Original Article

Yield of Follow-up Chest X-rays for Infection-associated Changes in Same Day Emergency Care

O Emeje, R Alkaissy, R De Butts, M Rajwani, CA O'Callaghan & ME Reschen

Abstract

Introduction: Patients with respiratory infection-associated changes on chest X-ray often have follow-up chest X-rays (CXRs) to exclude malignancy. In the UK, same day emergency care (SDEC) units have been developed to manage patients needing urgent hospital care on an ambulatory basis. The yield of findings and benefit from follow-up CXRs in this population is unknown. We report the non-malignant and malignant findings from our cohort of SDEC patients.

Methods: We performed a retrospective service evaluation of CXRs for adult patients who attended our SDEC between 6/1/2020 and 25/9/2023, identifying CXRs arranged as follow-up for infection-related findings and assessing outcomes stratified by lung malignancy-associated risk factors.

Results: Of 27,336 CXR requests from our SDEC unit, we identified 419 follow-up CXRs. From these, 341 follow-up CXRs were done to assess resolution of infection-related changes; 304 (89%) showed resolution and 37 (11%) showed persistent changes. Further investigation of persistent changes identified two malignancies and several non-malignant conditions including 7 cases of interstitial lung disease, 2 requiring ongoing respiratory follow up. Both patients with cancer were over 50 with risk factors.

Conclusions: The small number of malignancies detected in follow-up CXRs in SDEC patients support risk factor-based targeting of CXRs although non-malignant findings may benefit some patients.

Keywords

Chest X-rays, same day emergency care (SDEC), community acquired pneumonia, lung cancer

Key points

1. Patients presenting acutely with chest infections often have follow-up chest x-rays to exclude underlying malignancy regardless of whether they have relevant risk factors (age, smoking history, known cancer).
2. Patients seen on same day emergency care units (SDECs) include many younger patients at low risk.
3. We analysed all chest X-rays arranged by our SDEC unit for follow-up of radiological changes initially attributed to infection.
4. Only 2 (0.6%) led to a diagnosis of pulmonary malignancy, only one of which was a new diagnosis of cancer. Both patients had more than two of the three risk factors.
5. No malignancies were identified in patients under 50.
6. We document various benign findings and the value or otherwise of their detection.
7. Our results support British Thoracic Society guidance to target follow-up chest X-rays to those with a higher risk of malignancy.

Introduction

The chest X-ray remains a key investigation for patients who are assessed in hospital with suspected pulmonary infection.[1] X-ray findings associated with pneumonia can be similar to, or obscure, those associated with malignancy in the lungs. This creates a challenge for clinicians who must decide which patients should have follow-up imaging at a later date to help exclude malignancy by demonstrating resolution of changes seen initially. As the radiographic findings of infection may take weeks to resolve, follow up imaging is usually undertaken around 6 weeks after the initial chest X-ray. Follow-up imaging is burdensome. Patients must attend a unit with an X-ray facility, may have to take time off work and will be irradiated. The healthcare service must arrange, undertake and report the images as well as communicating the outcome to patients and following up the findings if necessary.

In the UK, people with acute illness who require hospital-based assessment and are deemed likely to be able to return home the same day are increasingly seen on same day emergency care units (SDECs). SDEC units are sometimes referred to as ambulatory emergency care (AEC) units. Our hospital SDEC

Ojoma Emeje
Department of Acute General Medicine, John Radcliffe Hospital, Oxford University Hospitals NHS Foundation Trust, Headley Way, OX3 9DU, Oxford, UK

Rand Alkaissy
Department of Acute General Medicine, John Radcliffe Hospital, Oxford University Hospitals NHS Foundation Trust, Headley Way, OX3 9DU, Oxford, UK

Richard De Butts
FRCP
Department of Acute General Medicine, John Radcliffe Hospital, Oxford University Hospitals NHS Foundation Trust, Headley Way, OX3 9DU, Oxford, UK

Mridula Rajwani
FRCP
Department of Acute General Medicine, John Radcliffe Hospital, Oxford University Hospitals NHS Foundation Trust, Headley Way, OX3 9DU, Oxford, UK

Christopher A O'Callaghan
FRCP
Nuffield Department of Medicine, Centre for Human Genetics, University of Oxford, Roosevelt Drive, Oxford, OX3 7BN, United Kingdom

Correspondence
Michael E Reschen
FRCP
Department of Acute General Medicine, John Radcliffe Hospital, Oxford University Hospitals NHS Foundation Trust, Headley Way, OX3 9DU, Oxford, UK
Email: Michael.reschen@ouh.nhs.uk

reviews adult patients referred from primary care, paramedics and the emergency department. Many of the patients assessed on the SDEC have a chest X-ray, especially as the top two presenting complaints are shortness of breath and chest pain, which commonly merit a chest X-ray.[2] These chest X-rays are initially interpreted by the SDEC clinician but are subsequently reported by a radiologist.

A key challenge is selecting those patients who need a follow-up X-ray. The British Thoracic Society guidance for community acquired pneumonia recommends a follow-up chest X-ray after 6 weeks for patients who are at 'higher risk of malignancy (especially smokers and those aged over 50)'.[1,3] Some radiologists recommend a repeat X-ray for any patient with an abnormal initial chest X-ray in the context of suspected infection. Our impression has been that over time the threshold for requesting a follow-up X-ray has diminished and it is sometimes performed for reassurance in patients with no risk factors. The utility of a follow-up chest X-ray in some elderly frail patients is questionable given the burden of an extra visit to hospital and the low likelihood of finding a malignancy for which there would be a realistic treatment option of value to the patient in this context.

Malignancy may be detected on imaging at presentation and estimates of the incidence of pulmonary malignancy after a diagnosis of pneumonia vary from less than 2% to over 9% depending on the interval between presentation and follow-up imaging and on the risk factor profile of the patients.[4,5,6,7] Studies assessing the utility of follow-up X-ray have often excluded patients with known cancer or those below the age of 50.

The aim of this study was to evaluate the utility of follow-up chest X-rays (CXRs) to detect lung malignancy in patients who had attended our SDEC unit and had radiographic changes suggestive of infection. Specific objectives included determining the rate of cancer detection on follow-up CXRs and determining this in patient groups stratified by the key risk factors for malignancy including age, smoking status and history of malignancy.

Methods

A retrospective service evaluation of chest X-rays was undertaken for patients aged 18 years and over who attended the SDEC (same day emergency care) unit between the dates of 6/1/2020 to 25/9/2023. The hospital electronic health record was queried for all patients with chest X-rays to allow filtering of the subset of patients where the X-ray had been flagged as a follow-up (an option button during the electronic requesting of chest X-rays at our institution). For these patients with follow-up X-rays, further manual filtering was performed by reviewing the X-ray request information, report and electronic discharge summary and subsequent clinical notes relating to the X-ray. Using these data, we identified the subset where the follow-up X-ray had been requested to determine whether there was resolution of changes referred to in the initial chest X-ray report that might indicate infection. The language used in radiology reports to describe changes which led to a follow-up CXR to exclude malignancy included terms such as 'consolidation', 'infiltrates', 'patchy changes' and 'opacity'. For this subset of patients, we obtained demographics including age and gender, smoking status and whether there was a pre-existing history of malignancy or asbestos exposure. We assessed the reports of the follow-up chest X-rays, the subsequent investigations done for persistent abnormalities and the final diagnosis following this, categorized as benign incidental findings, respiratory disease and malignancy.

Anonymized data were collated into a Microsoft Excel spreadsheet and analyzed in the R software environment.[8] The service evaluation was registered on the institution's quality improvement management system and in line with institutional policies no further ethical approval was required and informed consent was not required as this was an anonymised retrospective use of previously collected and limited routine clinical data. Statistical analysis was performed using Fisher's exact test for categorical data and Student's t test for continuous data, with p value thresholds for significance of 0.05.

Results

We screened a total of 27,336 chest X-ray requests for acute medical patients assessed in the SDEC unit and identified 419 requests for outpatient follow-up imaging. We manually screened the radiology reports and electronic medical notes to select the 341 chest X-rays that were performed to check for resolution of changes attributed to probable infection. Radiographic changes attributed to probable infection were described using terms such as 'consolidation', 'patchy changes' and 'infiltrates'. Follow-up X-rays were excluded if they were performed for reasons other than parenchymal infection such as pleural effusion, pneumothorax or nodule. The mean age of patients was 59.9 years with a range of 17-96 years and their age distribution is shown in Figure 1. The numbers of patients under 50 and over 85 years were 99 (29.03%) and 25 (7.33%) respectively. There were 188 (55%) female and 153 (45%) male patients.

As smoking is a major risk factor for lung cancer it could influence the utility of the chest x-ray in an individual. Smoking status was available for 336 patients of whom 178 (52%) were non-smokers, 121(35%) were ex-smokers and 37 (11%) were smokers. We also ascertained the number of patients with a history of malignancy as this is a risk factor for malignant lung

lesions. There were 44 patients (12.9%) with a history of cancer. There were 61 patients with a follow-up CXR who were under 50 years old, had no history of malignancy and were known to be non-smokers (61/336, 20%).

The majority of CXRs were reported as showing resolution of previous findings (304, 89%), but 37 (11%) showed persistent changes. In the 37 patients with persistent changes, the mean age was 66.1 years (range 34-92 years); 5 (13.51%) were under 50 years of age and 2 (5.41%) were 85 or older. Patients with persistent changes included 17 non-smokers, 17 ex-smokers and 3 smokers. The number with a history of cancer was 8 (22%).

Persistent changes included: persistent opacity 11, (29.7%), persistent consolidation 7 (18.9%), nodular opacity 4, (10.8%), baseline 3, (8.1%), pleural effusion 2 (5.4%), COVID-19 2 (5.4%), suspicious for underlying malignancy 2 (5.4%), persistent atelectasis/effusion 1 (2.7%), bulky hilum 1 (2.7%), right lower lobe collapse 1 (2.7%). The advice given in the radiology report for future imaging included: advised CT chest 18 (48.7%), further imaging not required 10 (27%), no specific advice 8 (21.6%), query organizing pneumonia 1 (2.7%)

A decision not to undertake further imaging was made in 8 (22%) of patients with persistent changes, based on factors associated with a benign diagnosis. The reasons given were that the follow up imaging was consistent with the previous baseline (3), explained by persistent covid-19 associated changes (3), explained by an alternative diagnosis of heart failure (1) or represented ongoing infective changes (1).

The remaining 29 patients with persistent changes underwent CT scanning of the chest to further investigate the follow-up chest X-ray observations. The findings from these scans are summarised in Figure 2. The 29 CT scans identified cancer in 2 patients (0.6% of the 341 patients who had a follow-up X-ray to look for resolution of changes attributed to infection and 5% of the 37 patients whose follow-up x-rays showed persistent changes). One of the two cancer diagnoses was new, but the other patient was already known to have cancer outside the lung. Only one patient who had a CT scan was over 85 years of age and they had a background of bladder cancer, but their CT was normal.

Of the 27 patients who did not have cancer on their CT, 5 had completely normal scans and 22 had non-malignant changes. Seven patients had pulmonary nodules on their CT scan and only one of these patients remains under long term surveillance for their nodule. Of the other 6 patients with nodules, one had a nodule that was already known about and follow-up was discontinued, one had a nodule that had resolved on a second CT, one had a nodule deemed benign and not

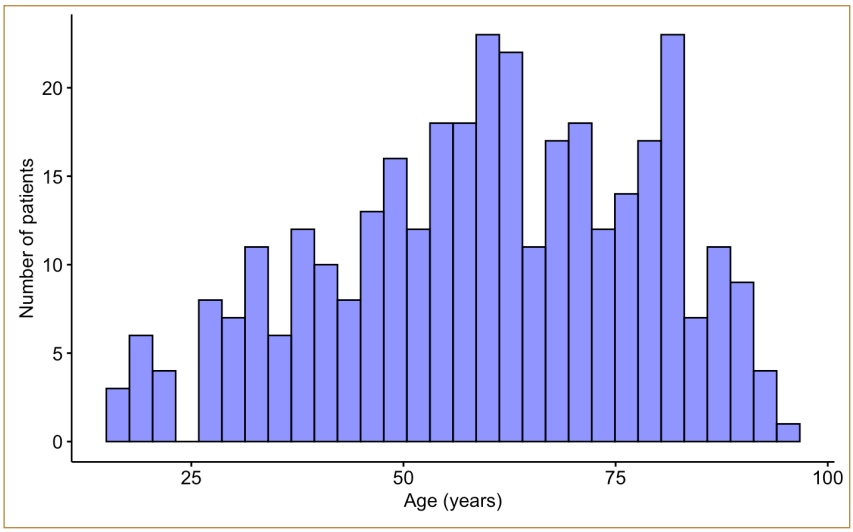

Figure 1. Histogram of the ages of patients having a follow-up chest X-ray

requiring follow up, one had a nodule deemed to be an old calcified granuloma not requiring follow up, one had tiny subpleural nodules that did not need follow up and one had two small nodules that were stable on a second CT scan and did not need further follow up. Other findings were mainly of limited clinical significance and included incidental findings such as healed rib fractures, a lung scar, a hamartoma. One scan indicated probable persistent infection, two scans indicated benign asbestos pleural effusion (BAPE) and one scan demonstrated a patch of mild bronchiectasis.

The possibility of interstitial lung disease was suggested by scans in 7 patients. Two of these were possible organizing pneumonia and were followed up in a respiratory clinic but resolved over time without specific treatment. Two scans raised the possibility of underling sarcoidosis, but neither required treatment. Two scans showed changes consistent with mild interstitial disease and neither required treatment. One scan showed mild interstitial changes in a patient

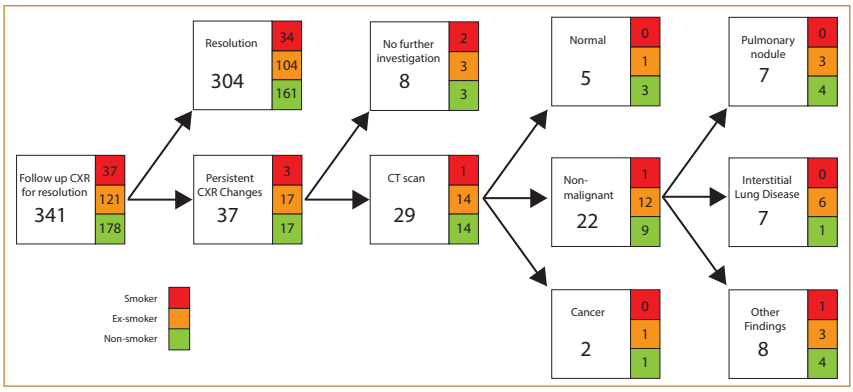

Figure 2. Flowchart of the investigation and findings in patients with persistent changes on their follow-up chest X-ray. Smoking information was only available for 336 of the 341 patients so in the two boxes labelled 'Follow up CXR for resolution' and 'Resolution' the sum of the numbers in the coloured squares is slightly lower than the total number in the white boxes.

know to have Crohn's disease who was started on immunosuppression for their gut disease. Overall, only 2 of the 7 patients with possible interstitial lung disease remained under respiratory follow up at the end of the study period.

The two patients diagnosed with cancer were aged 60 and 82 years old. One of the patients was a male ex-smoker with no prior history of cancer and a subsequent biopsy demonstrated lung cancer. The other patient was female, with no smoking history but was known to have breast cancer and was subsequently diagnosed with lung metastases. We evaluated the three major risk factors of age, smoking status and history of cancer to compare the risk characteristics of patients undergoing follow-up X-rays with resolved, resolving or benign findings to the two patients found to have cancer. There were no significant differences in the distribution of risk factors between the two groups, but there were only 2 patients in the cancer group. In both cases where cancer was diagnosed through the use of a follow-up chest X-ray the patients each had two of the three risk factors. Both were over 50 years old, one had a history of cancer and the other patient had a history of smoking in the past.

Discussion

When chest X-rays show changes in the context of infection, follow-up chest X-rays are often undertaken to exclude underlying lung cancer as a contributory factor in the radiological changes. The utility of systematically performing follow-up chest x-rays remains unclear and international guidelines vary in their recommendations. The British Thoracic Society guidance on follow-up chest x-rays is based on relatively few studies that were mostly performed several decades ago.[1] Our present study provides a contemporary analysis in the same-day emergency care unit setting, which has emerged as a major focus for acute medical activity in the UK.

The benefit of a follow-up chest X-ray must be weighed against the need for the patient to travel to a radiology unit, the radiation dose and the resource implications of performing, reporting and following up these X-rays. Machine learning may reduce the burden of interpreting the images, but currently they are almost always reported by radiologists. Studies analysing the detection of cancer not seen on the original chest X-ray but detected on a planned follow-up chest X-ray after about 6 weeks have demonstrated cancer detection rates of only 1-2% from these follow-up X-rays.[9-11]

The burden of follow-up chest x-rays may be higher for very elderly frail patients who may be immobile or have dementia and may not understand the purpose of the X-ray. The benefit in frail patients may be low because the likelihood of finding a malignancy which could be treated beneficially in this group is low. There is also evidence in the very elderly of a decline in the incidence of lung cancer.[12] Fewer than 10% of patients in our study were over 85 and no malignancies were detected in this group.

One strategy to increase the yield from follow-up chest X-rays might be to avoid performing them in patients with completely resolved symptoms, but this would require clinical time to assess symptoms. Furthermore, 50% of cancers detected in one study were found in patients with complete resolution of their symptoms. In the group of 88 patients with persistent symptoms, follow-up X-rays identified 2 cases of pulmonary malignancy.[6] By comparison, in the group of 524 patients whose symptoms had resolved by 5 weeks only 2 pulmonary malignancies were detected.[6] The American Thoracic Society recommends not routinely repeating imaging in patients whose symptoms of pneumonia have resolved within 5-7 days. However, in our experience symptoms such as lethargy and cough can often persist beyond this time point so the effect on the number of chest X-rays undertaken might not be large.[13]

Other studies have examined the utility of using cancer risk factors to select patients who would benefit

Table 1. Comparison of the clinical characteristics of patients diagnosed with cancer on the follow-up chest XR versus those with no new diagnosis of cancer.

Characteristic	Cancer (N=2)	No Cancer (N=339)	P value	Effect Size (95% CI)
History of Cancer/Asbestos Exposure			0.26	OR: 6.37 (0.39–103.62)
History	1(50%)	46 (14%)		
No history	1(50%)	293 (86%)		
Smoking history			1	
Ex-smoker vs Non-smoker	1 (50%)	120 (35% vs 177 (52%)		OR: 1.48 (0.09–23.81)
Current smoker vs non-smoker	0 (0%)	37 (11%)		OR: 1.58 (0.06–39.59)*
Unknown vs non-smoker	0 (0%)	5 (1.5%)		OR: 10.75 (0.39–294.52)*
Age >50			1	OR: 2.07 (0.10–43.47)*
Over 50	2 (100%)	240 (71%)		
Under 50	0 (0%)	99 (29%)		
Mean age	71	61	0.4	Mean diff: 10.00 (6.12–13.88); d=0.606

* p-values from Fisher's exact test (categorical) and t-test (age). ORs for zero cells use Haldane-Anscombe correction (+0.5)

most from follow-up imaging. In a cohort study of 3398 patients with radiographically confirmed pneumonia who were followed up for 5 years, 40% had follow-up chest x-rays which identified 34 new lung cancers. In the overall cohort, risk factors for subsequent lung cancer diagnosis included being male, older age and being a smoker. The authors demonstrated that if chest x-rays had been limited to patients aged over 50, they would have detected 98% of these within one year.[9] In a study of patients with pneumonia for whom a radiologist recommended a follow-up chest X-ray, 9 new malignancies were identified from 618 cases and 2 of these patients were under 50 years of age.[11] In a different study considering only patients over the age of 50, a 2% rate of cancer diagnosis was attributed to follow-up chest x-rays.[10] Of the 6 patients diagnosed with cancer, 5 had a smoking history, 5 had chronic obstructive pulmonary disease and two had died within 3 months. A further 5 patients were diagnosed with cancer over a median follow up of 19.5 months despite having a normal chest X-ray at 6-12 weeks.[10]

In our study, the malignancy rate was lower than some previous studies, which likely reflects in part a difference in the underlying risk factors in the patient populations. We have previously demonstrated that SDEC patients are younger than general medical inpatients.[2] The percentage of the population in England who are active smokers has decreased from 20% in 2011 to 11.6% in 2023.[14] In a 2011 study of the diagnostic yield from follow-up chest X-rays after pneumonia, the detection rate was higher at 2.5% but the percentage of active smokers was higher at 17%.[9]

The 2 cases where cancers were detected were both over 50 suggesting that this age might be a reasonable cut-off threshold for risk stratification to reduce the number of unnecessary follow-up X-rays. Also, each of these 2 patients had at least one other risk factor of either a history of cancer or a history of smoking. The British Thoracic Society guidance for a follow-up chest x-ray after about 6 weeks if there are persistent symptoms or if the patient is at higher risk of cancer ('especially those over 50 and smokers') is supported by our findings in the SDEC context as the two patients with cancer both had risk factors.[1] In the absence of risk factors the likelihood of missing a cancer in the SDEC population would seem low and we suggest that the practice of performing a follow up chest x-ray in everyone with lung changes in the context of likely acute infection is not necessary.

A further potential benefit of a follow-up chest X-rays is the detection of important non-malignant pulmonary diagnoses. In a study of 618 follow-up chest X-rays for pneumonia non-malignant diagnoses were made in 23 (3.7%) cases[11] and included mycobacterium tuberculosis, fungal infection and organizing pneumonia. However, these diagnoses are likely to be symptomatic and a strategy of safety net advice to seek medical attention based on ongoing or new symptoms might reduce the need for widespread radiological screening after otherwise uncomplicated infection.

In our trust, CXRs are routinely reported by a radiologist and their reports frequently recommend a follow-up CXR when there is any respiratory infection-related abnormality rather than making recommendations in line with the BTS guideline for follow up chest radiography to be considered in the context of risk factors for malignancy. This may have increased the probability of a follow-up CXR or CT scan in someone who may not have needed them. We initiated discussions with our radiology colleagues and jointly proposed a revised terminology for reports which aligns with BTS guidance and acknowledges the role of clinical judgement. This promotes informed decision-making about follow-up imaging based on each patient's clinical progress and risk factors. The initiative reflects a shared commitment to reducing unnecessary investigations, promoting evidence-based practice, and prioritising patient-centred care.

Limitations

The very low rate of cancer detection reduces the power of statistical comparisons between subgroups of patients stratified by cancer risk factors as indicated by the wide confidence intervals of the odds ratios for these subgroups. Our findings are based on ambulatory patients suitable for SDEC care and may not be generalizable to patients with severe pneumonia requiring inpatient admissions, potentially including critical care or to populations with a higher prevalence of smoking than the UK. We were unable to reliably ascertain whether some patients had persistent symptoms, so could not assess how this might have affected the use of follow-up CXRs. As this is a retrospective study, we relied on existing records which are not always complete, so for example, we did not have information on smoking for all patients.

Conclusions

Overall, our service evaluation shows that for patients assessed on an SDEC unit in the UK, the use of follow-up X-rays resulted in the diagnosis of a very small number of new malignancies and only in patients with known risk factors for cancer. Other respiratory diseases were detected which may potentially be of benefit to some patients. Our data support the current British Thoracic Society guidance to target follow-up X-rays to those with risk factors for malignancy, or ongoing symptoms, but does shows that additional pathology was detected by follow-up radiography.

Conflict of interest

none

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