Utility of Chest Radiographs in Rapid Access Tuberculosis Clinic

Gupta S1,2*, Stiles R2#, Kotecha J2*, Birk R1, Rao P1, Barnes D1, Haldar P2#

1. Radiology Department, Glenfield Hospital, Leicester, UNITED KINGDOM
2. University of Leicester, University Road, Leicester, UNITED KINGDOM

Introduction

Early diagnosis and treatment of infectious pulmonary tuberculosis (TB) is a key component of the WHO TB control strategy. Chest radiograph (CXR) is widely available, cheap and the primary diagnostic tool for identifying pulmonary TB. Leicester City is a high TB burden region of the UK. Since 2005, the local TB service has implemented a rapid access pathway (RATB) for the early assessment of suspected incident pulmonary TB. CXRs reported by radiologists as suspicious for TB are assigned a code that initiates the pathway for clinical triage and assessment. Accurate TB code assignment is a key determinant of efficiency, effectiveness and cost-effectiveness of the RATB service.

Purpose

To determine:
1. Factors that are important in coding CXR as possible TB.
2. Radiological features associated with TB to use for developing a systematic TB CXR scoring tool.

Methods and Materials

Patients evaluated by the RATB service between 2009 and 2014 were utilised to form two datasets.

Dataset 1 comprised randomly selected patients with a confirmed diagnosis of TB and either a CXR coded as TB (n=52), or a CXR not coded as TB (n=61) on clinical reporting. Diagnosis of TB was confirmed by sputum smear microscopy or sputum culture. Chi-square test was used to assess influence of (a) hospital site, (b) reporting radiologists’ sub-specialty and the (c) clinical details provided, on CXR coding for TB.

Dataset 2 comprised randomly selected patients evaluated by the RATB service between 2009 and 2014 that were (i) symptomatic, (ii) not suspected of TB, and (iii) were not already coded as TB by RATB. Two thoracic radiologists, blinded to all clinical data including demographic information and diagnosis, analysed all CXRs in dataset 2 for:

i. Likelihood of TB (score 1-4) and

ii. Presence of features that may indicate TB

Inter-observer agreement and multiple logistic regression analysis were performed.

CXR score for likelihood of TB

(1) Normal
(2) Abnormal, TB unlikely
(3) Abnormal, suspicious of TB further investigations required
(4) Abnormal, TB highly likely

CXR Features Evaluated

- Interstitial infiltrates
- Consolidation
- Nodules/masses
- Cavitation
- Bronchiectasis
- Lymphadenopathy
- Calcification
- Pleural effusion
- Pleural thickening
- Granulomas
- Paraspinal / vertebral disease
- Rib destruction

Analysis of Dataset 1

1. A clinical history of TB compatible symptoms was associated with coding of CXR as TB (p=0.007).
2. Hospital site and reporting radiologists’ sub-specialty did not influence coding of CXR as TB.

Analysis of Dataset 2

1. There was good agreement between two thoracic radiologists in assessment of CXRs for likelihood of TB (Cohen’s kappa = 0.8, Figure 1).

![Figure 1](image)

2. The sensitivity, specificity, positive likelihood ratio, negative likelihood ratio, positive predictive value and negative predictive value for both radiologists is shown (For this analysis TB was considered unlikely if CXR score was 1 or 2, and probable if CXR score was 3 or 4)

<table>
<thead>
<tr>
<th>Radiologist 1</th>
<th>Value</th>
<th>95% CI</th>
<th>Value</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity</td>
<td>74.00%</td>
<td>21.30% to 96.69%</td>
<td>72.68%</td>
<td>20.40% to 94.54%</td>
</tr>
<tr>
<td>Specificity</td>
<td>76.50%</td>
<td>57.00% to 89.77%</td>
<td>73.68%</td>
<td>53.10% to 90.97%</td>
</tr>
<tr>
<td>Positive Likelihood Ratio</td>
<td>2.54</td>
<td>1.53 to 4.22</td>
<td>2.20</td>
<td>1.46 to 3.49</td>
</tr>
<tr>
<td>Negative Likelihood Ratio</td>
<td>0.46</td>
<td>0.30 to 0.77</td>
<td>0.41</td>
<td>0.26 to 0.71</td>
</tr>
<tr>
<td>Disease prevalence (TP)</td>
<td>56.64%</td>
<td>46.30% to 66.77%</td>
<td>58.03%</td>
<td>48.77% to 67.17%</td>
</tr>
<tr>
<td>Disease prevalence (FN)</td>
<td>43.36%</td>
<td>30.01% to 56.72%</td>
<td>41.97%</td>
<td>32.83% to 51.30%</td>
</tr>
<tr>
<td>Positive Predictive Value</td>
<td>77.76%</td>
<td>73.04% to 81.68%</td>
<td>69.93%</td>
<td>63.06% to 76.26%</td>
</tr>
<tr>
<td>Negative Predictive Value</td>
<td>68.36%</td>
<td>57.29% to 79.50%</td>
<td>70.09%</td>
<td>59.05% to 80.52%</td>
</tr>
</tbody>
</table>

3. Multiple logistic regression analysis was performed to assess CXR features associated with (i) radiological diagnosis of probable TB (CXR likelihood score = 3 or 4), and (ii) final diagnosis of TB.

Conclusions

1. Diagnosis of probable TB on CXR is influenced by the clinical details provided, particularly patient symptoms indicative of TB.
2. Interpretation of CXR for TB by thoracic radiologists demonstrate good inter-observer agreement.
3. Consolidation, cavitation and lymphadenopathy are features that are associated with coding CXRs as probable TB.
4. The presence of mediastinal lymphadenopathy was the main feature on CXR associated with a final confirmed diagnosis of TB.
5. Formulation of a combined clinical and radiological scoring tool may help improve effectiveness of the rapid access TB pathway.

Future Work

- Validate CXR scoring tool for TB diagnosis on a different dataset.
- Create and validate a combined clinical and radiological scoring tool for utilisation in the rapid access TB service.