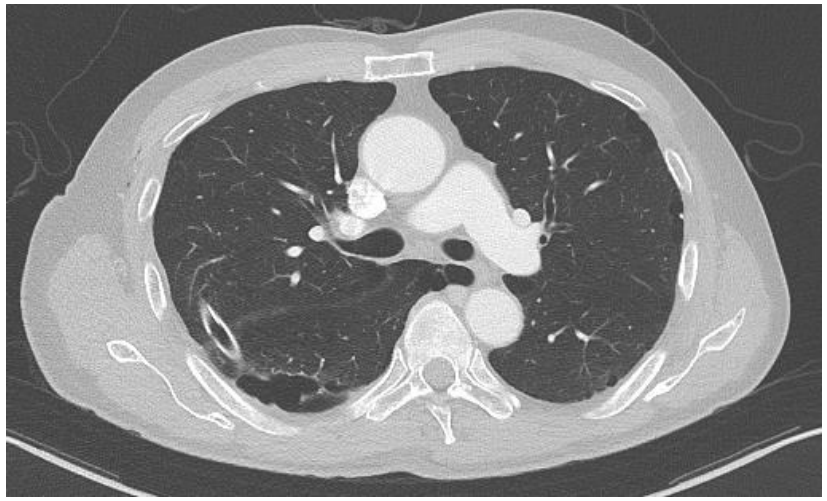
Definition : air leak more than 5 days

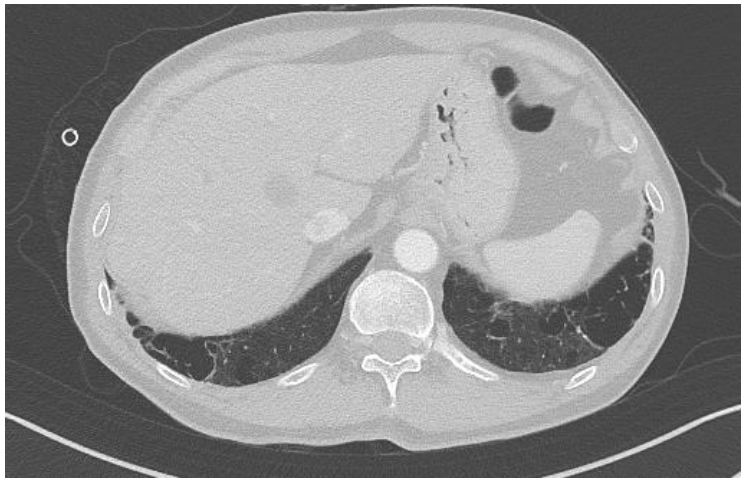
<u>ACCP guideline</u>

Air leakage persisting > 4 days should be evaluated for surgery (very good consensus)

Continued observation for 5 days (IQR, 4-7days)



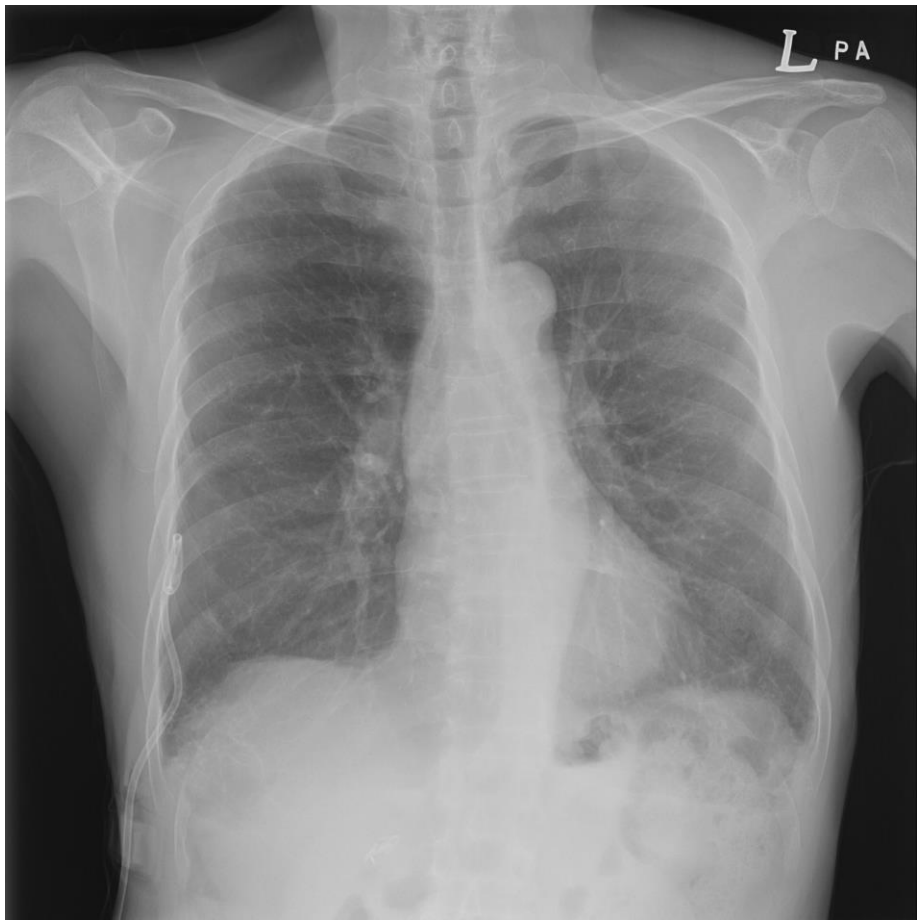




Prolonged Air Leaks – how to manage?

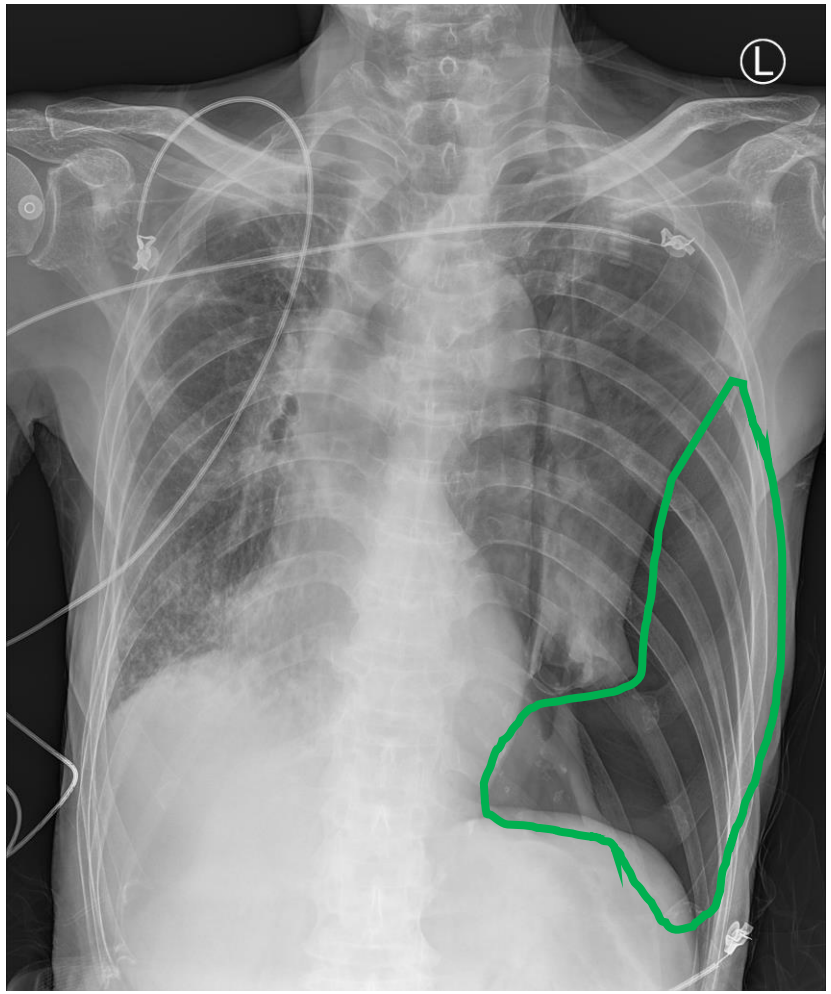
A. Surgical exploration
B. Chemical pleurodesis
C. Chest tube insertion

Small bore catheter with Heimlich bag



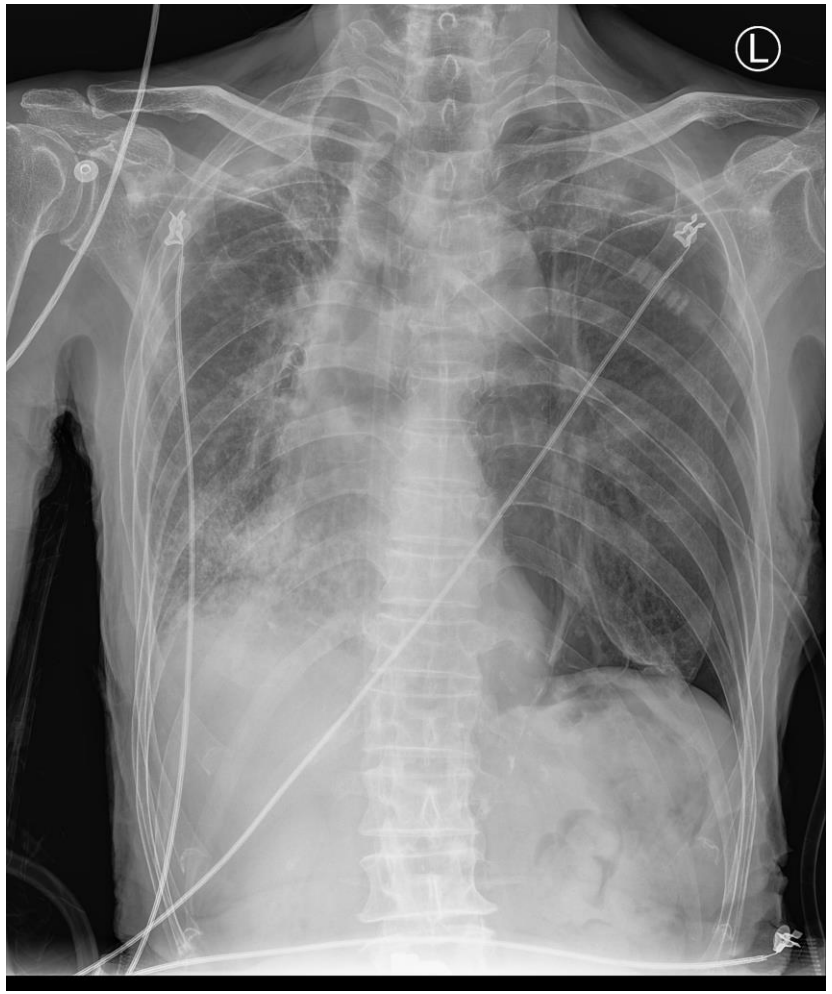
7 days after discharge

Clinically Stable Secondary Spontaneous Pnx

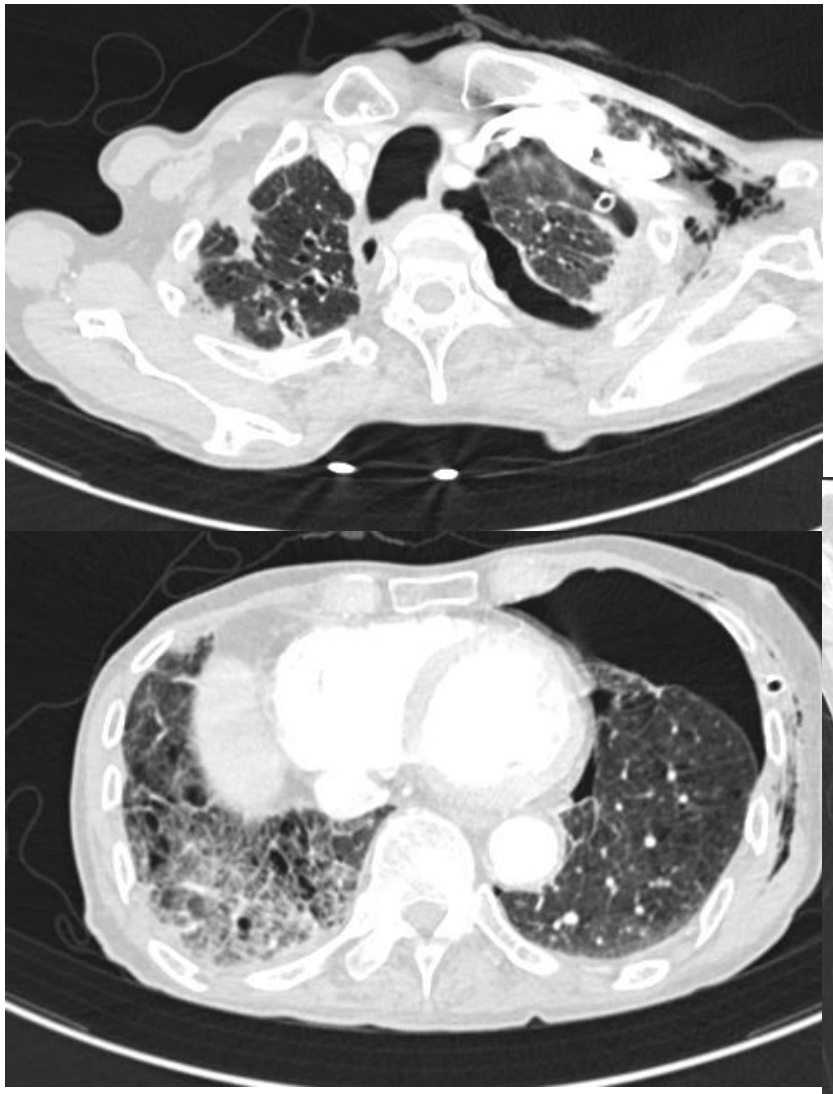


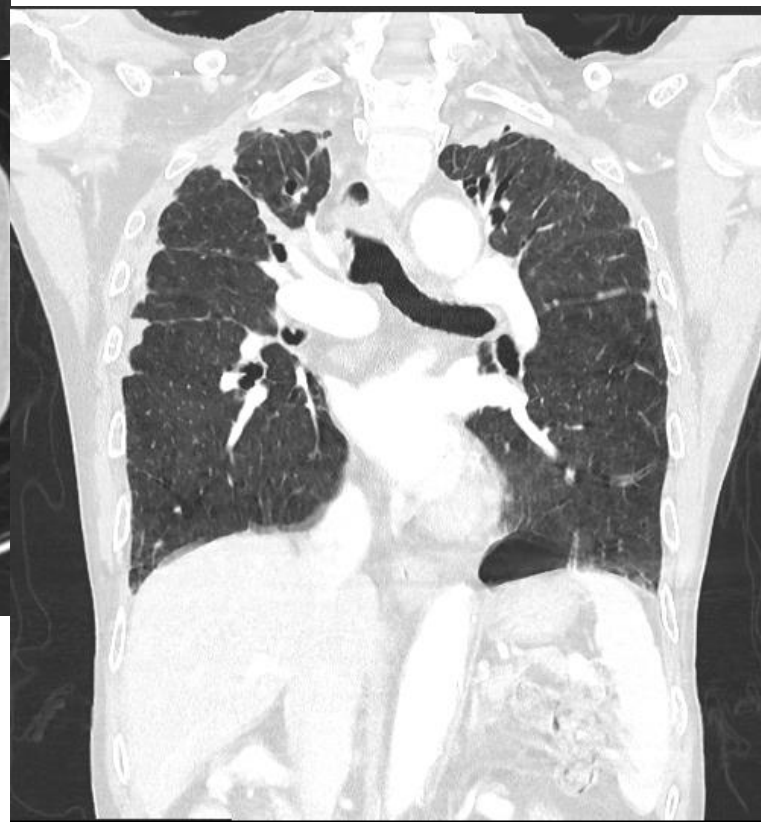
M/80
Dyspnea (1 day ago)
V/S stable
COPD, CVA, 2VD, Tbc
RLL infiltration, r/o pneumonia

Admission and Drainage
A. Small bore catheter
B. Moderate bore chest tube
C. Large bore chest tube



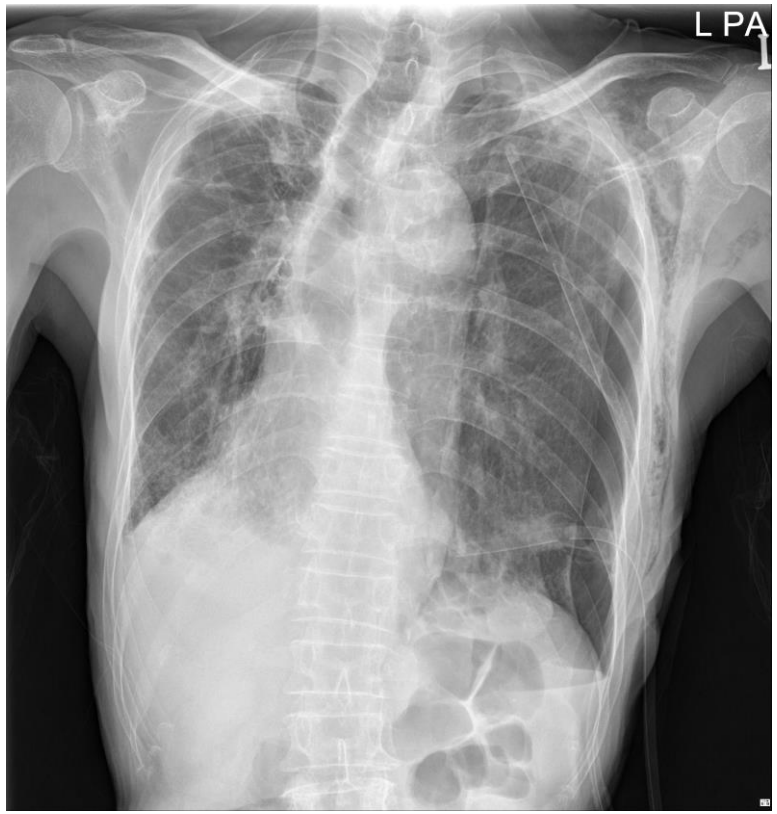
24Fr chest tube



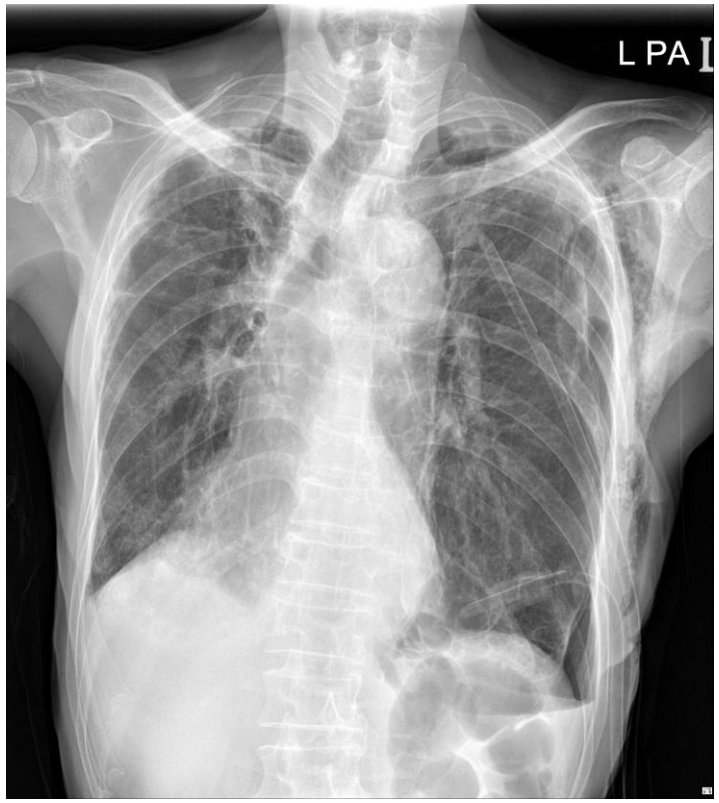


Prolonged Air Leaks – how to manage?

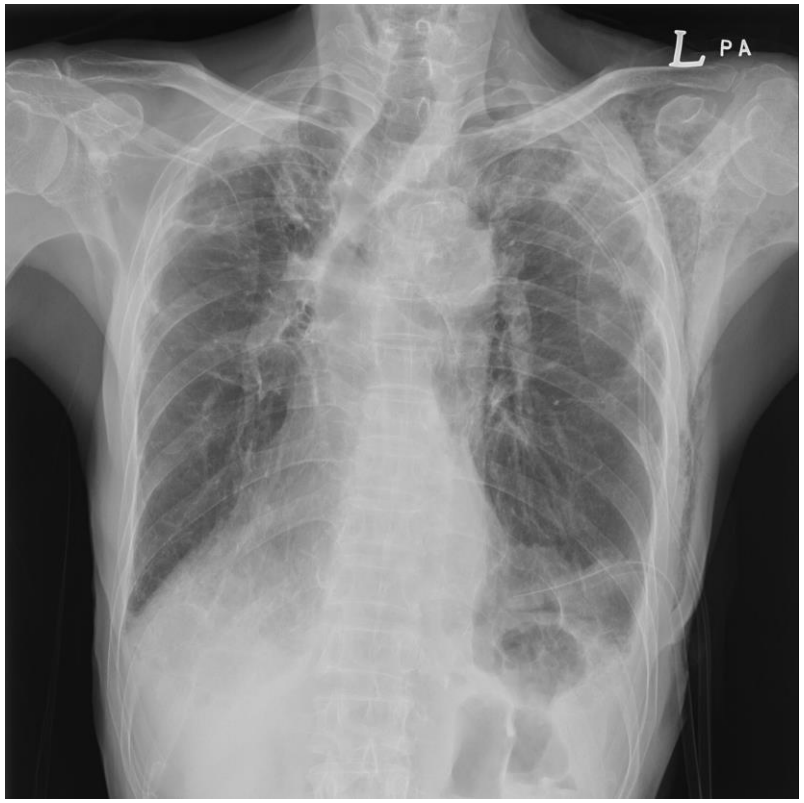
A. Surgical exploration
B. Chemical pleurodesis
C. Additional chest tube insertion
D. Observation



Additional chest tube (HD3)

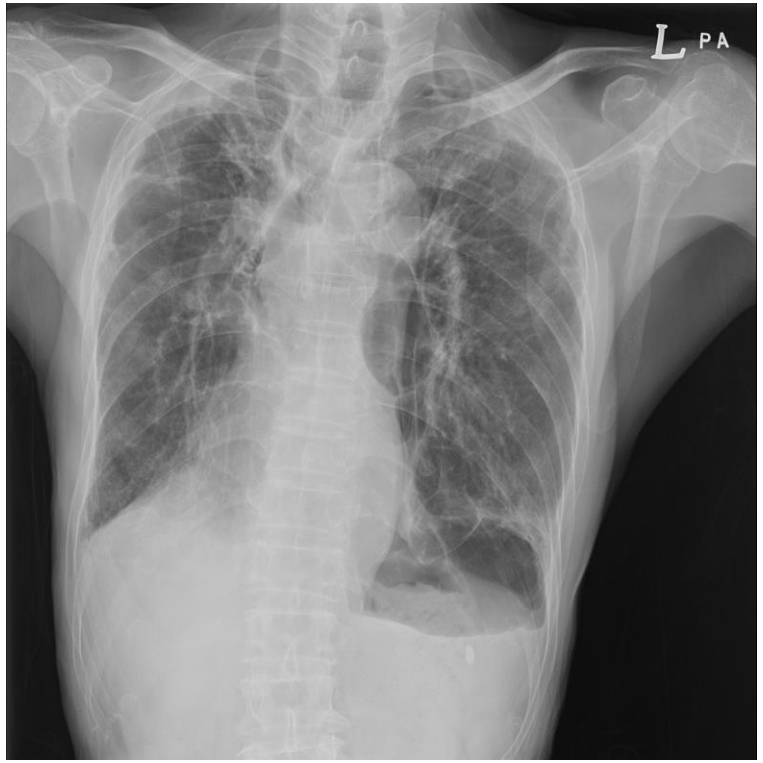


Water seal only
(suction off, HD 6)

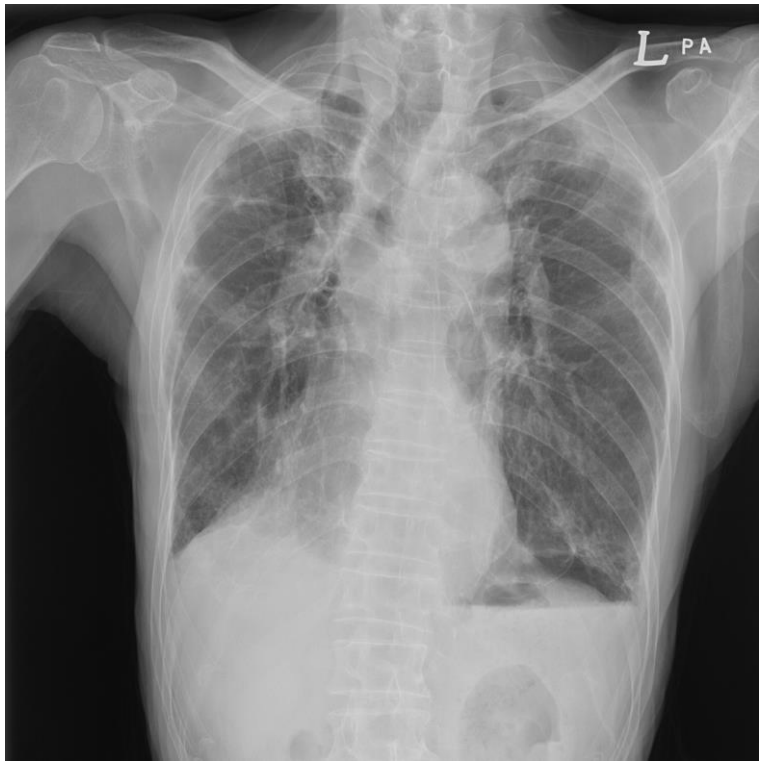


After 1 day

1st OPD
(2wks after Discharge)
No dyspnea



2nd OPD, 1 week later



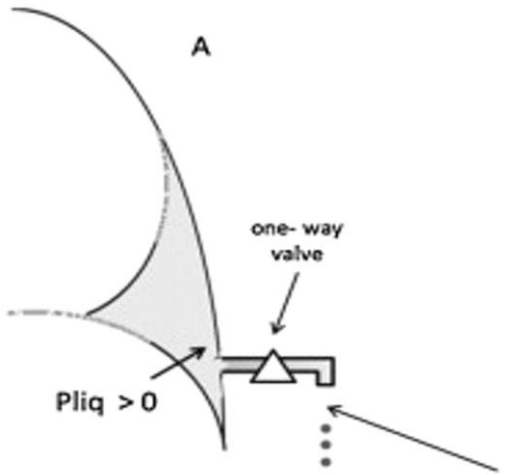
3rd OPD, 1 month later

		Ref	Pre Pre	% Ref
FVC		4.09	1.52	37
FEV_1		2.79	1.52	55
		67	100	
Diffusing Capacity				
DLCO	mL/mmHg/min	19.3	8.6	45

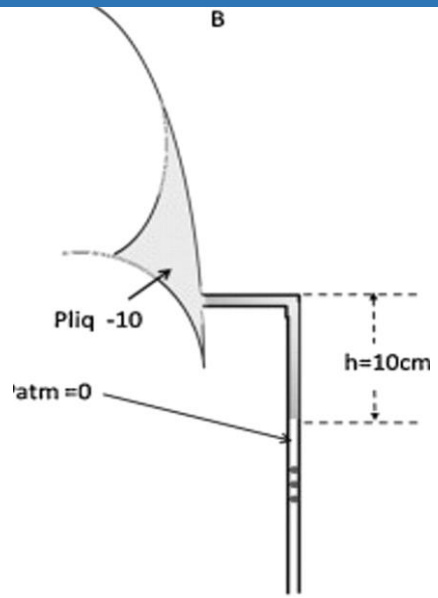
Suction should be employed?

The role of suction is to remove air from the pleural cavity faster than it can enter through a breach in the visceral pleura, promoting healing by bringing the visceral and parietal pleural layers together.

Pr. in the thorax > atmospheric pr. fluid will drain



fluid will drain under subatmospheric pr.



Rapid drainage
Risk of over distension
Increased fluid infiltration
(possible cause of hydrothorax)

A. Brunellie et al Eur J Cardiothorac Surg, 40 (2), 2011, P 291–297

Drainage-dependent air leak

Underlying non-expandable lung from visceral pleural restriction

- **Pleural thickening, fibrosis**
- **Adhesion**
- **Atelectasis**

- Shape mismatch between the lung and thoracic cavity
- Locally excessive tension and shear force on the pleura
- Excessively negative pleural pr → significant distortion of the subpleural alveolar units

Transient pressure-dependent alveolar pleural fistula

Heidecker et Chest, 2006

Suction or water seal

Still controversial

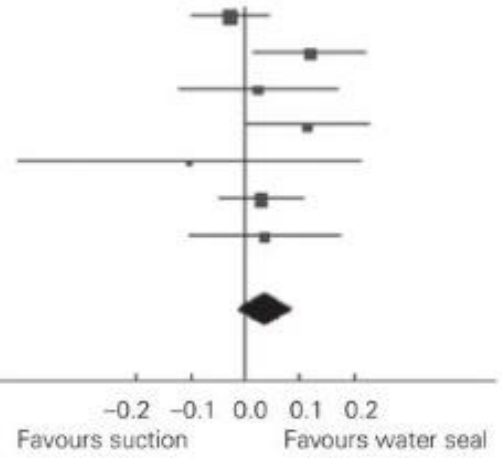
no difference or no definitive benefit of suction over water seal for air leakage

Meta-analysis of 7 RCTs

Prolonged air leakage

Study	Suction Events	Suction Total	Water seal Events	Water seal Total	Risk ratio (95% CI)*
Alphonso et al.[13]	9	116	13	123	−0.30 (−0.10 to 0.04)
Ayed[14]	7	50	1	50	0.12 (0.02 to 0.22)
Brunelli et al.[15]	22	73	20	72	0.02 (−0.12 to 0.17)
Cerfolio et al.[1]	14	70	6	70	0.11 (−0.00 to 0.23)
Daneshvar et al.[16]	3	13	6	18	−1.10 (−0.42 to 0.21)
Marshall et al.[2]	1	34	0	34	0.03 (−0.05 to 0.11)
Prokakis et al.[17]	7	47	5	44	0.04 (−0.10 to 0.17)
Total		403		411	0.04 (−0.01 to 0.09)

Risk ratio, 95% CI*

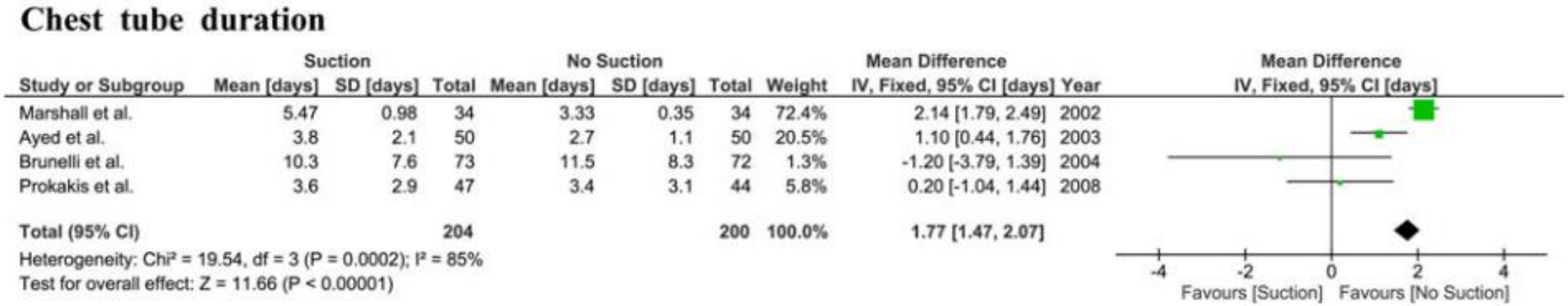


Total events: 63 (suction), 51 (water seal)
Heterogeneity: $Tau^2 = 0.00$, $X^2_6 = 8.07$, $p = 0.23$, $I^2 = 26\%$
Test for overall effect: $Z = 1.53$, $p = 0.12$
*Mantel-Haenszel test, random.

non significant trend toward a decreased incidence of prolonged air leak in the water seal group

Coughlin et al Can J Surg, 55 (4), 2012, P264-70

Suction or water seal



Patients without suction had a shorter chest tube indwelling time, and the difference was statistically significant (WMD 1.77 days, 95% CI 1.47–2.07).

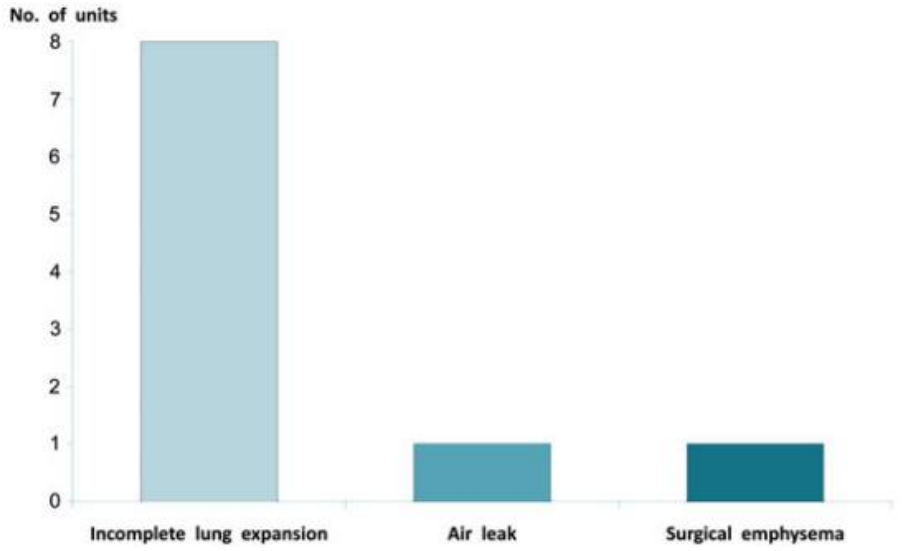
Lang et al European J of Cardiothoeracic Surg, 49, 2016, P611-616

Suction or water seal

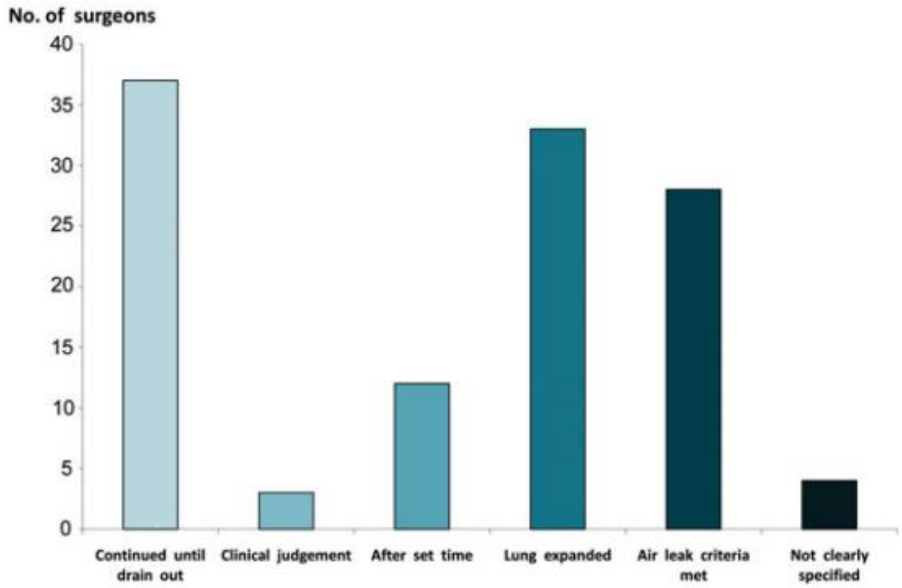
Survey of current practice - thoracic and cardiothoracic unit in UK

25 Unit, 91 Surgeons

Suction is routinely used by all surgeons in 11 units
not routinely used by any surgeons in 5 units and used routinely by some surgeons in 9 units. Of the 91 surgeons represented, 62 (68%) routinely used suction



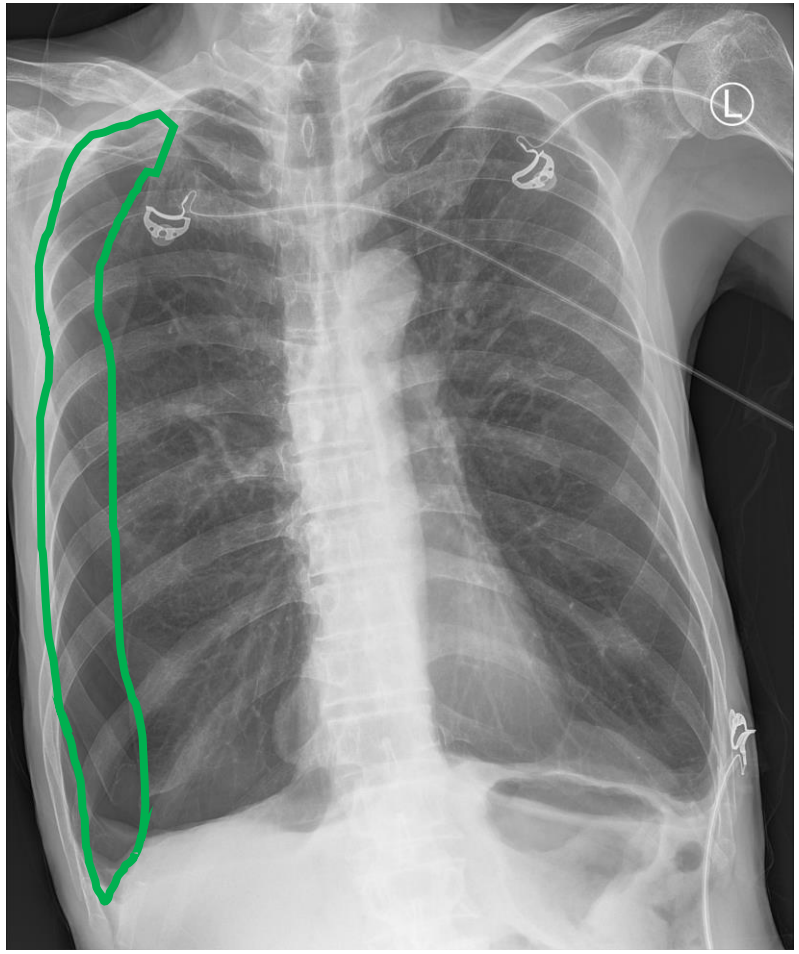
Reason for suction



Reason for discontinuation of suction

Lang et al European J of Cardiothoeracic Surg, 49, 2016, P611-616

Clinically unstable Secondary Spontaneous Pnx



M/63
Dyspnea (1 hour ago)
Unstable V/S
170/115-122-30-84%
Current smoker
COPD, HCC
H/O pneumothorax
:VATS wedge resection, Rt. (2021)

⇩

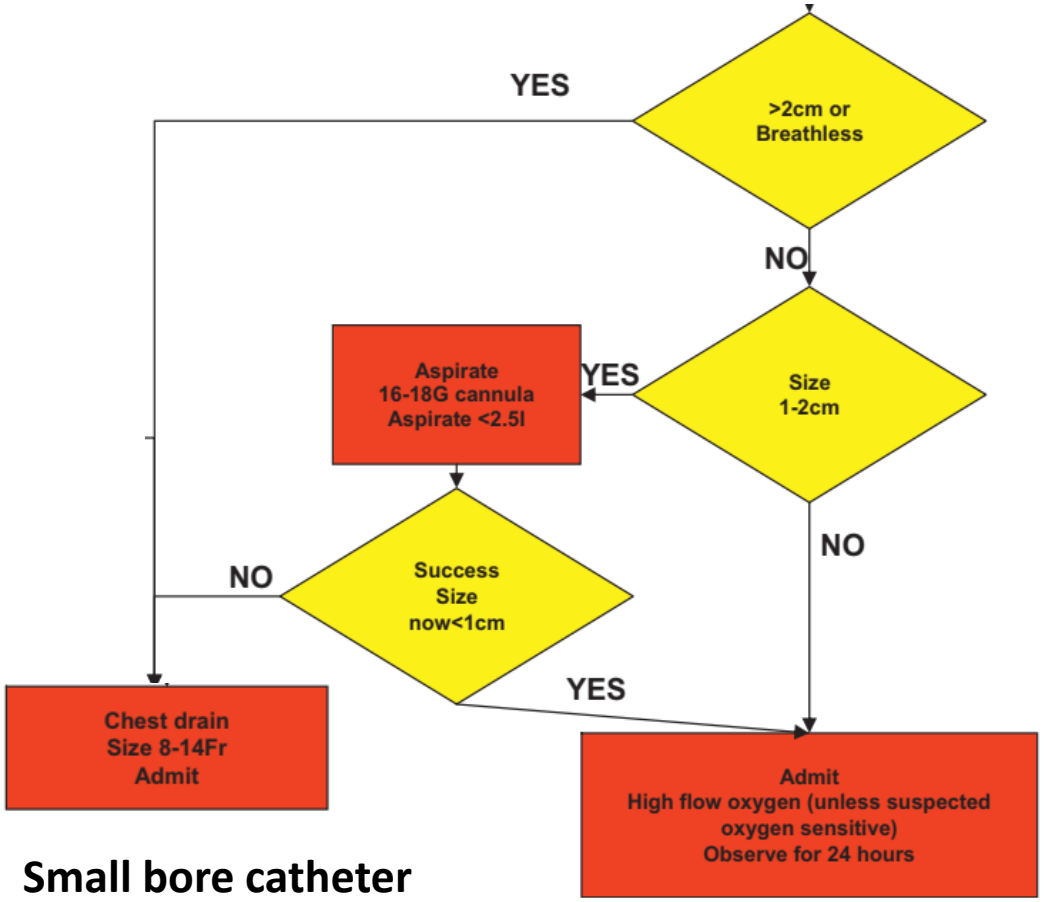
Admission and Drainage

Clinically Unstable Secondary Spontaneous Pnx

ACCP guideline

- Hospitalization and undergo placement of chest tube (very good consensus)
- Large bore (24-28Fr) chest tube

BTS guideline

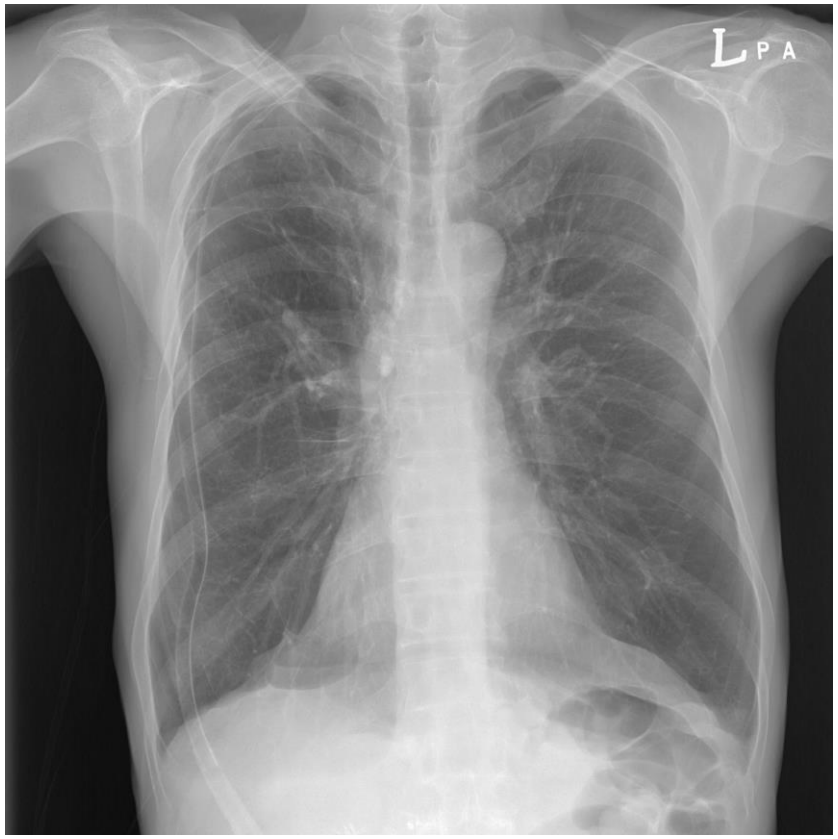


Small bore catheter

Baumann et al Chest 2011

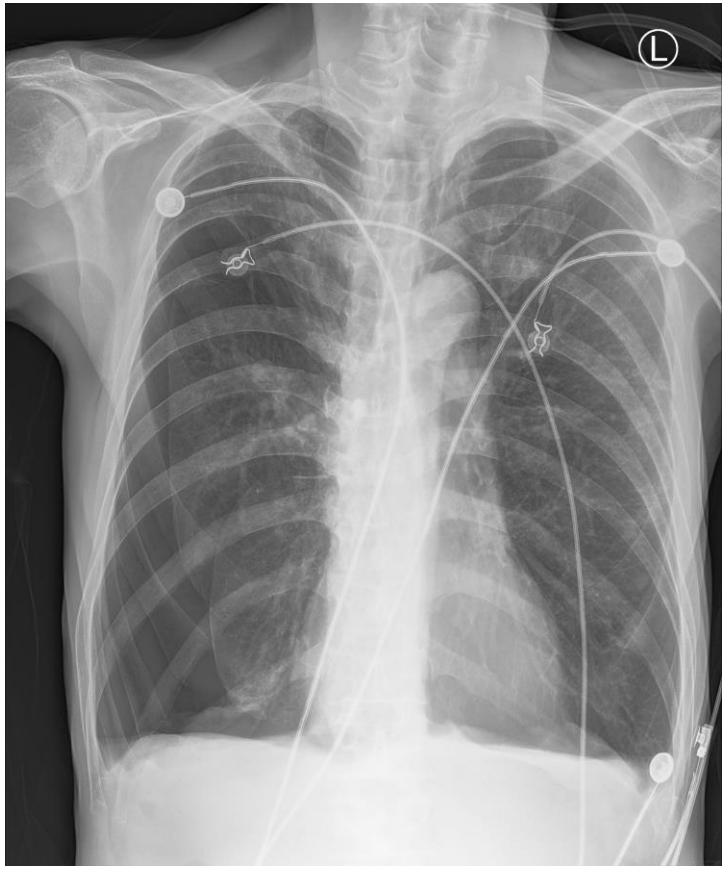
Macduff et al Thorax 2010

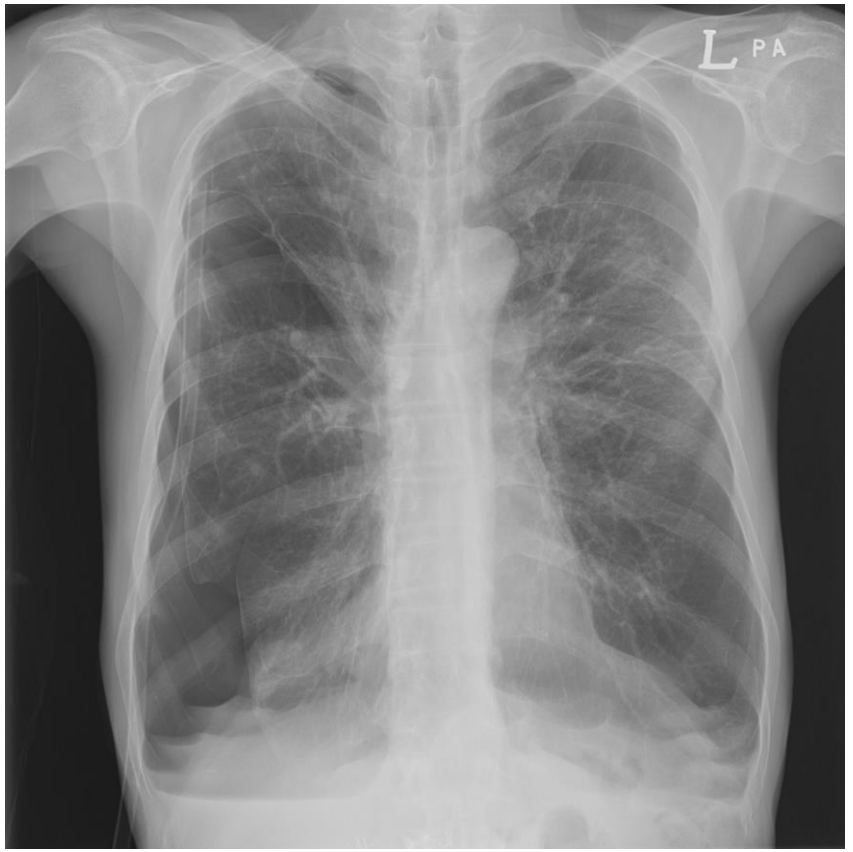
Clinically unstable Secondary Spontaneous Pnx

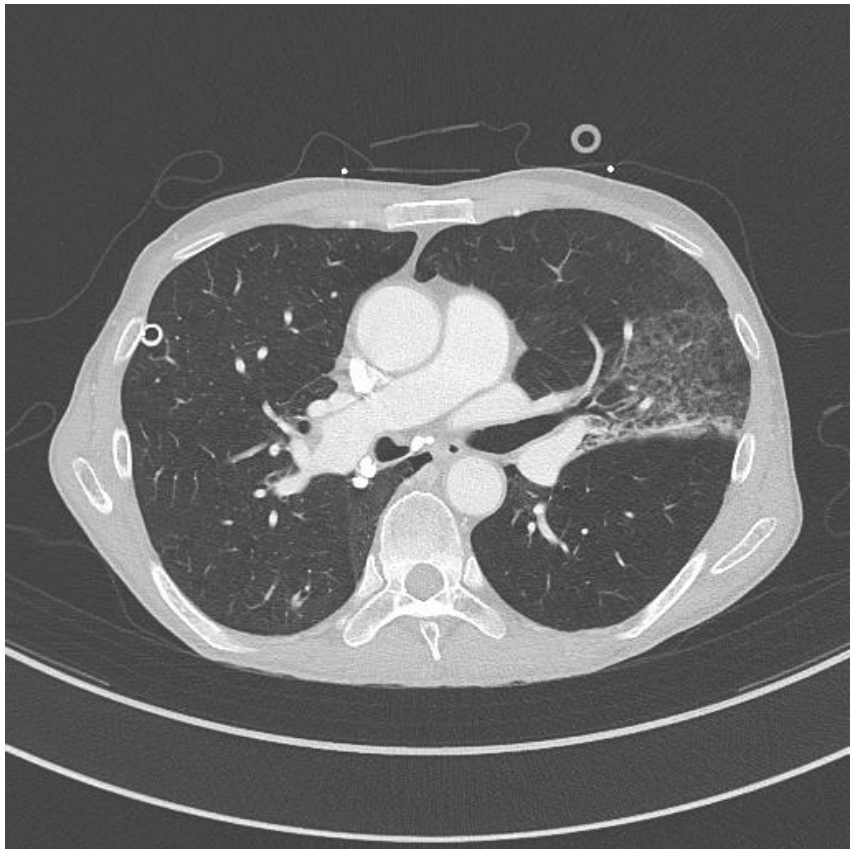


24Fr chest tube
HD 4 : Air lekage (-)
HD 5 : Discharge

Recurrence after 5 months







24Fr chest tube

Clinically unstable Secondary Spontaneous Pnx

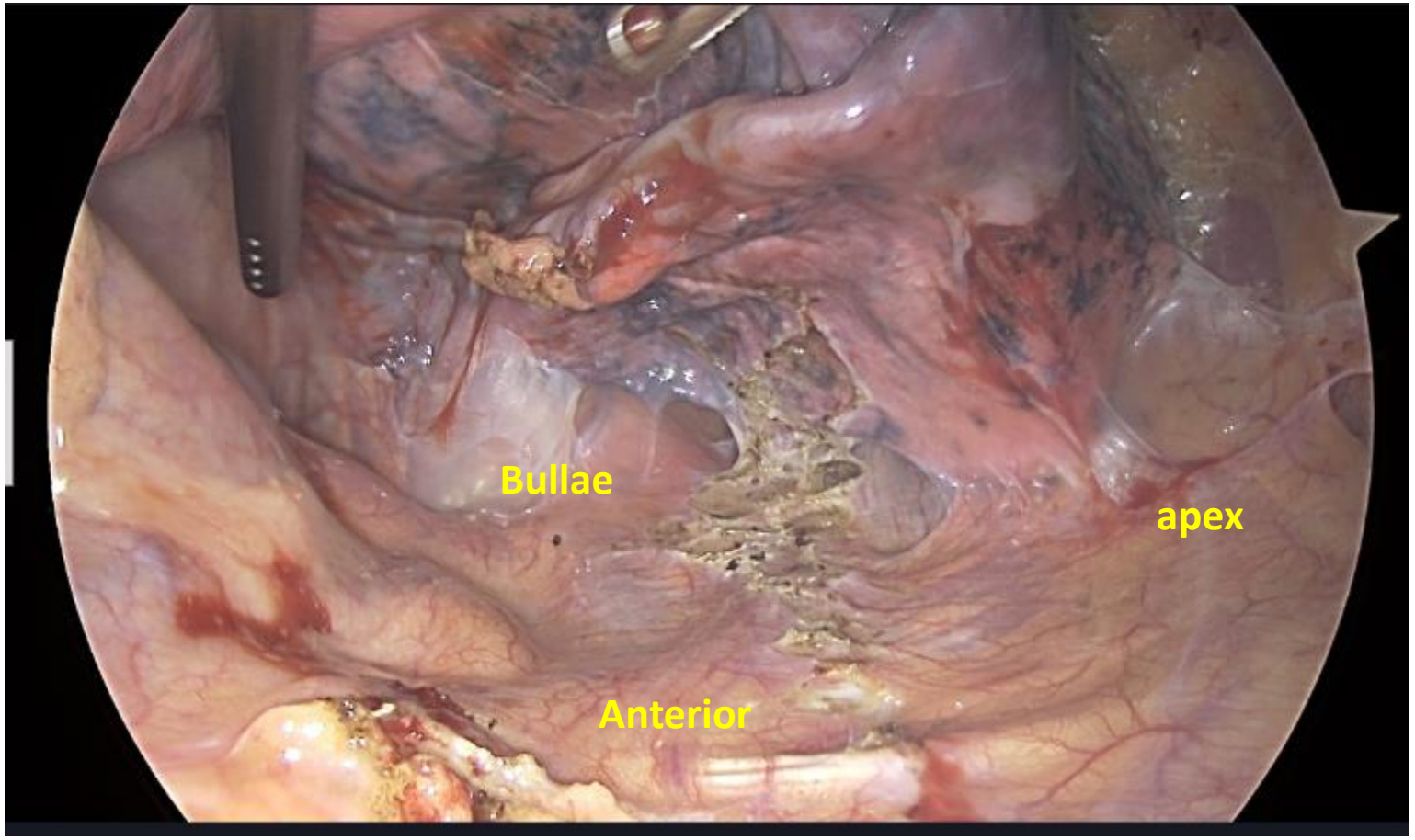
Prolonged Air Leaks

Very poor pulmonary function

		Ref	Pre	Pre % Ref
FVC		4.17	1.92	46
FEV_1		3.31	0.63	19
		74.92	32.69	
DLCO	mL/mmHg/min	22.20	6.35	29

A. Surgical exploration
B. Chemical pleurodesis
C. Additional chest tube insertion
D. Observation

VATS exploration, Rt.



In summary

- Non-surgical management of pneumothorax typically involves observation, needle aspiration, or drainage, with more conservative approaches maintained.
- Observation is suitable for small, asymptomatic pneumothoraces, while larger or symptomatic cases may require aspiration or drainage
- Prolonged air leaks can be managed with chest tubes, suction systems, and patience.
- However, if necessary, do not hesitate to perform surgery.