Aims and objectives

BACKGROUND

More than 41,000 people are diagnosed with lung cancer in the UK every year[1].

The factors that affect the prognosis in patients with lung cancer are stage, histology, performance status, comorbidity, age, and sex. Most of these factors are not modifiable.

Unfortunately, most lung cancers are found too late for a cure; only about 20% of patients undergo a radical surgical procedure, which is the only curative treatment[2].

Early lung cancer diagnosis has been associated with increased operability and a better prognosis[3-4].

People presenting at stage I have a 35% 5 year survival compared to 6% for those diagnosed with stage III disease[5]. Stage IV survival could not be calculated at five years due to the small number of people surviving more than two years[5].

Data from the Anglia Cancer Network shows that unfortunately a majority (67.6%) of patients diagnosed with lung cancer presented at stage III or IV[6].

The stage is dependent on delays in patient presentation and on diagnostic workup both in general practice and in specialist units[2].

In view of all this information it is imperative that health services continue to look into ways and means which ensure early diagnosis of lung cancer.

INTRODUCTION

A couple of important questions arise from the above statistics.

Is the late stage of cancer diagnosis unavoidable? AND

If the answer to the first question is 'NO' what can be done to improve early diagnosis?
To answer the first question it was thought that a study of our local practices should be undertaken to look at individual cases in detail and chart each patient’s pathway from hospital presentation to diagnosis.

Ideally this would have included primary care data with details about onset of symptoms, first visit to GP, etc. This was however, difficult to accurately obtain in all cases and was excluded for the purpose of this study.

A decision was made to focus on how secondary care performed in diagnosing lung cancer.

To the best of our knowledge there are no set standards which define the 'optimal time' between hospital presentation and diagnosis.

Generally patients have to undergo several investigations before a diagnosis of lung cancer is confirmed.

In our practice typically a chest x-ray, followed by a CT scan (0-2 weeks), multidisciplinary team discussion (0-1 week), organising and performing a bronchoscopic or imaging guided biopsy (0-2 weeks) takes 4-5 weeks.

If a pre-biopsy PET scan, an endobronchial ultrasound (EBUS) or surgical diagnosis such as mediastinoscopy is needed this can easily add 1-3 weeks to the diagnostic pathway.

We have hence set a standard of an 'optimal time' of 6 weeks between hospital presentation and lung cancer diagnosis.

The aims of our study were

- To check how many patients were diagnosed within the optimal timeframe of 6 weeks.
- To evaluate the causes of a delay in diagnosis in patients who failed to meet the diagnostic target of 6 weeks.
- To formulate practical recommendations for eradication of delayed diagnosis of lung cancer.

**Methods and materials**

Patients diagnosed with primary lung cancer in the year 2013 were included. Patients whose initial presentation was to another hospital were excluded from this audit. Similarly
patients who were diagnosed after follow-up of a <1cm solitary nodule were excluded from this study unless the Fleischner guidelines were not adhered to.

The audit was part prospective and part retrospective.

The data was collected using electronic hospital systems including Radiology Information System (CRIS), PACS, Somerset Cancer Registry, eHR (electronic medical records) and Apex (Pathology system).

Specific data collection parameters were identified. These are explained below.

1. **Date of Initial Presentation:** This was defined as 'the hospital based investigation which prospectively/retrospectively provided the first evidence of lung cancer'.

2. **Modality:** Nature of the investigation which demonstrated lung cancer on the date of initial presentation.

3. **Referring physician/s:** The referrer of the initial investigation which demonstrated lung cancer.

It is noteworthy that the first three parameters all relate to an investigation. This is almost universally a radiological investigation. Not surprisingly, the first objective evidence of lung cancer is most commonly obtained from a chest x-ray. It is not uncommon to detect lung cancer on x-rays performed for an unrelated indication. Lung cancer is also detected on CT scans done for this purpose or as an entirely incidental finding. Similarly an ultrasound on some occasions detects abdominal metastatic disease or pleural effusion as the first evidence of lung cancer.

Therefore the date of the first abnormal radiological investigation with evidence of lung cancer has been designated as the date of initial hospital presentation. The referring physician can be the GP, a hospital physician or the A&E department.

4. **Date of diagnosis:** The date on which a diagnosis of lung cancer was officially recorded on the Somerset Cancer register by the MDTM (lung cancer multidisciplinary team meeting) co-ordinator.

This data was entered after discussion of the patient's non-invasive and invasive diagnostic investigations in the weekly MDTM. In most cases a pathological confirmation of lung cancer is obtained. In a few cases the diagnosis was recorded on the basis of
clinical and imaging findings as obtaining a tissue diagnosis was not in the best interests of the patient.

5. Interval between 'Date of Initial Presentation' and 'Date of Diagnosis': Patients were divided into 3 groups based on this interval: 1 (<6 weeks), 2 (between 6 and 12 weeks), 3 (>12 weeks).

6. Causes of Delay in Diagnosis: The cause was defined and labelled as 'Delay caused by Radiology' or 'Delay due to a Non-Radiology Cause'. The latter sample included mistakes made by Clinicians, Patients themselves (if responsible for the diagnostic delay) and Logistical delay (in organisation and acquisition of diagnostic investigations).

Each case in Groups 2 and 3 was evaluated in detail to try and isolate the exact factors responsible for the delay.

Results

Out of a total of 175 lung cancer patients diagnosed in 2013 who were included in this audit, 113 (65%) were diagnosed within 6 weeks of initial hospital presentation.

Patients NOT diagnosed within this pre-defined optimal period of 6 weeks (Group 1) were divided into two groups; those diagnosed before or after 12 weeks (Groups 2 and 3 respectively).

The total number of patients with a delayed diagnosis of lung cancer was 62/175, with 22 patients placed in Group 2 (12%) and 40 (23%) in Group 3 (Figure 1).

This division of the 'delay' into two patient groups highlighted an interesting observation; only 6/22 (27%) were placed in Group 2 because of errors in radiological management, whereas in Group 3 this proportion jumped to 65% (26/40 patients).

A 'radiological delay' in most cases meant a very significant delay (Figure 2).

RESULTS FOR 'RADIOLOGY DELAY':
Out of a total of 32 Radiology delays, 29 were due to errors on CXR and 3 on CT.

The causes were Perceptual error (lesion missed) in 12/32 patients, Interpretive error in 8/32, as a result of Poor Communication of results in 9/32 and due to suboptimal X-ray Quality in 3/32 patients.

The results show that a radiology error caused a delay in 29 of the 138 patients (21%) initially presenting with a CXR.

The mean delay in diagnosis due to a Radiology error was 236 days with a standard deviation of 202 days.

RESULTS FOR 'NON-RADIOLOGY DELAY':

Overall 30/62 patients (48%) suffered a diagnostic delay due to Non-Radiology causes with a mean delay of 154 days. These 'Non-Radiology Causes' accounted for 16 patients in Group 2 and 14 in Group 3 respectively (Fig3).

The majority (18/30) were Logistical delays in acquisition of tertiary investigations (PET-CT, endobronchial ultrasound, etc); 7 delays were due to Clinician error and Patients themselves were responsible in 5 cases.

Images for this section:
**Fig. 1:** Distribution of patients into groups based on time taken from initial presentation to diagnosis.
**Fig. 2:** Significant impact of 'Radiology Delay' in comparison with 'Non-Radiology Delay'.
Conclusion

Generally patients have to undergo several investigations and hospital appointments before a diagnosis of lung cancer is confirmed.

In our practice typically a chest x-ray, followed by a CT scan (0-2 weeks), multidisciplinary team discussion (MDTM) and urgent clinic appointment (0-2 weeks), organising and performing a bronchoscopic or imaging guided biopsy (0-2 weeks) takes 5-6 weeks.

If a pre-biopsy PET scan, an endobronchial ultrasound (EBUS) or surgical diagnosis such as mediastinoscopy is needed this can easily add 1-3 weeks to the diagnostic pathway.

The diagnostic period from first symptoms to diagnosis in lung cancer patients has been determined to be approximately 3 months in earlier studies [7-8].

**RADIOLOGY ERRORS**

As this audit is based in the Radiology Department it is important to start by discussing where radiology has erred.

Chest x-ray is the universally accepted standard technique to start investigations of chest disease - and most of the radiology mistakes have to do with this basic investigation.

'Miss' rates on CXR vary between 10 - 50% [9-10]. In addition to errors of observation and interpretation [11], there are also errors due to poor communication of results and poor decision making [12-13].

Digital techniques with image processing improve detection rates [14].

Figures from the Mayo Clinic show that 90% of peripheral lesions and 75% of peri-hilar tumours are visible on retrospective review [15].

Chest x-ray errors have been classified as follows [16],

*Interpretive*: Lesion identified but misinterpreted

*Communication*: Lesion identified but not communicated to clinician

*Perceptual*: Lesion missed
Technical: Poor film quality

The radiological diagnosis of chest disease begins with the identification of an abnormality on a chest x-ray; in other words, that which is not seen cannot be appreciated [17].

Experience gives the radiologist the perceptual and cognitive skills to know what information to look for and how to interpret that information based on the information processed from previous encounters with the same type of abnormality [18].

Other aspects in interpretation should also be mentioned. No radiologist can deny diminution of visual and mental acuity when exposed to a heavy workload, the "reader fatigue." Errors due to reader fatigue can be reduced through frequent "rest periods" away from the PACS screen and a reasonable workload each day. Attention to comfort in the viewing facilities, e.g. background illumination, less noise reduces the risk of making mistakes.

The structure of the final report sent out to the referring physician is very important.

Words must be carefully chosen. As an example the term "infiltrate" is almost invariably used in the sense of any poorly defined opacity in the lung, and serves no useful purpose. Due to the lack of any specific connotation, it causes great confusion. Often it is assumed by clinicians to be another name for lung infection, whereas the radiologist is 'sitting on the fence'.

**NON-RADIOLOGY ERRORS**

A brief mention will be made to this group of cases. These can be broadly defined as failures to complete key diagnostic procedures, specialist referrals or investigations in a timely manner. The British Thoracic Society provides advice on this matter [19], in a key document on lung cancer management.

The causes are

1. Clinicians not acting on advice given in Radiology reports.
2. Physicians continuing to treat patients as 'chest infection' despite lack of objective evidence.
3. Clinician delay in requesting diagnostic tests.
4. Wrong investigation requested by a clinician delaying diagnosis.
5. Logistical delays in organisation of diagnostic tests such as percutaneous biopsy, EBUS guided biopsy and mediastinoscopy.
6. Patients failing to attend for diagnostic tests and initial patient refusal to undergo invasive investigations.

RECOMMENDATIONS

• There is a strong need to simplify the diagnostic process for patients with lung cancer. An attempt should be made to acquire immediate confirmatory tissue diagnosis wherever the combined clinical and CT appearances can be due to lung cancer, rather than wait for other tests such as PET-CT scans. These latter investigations should follow the diagnosis, when treatment options are being considered.

• In our audit an issue was of 'logistical delays' in acquisition of tertiary referral diagnostic investigations such as EBUS guided FNA, diagnostic mediastinoscopy and VATS guided biopsy. These issues need to be tackled at institutional level as there are issues of capacity and skilled manpower.

• Physicians should attempt to consistently request the 'correct' diagnostic test, e.g. percutaneous biopsy rather than bronchoscopy for peripheral inaccessible lesions.

• Multidisciplinary teams should try to avoid reliance on follow-up imaging investigations as a diagnostic test. The only exceptions are when it is not possible to safely obtain a diagnosis, the patient does not wish to undergo an invasive procedure or the patient is not medically fit for a diagnostic procedure.

• An important radiology failing in our study has been 'errors of perception'. Abnormalities are observed on the CXR but thought to be due to infection/pneumonia, when both radiological features and clinical presentation are not in keeping with community acquired pneumonia.

• An issue has been failure to adhere to hospital policies by Radiology, especially with regard to organization of urgent CT after abnormal CXR and ‘fast-tracking’ of the CT report to respiratory physicians. The protocols have been widely distributed but a further formal effort is required to ensure everybody is aware.

• Unfortunately, despite the best of efforts tumours will go undetected on CXRs (errors of observation). On occasion this has to do with
  • Workloads
  • Reporting conditions
  • Subtle lesions present in 'hidden areas' on the CXR.
  • Comparison not made with previous films. An effort should be made by the reporting radiologist/radiology department to ensure the first
two issues are addressed internally. The hidden areas on the x-ray should be individually looked at for completion of the report. The importance of 'previous films' cannot be overstated for radiologists, as this has been their saviour in many a case.

- There have been several 'misses' on chest x-rays reported externally by Teleradiology companies. The causes are not completely clear but are perhaps related to workloads/meeting reporting targets and skill level. An effort should be made to report community/GP and outpatient clinic referred CXRs internally by departmental radiologists more experienced in chest reporting and more aware of hospital policies.

- The radiology report should use proper anatomical and pathological terminology and try to provide a clear summary of the findings. Use of misleading terms has erroneously lead to lowered suspicion of cancer by the referring doctor.

- Outpatient/GP CXRs should be acquired using a high kV technique in the new DR (digital radiography) rooms. The hospital should plan to replace all x-ray equipment with digital radiography machines which are capable of producing good quality high kV x-rays without incurring increased radiation dose.

SUMMARY

Lung cancer diagnosis is a complex process requiring an efficient multidisciplinary approach.

There has been no documented study to date which has provided an optimal timeframe for diagnosis after initial presentation. We have identified this target time as 6 weeks based on our local practice.

The majority of our patients (65%) met this target. Radiology errors were overall responsible for half of the total delays, but perhaps more significantly for two thirds of the significant delays.

It is clear to the authors that most of the delays could be avoided if the above recommendations are followed.

Images for this section:
Fig. 4: Right lower lobe nodule 'missed on x-ray; this was not present on a previous x-ray done 2 years earlier. Proven as lung cancer.
Fig. 5: Figures 5, 6, 7 and 8 pertain to the same patient. Initial CT (Figure 5) demonstrated a left upper lobe spiculated nodule with surrounding groundglass attenuation interpreted as infection. Follow-up CT and PET-CT after 6 months (Figures 6, 7 and 8) showed increase in size of the lung nodule, hilar lymphadenopathy and vertebral metastases. Percutaneous biopsy of the lung nodule confirmed primary lung adenocarcinoma.
Fig. 6: Figures 5, 6, 7 and 8 pertain to the same patient. Initial CT (Figure 5) demonstrated a left upper lobe spiculated nodule with surrounding groundglass attenuation interpreted as infection. Follow-up CT and PET-CT after 6 months(Figures 6, 7 and 8) showed increase in size of the lung nodule, hilar lymphadenopathy and vertebral metastases. Percutaneous biopsy of the lung nodule confirmed primary lung adenocarcinoma.
Fig. 7: Figures 5, 6, 7 and 8 pertain to the same patient. Initial CT (Figure 5) demonstrated a left upper lobe spiculated nodule with surrounding groundglass attenuation interpreted as infection. Follow-up CT and PET-CT after 6 months (Figures 6, 7 and 8) showed increase in size of the lung nodule, hilar lymphadenopathy and vertebral metastases. Percutaneous biopsy of the lung nodule confirmed primary lung adenocarcinoma.
**Fig. 8**: Figures 5, 6, 7 and 8 pertain to the same patient. Initial CT (Figure 5) demonstrated a left upper lobe spiculated nodule with surrounding groundglass attenuation interpreted as infection. Follow-up CT and PET-CT after 6 months (Figures 6, 7 and 8) showed increase in size of the lung nodule, hilar lymphadenopathy and vertebral metastases. Percutaneous biopsy of the lung nodule confirmed primary lung adenocarcinoma.
Fig. 9: Figures 9 and 10. The initial x-ray (Figure 9) was reported as showing left upper and right middle lobe consolidation (secondary to pneumonia). Follow-up x-ray 6 weeks later (Figure 10) reported resolution of the left upper lobe pneumonia, persistent right middle lobe pneumonia and a right apical nodule. This nodule was not detected on the earlier film by the same radiologist as the first x-ray was done with poor penetration. This was proven as lung carcinoma on biopsy. The right middle lobe consolidation subsequently resolved.
Fig. 10: Figures 9 and 10. The initial x-ray (Figure 9) was reported as showing left upper and right middle lobe consolidation (secondary to pneumonia). Follow-up x-ray 6 weeks later (Figure 10) reported resolution of the left upper lobe pneumonia, persistent right middle lobe pneumonia and a right apical nodule. This nodule was not detected on the earlier film by the same radiologist as the first x-ray was done with poor penetration. This was proven as lung carcinoma on biopsy. The right middle lobe consolidation subsequently resolved.
Fig. 11: Figures 11, 12 and 13. On the first CT (Figure 11) there was incidental detection of a 9mm right upper lobe nodule. The radiologist advised follow-up as per Fleishner Society guidelines in this patient at high risk for lung cancer. The first follow-up CT at 3 month interval (Figure 12) showed no obvious change in size. The referring physician failed to organise the 9 month and 24 month CT as per protocol. The patient presented 4 years later (Figure 13) with a much larger lesion and metastatic thoracic lymphadenopathy.
Fig. 12: Figures 11, 12 and 13. On the first CT (Figure 11) there was incidental detection of a 9mm right upper lobe nodule. The radiologist advised follow-up as per Fleishner Society guidelines in this patient at high risk for lung cancer. The first follow-up CT at 3 month interval (Figure 12) showed no obvious change in size. The referring physician failed to organise the 9 month and 24 month CT as per protocol. The patient presented 4 years later (Figure 13) with a much larger lesion and metastatic thoracic lymphadenopathy.
Fig. 13: Figures 11, 12 and 13. On the first CT (Figure 11) there was incidental detection of a 9mm right upper lobe nodule. The radiologist advised follow-up as per Fleishner Society guidelines in this patient at high risk for lung cancer. The first follow-up CT at 3 month interval (Figure 12) showed no obvious change in size. The referring physician failed to organise the 9 month and 24 month CT as per protocol. The patient presented 4 years later (Figure 13) with a much larger lesion and metastatic thoracic lymphadenopathy.
Fig. 3: Proportion of delay caused by Radiological and Non-radiological causes.
Personal information

References


17. Fraser RG, Pare JAP, Pare PD et al. Diagnosis of diseases of the chest. WB Saunders, Philadelphia 1988.
