

# Prevalence of pneumothorax identified by PET/CT following transthoracic needle lung biopsy

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## Background

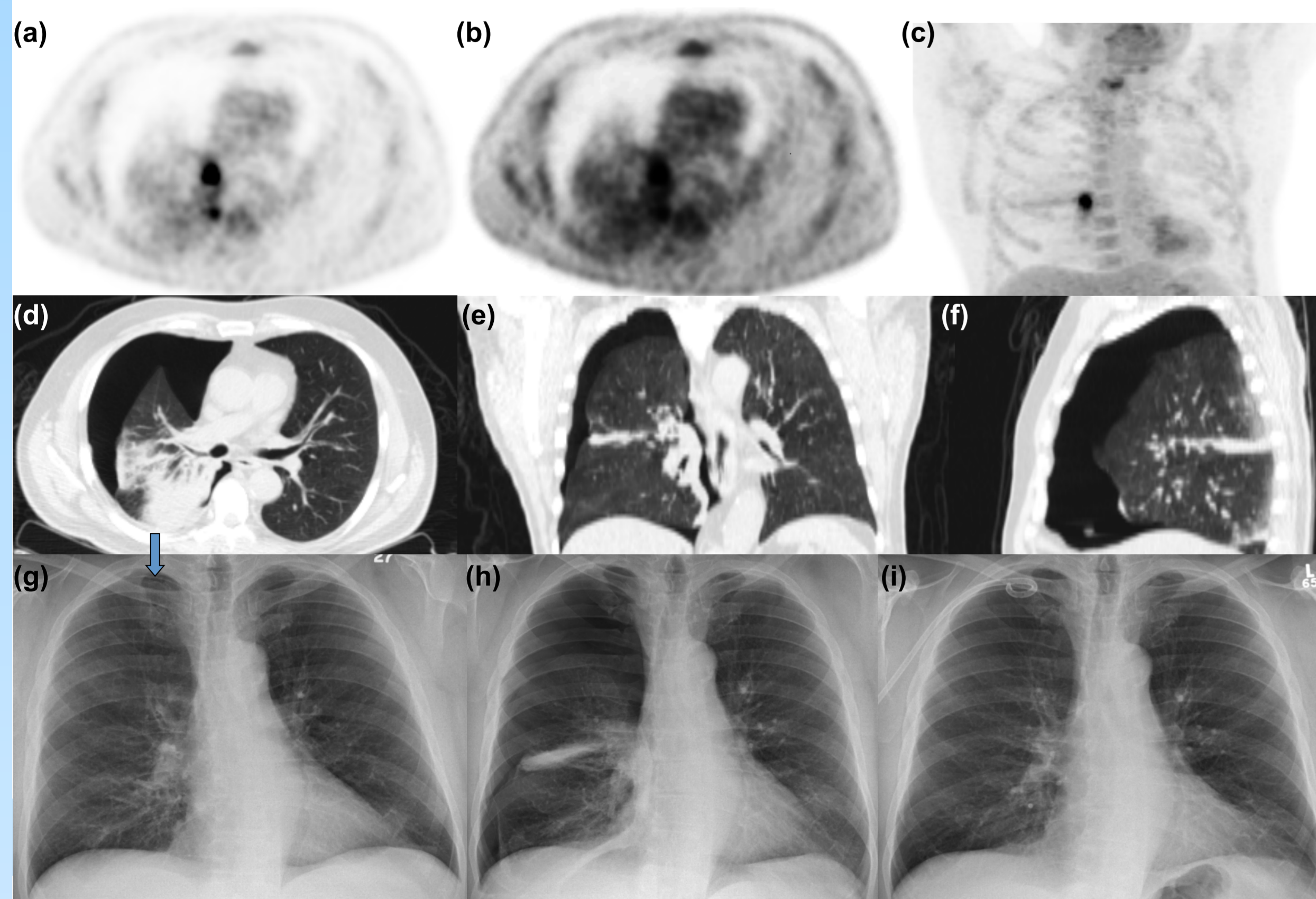
- Two relatively recent technologies which have impacted work-up and staging of lung cancer are transthoracic needle biopsy (TTNB)<sup>1</sup> and FDG-PET/CT scanning<sup>2</sup>.
- Following TTNB, all patients at The Ottawa Hospital are screened by a posteroanterior (PA) chest x-ray 30 minutes after biopsy.
  - While the incidence of pneumothorax immediately after biopsy is not infrequent (approximately 23%<sup>3</sup>), patients are triaged based on physical findings and the stability of the pneumothorax.
  - If an asymptomatic pneumothorax is identified, a second radiograph is obtained approximately 1 hour thereafter.
  - If the patient remains asymptomatic and the pneumothorax has not enlarged, the patient is discharged home with instructions to return to hospital for treatment if they become increasingly breathless or experience worsening chest pain.
  - If the pneumothorax has enlarged or if the patient is symptomatic (such as shortness of breath), an 8 French pigtail drain is inserted.
  - The majority of asymptomatic patients with pneumothorax return home with conservative management<sup>4</sup>.
  - The prevalence of delayed pneumothoraces after lung biopsy is less well studied.
- FDG-PET scanning has become a mainstay of characterizing lung nodules, as well as an important method of tumour staging<sup>5</sup>. Current scanners incorporate an in-line PET and CT scanner, the latter used both for attenuation correction estimations and for anatomic localization.
- In the effort to provide timely work-up, FDG-PET/CT scans are scheduled in close proximity to TTNB. Indeed, a demonstrable incidence of pneumothorax in these relatively asymptomatic outpatients has been observed in these PET/CT studies.

## Objective

The objective of this project is to determine the natural history of asymptomatic new pneumothoraces that develop in the days following lung biopsy or previously-identified pneumothoraces that persist following return home.

## Case Study

A 64-year-old male underwent CT guided biopsy of a 1.4 x 1.8 cm nodule in the superior segment of the right lower lobe using a 22 gauge needle.



PET scan was performed 2 days later demonstrating increased FDG activity in the right lower lobe pulmonary nodule and a right hilar lymph node (a and b). Axial PET images at different intensities demonstrate an area of photopenia corresponding to the moderately sized pneumothorax. MIP images from PET scan demonstrate FDG activity in the right lower lobe nodule (c). Moderately sized right pneumothorax was present on corresponding axial CT (d). Coronal and sagittal CT images redemonstrate pneumothorax (e and f). Chest radiograph obtained immediately after biopsy (g) showed a tiny right apical pneumothorax measuring 0.9 cm at the apex. No active management was initiated at the time of PET scan and the patient presented to the emergency department (ED) one day after PET scan with shortness of breath. Chest radiograph in the ED demonstrated a pneumothorax measuring 6.5 cm (h). Pigtail chest tube was inserted with subsequent resolution of pneumothorax (i).

## Methods

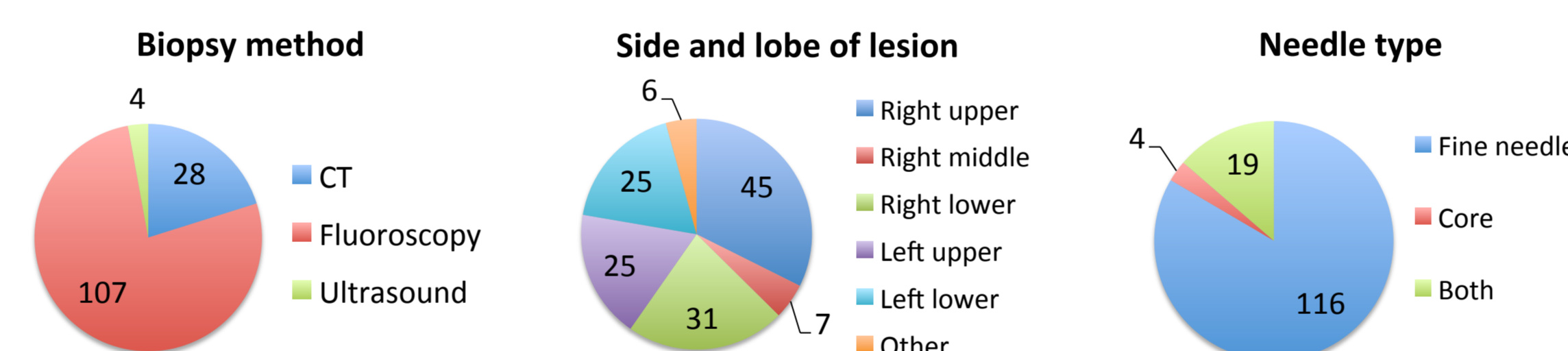
- Patient population**
  - Patients with a solitary lung nodule who underwent FDG-PET scanning within 1 week following TTNB from January 2013 to December 2013 were identified from the PACS database.
  - Excluded were patients with biopsy performed at an outside institution and endotracheal biopsy.
- Variables collected**
  - The biopsy reports were searched for biopsy method, side and lobe of lesion, and needle type.
  - Presence of pneumothorax on chest x-ray immediately post-procedure and management used (i.e. chest tube insertion) were noted.
- Primary measure**
  - The PET reports were reviewed for documentation of the presence and size of pneumothorax.
  - Patients were categorized according to number of days the FDG-PET scan was performed after biopsy.
    - From 1 to 7 days

## Results

### Patient demographics:

- 142 patients underwent PET scans within 7 days after lung biopsy
  - 68 male (47.8%)
  - Mean age: 68.9 ± 10.6 years
  - 5 had prior thoracic surgery, 12 had prior lung biopsy
  - 3 biopsies were failed and excluded → **139 eligible patients**

### Biopsy data:

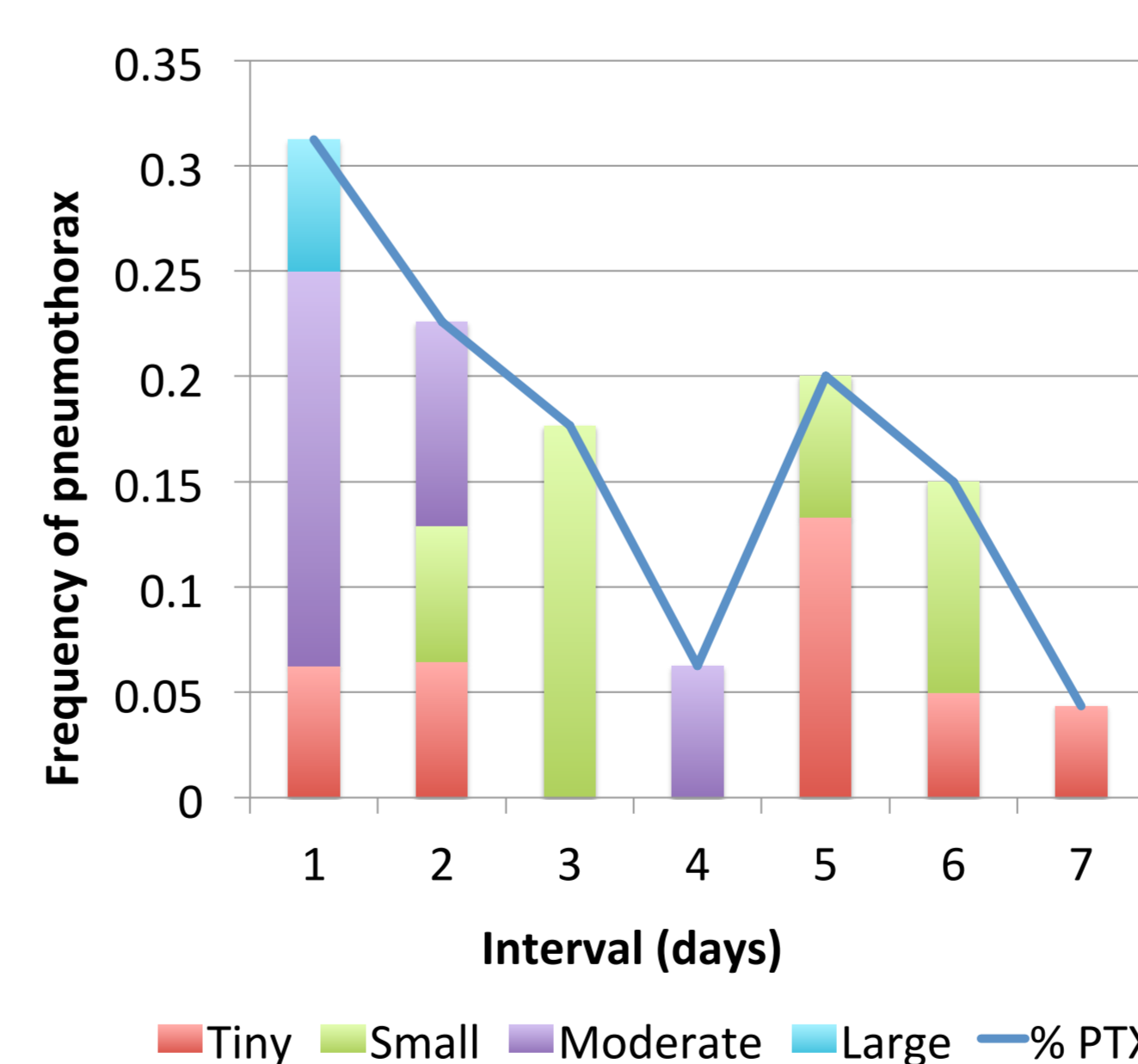


### Post-biopsy:

- Immediate post-procedure chest x-ray:
  - 13 tiny, 28 small, and 4 moderately sized pneumothoraces detected
- 1 hour delayed chest x-ray:
  - 10 enlarged, 9 decreased in size and 26 stayed constant

### PET after biopsy:

Interval between biopsy and PET (days)	# of patients	PTX detected on PET/CT	Frequency (%)
1	16	5	0.31
2	31	7	0.23
3	17	3	0.18
4	16	1	0.063
5	15	3	0.20
6	20	3	0.15
7	23	1	0.043
<b>Total</b>	<b>139</b>	<b>23</b>	



### Natural history:

Immediate post-biopsy chest x-ray	94 studies with no PTX visible	13 tiny PTX	28 small PTX	4 moderate PTX
On delayed PET/CT scanning	<ul style="list-style-type: none"> <li>6 developed new PTX:                             <ul style="list-style-type: none"> <li>2 tiny (1d, 6d)</li> <li>1 small (3d)</li> <li>3 moderate (1d, two 2d)</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>9 resolved (five 2d, 4d, 5d, 6d, 7d)</li> <li>1 stayed constant (2d)</li> <li>1 → small (6d)</li> <li>1 → moderate (2d)</li> <li>1 → large (1d)</li> </ul>	<ul style="list-style-type: none"> <li>16 resolved (1d, 2d, 3d, three 4d, 5d, seven 6d, two 7d)</li> <li>6 stayed constant (two 2d, two 3d, 5d, 6d)</li> <li>3 → tiny (2d, two 5d)</li> <li>3 → moderate (two 1d, 4d)</li> </ul>	<ul style="list-style-type: none"> <li>All 4 resolved (two 2d, 4d, 5d)</li> </ul>

## Conclusions

- In the subset of patients that underwent PET scanning within a week following lung biopsy, there is an appreciable frequency of pneumothorax.
- The frequency of pneumothorax is inversely correlated with the number of days between PET and biopsy ( $r = -0.777$ ,  $p = 0.040$ ).
- Because of the high frequency of pneumothorax encountered during staging PET/CT, nuclear medicine technologists and physicians must become expert in recognition of this finding.

### Limitations:

- Due to the retrospective nature of this study, larger pneumothoraces immediately post-biopsy may have been diverted to management and thus missed in both the PET reports and the calculation of frequency.
- Another limitation is the small sample size and narrow date range (some pneumothoraces may have persisted or grown past 7 days).

## Future Directions

- In the future, the dataset will be expanded:
  - Another year of eligible PET studies (i.e. from January 2014 to December 2014) will be identified to increase sample size.
  - PET scans performed up to 2 weeks following lung biopsy will be analyzed.
- Management of delayed pneumothorax will be studied:
  - Rates of chest tube insertion, non-emergent follow-up, presentation to emergency department with symptoms, and admission to hospital will be evaluated.
- Two board certified radiologists will re-review the PET/CT scans for presence of pneumothorax.
  - True numerical size of pneumothorax will be measured.
  - These results will be compared with the PET reports to estimate the accuracy of the nuclear medicine readers in detecting incidental pneumothorax on PET/CT scans.

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## Acknowledgements

- I would like to thank my supervisor Dr. Lionel Zuckier as well as Dr. Joseph Sommerfeldt for this opportunity and for their mentorship throughout the project.
- Thanks to the Undergraduate Research Opportunity Program (UROP) at the University of Ottawa for providing the funding for this project.
- This study has been approved by the Ottawa Health Science Network Research Ethics board.

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Undergraduate Research  
Opportunity Program (UROP)  
Symposium | April 2, 2015