

The Outcome of the Follow-Up of Consolidations on Chest Radiographs in a Maltese Population, Presenting from the Community, Aged 50 or over – a Retrospective Study

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Abstract

Background: The British Thoracic Society (BTS) guidelines for community-acquired pneumonia (CAP) suggest a repeat chest radiograph 6 weeks after treatment for patients over the age of 50 to screen for lung malignancy. The benefit of this practice is not well determined.

Method: We conducted a retrospective study involving patients from the community over 50 years old with consolidations on chest radiography. These patients presented in Mater Dei Hospital, Gozo General Hospital and Maltese Health Centres during the months of January 2013-2017 and August 2013-2016.

The occurrence of follow-up imaging and subsequent diagnosis of lung malignancy was documented. All chest radiographs were reviewed by a radiologist.

Results: 402 patients met our inclusion criteria. Follow-up imaging was done in 214 patients (53.2%) within 12 weeks. There was no statistical significance in the follow-up rates when matched for the presenting month, whether radiologists recommended repeat imaging, whether patients were admitted to hospital, and for the patients' age and gender.

The diagnostic yield of lung malignancy was 1.74% (7 patients) within 12 weeks with all malignancies being at an advanced stage at diagnosis (lowest stage being IIIA) when detected. All seven patients had a smoking history.

Conclusion: 53.2% of community-acquired pneumonia patients over the age of 50 had follow-up imaging within 12 weeks. No clinical variables explaining this low rate could be identified.

This practice results in a low diagnostic yield. Moreover, the diagnosis of lung malignancy is achieved at an advanced stage, making it a poor screening tool.

Keywords

Community-acquired pneumonia, Follow-up imaging, Lung Malignancy, Screening

Abbreviations

CAP: Community-acquired pneumonia

BTS: British Thoracic Society

PACS: Picture Archiving and Communication System

Introduction

Scheduling repeat imaging in patients diagnosed with community acquired pneumonias (CAPs) with a consolidation on radiographs is routine practice for many a physician. Lung malignancies can have similar radiological features to that of a consolidation, while an airspace shadow caused by an infection can easily mask an underlying neoplasm. It is on this trail of thought that repeat imaging is routinely done within the first 2 to 3 months.

The 2009 British Thoracic Society (BTS) guidelines¹ on Community Acquired Pneumonias mention that repeat chest radiography should be performed 6 weeks after the initial chest X-ray in patients over the age of 50 or those with a smoking history. Similarly, the 2005 American College of Chest Physicians guidelines² suggest follow-up radiography after approximately 8 weeks.

On the other hand, the 2007 Infectious Disease Society of America and the American Thoracic Society consensus guidelines³ do not mention any follow-up chest radiography in the management of CAPs.

More detailed guidelines on follow-up imaging are conspicuous by their absence. Consequently, physicians are left with their clinical judgment and patchy guidelines when they need to decide who the patients meriting future chest imaging are.

To address this void in the management of community acquired pneumonias, we have embarked on this retrospective study where our aims were twofold. Firstly, are patients over the age of 50 diagnosed with a community acquired pneumonia really being followed-up, as suggested

by the BTS guidelines, and if not, why? Secondly, is this practice really feasible and efficient? Using this strategy, what is the diagnostic yield of lung malignancy and is the diagnosis being achieved early enough?

Methodology

In this retrospective study, we considered patients 50 years old or over who presented to Mater Dei Hospital, Gozo General Hospital and Maltese Health Centres with radiological findings of a pneumonia.

The age 50 was chosen since the The 2009 British Thoracic Society (BTS) guidelines¹ on Community Acquired Pneumonias actually consider patients over the age of 50 to be at high risk for lung malignancy when recommending repeat chest imaging.

Patients were recruited by searching for the keywords “consolidation”, “pneumonia” and “opacification” in the radiologist reports for all the radiographs done in the months of January during the years 2013, 2014, 2015, 2016 and 2017 and the months of August in the years 2013, 2014, 2015 and 2016.

These reports were obtained using the local Picture Archiving and Communication System (PACS) software used in all Maltese state hospitals and health centres.

The patients whose reports had one or more of these keywords were then sieved through according to the inclusion and exclusion criteria as mentioned in **Tables 1 & 2**.

The consolidation must have been present only on chest radiographs. Thus, patients who had other modalities of chest imaging for up to one week after the presenting chest radiograph were excluded. Since this study focuses specifically on community acquired pneumonias, patients who were admitted for any reason in hospital during the three weeks prior to the chest radiograph were excluded. Patients with active malignancy were also excluded.

A radiologist higher specialist trainee reviewed all the chest radiographs which were reported to have a consolidation. This helped ensure that only chest radiographs with clear signs of consolidations were included in this study.

The final number of patients who satisfied all the aforementioned was 402 (*n*).

Table 1: Inclusion criteria for patients to be eligible to form part of the study cohort

Inclusion Criteria
Patients whose chest radiographs' reports contained the search words "consolidation", "opacification" and/or "pneumonia"
Age: 50 years or over
Consolidation must be seen on chest radiograph
Patients presenting in the months of January 2013-2017
Patients presenting in the months of August 2013-2016
Chest X-rays performed in Mater Dei Hospital, Gozo General Hospital and Maltese Health Centres

Table 2: Exclusion criteria preventing patients from being eligible for the study cohort

Exclusion Criteria
Patients under the age of 50
Patients who had chest imaging other than chest radiographs done in the first week after the initial chest X-ray
Patients deceased within 12 weeks of initial chest radiographs
Hospital Acquired Pneumonias, i.e. patients who had been admitted in hospital at any stage during the three weeks prior to presentation
Chest radiographs that were never formally reported
Lesion described on chest x-ray was already identified in previous imaging
Patients with pleural effusions that required drainage
Lung transplant patients
Patients with active pulmonary tuberculosis
Patients who did not have a fixed address in Malta (thus potentially making follow-up less likely)
Chest X-rays done over 24 hours after admission if no CXR was performed on admission
Presenting CXRs where the reporting radiologist recommended cross-sectional imaging and/or bronchoscopy and/or PET scans due to a high index of suspicion for a lung malignancy

The patients' demographics were documented along with the mortality and whether or not follow-up imaging was done or not. The initial chest radiograph reports were analysed to see whether the reporting radiologist had recommended follow-up imaging and consequently whether this affected the rate of follow-up or not. Other variables that may have affected rate of follow-up such as whether the patient was admitted and whether the consolidations were unilateral or bilateral were also documented.

All follow-up imaging done from one week until 12 weeks after the initial chest radiograph was scrutinized. The data collected was analysed using Statistical Package for Social Sciences (SPSS) software.

Where relevant, the histology, if available, and stage of the lung malignancy were noted. The 8th edition TNM classification⁴ was used to assess staging.

Results

As mentioned previously, a total of 402 patients met our inclusion criteria. 207 were male (51.5%) and the age ranged from 50 till 99 years. The mean age was 74.18 years (S.D. \pm 11.8 years) with the median being 76 years.

Follow-up imaging was performed in 214 patients within 12 weeks after the initial chest radiograph. This implies that 214 patients had chest imaging done between 1 week and 12 weeks after initial presentation (as documented in **Table 3**). Chest radiographs done on admitted patients who were in hospital for at least 24 hours were excluded.

316 patients of the cohort of 402 patients (78.6%) required hospital admission after the initial chest radiograph. Repeat imaging after treatment of the pneumonia was suggested by a radiologist in 130 chest radiographs, i.e. in 32.3% of the CAP population. Refer to **Tables 3** and **4** for an overview of the data collected.

Different follow-up rates within 12 weeks were compared according to gender, the month of presentation and whether follow-up was recommended by radiologist or not (**Figure 1**), if the consolidations was bilateral and whether the patient required admission by using a chi square statistical test for each variable.

Taking a p-value of <0.05 as being statistically significant, it was noted that no significant difference was detected among the follow-up rates when comparing these different predictors (**Table**

5). A paired t-test was done to compare age and follow-up rates. Once more, no statistical significance was noted (**Table 6**).

Additionally, logistic regression testing was done to assess any interaction among all the aforementioned predictors that may affect the follow-up rate. Once again, no significant difference in follow-up rate was detected.

A total of 58 patients (i.e. 27.1% of all patients followed up) had non-resolving radiological findings on repeat imaging. 38 of these were eventually diagnosed with benign conditions while 13 did not have further imaging done.

The remaining 7 patients had non-resolving radiological findings that led to the diagnosis of lung malignancy. This means that 3.27% of patients followed up were diagnosed with lung malignancy, while the diagnostic yield (i.e. the number of patients diagnosed with lung cancer compared to the total number of patients with a community-acquired pneumonia) was 1.74%.

The diagnostic yield in the months of January was 1.48% while that in the months of August was similar at 2.27%. Using proportion testing, this difference was not significant (**p-value: 0.570**).

Diagnosis of lung cancer was achieved at a relatively late stage in all cases; the most favourable stage was IIIA (as documented in **Table 7**).⁴

In addition to the aforementioned data, when including all radiology studies from one week after presentation up until 12 months after, a total of 320 patients had chest imaging done, i.e. 79.6% of the total cohort. In this scenario, 8 patients had unresolved lesions that led to a diagnosis of lung malignancy, i.e. only one patient was diagnosed with lung malignancy after not being followed up within 12 weeks. All 8 patients had a smoking history and their age ranged from 61 till 80 years (as shown in **Figure 2**). 7 of these patients were males. A cytology and/or histology confirmation of malignancy was achieved in 7 patients; one patient unfortunately passed away before this was achieved with his diagnosis only being done using radiological means. Three cases were adenocarcinoma, two squamous cell carcinoma and two small cell carcinoma. All were reported to be likely bronchial in origin. **Table 8** gives a detailed account of these 8 patients.

Moreover, similar to the rest of the cohort, repeat imaging had only been suggested in 4 of the 8 patients who were diagnosed with lung malignancy within one year.

Table 3: Overview of the data gathered from all 402 patients with radiological signs of a lung consolidation and presenting with a community-acquired pneumonia from the months of January and August 2013-2016 and the month of January 2017

Number of Patients (<i>n</i>)	402
Number of Males	207
Patients over 80 years old	143
Patients 50-80 years olds	259
Patients requiring admission	316
Follow-up imaging done (within 12 weeks)	214
% Follow-up done imaging within 12 weeks	53.2%
Follow-up Recommended by Radiologist	130
Follow-up done after Radiologist Recommendation (within 12 weeks)	76
% 12 week follow-up rate after Radiologist Recommendation	58.5%
12 week follow-up in patients over 80 years old	73
% 12-week follow up in patients over 80 years old	51.0%
12 week follow-up in patients 50-80 years old	141
% 12-week follow up in patients 50-80 years old	54.4%
Number of males with a follow-up chest imaging within 12 weeks	110
% 12-week follow up in males	53.1%
Number of females with a follow-up chest imaging within 12 weeks	104
% 12-week follow up in females	53.3%
Lung malignancy cases diagnosed on follow-up of non-resolving lesions	7
% diagnostic yield on follow-up (i.e. number of patients diagnosed with lung malignancy compared to total number - <i>n</i>)	1.74%
% of followed-up patients diagnosed with lung malignancy	3.27%
Chest imaging done within 12 months	320
% of cases having chest imaging done within 12 months	79.6%
Lung malignancy cases diagnosed within 12 months	8
% potential diagnostic yield (as identified by looking at all imaging done within 12 months)	1.99%

Table 4: Comparing community-acquired pneumonias' follow-up in the months of August 2013-2016 with the months of January 2013-2017

	Januaries 2013-2017	Augusts 2013-2016
Number of Patients (n)	270	132
Number of Males	133	74
Patients over 80 years old	96	47
Patients 50-80 years olds	174	85
Follow-up imaging done (within 12 weeks)	147	67
% Follow-up done imaging within 12 weeks	54.4%	50.8%
Patients requiring admission	215	101
Follow-up done in admitted patients (within 12 weeks)	114	53
% 12 week follow-up rate in admitted patients	53.0%	52.5%
Follow-up Recommended by Radiologist	98	32
Follow-up done after Radiologist Recommendation (within 12 weeks)	59	17
% 12 week follow-up rate after Radiologist Recommendation	60.2%	53.1%
12 week follow-up in patients over 80 years old	46	27
% 12-week follow up in patients over 80 years old	47.9%	57.4%
12 week follow-up in patients 50-80 years old	101	40
% 12-week follow up in patients 50-80 years old	58.0%	47.1%
Number of males with a follow-up chest imaging within 12 weeks	72	38
%12-week follow up in males	54.1%	51.4%
Number of females with a follow-up chest imaging within 12 weeks	75	29
%12-week follow up in females	54.7%	50.0%
Lung malignancy cases diagnosed on follow-up of non-resolving lesions	4	3
% diagnostic yield on follow-up (i.e. number of patients diagnosed with lung malignancy compared to total number - n)	1.48%	2.27%
% of followed-up patients diagnosed with lung malignancy	2.72%	4.48%
Chest imaging done within 12 months	217	103
% of cases having chest imaging done within 12 months	80.4%	78.0%
Lung malignancy cases diagnosed within 12 months	5	3
% potential diagnostic yield (as identified by looking at all imaging done within 12 months)	1.85%	2.27%

Figure 1: Pie Charts showing follow-up rates within 12 weeks of chest radiographs with signs of a community acquired pneumonia according to whether or not repeat imaging was suggested by the reporting radiologist

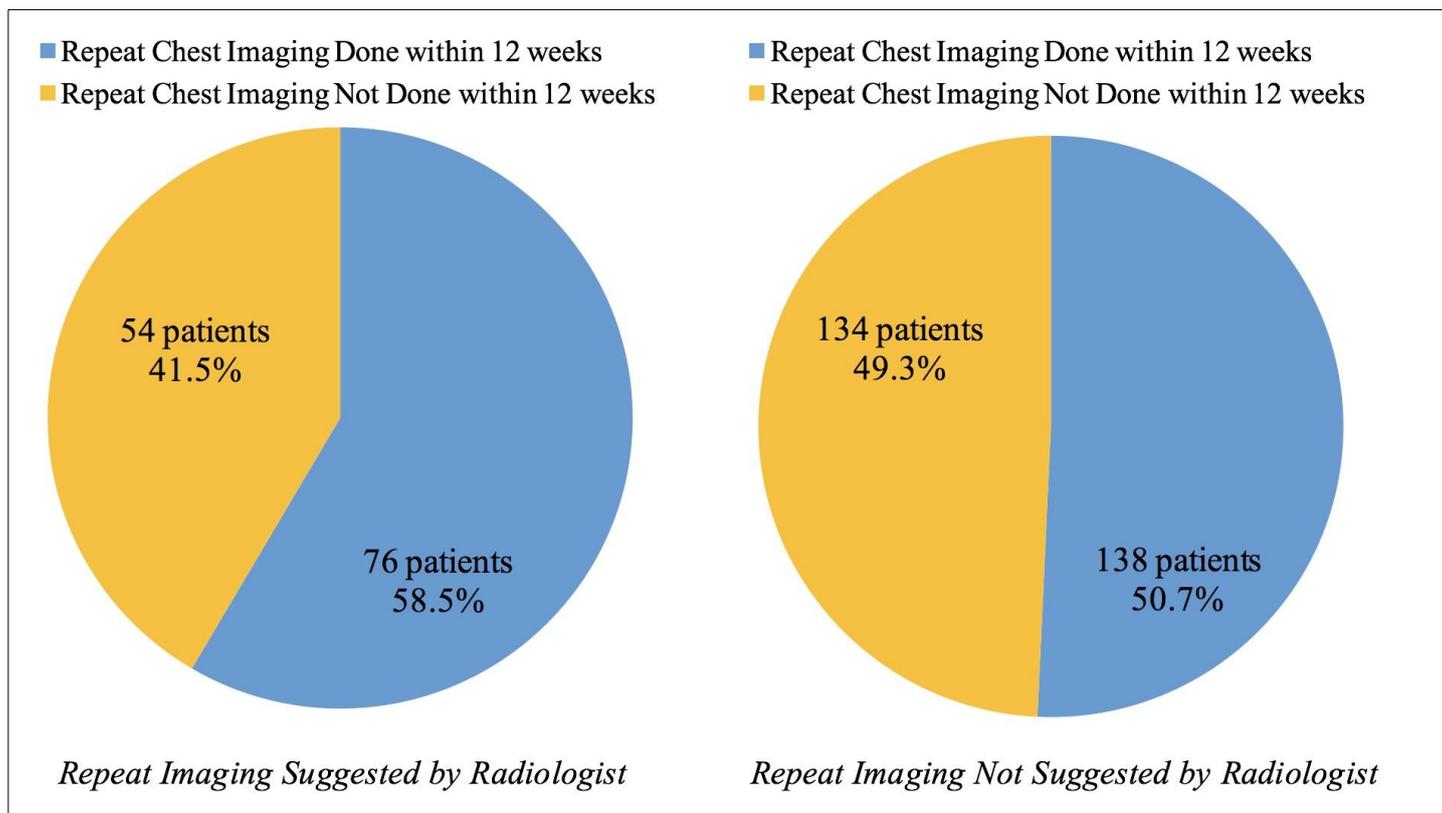


Table 5: Chi-Square Test (Pearson Chi-Square) to assess significance when comparing follow-up done within 12 weeks with the clinical predictors listed in the first column. None were statistically significant (i.e. p-values were all above 0.05)

Pearson Chi-Square Test comparing 12 week follow-up rates with different predictors	
	Asymptotic Significance (2-sided) <i>p</i> -value
Gender (Male vs Female)	0.969
Month (January vs August)	0.487
Admission to Hospital (Admitted to Hospital vs Not admitted)	0.766
Follow-up Recommended by Radiologist	0.215
Unilateral vs Bilateral Pneumonia	0.775

Table 6: The results when comparing 12 week follow-up rates according to the age

Follow-up done within 12 weeks	Number of Patients	Mean Age (in years)		
Y	188	74.34		
N	214	74.05		
T-Test For Equality of Means				
Significance (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of Difference	
			Lower	Upper
.810	.284	1.181	-2.039	2.606

Table 7: Detailed overview of the seven patients who were diagnosed with lung malignancy on follow-up within 12 weeks

Patient	Month when initial CXR was done	Gender	Age (years)	Imaging Modality used for first follow-up	Histology	Lung Malignancy Stage & TNM classification on diagnosis ^[4]
1	January 2013	Male	73	CXR	Squamous Cell Carcinoma	T2b N3 M1a Stage IV
2	August 2013	Male	75	CXR	Adenocarcinoma	T4 N3 M1c Stage IV
3	August 2013	Male	75	CXR	Small Cell Carcinoma	T2a N2 M1c Stage IV
4	January 2014	Male	79	CXR	Small Cell Carcinoma	T4 N3 M1a Stage IV
5	January 2015	Male	69	CXR	Adenocarcinoma	T3 N0 M1c Stage IV
6	August 2015	Male	61	CT	Not available *	T1c N2 M0 Stage IIIA
7	January 2017	Male	67	CXR	Adenocarcinoma	T2 N2 Mo Stage IIIA

*No histology was obtained in this case; diagnosis of lung malignancy was only radiological.

Figure 2: Simple column chart showing distribution of the age of the patients who were diagnosed with a lung malignancy within 12 months after presenting with a community-acquired pneumonia

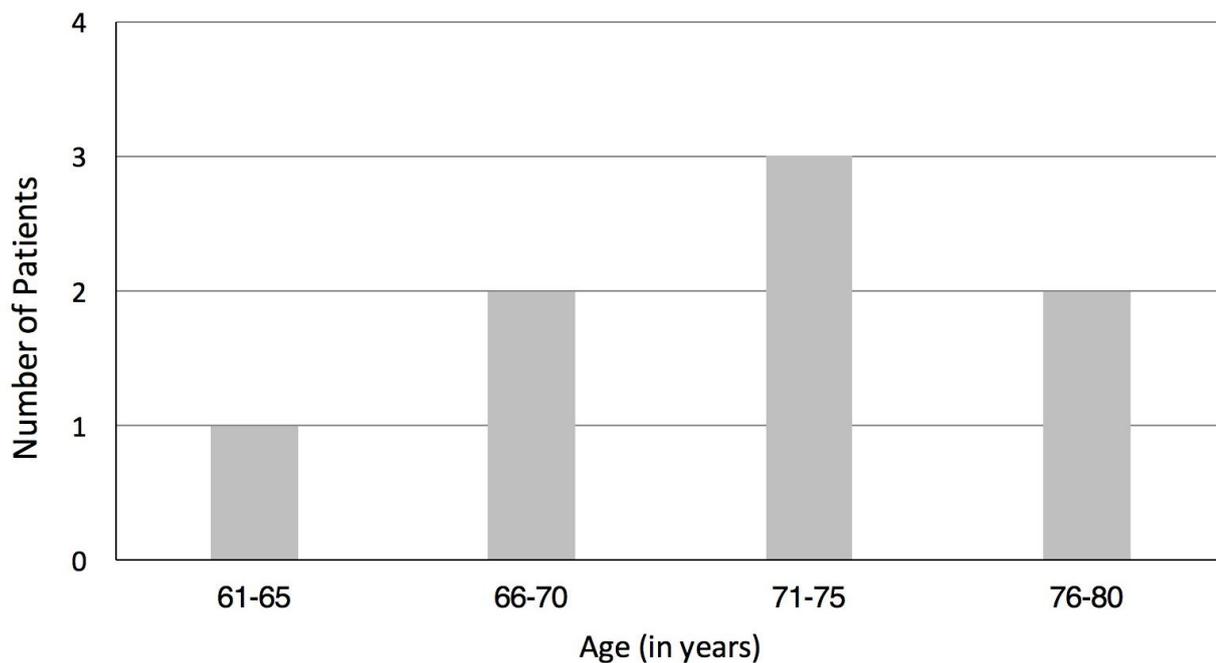


Table 8: Detailed overview of the patients who were diagnosed with lung malignancy within 12 months after first chest radiograph. All patients had a smoking history

Patient	Month when initial chest radiograph was done	Gender	Age (years)	Number of days after first chest radiograph when repeat chest imaging was done	Imaging Modality used for first follow-up	Histology
1	January 2013	Male	73	37 days	CXR	Squamous Cell Carcinoma
2	August 2013	Male	75	15 days	CXR	Adenocarcinoma
3	August 2013	Male	75	7 days	CXR	Small Cell Carcinoma
4	January 2014	Male	79	60 days	CXR	Small Cell Carcinoma
5	January 2015	Male	69	9 days	CXR	Adenocarcinoma
6	August 2015	Male	61	14 days	CT	Not available
7	January 2017	Male	67	25 days	CXR	Adenocarcinoma
8	January 2017	Female	80	283 days	CXR	Squamous Cell Carcinoma

Discussion

The most striking consideration from this study is that lung malignancy was diagnosed at a late stage during radiological follow-up of community acquired pneumonias. Using such a practice as a screening tool for lung malignancy is clearly inadequate from our data. None of the patients diagnosed with lung cancer on follow-up could reasonably be offered curative surgery as the most favourable lung cancer stage was IIIA. To our knowledge, no recent studies have been done delving into the actual stage of the lung cancer on diagnosis when following-up community acquired pneumonias.

Secondly, and equally as noteworthy, is the low diagnostic yield of lung malignancy on follow-up of community acquired pneumonias. Only 1.74% of patients who had follow-up chest imaging within 12 weeks were diagnosed with lung malignancy. This diagnostic yield did not vary significantly from the months of January to August.

53.2% of CAP patients were followed up with repeat imaging within 12 weeks, a figure that is similar to that in other studies.⁵⁻⁷ This seems to suggest that multiple centres do not feel the need to adhere to guidelines such as those of the British Thoracic Society in each and every patient. The reason for this is likely multifactorial. Follow-up rate was however not affected by the presenting month, age and gender of the patients and neither by whether or not the patients were admitted, nor whether the radiologist suggested repeat imaging when reporting the first chest radiograph.

The fact that only one case of lung malignancy was diagnosed within one year in those patients who were followed-up within 12 weeks seems to suggest that physicians are picking up clinical clues that help choose which patients are most likely to benefit from repeat imaging. This study was unable to identify any such indicators.

Larger, prospective studies looking into multiple patient co-morbidities and demographics may help identify other, more specific clinical predictors that can better guide physicians to decide regarding follow-up imaging.

Limitations

This study had various limitations that one must point out. Firstly, the study was carried out retrospectively in a relatively small cohort. Similar studies have been carried out, however they are

sporadic and thus, it was difficult to compare results. The clinical features on presentation, patient co-morbidities (apart from the presence of an active malignancy) and serology results that aid in the diagnosis of a pneumonia were not included in this study making it heavily reliant on radiologic findings.

Moreover, it was impossible to obtain proper smoking histories and detailed documentation from the patients' medical notes when they presented with the pneumonia. The reasons for this were several including the fact that a substantial cohort of patients have since passed away making access to their medical notes very difficult. Documentation outside Mater Dei Hospital, especially in the Health Centres, is also very sparse and not easily accessible.

Consolidations were identified only by three keywords on the radiograph report, thus the study was dependent on the report of the initial imaging. Only PACS software used in state-funded hospitals and health centres was analysed, meaning that follow-up imaging that could have potentially been done in the private sector or overseas was missed. This was mitigated to a certain extent by excluding patients without a Maltese fixed address.

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Conclusion

This study shows that, similar to other studies done in different centres, the follow-up rate locally of consolidations on chest radiographs in patients presenting from the community is low (53.2%). Why this is so is still unclear.

The diagnostic yield of lung malignancies on follow-up within 12 weeks in patients over 50 years of age is just 1.74%. When analysing all chest imaging done within one year in all the patients who fitted our inclusion and exclusion criteria, lung malignancy was diagnosed in 1.99%.

When lung malignancy *is* detected, the stage was always noted to be advanced, and hence inoperable and with a poor prognosis. Following up consolidations on chest radiographs in community acquired pneumonias is a poor screening tool.

Summary Box

1. The follow-up rate of chest radiographs in patients presenting with a community-acquired pneumonia is 53.2% within 12 weeks in state-run hospitals and health centres in the Maltese Islands.
2. Lung malignancy is diagnosed at a late stage when following up community-acquired pneumonias.
3. The diagnostic yield of lung malignancy when following up community-acquired pneumonias within 12 weeks is 1.74%.

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