

## Chest radiograph reading and recording system: evaluation for tuberculosis screening in patients with advanced HIV

R. Dawson,\* P. Masuka,† D. J. Edwards,† E. D. Bateman,\* L-G. Bekker,† R. Wood,† S. D. Lawn†\*

\*University of Cape Town Lung Institute, Division of Pulmonology & E16 Respiratory Clinic, Groote Schuur Hospital, Cape Town, †Desmond Tutu HIV Centre, Institute for Infectious Disease and Molecular Medicine, Faculty of Health Sciences, University of Cape Town, Cape Town, South Africa; \*Clinical Research Unit, Department of Infectious and Tropical Diseases, London School of Hygiene & Tropical Medicine, London, UK

### SUMMARY

**SETTING:** An antiretroviral treatment (ART) service in Gugulethu township, Cape Town, South Africa.

**OBJECTIVE:** To assess the inter-observer agreement when using the chest radiographic reading and reporting system (CRRS) to detect radiographic abnormalities in patients with advanced human immunodeficiency virus (HIV) associated immunodeficiency being actively screened for tuberculosis (TB). Second, to assess the associated performance characteristics of radiology as a routine screening test for detection of culture-confirmed pulmonary TB.

**DESIGN:** Radiographs from a study in which patients were actively screened for TB just before starting ART were independently reported by two CRRS-certified readers blinded to clinical status.

**RESULTS:** Good kappa statistic agreements between observers were found when reporting any radiological

abnormality consistent with TB among all patients ( $n = 203$ ,  $\kappa = 0.63$ , 95%CI 0.52–0.73) and among those with culture-confirmed TB ( $n = 53$ ,  $\kappa = 0.61$ , 95%CI 0.40–0.83). However, in comparison with sputum culture, the sensitivity (0.68, 95%CI 0.54–0.79) and specificity (0.53, 95%CI 0.45–0.61) of radiology in this patient group were low.

**CONCLUSION:** This study provides evidence of the good inter-observer agreement using the CRRS standardised reporting methodology when used among patients with advanced HIV-associated immunodeficiency and a high prevalence of culture-proven pulmonary TB. The utility of radiology as a screening test for TB in this patient group, however, remains limited.

**KEY WORDS:** HIV; tuberculosis; antiretroviral; radiology; screening; CRRS

THE PREVALENCE of tuberculosis (TB) among human immunodeficiency virus (HIV) infected patients enrolling in antiretroviral treatment (ART) programmes in sub-Saharan Africa is high and is associated with morbidity, mortality and nosocomial disease transmission.<sup>1–3</sup> Routine screening for TB at baseline is therefore important. However, in the context of advanced immunodeficiency, diagnosis of TB is particularly challenging. A large proportion of disease is sputum smear-negative and, where available, mycobacterial culture is associated with considerable delays.<sup>4,5</sup>

More accurate, rapid and reproducible tools for screening for TB and sub-clinical pulmonary disease at the time of entry to ART programmes are greatly needed. Although rapid, the role of routine chest radiology in screening for TB in HIV-infected adult patients is not clearly defined. Radiographic appearances are highly dependent on the degree of immunodeficiency.<sup>6–10</sup>

With well preserved immune function, the classic findings of upper lobe disease, cavitation and fibrosis are more likely to be observed. However, in patients with advanced immunodeficiency, appearances are often atypical, with lower lobe air space opacification, pleural effusions and hilar or mediastinal lymphadenopathy,<sup>6–10</sup> and radiographs may be normal in up to 50% of microbiologically proven cases.<sup>5</sup> Interpretation is further complicated by high rates of other HIV-associated pulmonary disease such as acute bacterial pneumonia and *Pneumocystis jirovecii* pneumonia, which may be difficult to distinguish radiologically from TB.

A further limitation of chest radiography in TB screening and diagnosis is inter-observer and intra-observer variation in interpretation.<sup>11,12</sup> This variation is likely to be heightened in patients with advanced HIV in whom the radiographic appearances of TB may be attenuated and highly atypical. Interpretation

Correspondence to: Stephen D Lawn, Desmond Tutu HIV Centre, Institute of Infectious Disease and Molecular Medicine, Faculty of Health Sciences, University of Cape Town, Anzio Road, Observatory 7925, Cape Town, South Africa. Tel (+27) 21 650 6957. Fax (+27) 21 650 6963. e-mail: stevelawn@yahoo.co.uk

Article submitted 25 May 2009. Final version accepted 4 August 2009.

[A version in French of this article is available from the Editorial Office in Paris and from the Union website [www.theunion.org](http://www.theunion.org)]

of the findings of radiographic TB screening surveys and studies comparing different diagnostic strategies for TB in this patient group are often hindered by non-standardised radiological reporting.<sup>5</sup>

The chest radiograph reading and recording system (CRRS) is a previously validated recording tool that transforms observed radiological patterns into categorical forms with satisfactory inter- and intra-reader agreement.<sup>13</sup> This previously reported evaluation of CRRS assessed radiographs from a large community TB prevalence survey in which the prevalence of radiographic abnormalities was low and HIV status was unknown. Further validation of this tool is needed in varied clinical settings, including in-patients with HIV infection. The importance of screening for TB among individuals enrolling in ART services in sub-Saharan Africa is increasingly recognised, and a study evaluating different diagnostic tests for TB among patients enrolling within such a clinical service in Cape Town, South Africa, provided the ideal opportunity to evaluate the CRRS methodology.<sup>14</sup> The primary outcomes of interest were the level of agreement between independent blinded readers and the overall sensitivity and specificity of radiological abnormalities compared to sputum culture for diagnosis of pulmonary TB.

## METHODS

### *Antiretroviral treatment service*

The ART service in Gugulethu township in Cape Town has been described previously in detail.<sup>1,15,16</sup> The district has a predominantly African population of over 300 000, the vast majority of whom live in conditions of low socio-economic status. At the time of the study, the antenatal HIV prevalence in this community was approximately 30% and the annual TB notification rate exceeded 1500 per 100 000 population.<sup>15</sup> Patients were referred to this primary care ART clinic from a variety of other clinics in the area, including antenatal care, TB and HIV testing clinics. National guidelines for use of ART were based on the World Health Organization (WHO) 2002 recommendations, providing treatment for those with a previous acquired immune-deficiency syndrome diagnosis (AIDS, WHO Stage 4 disease) or a blood CD4 cell count < 200 cells/ $\mu$ l. The extraordinarily high burden of TB among patients accessing this service diagnosed under routine clinical practice has been described previously.<sup>1,17,18</sup>

### *Patients, laboratory investigations and follow-up*

This study forms part of a larger study of screening for TB among patients accessing this ART service.<sup>14</sup> Eligible patients were ART-naïve adults (age  $\geq$ 18 years) referred to start ART and who did not have a current diagnosis of TB. Non-selected eligible patients completed a symptom screen and provided two sputum samples, with one or both being induced using nebu-

lised hypertonic (3%) saline. As previously described in detail,<sup>14</sup> sputum samples were analysed in accredited laboratories and were examined for acid-fast bacilli using fluorescence microscopy and cultured using Mycobacteria Growth Indicator Tubes (MGIT, BD Diagnostic Systems, Sparks, MD, USA). Standard postero-anterior chest radiographs (CXR) were obtained on all patients the same day as sputum samples, with the exception of any pregnant women in whom it was judged that there was no clinical indication.

All patients gave written informed consent. The study was approved by the Research Ethics Committee of the Faculty of Health Sciences of the University of Cape Town.

### *Case definition*

Cases of TB were defined by one or more positive cultures of *Mycobacterium tuberculosis*.

### *Evaluation using the CRRS*

Once routine diagnostic interpretation and safety monitoring had been performed to inform patient care, the radiographs were assimilated for later controlled reading using the CRRS methodology.<sup>13,19</sup> The CRRS protocol records radiographic abnormalities on the CRRS form.<sup>19</sup> These abnormalities are classified into major categories, which include the following: 1) parenchymal abnormalities, 2) pleural abnormalities, 3) central abnormalities and 4) other abnormalities. An assessment is then made on whether the radiograph is completely normal or whether there are abnormalities consistent with TB.

The readings were performed separately, with radiographs being read in random order by two expert readers (specialists in respiratory medicine and infectious diseases). Each reader was a certified CRRS 'B-grade' reader, reflecting that the reader has previously completed a 3-day CRRS training course and formal examination and is certified to report chest radiographic surveys. Both readers were blinded to clinical patient information and sputum results, and the radiographs were interpreted in a controlled reading environment over a 2-day period. A pre-reading session to concur on reading strategies was conducted as per CRRS methodology on 20 unrelated CXRs.

### *Data analysis*

Data were recorded manually by both readers on the CRRS (Version 2007) report form. The data were double-entered manually into a database, and analyses were performed using STATA Version 10.0 (Stata Corp, College Station, TX, USA). The kappa statistic<sup>20</sup> and 95% confidence intervals (95% CIs) were calculated to evaluate inter-reader agreement for CXRs categorised as normal, abnormalities consistent with TB, parenchymal abnormalities, large opacifications, small opacifications, cavities, pleural abnormalities, central abnormalities and other abnormalities. Results of

agreement were interpreted as follows: values  $< 0.2$  were considered to represent poor agreement, values between 0.2 and 0.4 were considered to represent fair agreement, between  $>0.40$  and 0.60 moderate agreement, between  $>0.60$  and 0.80 good agreement and between  $>0.80$  and 1.00 very good agreement.

## RESULTS

### *Patients and culture-positive TB diagnoses*

Of 235 eligible HIV-infected patients who were systematically screened for pulmonary TB using sputum culture and radiology, the median age was 33 years (interquartile range [IQR] 29–39), 73% were female and 24 (10%) were pregnant. The median CD4 cell count was 125 cells/ $\mu$ l (IQR 67–185) and 53% had WHO Stage 3 or 4 disease. A history of previous TB was recorded for 79 (34%) patients. Overall, 155 (66%) patients reported one or more of the following symptoms during systematic symptom screening: cough for  $\geq 2$  weeks, night sweats, fever or significant recent weight loss.

Sputum culture-positive TB was diagnosed in 58 patients (median CD4 cell count, 78 cells/ $\mu$ l), giving a disease prevalence of 0.25 (95%CI 0.20–0.31). The sensitivity of sputum microscopy was very low ( $n = 8$ , 14%). Among TB cases, any of the above four symptoms were reported by 46 (79%) patients, and the remaining TB cases reported none of these symptoms. All TB cases were referred to a TB treatment service, and following re-evaluation all were commenced on TB treatment according to national guidelines.

### *Evaluation of radiographs using CRRS*

Of the total 235 patients enrolled, CXRs underwent controlled reading in 209 (89%): 16 patients were excluded from chest radiography because of pregnancy, 6 radiographs were missing and 4 were considered by consensus between the readers to be of too poor technical quality to be evaluable. Of the 209 radiographs assessed, 53 were from patients with culture-positive TB and 156 were from patients with negative sputum cultures.

Using CRRS, any abnormality consistent with TB was reported by one or both readers in 36/53 patients with sputum culture-positive TB cases and in 73/156 patients who were TB-free. The overall sensitivity of chest radiology in this patient population was thus 0.68 (95%CI 0.54–0.79), the specificity was 0.53 (95%CI 0.45–0.61) and the negative predictive value (NPV) was 0.83 (95%CI 0.74–0.89). Among those TB patients with analysed CXRs who did not report any symptoms ( $n = 10$ ), five CXRs were normal and five abnormal. Analysis of the sub-set of radiographs from patients who had no previous history of TB revealed similar sensitivity (0.67, 95%CI 0.51–0.79) and specificity (0.57, 95%CI 0.46–0.60) values to those observed in the overall group.

The agreement of the independent CRRS assessments made by the two blinded readers is shown in Table 1. For the whole cohort ( $n = 209$ ), the proportion of radiographs in which there was agreement between readers ranged from 0.74 to 0.95 for each of the variables scored.  $\kappa$  statistics revealed good agreement between readers for identifying parenchymal abnormalities, large opacifications  $>1$  cm in size and pleural abnormalities. Moderate agreement was observed in the assessment of cavitation, whereas assessment of the presence of small opacifications and central abnormalities showed fair agreement. Overall, assessment of the presence of any abnormality consistent with TB was made by the observers with a good level of agreement (Table 1).

Separate analysis was made of the subset of radiographs ( $n = 53$ ) available from patients with confirmed culture-positive TB (Table 2). Again, the proportion of radiographs in which there was agreement between readers ranged from 0.72 to 0.98.  $\kappa$  statistics revealed good agreement in the assessment of parenchymal abnormalities, large opacifications, cavitation and pleural abnormalities. For small opacifications and central abnormalities, agreement was fair and poor, respectively. Overall, assessment of the presence of any abnormality consistent with TB was made by the observers with a good level of agreement in this subset of radiographs (Table 2).

## DISCUSSION

This is the second study to examine reader agreement using the CRRS methodology, and the first to provide an evaluation in HIV-infected subjects. Since the first iteration in 2004,<sup>13</sup> the CRRS has been modified, moving away from a profusion-based methodology of describing parenchymal abnormalities to reporting more easily described and defined large and small opacities. This simplified reporting form also obviates the need for reference radiographs such as those used for evaluation of occupational lung diseases. The data from the present study indicate that a substantial level of agreement is achievable when CRRS 2007 version is used by independent readers in HIV-infected patients who have advanced immunodeficiency and a high prevalence of sputum smear-negative pulmonary TB. Despite good inter-observer agreement, however, the overall performance of radiology as a screen for TB in this patient group was limited.

Reliable evidence for the additive diagnostic role of chest radiology for TB screening in patients with advanced HIV is conflicting,<sup>5</sup> and a key limitation in many studies is the failure to employ a standardised reporting methodology. For example, one small survey from Tanzania found that symptoms and chest radiology were poorly predictive of TB,<sup>21</sup> whereas a study of HIV-infected miners in South Africa being screened for TB before starting isoniazid preventive

**Table 1** The proportional agreement and  $\kappa$  statistics for two readers of abnormalities in chest radiographs ( $N = 209$ )

Agreement index	Parenchymal abnormalities	Large opacifications	Small opacifications	Cavitation	Pleural abnormalities	Central abnormalities	Normal radiograph	Abnormalities consistent with TB
Both readers agree on radiographic abnormality	74	55	24	7	33	6	59	87
Only Reader 1 reports abnormality	23	14	44	8	12	15	30	24
Only Reader 2 reports abnormality	14	18	10	2	6	12	20	15
Both readers agree no abnormality present	98	122	131	192	158	176	100	83
Agreement (95%CI)	0.82 (0.77–0.86)	0.85 (0.79–0.89)	0.74 (0.67–0.80)	0.95 (0.91–0.97)	0.91 (0.87–0.95)	0.87 (0.82–0.91)	0.76 (0.70–0.81)	0.81 (0.75–0.86)
$\kappa$ (95%CI)	0.64 (0.54–0.75)	0.66 (0.55–0.77)	0.32 (0.19–0.46)	0.56 (0.32–0.80)	0.73 (0.62–0.85)	0.24 (0.04–0.44)	0.50 (0.39–0.62)	0.63 (0.52–0.73)
Strength of agreement	Good	Good	Fair	Moderate	Good	Fair	Moderate	Good

CI = confidence interval.

**Table 2** The proportional agreement and  $\kappa$  statistics for two readers regarding abnormalities observed in the subset of chest radiographs from patients with sputum culture-positive tuberculosis ( $n = 53$ )

Agreement index	Parenchymal abnormalities	Large opacifications	Small opacifications	Cavitation	Pleural abnormalities	Central abnormalities	Normal radiograph	Abnormalities consistent with TB
Both readers agree on radiographic abnormality	24	20	7	2	7	1	13	26
Only Reader 1 reports abnormality	6	3	13	1	3	7	5	7
Only Reader 2 reports abnormality	4	5	2	0	2	1	6	3
Both readers agree no abnormality present	19	25	31	50	41	44	29	17
Agreement (95%CI)	0.81 (0.68–0.90)	0.85 (0.73–0.92)	0.72 (0.58–0.82)	0.98 (0.89–1.00)	0.91 (0.79–0.96)	0.85 (0.73–0.92)	0.79 (0.66–0.88)	0.81 (0.68–0.90)
$\kappa$ (95%CI)	0.62 (0.41–0.83)	0.70 (0.50–0.89)	0.32 (0.08–0.57)	0.79 (0.39–1.00)	0.68 (0.42–0.94)	0.15 (–0.17–0.47)	0.54 (0.31–0.78)	0.61 (0.40–0.83)
Strength of agreement	Good	Good	Fair	Good	Good	Poor	Moderate	Good

CI = confidence interval.

therapy (IPT) found that radiology greatly increased the sensitivity of TB screening.<sup>22</sup> Similarly, chest radiology was found to have limited utility as a stand-alone screening tool in Botswana,<sup>23</sup> whereas radiology was used to identify a high yield of TB suspects for further investigation in a study in Vietnam.<sup>24</sup>

It was anticipated that the patients enrolled in the present study might present a major challenge with regard to the likely utility of chest radiology for screening for TB. These HIV-infected patients had advanced immunodeficiency, approximately one third had been treated for TB at some time in the past, there was a high prevalence of sputum smear-negative culture-positive TB and a high rate of other comorbidity.<sup>14</sup> Moreover, as patients were investigated systematically, regardless of the presence or absence of symptoms, their TB disease was likely to be less advanced than would typically be the case among TB suspects with overt symptoms.<sup>25,26</sup>

The numbers of mycobacteria present in sputum were likely to be low, as indicated by the previously reported findings that the sensitivity of sputum fluorescence microscopy was very low (<20%) and the mean time to positivity of automated liquid cultures was prolonged (approximately 3 weeks).<sup>14</sup>

This combination of factors is likely to underlie the findings that both the sensitivity (0.68) and the specificity (0.53) of radiological abnormalities consistent with TB were limited. Despite this, radiology had much greater sensitivity than smear microscopy and provides a rapid means of patient assessment at the patient's first screening visit to the clinic. Further potential reasons for this limitation include the high frequency of non-specific radiological abnormalities associated with other current and previous pulmonary infections.

The finding of a high proportion of culture-proven TB patients with normal CXRs and/or a negative symptom screen is not new in the context of advanced HIV.<sup>7,9,27-30</sup> Half the patients with confirmed TB who were asymptomatic had radiographic abnormalities detected, however. These findings reinforce the need for a high degree of vigilance for TB in this patient group and further suggest that routine investigation for TB is warranted in all patients in this clinical setting. The reliability of chest radiography alone to exclude active TB in this patient population was limited (NPV 0.83), however, and it could not therefore be used to reliably exclude TB before initiating IPT, for example.

Similar studies in which chest radiology is found to have relatively poor performance characteristics might ordinarily raise concerns about the reliability of radiological reporting. However, a key finding in this study was that use of CRRS by two trained readers resulted in good levels of agreement in interpreting parenchymal abnormalities, pleural abnormalities and overall abnormalities consistent with TB. In

further subanalysis restricted to those patients with culture-confirmed TB, good agreement was also found in the reporting of radiographic abnormalities suggestive of TB, including parenchymal abnormalities, large opacifications (>1 cm), cavitation and pleural disease. Such levels of agreement are higher than those reported previously for other studies,<sup>11,31</sup> and this may reflect the emphasis placed by the scoring system used in CRRS.

The inter-observer agreement for reporting pleural disease in this study is better than that seen previously, and may reflect an excess of primary pleural disease seen in these subjects. The agreement for small opacifications and central abnormalities was fair and poor, respectively, confirming the difficulty in detecting small (<1 cm) radiographic abnormalities and consistently documenting mediastinal disease. While most sources document the presence of lymphadenopathy in advanced HIV disease, it remains problematic to reproducibly report these radiographic findings between readers. Reasons for this may include technical issues related to patient positioning and varied anatomical understanding of mediastinal adenopathy. Parenchymal disease and pleural disease using the CRRS format in this cohort of patients with advanced disease appear to be the most reliably recorded variables.

Major strengths of this study were the well characterised study population and the use of a robust gold standard for TB diagnosis. Patients were typical of those enrolling in public sector ART clinics in the southern African region. Although the overall sample size was modest, the very high prevalence of TB in this patient group resulted in many more confirmed TB cases being included in this study compared to the previous evaluation of CRRS.<sup>13</sup> A limitation of using radiology as a screening tool was the necessary exclusion of some pregnant women, representing approximately 7% of the total sample in this study. In addition, limited sample size precluded assessment of intra-observer agreement in view of potential introduction of bias. This and the potential impact of female sex on CRRS reporting are being addressed in ongoing studies.

## CONCLUSION

Using CRRS, independent readers were able to document, with a substantial level of agreement, the presence of pulmonary radiological abnormalities consistent with TB. These findings provide further validation of the CRRS as a reliable tool for recording pulmonary radiographic abnormalities in its primary intended role as a screening tool for use in radiographic surveys. In this particular patient population with advanced HIV and a high prevalence of sputum smear-negative culture-positive pulmonary disease, the performance characteristics of radiology as a diagnostic tool to inform clinical practice remain limited.

## Acknowledgements

The authors gratefully acknowledge the dedicated staff of the Hannan Crusaid ART clinic, the Desmond Tutu HIV Centre and the Centre for Tuberculosis Research Innovation at the University of Cape Town Lung Institute. RD was funded by the National Institutes of Health (NIH) as Principal Investigator on an R01 HL 090316-02 sub-award grant. SDL was funded by the Wellcome Trust, London, UK. RW and LGB are funded in part by the NIH through a CIPRA (Comprehensive International Program of Research on AIDS) grant 1U19AI53217-01 and R01 grant (A1058736-01A1). DJE was funded by the NIH through the International Clinical Research Fellows Program at Vanderbilt (R24 TW007988).

## References

- Lawn S D, Myer L, Bekker L G, Wood R. Burden of tuberculosis in an antiretroviral treatment programme in sub-Saharan Africa: impact on treatment outcomes and implications for tuberculosis control. *AIDS* 2006; 20: 1605–1612.
- Moore D, Liechty C, Ekwaru P, et al. Prevalence, incidence and mortality associated with tuberculosis in HIV-infected patients initiating antiretroviral therapy in rural Uganda. *AIDS* 2007; 21: 713–719.
- Lawn S D, Harries A D, Anglaret X, et al. Early mortality among adults accessing antiretroviral treatment programmes in sub-Saharan Africa. *AIDS* 2008; 22: 1897–1908.
- Getahun H, Harrington M, O'Brien R, Nunn P. Diagnosis of smear-negative pulmonary tuberculosis in people with HIV infection or AIDS in resource-constrained settings: informing urgent policy changes. *Lancet* 2007; 369: 2042–2049.
- Reid M J, Shah N S. Approaches to tuberculosis screening and diagnosis in people with HIV in resource-limited settings. *Lancet Infect Dis* 2009; 9: 173–184.
- Perlman D C, El-Sadr W M, Nelson E T, et al. Variation of chest radiographic patterns in pulmonary tuberculosis by degree of human immunodeficiency virus-related immunosuppression. The Terry Bein Community Programs for Clinical Research on AIDS (CPCRA). The AIDS Clinical Trials Group (ACTG). *Clin Infect Dis* 1997; 25: 242–246.
- Post F A, Wood R, Pillay G P. Pulmonary tuberculosis in HIV infection: radiographic appearance is related to CD4+ T-lymphocyte count. *Tubercle Lung Dis* 1995; 76: 518–521.
- Saurborn D P, Fishman J E, Boisselle P M. The imaging spectrum of pulmonary tuberculosis in AIDS. *J Thorac Imaging* 2002; 17: 28–33.
- Greenberg S D, Frager D, Suster B, et al. Active pulmonary tuberculosis in patients with AIDS: spectrum of radiographic findings (including a normal appearance). *Radiology* 1994; 193: 115–119.
- Lawn S D, Evans A J, Sedgwick P M, Acheampong J W. Pulmonary tuberculosis: radiological features in West Africans co-infected with HIV. *Br J Radiol* 1999; 72: 339–344.
- Nyboe J. Results of the international study on X-ray classification. *Bull Int Union Tuberc* 1968; 41: 115–124.
- Garland L H. Studies on the accuracy of diagnostic procedures. *Am J Roentgenol Radium Ther Nucl Med* 1959; 82: 25–38.
- Den Boon S, Bateman E D, Enarson D A, et al. Development and evaluation of a new chest radiograph reading and recording system for epidemiological surveys of tuberculosis and lung disease. *Int J Tuberc Lung Dis* 2005; 9: 1088–1096.
- Lawn S D, Edwards S D, Kranzer K, et al. Urine lipoarabinomannan assay for tuberculosis screening prior to ART: diagnostic yield and association with immune reconstitution disease. *AIDS* 2009; 23: 1875–1880.
- Bekker L G, Myer L, Orrell C, Lawn S, Wood R. Rapid scale-up of a community-based HIV treatment service: programme performance over 3 consecutive years in Guguletu, South Africa. *S Afr Med J* 2006; 96: 315–320.
- Lawn S D, Myer L, Orrell C, et al. Early mortality among adults accessing a community-based antiretroviral service in South Africa: implications for programme design. *AIDS* 2005; 19: 2141–2148.
- Lawn S D, Myer L, Bekker L G, Wood R. Tuberculosis-associated immune reconstitution disease: incidence, risk factors and impact in an antiretroviral treatment service in South Africa. *AIDS* 2007; 21: 335–341.
- Lawn S D, Myer L, Edwards D, Bekker L G, Wood R. Short-term and long-term risk of tuberculosis associated with CD4 cell recovery during antiretroviral therapy in South Africa. *AIDS* 2009; 23: 1717–1725.
- University of Cape Town Lung Institute. Instructions for the use of the Chest Radiograph Reading and Recording System (CRRS). Cape Town, South Africa: University of Cape Town, 2007. [http://www.lunginstitute.co.za/content/ctbri\\_adding\\_value.html](http://www.lunginstitute.co.za/content/ctbri_adding_value.html) Accessed May 2009.
- Cohen J. A coefficient of agreement for nominal scales. *Educ Psychol Meas* 1960; 70: 213–220.
- Ngowi B J, Mfinanga S G, Bruun J N, Morkve O. Pulmonary tuberculosis among people living with HIV/AIDS attending care and treatment in rural northern Tanzania. *BMC Public Health* 2008; 8: 341.
- Day J H, Charalambous S, Fielding K L, et al. Screening for tuberculosis prior to isoniazid preventive therapy among HIV-infected gold miners in South Africa. *Int J Tuberc Lung Dis* 2006; 10: 523–529.
- Mosimaneotsile B, Talbot E A, Moeti T L, et al. Value of chest radiography in a tuberculosis prevention programme for HIV-infected people, Botswana. *Lancet* 2003; 362: 1551–1552.
- Shah N S, Anh M H, Thuy T T, et al. Population-based chest X-ray screening for pulmonary tuberculosis in people living with HIV/AIDS, An Giang, Vietnam. *Int J Tuberc Lung Dis* 2008; 12: 404–410.
- Ward H A, Marciniuk D D, Pahwa P, Hoepfner V H. Extent of pulmonary tuberculosis in patients diagnosed by active compared to passive case finding. *Int J Tuberc Lung Dis* 2004; 8: 593–597.
- Den Boon S, Verver S, Lombard C J, et al. Comparison of symptoms and treatment outcomes between actively and passively detected tuberculosis cases: the additional value of active case finding. *Epidemiol Infect* 2008; 136: 1342–1349.
- Pedro-Botet J, Gutierrez J, Miralles R, Coll J, Rubies-Prat J. Pulmonary tuberculosis in HIV-infected patients with normal chest radiographs. *AIDS* 1992; 6: 91–93.
- Mtei L, Matee M, Herfort O, et al. High rates of clinical and subclinical tuberculosis among HIV-infected ambulatory subjects in Tanzania. *Clin Infect Dis* 2005; 40: 1500–1507.
- Corbett E L, Bandason T, Cheung Y B, et al. Epidemiology of tuberculosis in a high HIV prevalence population provided with enhanced diagnosis of symptomatic disease. *PLoS Med* 2007; 4: e22.
- Wood R, Middelkoop K, Myer L, et al. Undiagnosed tuberculosis in a community with high HIV-prevalence: implications for TB control. *Am J Respir Crit Care Med* 2007; 175: 87–93.
- Yerushalmy J. The statistical assessment of the variability in observer perception and description of roentgenographic pulmonary shadows. *Radiol Clin North Am* 1969; 7: 381–392.

## R É S U M É

**CONTEXTE :** Un service de traitement antirétroviral (ART) dans le faubourg de Gugulethu, Cape Town, Afrique du Sud.

**OBJECTIFS :** Evaluer la concordance entre observateurs en matière de lecture des clichés thoraciques ainsi que le système de déclaration (CRRS) pour détecter les anomalies radiographiques chez les patients atteints d'une immunodéficience avancée due au virus de l'immunodéficience humaine (VIH) sélectivement dépistés pour la tuberculose (TB). En outre, évaluer les caractéristiques associées à la performance de la radiologie comme test de routine du dépistage pour la détection des TB pulmonaires confirmées par la culture.

**SCHÉMA :** Les radiographies provenant d'une étude dans laquelle les patients avaient été dépistés activement pour la TB immédiatement avant le début d'un ART ont été décrites par deux lecteurs spécialisés en CRRS, aveugles quant au statut clinique.

**RÉSULTATS :** Des concordances statistiques kappa satis-

faisantes entre les observateurs ont été trouvées en ce qui concerne n'importe quelle anomalie radiologique compatible avec une TB chez l'ensemble des patients ( $n = 203$  ;  $\kappa = 0,63$  ; IC95% 0,52–0,73) ainsi que chez ceux atteints d'une TB confirmée par la culture ( $n = 53$  ;  $\kappa = 0,61$  ; IC95% 0,40–0,83). Toutefois, par comparaison avec la culture des crachats, la sensibilité et la spécificité de l'examen radiologique ont été faibles dans ce groupe de patients (respectivement 0,68 ; IC95% 0,54–0,79 ; et 0,53 ; IC95% 0,54–0,61).

**CONCLUSION :** Cette étude démontre la bonne concordance entre observateurs utilisant la méthodologie de déclaration standardisée CRRS lorsqu'elle est utilisée chez des patients atteints d'une immunodéficience avancée due au VIH et chez ceux où la TB pulmonaire s'accompagne d'une prévalence élevée de confirmation par la culture. L'utilité de la radiologie reste toutefois limitée comme test de dépistage de la TB dans ce groupe de patients.

## R E S U M E N

**MARCO DE REFERENCIA:** Un centro de tratamiento antirretrovírico (ART) en la municipalidad de Gugulethu, Ciudad del Cabo, en Sudáfrica.

**OBJETIVO:** Evaluar la concordancia entre los observadores cuando se utiliza un sistema codificado de lectura y registro de las radiografías de tórax (CRRS) a fin de detectar las imágenes anormales en pacientes con deficiencia inmunitaria avanzada causada por el virus de la inmunodeficiencia humana (VIH), en quienes se practica una búsqueda activa de tuberculosis (TB). Se procuró además evaluar las características del rendimiento diagnóstico de la radiografía como método de detección sistemática de la TB pulmonar que se confirma por cultivo.

**MÉTODO:** Se practicaron dos lecturas independientes de las radiografías practicadas a los participantes en un estudio, en el cual se buscaba activamente la TB antes de comenzar el ART. Los lectores desconocían el estado clínico de los pacientes.

**RESULTADOS:** El índice de  $\kappa$  demostró una buena concordancia estadística interobservadores, cuando se informó cualquier anomalía radiográfica sugestiva de TB en los pacientes ( $n = 203$ ;  $\kappa = 0,63$ ; IC95% 0,52–0,73) y en los pacientes con TB confirmada por cultivo ( $n = 5$ ;  $\kappa = 0,61$ ; IC95% 0,40–0,83). Sin embargo, la sensibilidad (0,68; IC95% 0,54–0,79) y la especificidad (0,53; IC95% 0,54–0,61) de la radiografía fueron bajas, cuando se compararon con el cultivo de esputo en este grupo de pacientes.

**CONCLUSIÓN:** El presente estudio puso en evidencia una buena concordancia entre los observadores cuando se usa un sistema CRRS en pacientes con inmunodeficiencia avanzada causada por el VIH y una alta prevalencia de TB pulmonar confirmada por cultivo. Sin embargo, la detección sistemática de la TB en este grupo de pacientes mediante radiografía de tórax ofrece una utilidad limitada.