

Development and evaluation of a new chest radiograph reading and recording system for epidemiological surveys of tuberculosis and lung disease

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SUMMARY

OBJECTIVE: The development and evaluation of a new chest radiograph reading and recording system (CRRS) for community surveys of tuberculosis (TB) and lung disease.

DESIGN: An experienced pulmonologist read 2608 chest X-rays (CXRs) performed as part of a TB prevalence survey using the newly developed CRRS. The kappa (κ) for inter-reader agreement was calculated after a second reader reported on a stratified random sample of 810 (31%) of the 2608 CXRs. The κ for intra-reader agreement was calculated from the repeated reporting of a stratified random sample of 104 CXRs.

RESULTS: The κ agreement between the two readers

was 0.69 (95%CI 0.64–0.74) for abnormalities consistent with TB and 0.47 (95%CI 0.42–0.53) for any abnormalities. The κ for intra-reader agreement was 0.90 (95%CI 0.81–0.99) for abnormalities consistent with TB and 0.85 (95%CI 0.74–0.95) for any abnormalities. **CONCLUSION:** This standardised method for CXR reading and recording provides satisfactory inter- and intra-reader agreement, making it suitable for surveys of TB and other forms of lung disease in the community. Its use will permit comparisons of results obtained in different surveys.

KEY WORDS: tuberculosis; chest radiograph; kappa; dual reading; reproducibility

THE INTERPRETATION of chest X-rays (CXRs), because of its subjectivity, is highly dependent on the reader. Inter-observer differences and lack of consistency of reporting,^{1–3} even by the same reader, has led chest radiography, although widely used as a diagnostic tool, to be not well regarded as a tool in tuberculosis (TB) surveys. Current practice is to minimise the effects of observer error by employing a second or third reader and then seek consensus,^{4–11} which is both costly and effort-intensive. For the study of occupational lung disease, the use of radiology for both clinical purposes and research has been greatly improved by the use of a standardised reading methodology utilising reference radiographs, and a system of accreditation for readers.^{12,13}

We hypothesised that the use of a method similar to that used for occupational lung disease might be of benefit to researchers and even to practitioners evaluating and recording CXRs on individual subjects for the purposes of identifying and systematically recording abnormalities. By transforming observed patterns into categorical and semi-quantitative forms, these may be used for both screening and follow-up of patients. We report here the development and first results obtained using a chest radiograph reading and recording system (CRRS) that employs principles similar to those used in the International Union Against Cancer and the International Labour Organization (UICC/ILO) and the National Institute for Occupational Safety and Health (NIOSH)^{12,13} radiographic reading methods and may be used in conjunction with the UICC/ILO reference radiographs and scoring system for occupational diseases, but

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extends this to recording detailed information and descriptions of TB and non-occupational forms of lung disease.

METHODS

Development of the CRRS

During the course of surveys of occupational diseases and TB performed in southern Africa, one of the authors (NWW) recorded the number and diversity of radiographic features that might signify the presence of alternative pathology. While employing the UICC/ILO recording and reporting system for features for which that system is devised, additional categories were developed, where possible with provision for semi-quantitation. The aim was to develop a reading and recording system suitable for community-based research, where the focus is on establishing the prevalence of lung diseases, including TB. Other requirements were that all data could be captured on a single form designed for electronic data capture and entry into a database, and that its use could be easily taught and learned. The reporting form was developed and refined in a series of studies and employed prospectively in a large community survey in Cape Town: the 'Lung Health Survey 2002 (LHS2002)'. The report form (Appendix A) and instructions for its use (Appendix B) are provided with this report. The form comprises sections devoted to a description of TB disease in its many forms, affecting the parenchyma, pleural and central structures. It also makes provision for recording complications of TB (mycetomas, granulomas, lobar volume loss, collapse and bronchiectasis), and for description of many other lung diseases that might be of value in characterising the burden of lung disease in a community.

Evaluation of the performance of the CRRS in a TB and burden of lung disease prevalence study

A lung health survey, including a TB prevalence survey, was performed in 2002 in two neighbouring communities in Cape Town, South Africa. The prevalence of new smear-positive TB was calculated to be 3 per 1000 (95% confidence interval [CI] 1–5/1000) (Den Boon et al., submitted). During the survey, postero-anterior chest radiography was performed on 2608 adults (≥ 15 years) in a local clinic using a 200 MA X-ray machine and 35×43 cm CXRs.

Training of readers and reading of CXRs

One experienced and trained pulmonologist (reader 1, NWW), who had no clinical or bacteriological information about the participants, read all 2608 CXRs and completed the standardised report form. A second reader (reader 2, DAE) received 5 h of special instruction on the use of the modified evaluation method from reader 1. This involved reading at least 50 CXRs selected to provide a range of representative patholo-

gies that would be encountered in the study set of CXRs. Where relevant, these were viewed alongside the UICC/ILO standard radiographs to ensure correct scoring of profusion of abnormalities. Reader 2, blinded both to the clinical and bacteriological results of the subjects enrolled into LHS2002 and to the results of reader 1, then reported on a stratified sample of 810 CXRs, comprising 31% of the complete data set.

The sample was stratified to contain all categories of abnormality observed by reader 1. Intra-observer variability was assessed by reader 2 rereading a sub-sample of 104 of the sample of 810 CXRs, blinded to his previous report. The sub-sample was selected by a third investigator, and presented in random order, interspersed with previously unread CXRs. Both readers had originally attained the status of 'B' reader in the UICC/ILO system of accreditation for reading of CXRs from subjects with occupational lung disease, but at the time of the study both were certified only as grade 'A' readers.

Data collection and statistical analysis

Data recorded manually on the CRRS report form by reader 1 were entered into a customised relational database (Prospect Medical Information Services, Cape Town, South Africa) by electronic capture involving high speed scanning of the forms and electronic recognition. Second entry was performed manually. The reports from reader 2 were captured manually through double data entry. Inconsistencies between the first and second entries from either reader were corrected after scrutiny of the original reading form.

The primary objective was to examine the inter- and intra-observer variation in recording major diagnostic categories on CXRs when using the CRRS. These categories included 1) abnormal CXR, any abnormalities; 2) parenchymal abnormalities; 3) pleural abnormalities; and 4) central structure abnormalities. Where any of the abnormalities in the last three categories were considered potentially related to TB they were also included in a fifth category: abnormalities consistent with TB. The CXRs in the original set of 2608 were categorised as follows: 1906 were normal, 337 consistent with TB and 365 abnormal but not consistent with TB. The following sample was taken: 300 normal CXRs ($300/1906 = 16\%$), 310 CXRs with abnormalities that were consistent with TB ($310/337 = 92\%$) and 200 CXRs with abnormalities that were not related to TB ($200/365 = 55\%$). However, during retrieval of the selected CXRs from the CXR storage bank for the second reading, five CXRs could not be located and the final sample comprised 299 normal CXRs, 310 CXRs with abnormalities consistent with TB and 196 CXRs with other abnormalities (totalling 805 CXRs).

The kappa (κ) statistic¹⁴ and its 95%CI were calculated to evaluate inter- and intra-reader agreement for abnormal CXRs, parenchymal abnormalities, pleu-

Table 1 Kappa (κ) statistic and percentage observed agreement (Po) between two readers for abnormalities on CXR ($n = 798$)

Agreement index	Abnormal, any abnormalities <i>n</i>	TB-related abnormalities* <i>n</i>	Parenchymal abnormalities <i>n</i>	Pleural abnormalities <i>n</i>	Central structure abnormalities <i>n</i>
++	307	233	204	97	93
+-	195	74	66	33	66
-+	25	41	20	49	29
--	271	450	508	619	610
Po (95%CI)	0.72 (0.69–0.76)	0.86 (0.83–0.88)	0.89 (0.87–0.91)	0.90 (0.87–0.92)	0.88 (0.86–0.90)
κ (95%CI)	0.47 (0.42–0.53)	0.69 (0.64–0.74)	0.75 (0.70–0.80)	0.64 (0.57–0.71)	0.59 (0.52–0.66)

* A combination of the categories parenchymal abnormalities, pleural abnormalities and central structure abnormalities.

CXR = chest radiograph; TB = tuberculosis; ++ = both readers agree positive; +- = reader 1 positive, reader 2 negative; -+ = reader 1 negative, reader 2 positive; -- = both readers agree negative; CI = confidence interval.

ral abnormalities, central structure abnormalities and abnormalities consistent with TB. Results of agreement are interpreted as follows: values between 0.21 and 0.40 are considered to represent fair agreement, between 0.41 and 0.60 moderate, between 0.61 and 0.80 substantial and between 0.81 and 1.00 strong (almost perfect) agreement.¹⁵ In addition, the percentage observed total agreement (Po) was calculated. Data analyses were done using SPSS 12.0 for Windows (SPSS Inc, Chicago, IL) and an Excel spreadsheet (Microsoft Excel, Palisade Corp, Newfield, NY).¹⁶

Ethics approval

The protocol for the LHS was approved by the ethics committees of Stellenbosch University and the University of Cape Town. Permission to perform the study was obtained from the City of Cape Town and the Western Cape Provincial Department of Health. The health committees of the community were involved in the study and informed consent was obtained from all participants.

RESULTS

Reader 2 considered 7 of 805 CXRs (0.9%) of inadequate quality. These CXRs were not read further and can therefore not be compared with reader 1. Reader 2 considered 466 (58%) CXRs to be normal, 274 (34%) to show abnormalities consistent with TB and 58 (7%) to have abnormalities that were not related to TB. The κ agreement for whether or not the CXR

was normal was 0.47 (95%CI 0.42–0.53). Better agreement was reached for the question if abnormalities consistent with TB were seen: ($\kappa = 0.69$, 95%CI 0.64–0.74). For the TB-related abnormalities, the highest κ agreement was reached for parenchymal abnormalities and the lowest for abnormalities of central structures (Table 1).

During the prevalence survey, 29 bacteriologically-positive cases (at least one positive smear and/or one positive culture) were detected, of which 26 cases had CXRs read by both readers. The readers agreed on 23 of the 26 (88%) cases having abnormalities on CXR and one case having a normal CXR. They also agreed on 22 of the 26 (85%) cases having abnormalities consistent with TB and three cases not having abnormalities consistent with TB (Table 2).

The intra-reader agreement for reader 2 was high, and better than between readers. The κ agreement for whether or not the CXR was normal was 0.85 (95%CI 0.74–0.95), and for the presence of abnormalities consistent with TB it was 0.90 (95%CI 0.81–0.99). The intra-reader agreement was highest for parenchymal abnormalities and lowest for abnormalities of central structures (Table 3).

DISCUSSION

The ability to compare the results of disease prevalence studies from different countries and regions forms part of the global approach to addressing the burden of TB and respiratory diseases. For this pur-

Table 2 Percentage observed agreement (Po) between two readers regarding CXR abnormalities for bacteriologically positive TB cases ($n = 26$)

Agreement index	Abnormal, any abnormalities <i>n</i>	TB-related abnormalities* <i>n</i>	Parenchymal abnormalities <i>n</i>	Pleural abnormalities <i>n</i>	Central structure abnormalities <i>n</i>
++	23	22	21	10	9
+-	2	1	2	0	2
-+	0	0	0	4	1
--	1	3	3	12	14
Po (95%CI)	0.92 (0.75–0.99)	0.96 (0.80–1.00)	0.92 (0.75–0.99)	0.85 (0.65–0.96)	0.88 (0.70–0.98)

Kappa (κ) is not presented in this table because the total number of cases is small and this may bias the κ results.

* A combination of the categories parenchymal abnormalities, pleural abnormalities and central structure abnormalities.

CXR = chest radiograph; TB = tuberculosis; ++ = both readers agree positive; +- = reader 1 positive, reader 2 negative; -+ = reader 1 negative, reader 2 positive; -- = both readers agree negative; CI = confidence interval.

Table 3 Kappa (κ) statistic and percentage observed agreement (Po) for two readings by one reader for CXR abnormalities ($n = 104$)

Agreement index	Abnormal, any abnormalities <i>n</i>	TB-related abnormalities* <i>n</i>	Parenchymal abnormalities <i>n</i>	Pleural abnormalities <i>n</i>	Central structure abnormalities <i>n</i>
++	44	39	33	20	13
+-	6	4	3	2	5
-+	2	1	0	5	4
--	52	60	68	77	82
Po (95%CI)	0.92 (0.85–0.97)	0.95 (0.89–0.98)	0.97 (0.92–0.99)	0.93 (0.87–0.97)	0.91 (0.84–0.96)
κ (95%CI)	0.85 (0.74–0.95)	0.90 (0.81–0.99)	0.94 (0.86–1.00)	0.81 (0.67–0.94)	0.69 (0.50–0.88)

* A combination of the categories parenchymal abnormalities, pleural abnormalities and central structure abnormalities.

CXR = chest radiograph; TB = tuberculosis; ++ = both readers agree positive; +- = reader 1 positive, reader 2 negative; -+ = reader 1 negative, reader 2 positive; -- = both readers agree negative; CI = confidence interval.

pose, standardised methodologies have been developed for the study of several diseases, including asthma (the International Survey of Asthma and Allergic Diseases in Children [ISAAC] methodology)¹⁷ and chronic obstructive lung disease (the Burden of Obstructive Lung Disease [BOLD] methodology).¹⁸ Similar standardisation has been achieved for radiographic surveys of occupational lung disease. The UICC/ILO^{12,13} and NIOSH radiographic evaluation systems provide validated standardised methodology and accreditation of readers. There is a need for similar standardised methodology for the study of TB and other lung diseases, for which chest radiology provides a useful method of detection and quantitation.

To date, a variety of reading methods of varying quality and rigour have been applied in TB prevalence studies, but to our knowledge there are no published validations of these methods. The CRRS was developed by the late Neil White to address this deficiency. The system, although primarily oriented towards TB, provides for collection of data on the most significant forms of lung disease for which radiology is a useful screening method. The aim was to produce a method that is less rigorous for the description of occupational diseases than the UICC/ILO and NIOSH methods, and which therefore does not require accreditation, but is suitable for use by any person with clinical experience in chest radiology, whether formally trained in radiology or not. Simplifications are the absence of descriptions of the shape of parenchymal abnormalities and quantitation of pleural disease. Reference CXRs that provide more accurate assessments of profusion of parenchymal lesions may be used, but are not considered essential in epidemiological studies of general respiratory disease. On the other hand, the CRRS includes more details of post-tuberculous lung disease (lobar shrinkage, atelectasis and bronchiectasis) and provides for the recording of many additional radiological features. For convenience, these appear not only as symbols, but are described in full on the report form. An additional useful feature is the electronically compatible one-page format of the report form.

The present study reports the first results on the reader agreement obtained using this CRRS. The reading form may need further development and evaluation, but the application of the CRRS in LHS2002 provides at least partial validation of the method, in that two non-radiologists, with experience in reading large numbers of CXRs both in clinical practice and as part of epidemiological surveys, showed an acceptable level of agreement in detecting major categories of abnormality. Furthermore, the less experienced reader reported with a high level of reproducibility. The intra-reader agreement was almost perfect for the question as to whether or not the CXR was normal as well as for the presence of abnormalities consistent with TB. These levels of agreement are higher than those reported previously,^{1-3,19} and may be attributable to the use of the standardised evaluation method. Our results also compare favourably with those of a recent study in which a similar simplified classification system was used.²⁰

The higher level of agreement for TB-related abnormalities than for any abnormalities may be explained by the fact that the CRRS makes provision for more details of TB than for other lung diseases. This focus on TB might influence the reader to consider this disease more systematically. However, confirmation of these results by other observers in other settings would be of value.

One of the weaknesses of our study is the fact that a set of standard CXRs was not used to ensure that all readers reported features in a consistent manner. Consideration will be given to producing a standard set of CXRs containing representative examples of common and less common radiological features of TB (and other lung diseases). These are likely to be of greatest benefit in instances where reading is performed by less experienced clinicians. Another weakness was that we used only two readers, and that they had similar experience. We can therefore not be sure that the method can be applied with the same level of accuracy by other readers of lesser experience. This requires further study, preferably using readers with a different background and experience. Finally, the κ

statistic is influenced by disease prevalence.²¹⁻²³ In our study, the process of stratifying CXRs for reader 2 on the basis of categories of abnormality recorded by reader 1 might have introduced a bias. Normal CXRs were under-sampled and CXRs containing abnormalities were over-sampled, making the results more relevant to high-prevalence disease areas; caution should be exercised in extrapolating to situations where disease prevalence is low. In addition, the survey was performed in high TB, low human immunodeficiency virus (HIV) infection prevalence area, and the study needs to be repeated in areas where the HIV infection rate is high.

CONCLUSIONS

The use of the CRRS resulted in good inter-reader agreement for TB-related abnormalities and almost perfect intra-reader agreement. This CXR reading and recording system may be useful in large-scale surveys of TB prevalence and studies of respiratory disease in communities. This study suggests that chest radiography may be much more useful as a screening tool for TB than has been previously recognised. This reading methodology needs further evaluation by more readers and in different study settings.

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Details of the chest radiograph reading and recording system developed by Neil White may be obtained from the University of Cape Town Lung Institute at www.lunginstitute.uct.ac.za

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APPENDIX B

Instructions for the use of the chest radiograph reading and recording system (CRRS 2004) for surveys of TB and lung disease (developed by the late Prof Neil W White).

1 The chest X-ray (CXR)

- a This system is designed for recording features observed on a standard-sized postero-anterior CXR performed in the recommended manner.
- b Reference radiographs, like those of the UICC/ILO set, should be interspersed with those of the subjects to ensure that descriptions of profusion and size of nodules remain constant.
- c Where previous or follow-up radiographs are available, these may be provided with the index set, to enable the clinical course of the disease to be assessed.

2 The readers

- a The system has been developed for use by trained radiologists or experienced respiratory physicians who are able to correctly recognise and interpret CXR abnormalities of all varieties.
- b All readers should receive training in the use of the CRRS, preferably at a common session to ensure consistency of use and interpretation of instructions. It is recommended that training involve at least 50 CXRs containing abnormalities, and that readers agree on interpretation and rating of abnormalities on these CXRs before they begin to assess the test series.
- c For the purposes of surveys, CXRs should be read by two readers, and concordance should be obtained on the major categories of abnormalities; the presence of tuberculous disease (current or healed), parenchymal abnormalities (broad agreement of primary lesions), pleural disease and abnormalities of central structures. Where reports differ, consensus should be sought in each case.
- d The readers should be 'blinded' to the history and clinical features of each subject and to the report of the other reader. Where rereading is performed, the order of presentation for reading should be altered.

3 The report form

- a *Form number* The report form (Appendix A) is a single page and has a unique serial number and positioning blocks at each corner to permit the contents of each response block to be captured electronically via a high quality facsimile machine or scanner. The data can be ordered and stored according to the unique form number, ensuring subject confidentiality. In addition, each subject is identified by a subject number.
- b *Completing the form* The form is completed by hand. Use of a soft black pencil is advised. To en-

able electronic capture, a cross should be made in each block with bold strokes. Care must be exercised to ensure that as much of the block as possible is covered by the cross, and, although it is acceptable to stray outside the block, no mark must be allowed to appear in a neighbouring square. The following fields are completed in order:

Section 0

0.1 Subject number For reasons of confidentiality, the form must not contain any personal identifiers such as name, date of birth, or address. Instead, each subject or patient is assigned a unique subject number up to 5 digits. The code linking subjects to their numbers must be stored separately by a designated clinical researcher, according to requirements of the local ethics review board. Each digit (1 to 9) is made recognisable for electronic capture writing them as squared-off numbers on a grid of 6 dots arranged in two columns of 3. Numbers are written as follows: 1 = join 3 left hand dots; 2 = join all dots starting with the top left dot and ending at the right bottom dot; 3 = join all dots starting with top left dot to form a 3; 4 = join top two dots on left, middle two and all 3 on right; 5 = join top dots, left hand upper two, middle two, right lower two and bottom two; 6 = join top two, left three, bottom two, right lower two and middle two; 7 = join upper two and right hand three; 8 = join all 6 dots to form the number 8; 9 = join top two, left hand top two, middle two and right hand 9.

0.2 Date of X-ray The date is entered in numbers as described above, beginning with the day, then the month in numerals, and then the year as four digits.

0.3 Radiograph quality Radiograph quality is judged as follows. 1 = high quality, 2 = acceptable quality, 3 = poor quality, barely readable (caution must be exercised in interpreting abnormalities on radiographs of this quality), and 4 = unreadable radiograph (no attempt should be made to read such radiographs). When 2, 3 or 4 is entered, a comment should be entered in the adjacent block identifying the nature of the quality deficiency. Examples are: over-exposed, under-exposed, movement artefact, poor positioning of subject, and absence of date or subject identifier.

Section 1.0

This section requires a response to the question 'Radiograph completely negative?'. If answered in the affirmative, no further details need to be recorded, and the exercise is complete. However, as this can only be completed when a full assessment of the radiograph has been made, it should be completed last, and only when no other entries of positive features have been made on the form.

Section 2.0

Features of TB The question 'Any abnormalities consistent with TB?' serves as a summary statement for the presence of features of TB useful for prevalence studies. These may involve any of the thoracic structures (parenchyma, pleura, nodes or bones), and the question refers to any lesions, whether considered active or 'healed'. This question should only be completed when the assessment of each of the thoracic structures and Sections A to E have been completed.

Section A

A.1 Parenchymal abnormalities A.1 records the presence of parenchymal abnormalities, categorising them into cavities, fibrosis, infiltrates or nodules. Fibrosis refers to scarring of the lungs considered to be caused by TB, and should not be used to describe diffuse fibrosis as occurs in idiopathic pulmonary fibrosis and other forms of diffuse parenchymal disease. TB-related fibrosis occurs in characteristic locations—the apico-posterior or apical regions of the upper lobes—but can occur elsewhere and be extensive. Infiltrates refers to all intra-pulmonary opacities considered not to represent cavitation, fibrosis or nodules (of any size). This includes consolidation of lung parenchyma. Changes that are dominant are described as primary (A.1.1), and those of lesser significance as secondary (A.1.2). This requires the clinical judgment of the reader, and is based upon the likely origin of the lesion and its clinical effects. More than one block may be scored. In A.1.3, the number and location of lung zones affected by the pathology in A.1.1 and A.1.2 is recorded as left and right lungs, upper, mid and lower zones, as viewed on a PA radiograph.

A.2 Nodular abnormalities Question A.2 is only used if the reader has recorded the presence of nodules as a primary or secondary abnormality in question A.1. First, their size is recorded. This is recorded in one of three size categories: <1.5 mm, 1.5–3.5 mm, or 3.5–10 mm in diameter. Unlike the UICC/ILO classification, the shape of the lesions (rounded or irregular) is not recorded. When they are homogeneous, the size response is entered as a primary abnormality. If size is heterogeneous, the predominant lesion should be considered primary, and the minority lesion size as secondary. The second exercise is to record profusion. In accordance with the methodology of the UICC/ILO classification, profusion is scored on a 12-point scale ranging from 0/– to 3/4 (0/–, 0/0, 0/1, 1/0, 1/1, 1/2, 2/1, 2/2, 2/3, 3/2, 3/3, 3/4). The appropriate profusion score is entered as a single point on a latin square on the report form. The UICC/ILO standard reference radiographs may be used as a check of scaling and consistency of recording (see 1.b, above).

A.3 Mycetoma Questions A.3, A.4 and A.5 describe specific pathologies. In A.3, the presence of a mycetoma (almost always within a pre-formed cavity) is

recorded as absent or present, and the lung in which it occurs is recorded as left and/or right.

A.4 Granulomas These differ from nodules in that they are usually larger than 10 mm, and are frequently calcified. They are recorded as absent, or if present, the lung in which they occur is noted, as is the presence or absence of calcification. If non-calcified, other causes of solitary nodules should be considered, and this should be recorded as 'Ca' (suspected cancer) in section F.1. Non-calcified granulomas should only be considered as being caused by TB if they occur in the presence of other clearly identifiable features of TB.

A.5 Lobar volume loss/collapse/bronchiectasis The presence of any of these features is recorded as absent, or present in the right and/or left lung. They are grouped, as in TB these features frequently co-exist and may be difficult to distinguish without the assistance of computerised tomography.

Section B

B.1 Pleural abnormalities The presence of any pleural abnormality is recorded. If any is present, the following three forms of pleural disease that are commonly associated with TB are recorded.

B.2–B.4 Apical caps, pleural effusions or thickening (these can be difficult to distinguish from one another and are therefore grouped) and costophrenic angle obliteration, often a sign of early or previous pleural disease. The latter is reserved for when there is no evidence of effusion/thickening superior to the costophrenic recess, i.e., extending up the lateral chest wall.

Section C

Previous X-ray The value of viewing previous radiographs is recognised in this question. If any are available, the reader is required to simply select the most appropriate radiograph from which to judge the natural history or 'projectile' of the abnormality; are the abnormalities improving, unchanged or deteriorating? This requires clinical judgement. The date of the comparator radiograph is entered in block numerals, as described above.

Section D

D.1 Central structure abnormalities The following features, each commonly associated with tuberculous disease, are recorded:

D.2 Tracheal deviation

D.3 Hilar elevation

D.4 Mediastinal shift

D.5 Pericardial effusion Unless calcified, the radiograph has low accuracy for distinguishing pericardial effusions from other causes of an enlarged cardiac silhouette. The latter should be considered in each case, and other features of left ventricular failure should be sought.

D.6 Lymphadenopathy (subcategorised as hilar, mediastinal and/or calcified).

Section E

E.1 Any other abnormality consistent with tuberculosis A coded box allows entry of yes or no, but the abnormality may be entered in writing. Examples are pericardial disease or bone involvement.

Section 3.0

Any other abnormality This summary question relates to Section F, which comprises, for convenience of reporting, a checklist of abnormalities under the following headings: surgical (signs of surgical interventions), skeletal (bony abnormalities), pleural disease (other than that described above under features of TB), mediastinal, and abnormalities of the lungs and hilum. To aid the user, definitions of the abnormalities appear on the report form. Mesothelioma

refers to suspected mesothelioma. Honeycomb lung is applied to areas of diffuse reticulation representing broad bands of fibrosis, as occurs in the presence of extensive parenchymal fibrosis.

Section G

G.1 Other disease The reader has an option to use free text to provide a radiological diagnosis of any specific disease entity that has not been adequately covered.

G.2 Comments This may be used to elaborate on any symbol used, to describe another (non-disease) abnormality or provide further details about conditions mentioned in Section G.1.

0.4 Reader This section resumes from the first section. The reader's name is recorded.

0.5 Reading date Date of the reading is recorded in squared digits (as described above).

R É S U M É

OBJECTIF: Elaboration et évaluation d'un nouveau système de lecture et d'enregistrement des clichés thoraciques (CRRS) pour les enquêtes concernant la tuberculose (TB) et les maladies pulmonaires dans la collectivité. **SCHÉMA:** Un pneumologue expérimenté a lu 2.608 clichés thoraciques réalisés au sein d'une enquête de prévalence de la TB en utilisant le CRRS élaboré récemment. Le kappa (κ) pour la concordance entre lecteurs a été calculé après qu'un deuxième lecteur ait enregistré ses résultats dans un échantillon stratifié pris au hasard de 810 (31%) des 2.608 clichés thoraciques. Le κ de concordance chez le même lecteur a été calculé à partir de résultats enregistrés à répétition dans un échantillon de 104 clichés thoraciques stratifié et pris au hasard.

RÉSULTATS: Le κ de concordance entre les deux lecteurs

a été de 0,69 (IC95% 0,64–0,74) pour les anomalies compatibles avec une TB et de 0,47 (IC95% 0,42–0,53) pour n'importe quel type d'anomalies. Le κ de concordance entre deux lectures du même lecteur a été de 0,90 (IC95% 0,81–0,99) pour les anomalies compatibles avec une TB et de 0,85 (IC95% 0,74–0,95) pour n'importe quel type d'anomalies.

CONCLUSION: Cette méthode standardisée de lecture et d'enregistrement des clichés thoraciques obtient des concordances satisfaisantes entre lecteurs et chez le même lecteur, ce qui la rend adéquate pour les enquêtes de TB et d'autres maladies pulmonaires dans la collectivité. Son utilisation permettra la comparaison des résultats obtenus dans différentes enquêtes.

R E S U M E N

OBJETIVO: Establecer y evaluar un nuevo sistema de lectura y registro de las radiografías de tórax (CRRS) para estudios comunitarios sobre tuberculosis (TB) y enfermedades pulmonares.

MÉTODO: Un neumólogo con experiencia leyó 2608 radiografías de tórax que formaban parte de una encuesta de prevalencia de TB, utilizando el CRRS. El índice κ de concordancia entre los lectores se calculó teniendo en cuenta el informe de la segunda lectura de una muestra aleatoria de 810 de las 2608 radiografías torácicas (31%). El índice κ de concordancia para cada lector se calculó a partir de los informes repetidos de una muestra estratificada de 104 radiografías de tórax.

RESULTADOS: El índice κ de concordancia entre dos

lectores fue 0,69 (IC95% 0,64–0,74) para las anomalías indicativas de TB y 0,47 (IC95% 0,42–0,53) para todo tipo de anomalías. El índice κ de concordancia para cada lector fue 0,90 (IC95% 0,81–0,99) para las anomalías indicativas de TB y 0,85 (IC95% 0,74–0,95) para todo tipo de anomalías.

CONCLUSIÓN: Este método normalizado para la lectura y el registro de las radiografías de tórax comporta un grado satisfactorio de concordancia intra e interobservadores, que lo hace idóneo para las encuestas sobre TB y otras formas de enfermedad pulmonar en la comunidad. Su utilización permitirá establecer comparaciones entre los resultados obtenidos en diferentes estudios.