Liquid vs. solid culture for tuberculosis: performance and cost in a resource-constrained setting

V. N. Chihota,* A. D. Grant,† K. Fielding,† B. Ndibongo,* A. van Zyl,* D. Muirhead,** G. J. Churchyard***

* Aurum Institute for Health Research, Johannesburg, South Africa; † London School of Hygiene & Tropical Medicine, London, UK

Correspondence to: Violet Chihota, Aurum Institute for Health Research, Private Bag X 30500 Houghton, Johannesburg, South Africa 2041. Tel: (+27) 11 484 8844. Fax: (+27) 11 484 4682. e-mail: vchihota@auruminstitute.org


SETTING: National Health Laboratory Services tuberculosis (TB) laboratory, South Africa.

OBJECTIVES: To compare Mycobacterium Growth Indicator Tube (MGIT) with Löwenstein-Jensen (LJ) medium with regard to Mycobacterium tuberculosis yield, time to positive culture and contamination, and to assess MGIT cost-effectiveness.

DESIGN: Sputum from gold miners was cultured on MGIT and LJ. We estimated cost per culture, and, for smear-negative samples, incremental cost per additional M. tuberculosis gained with MGIT using a decision-tree model.

RESULTS: Among 1267 specimens, MGIT vs. LJ gave a higher yield of mycobacteria (29.7% vs. 22.8%), higher contamination (16.7% vs. 9.3%) and shorter time to positive culture (median 14 vs. 25 days for smear-negative specimens). Among smear-negative samples that were culture-positive on MGIT but negative/contaminated on LJ, 77.3% were non-tuberculous mycobacteria (NTM). Cost per culture on LJ, MGIT and MGIT+LJ was respectively US$12.35, US$16.62 and US$19.29. The incremental cost per additional M. tuberculosis identified by standard biochemical tests and microscopic cording was respectively US$504.08 and US$328.10 using MGIT vs. LJ, or US$160.80 and US$109.07 using MGIT+LJ vs. LJ alone.

CONCLUSION: MGIT gives higher yield and faster results at relatively high cost. The high proportion of NTM underscores the need for rapid speciation tests. Minimising contaminated cultures is key to cost-effectiveness.

KEY WORDS: Mycobacterium tuberculosis; LJ medium; MGIT; microscopic cording; anti-MPB64 assay

SUMMARY

THE HUMAN immunodeficiency virus (HIV) epidemic has worsened the public health problem posed by tuberculosis (TB), partly by increasing TB incidence, especially in sub-Saharan Africa,1 but also by making the diagnosis of TB more difficult. HIV-infected patients are more likely to have smear-negative TB,2,3 although this may be in the context of disseminated disease, a high total bacillary burden and a high risk of mortality,4 underlining the need for rapid diagnosis.

In low-income settings, TB diagnosis relies on sputum microscopy for acid-fast bacilli (AFB). The few facilities for culture generally use Löwenstein-Jensen (LJ) media, which can take months to give a result; wider use of LJ culture thus has limited potential to accelerate TB diagnosis.5 Liquid media systems with early growth indicators, such as the Mycobacterial Growth Indicator Tube (MGIT), are more rapid and detect more mycobacterial isolates than LJ;6–8 however, morphological examination of colonies alone can no longer be used for species identification, making other rapid methods more important.9 The Capilia TB (anti-MPB64 monoclonal) assay (TAUNS, Numazu, Japan) uses monoclonal antibodies to detect a secreted mycobacterial protein, MPB64, which can differentiate M. tuberculosis complex from non-tuberculous mycobacteria (NTM)10–12 and shows promise as an easy and rapid tool for identifying M. tuberculosis complex in liquid cultures.13–15

Liquid culture and molecular species identification tests have seldom been used in resource-constrained settings, largely because of cost, but these have the potential to reduce mortality by facilitating more rapid diagnosis of smear-negative TB. Economic evaluations of diagnostic strategies are needed to guide decisions on prioritising health care resources in TB control;16 however, data on the cost-effectiveness of newer diagnostics are limited.

The aims of this study were to compare MGIT with LJ in the diagnosis of TB with respect to yield, time to positive culture and contamination rates in a high TB incidence and high HIV prevalence setting, and to evaluate microscopic cording and the anti-MPB64 assay in the identification of mycobacterial species. We also conducted a cost-effectiveness analysis comparing
MGIT and MGIT+LJ with LJ alone, including standard biochemical assays, cording and anti-MPB64 assay in the diagnosis of smear-negative TB.

The study was nested within a cluster randomised trial of community-wide isoniazid preventive treatment (IPT), ‘Thibela TB’ (meaning ‘Prevent TB’ in seSotho), in three South African gold mining companies.

METHODS

Study population
TB suspects were enrolled from routine mine health services participating in the Thibela TB study (limited to individuals with no previous history of TB); and from the Thibela TB study, at screening and prior to or during follow-up visits while taking IPT (regardless of TB history). Participants gave one on-the-spot sputum sample, after nebulisation if necessary.

Laboratory methods
All laboratory work was undertaken at the National Health Laboratory Services regional TB laboratory in Johannesburg, South Africa. Specimens were decontaminated using the sodium hydroxide-N-acetyl-L-cystein (NaOH-NALC) method and concentrated by centrifugation. The pellet was resuspended in 1–2 ml of sterile phosphate buffer (pH 6.8), and an auramine-stained smear was examined under a fluorescence microscope; 0.5 ml of sediment was cultured using the BACTEC MGIT 960 system (BD Diagnostic Systems, Sparks, MD, USA); another 0.5 ml was inoculated onto an LJ slant. Positive cultures were confirmed by examining Ziehl-Neelsen (ZN) stained smears for AFB. Mycobacteria were identified using 1) standard biochemical tests (growth rate at 25°C and 37°C, pigment production, susceptibility to p-nitrobenzoic acid and biochemical tests, including 68°C heat stable catalase, nitrate reduction), 2) the anti-MPB64 monoclonal antibody assay (TAUNS) following the manufacturer’s instructions, and 3) by examining smears for microscopic serpentine cords of AFB. A culture that was considered contaminated was only re-decontaminated and re-cultured if the ZN-stained smears were positive for AFB.

Statistical methods
Data were analysed using Stata version 10.0 (STATA, College Station, TX, USA). The time to positive culture was summarised using Kaplan-Meier curves, stratified by smear status and compared between culture methods using the Wilcoxon signed-ranks test.

Using standard biochemical testing as the gold standard, the sensitivity and specificity of microscopic cording and the anti-MPB64 assay in identifying M. tuberculosis were determined, stratified by smear status. The 95% confidence intervals (CIs) for sensitivity and specificity were calculated using the exact binomial method.

Cost analyses
Economic cost analyses from a provider perspective compared LJ alone to 1) MGIT alone and 2) MGIT+LJ, each in conjunction with anti-MPB64 assay or cording vs. standard biochemical assay. Cost per culture (based on all specimens) and per M. tuberculosis case identified were calculated from time of arrival of specimens to identification of mycobacterial species in the laboratory. Specimen collection, transport to the laboratory and return of results were costed, but the costs were excluded on the basis that they were study-specific and not generalisable.

All resources used in the steps required for culturing were measured using an ingredients-based approach. Infrastructure costs were obtained through capital audit and apportioned to the diagnostic process based on proportion of time and space used. Capital costs were annualised using a useful life of 20 years for buildings, 5 years for furniture and 6 years for equipment and a discount rate of 3%. Use of laboratory, medical and other supplies was measured through detailed staff re-enactment of specimen processing. Staff time in laboratory was estimated by staff interview. Administrative staff time and supplies were included in the costing, but laboratory overhead costs (equipment maintenance, lighting, cleaning, water, etc.) were not available at the time of data collection and these were therefore estimated at 5% of all capital items at the laboratory.

All costs were valued at current market prices and expressed in 2007 SUS, using an exchange rate of US$1 = ZAR7.00 (as estimated for 30 June 2007, the end of the study period, using http://www.x-rates.com).

Cost-effectiveness
Cost-effectiveness analysis was restricted to smear-negative specimens. The incremental cost per additional positive culture and additional M. tuberculosis isolated using MGIT or MGIT+LJ vs. LJ alone, specified by standard biochemical tests, anti-MPB64 assay or microscopic cording, was calculated using a decision tree model programmed in Excel 2003 (Microsoft, Redmond, WA, USA). For the cost per additional M. tuberculosis case isolated, the same species identification method was used for the positive culture system (MGIT or MGIT+LJ) and the comparator LJ alone.

Sensitivity analysis
The base-case scenario assumed that the MGIT system was used at 75% throughput (as was observed with MGIT systems used under routine conditions in the same laboratory), 5% overheads and 16% contamination rate of MGIT cultures (as observed). This
The International Journal of Tuberculosis and Lung Disease

differed from the actual study conditions, where the MGIT system was used exclusively for study specimens and ran at 4% capacity. In a sensitivity analysis, we explored a low-cost scenario assuming an MGIT system throughput of 100% and a high-cost scenario assuming 50% throughput and overheads of 25%. For all cost-effectiveness estimates, we also explored the effect of reducing the proportion of MGIT cultures contaminated from 16% (as observed) to 4% (the best achieved in this laboratory using an alternative decontamination regimen [unpublished data]), assuming the proportion of specimens yielding *M. tuberculosis* was the same in contaminated and uncontaminated samples.

**Ethical considerations**

All participants who provided a sputum specimen gave written or witnessed verbal informed consent. The study was approved by the Research Ethics Committees of the University of KwaZulu-Natal and the London School of Hygiene & Tropical Medicine.

**RESULTS**

**Participants**

From July 2006 to June 2007, 1267 specimens (763 from routine mine health services and 504 from the Thibela TB study) had culture results available from both LJ and MGIT. Among the 1267 participants, 99.4% (*n* = 1260) were male, reflecting the sex distribution of this workforce, with a median age of 43 years (range 19–67, *n* = 1256); 51 (4.0%) were taking IPT at the time of enrolment and 35 (2.8%) had previously taken IPT; 1105 of the 1267 (87.2%) sputum specimens were smear-negative.

**Yield and contamination rates of cultures**

Overall, 254 specimens were culture-positive for mycobacteria on both LJ and MGIT, and 634 were negative on both systems. The yield of mycobacteria was higher for MGIT (376/1267, 29.7%) compared to LJ (289/1267, 22.8%; *P* < 0.001). MGIT alone detected mycobacteria on culture in 122 specimens where LJ was either negative or contaminated, compared to 35 detected by LJ which were negative or contaminated on MGIT. Contamination rates were generally high, and were higher for MGIT (16.7%) than LJ (9.3%).

Among the 162 smear-positive samples, 151 (93.2%) were positive for mycobacteria on MGIT, 144 (88.9%) were positive on LJ and 138 (85.2%) were positive on both (Table 1).

Among smear-negative samples, the yield of

**Table 1 Comparison of results of mycobacterial culture (Mycobacterium tuberculosis and non-tuberculous mycobacteria combined) on LJ medium vs. MGIT, stratified by smear status**

<table>
<thead>
<tr>
<th></th>
<th>LJ culture</th>
<th>MGIT culture</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Positive</td>
<td>Negative</td>
</tr>
<tr>
<td>Smear-positives</td>
<td>138</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Total (row %)</td>
<td>151 (93.2)</td>
<td>5 (3.1)</td>
</tr>
<tr>
<td>Smear-negatives</td>
<td>116</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>632</td>
</tr>
<tr>
<td>Contaminated</td>
<td>9</td>
<td>30</td>
</tr>
<tr>
<td>Total (row %)</td>
<td>225 (20.4)</td>
<td>674 (61.0)</td>
</tr>
</tbody>
</table>

LJ = Löwenstein-Jensen; MGIT = Mycobacterial Growth Indicator Tube.

**Table 1** Comparison of results of mycobacterial culture (Mycobacterium tuberculosis and non-tuberculous mycobacteria combined) on LJ medium vs. MGIT, stratified by smear status.

<table>
<thead>
<tr>
<th></th>
<th>LJ culture</th>
<th>MGIT culture</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Positive</td>
<td>Negative</td>
</tr>
<tr>
<td>Smear-positives</td>
<td>138</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Total (row %)</td>
<td>151 (93.2)</td>
<td>5 (3.1)</td>
</tr>
<tr>
<td>Smear-negatives</td>
<td>116</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>632</td>
</tr>
<tr>
<td>Contaminated</td>
<td>9</td>
<td>30</td>
</tr>
<tr>
<td>Total (row %)</td>
<td>225 (20.4)</td>
<td>674 (61.0)</td>
</tr>
</tbody>
</table>

LJ = Löwenstein-Jensen; MGIT = Mycobacterial Growth Indicator Tube.

**Figure** Kaplan-Meier plots showing time to positive *Mycobacterium tuberculosis* culture for MGIT compared to LJ medium for smear-positive and smear-negative specimens. Smear-positives (*n* = 117): median (range) MGIT 7 (3–30) vs. LJ 14 (2–57). Smear-negatives (*n* = 85): median (range) MGIT 14 (5–53) vs. LJ 25 (12–57). MGIT = Mycobacterial Growth Indicator Tube; LJ = Löwenstein-Jensen.
mycobacteria was higher for MGIT (225/1105, 20.4%) compared to LJ (145/1105, 13.1%; Table 1). MGIT alone detected an additional 109 cultures positive for mycobacteria where LJ was either negative or contaminated, compared to the additional 29 positive cultures detected by LJ alone (Table 1).

**Time to positive** M. tuberculosis culture

Among all TB suspects, the yield of M. tuberculosis was slightly higher for MGIT (233/1266, 18.4%) than for LJ (215/1266, 17.0%; P = 0.01).

Among specimens positive on both MGIT and LJ, time to positive M. tuberculosis culture was shorter with MGIT both for smear-positive specimens (median 7 vs. 14 days, respectively; Wilcoxon signed-ranks test \( P < 0.001, n = 117 \), Figure) and for smear-negative specimens (median 14 vs. 25 days respectively, Wilcoxon signed-ranks test \( P < 0.001, n = 85 \)).

**Organism identification**

Among smear-positive specimens, the majority of positive cultures were M. tuberculosis on both MGIT and LJ (78.9% and 80%, respectively); M. kansasii was the most common NTM identified (13.8% and 11.7% on MGIT and LJ, respectively; Table 2).

Among smear-negative specimens, fewer than half (48.7%) of the cultures positive on MGIT were M. tuberculosis, compared with 64.8% on LJ (Table 2). M. kansasii was identified in a similar proportion of positive cultures on MGIT and on LJ (10.1% vs. 11.2%). M. avium complex was identified in 10.1% of positive MGIT cultures vs. 4.8% LJ (Table 2). Among 88 mycobacterial isolates from smear-negative specimens 'gained' on MGIT (i.e., specimens that were culture-positive on MGIT but negative or contaminated on LJ), only 22.7% were M. tuberculosis, the majority being NTM (Table 2).

Species identification results, comparing microscopic cording and the anti-MPB64 assay with standard biochemical tests as the gold standard, were available for 341 specimens (Table 3). Among the 213 smear-negative specimens, the sensitivity and specificity of microscopic cording were respectively 99.0% and 99.1% (Table 3). One smear-negative isolate showing typical cording morphology was identified as NTM and another isolate with no cording was identified as M. tuberculosis complex, using standard biochemical tests. Two smear-positive isolates showing typical cording morphology were identified as NTM and one isolate with no cording was positive for M. tuberculosis, using standard biochemical tests.

The sensitivity and specificity of the anti-MPB64 assay among smear-negatives was respectively 99.0% and 99.1% (Table 3). Using standard biochemical tests, one smear-negative isolate that was negative with the anti-MPB64 assay was identified as M. tuberculosis complex, while another that was positive for M. tuberculosis complex using the anti-MPB64 assay was identified as M. kansasii. Two smear-positive isolates identified as M. tuberculosis complex using the anti-MPB64 assay were identified as M. kansasii and unspecified NTM using standard biochemical tests.

The four isolates that were discrepant in comparing the anti-MPB64 assay with standard biochemical tests were also discrepant on cording compared with standard biochemical tests.

**Costs of culture and organism identification**

Costs were calculated over the 12-month study period for all 1275 cultures (Table 4). Transport costs

### Table 2 Organisms identified from positive mycobacterial cultures, stratified by smear status

<table>
<thead>
<tr>
<th>Organism</th>
<th>MGIT-positive</th>
<th>LJ-positive</th>
<th>Gain from MGIT*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smear-positives</td>
<td>n (column %)</td>
<td>n (column %)</td>
<td>n (column %)</td>
</tr>
<tr>
<td>M. tuberculosis</td>
<td>97 (78.9)</td>
<td>96 (80.0)</td>
<td>4 (50.0)</td>
</tr>
<tr>
<td>M. kansasii</td>
<td>17 (13.8)</td>
<td>14 (11.7)</td>
<td>3 (37.5)</td>
</tr>
<tr>
<td>M. avium complex</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>NTM (unspeciated)</td>
<td>9 (7.3)</td>
<td>10 (8.3)</td>
<td>1 (12.5)</td>
</tr>
<tr>
<td>Smear-negatives</td>
<td>n (column %)</td>
<td>n (column %)</td>
<td>n (column %)</td>
</tr>
<tr>
<td>M. tuberculosis</td>
<td>92 (48.7)</td>
<td>81 (46.8)</td>
<td>20 (22.7)</td>
</tr>
<tr>
<td>M. kansasii</td>
<td>19 (10.1)</td>
<td>14 (11.2)</td>
<td>9 (10.2)</td>
</tr>
<tr>
<td>M. avium complex</td>
<td>19 (10.1)</td>
<td>6 (4.8)</td>
<td>15 (17.1)</td>
</tr>
<tr>
<td>NTM (unspeciated)</td>
<td>59 (31.2)</td>
<td>24 (19.2)</td>
<td>44 (50.0)</td>
</tr>
</tbody>
</table>

*Additional organisms identified using MGIT where LJ was negative or contaminated.

LJ = Löwenstein-Jensen; MGIT = Mycobacterial Growth Indicator Tube; NTM = non-tuberculous mycobacteria.

### Table 3 Sensitivity and specificity of microscopic cording and the anti-MPB64 TB assay in identification of Mycobacterium tuberculosis complex, compared with standard biochemical tests as the gold standard

<table>
<thead>
<tr>
<th></th>
<th>Overall (N = 341)</th>
<th>Smear-positive (n = 128)</th>
<th>Smear-negative (n = 213)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n/N (%)</td>
<td>95% CI</td>
<td>n/N (%)</td>
</tr>
<tr>
<td>Cording</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensitivity</td>
<td>199/201 (99.0)</td>
<td>96.5–99.9</td>
<td>99/100 (99.0)</td>
</tr>
<tr>
<td>Specificity</td>
<td>137/140 (97.9)</td>
<td>93.9–99.6</td>
<td>26/28 (92.9)</td>
</tr>
<tr>
<td>MPB64</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensitivity</td>
<td>199/200 (99.5)</td>
<td>97.2–100</td>
<td>99/99 (100)</td>
</tr>
<tr>
<td>Specificity</td>
<td>137/140 (97.9)</td>
<td>93.9–99.6</td>
<td>26/28 (92.9)</td>
</tr>
</tbody>
</table>

*One sided, 97.5% CI.

CI = confidence interval.
were calculated at US$11.72 per culture, but were excluded from the final calculation of a public sector laboratory cost per culture because they were private sector provider costs. In the base-case scenario, average cost per LJ, MGIT and MGIT+LJ conducted was respectively US$12.35, US$16.62 and US$19.29 (Table 3). The capital cost component was similar for LJ and MGIT, at respectively 12% and 18%. At the laboratory level, staff and medical consumables were the highest cost drivers for LJ and MGIT, respectively.

The cost of organism identification per positive culture on MGIT in the base-case scenario was US$35.94 using standard biochemical tests, US$15.49 for anti-MPB64 assay and US$2.28 for cording.

Cost-effectiveness of MGIT vs. LJ
Subsequent analysis was restricted to 1113 smear-negative specimens (1105 included in the laboratory analysis plus eight for which laboratory data were incomplete). In the base-case scenario, the cost per additional \( M. \) tuberculosis case identified with standard biochemical tests was US$504.08 for MGIT and US$160.80 for MGIT+LJ vs. LJ alone (Table 5); this decreased to respectively US$397.67 and US$129.53 if the anti-MPB64 assay was used for identification, and further decreased to respectively US$328.10 and US$109.07 with microscopic cording.

Sensitivity analyses
In the low-cost scenario (assuming the MGIT system ran at 100% of maximum capacity), the cost per MGIT...
culture decreased from US$16.62 to US$16.53 (Table 5). Costs per additional *M. tuberculosis* confirmed with cording were likewise altered from US$328.10 to US$302.33 for MGIT and US$109.07 to US$107.48 for MGIT+LJ vs. LJ alone.

In a high-cost scenario (50% throughput on MGIT and overheads increased to 25%), the cost per culture for LJ, MGIT and MGIT+LJ increased from respectively US$12.35 to US$13.04, US$16.62 to US$18.66 and US$19.29 to US$21.65. The cost per additional *M. tuberculosis* case confirmed with cording changed from respectively US$328.10 to US$428.87 and US$109.07 to US$135.18 for MGIT and MGIT+LJ.

In scenarios assuming a reduction in contamination rates from 16% to 4% of MGIT cultures (assuming 75% throughput and 5% overheads), the cost per additional *M. tuberculosis* case identified for 1) MGIT alone and 2) MGIT+LJ using standard biochemical tests, anti-MPB64 assay and cording was respectively US$248.06 and US$135.19; US$180.06 and US$105.22; and US$135.79 and US$84.68 (Table 5).

Changes in discount rates (from 3% to 6%) did not show significant changes in cost per culture and cost-effectiveness ratios (data not shown).

**DISCUSSION**

The World Health Organization now recommends expanded use of liquid culture systems in resource-constrained settings; our data are among the first to document how these systems perform in a routine laboratory in such a setting. The higher yield and shorter time to positive culture with MGIT, particularly among smear-negative specimens, were expected and consistent with other work. Less expected was the high yield of NTM, accounting for three quarters of mycobacterial isolates from specimens positive on MGIT but not on LJ. The proportion of NTM in our study was higher than reported from similar studies in Taiwan, Thailand and Zambia, where case identification rate is key to maximising cost-effectiveness. The cost per additional *M. tuberculosis* case detected using MGIT vs. LJ was substantially lower when contamination was reduced from 16% to 4%.

Our costs per culture were lower than estimates from a similar study in Zambia, where base-case throughput was substantially lower and overhead costs, which included transport and all resources not directly involved in performing the culture, were substantially higher. Comparable costs (i.e., excluding transport) in our study were slightly higher than estimates from Brazil; this may be due to the assumption of available infrastructure capacity with no additional cost used in the Brazil study. The culture processing costs in our study (medical consumables, medical equipment and staff time used in performing cultures) accounted for respectively 74% and 82% of our total cost per culture for LJ and MGIT. We found improved cost-effectiveness, particularly in the scenario with high MGIT contamination, if both MGIT and LJ were used vs. MGIT alone, because having two cultures reduced the probability of a 'contaminated' result.

MGIT costs were also sensitive to throughput, with estimated costs for maximum throughput reflecting the costs that would be expected under operational conditions in a large routine laboratory. However, even assuming maximal throughput, the cost per additional *M. tuberculosis* case detected was substantially, raising questions about how MGIT technology should be prioritised in resource-constrained settings. Our data suggest that minimising the MGIT contamination rate is key to maximising cost-effectiveness.

Further work will follow up treatment outcomes based on earlier diagnosis to provide a cost-effectiveness analysis using cost per life year gained as a final health outcome, to provide better guidance for resource allocation across differing prevention and treatment strategies.

The high prevalence of *M. kansasii* among our study population of gold miners is unlikely to be generalisable to community TB clinics, and this is a limitation of our study; in addition, we do not yet have data on the clinical significance of the NTM isolates.
CONCLUSIONS

In a routine laboratory setting in South Africa, the higher yield of MGIT compared to LJ has to be balanced against the higher proportion of NTM cultured. MGIT costs are high, and sensitive to throughput and particularly to contamination rates. Microscopic cording and the anti-MPB64 assay both performed very well compared with standard biochemical tests for organism identification; both, particularly cording, were less expensive. The clinical significance of the NTM, and the health outcome gains from earlier diagnosis, will be determined in future work.

Acknowledgements

The authors thank the participants, staff of the Thabela TB study teams, and M van der Meulen, X Poswa and G Coetzee at the National Health Laboratory Services (NHLS) for essential contributions to the laboratory aspects of the study. They also thank R O’Brien at the Foundation for Innovative New Diagnostics (FIN Diagnostics) for advice on the laboratory aspects of the study.

References

29 Churchyard G J, Kleinschmidt I, Corbett E L, Mulder D, de Cock K M. Mycobacterial disease in South African gold miners

**CONTEXTE :** Laboratoire de tuberculose des Services du Laboratoire National de la Santé, Afrique du Sud.

**OBJECTIFS :** Comparer la technique du Mycobacterium Growth Indicator Tube (MGIT) avec les milieux de Löwenstein-Jensen (LJ) concernant le rendement en Mycobacterium tuberculosis, la durée avant une culture positive ainsi que le taux de contamination pour évaluer le rapport coût-efficacité de MGIT.

**SCHEMA :** On a cultivé sur MGIT et sur LJ l’expectoration provenant de mineurs d’or. Nous avons estimé, grâce à l’emploi d’un modèle d’arbre de décision, le coût par culture et, pour les échantillons à bacilloscopie négative de frottis, le coût supplémentaire par unité de M. tuberculosis identifié par les tests biochimiques standard et la présence de torules à l’examen microscopique a été respectivement de 504,08 US$ pour MGIT et 328,10 US$ pour LJ, ou encore de 160,80 US$ pour MGIT+LJ contre 109,07 US$ pour LJ seul.

**CONCLUSION :** Le MGIT a consisté en un rendement plus élevé et donne une réponse plus rapide mais un coût relativement élevé. La proportion élevée de NTM souligne la nécessité de tests rapides de détermination de l’espèce ; la réduction du taux de cultures contaminées est essentielle en matière de rapport coût-efficacité.

**RESUMEN**

**MARCO DE REFERENCIA :** Un laboratorio de tuberculosis del Sistema Nacional de Salud de Sudáfrica.

**OBJETIVOS :** Comparar el rendimiento diagnóstico del sistema de cultivo con indicador de crecimiento de micobacterias en tubo (MGIT) con el medio Löwenstein-Jensen (LJ) en la detección de Mycobacterium tuberculosis, en relación con los resultados positivos, el lapso hasta obtener un cultivo positivo y la contaminación. Se evaluó además la rentabilidad del sistema MGIT.

**MÉTODO :** Se cultivaron muestras de esputo de trabajadores de minas de oro en el sistema MGIT y en LJ. Se calcularon los costos por cultivo y por muestras con bacilloscopía negativa y el incremento del costo por cada diagnóstico adicional de M. tuberculosis logrado con MGIT, aplicando un modelo de árbol de decisiones.

**RESULTADOS :** En las 1267 muestras analizadas, con MGIT se obtuvieron más resultados positivos que en LJ (29,7% contra 22,8%), se presentó mayor contaminación (16,7% contra 9,3%) y se precisó un lapso más corto hasta obtener un cultivo positivo (mediana de 14 días contra 25 días, en muestras con bacilloscopía negativa). De las muestras con bacilloscopía negativa y cultivo positivo en MGIT pero cultivo negativo o contaminado en LJ, 73% fueron micobacterias atípicas (NTM). El costo por cultivo en LJ fue US$ 12,35, en MGIT fue US$ 16,62 y usando ambos fue US$ 19,29. El costo adicional por cada M. tuberculosis detectado con los métodos bioquímicos corrientes fue US$ 504,08 y con la observación microscópica de la formación de cuerpos fue US$ 328,10 cuando se usó MGIT en comparación con LJ y de US$ 160,80 y US$ 109,07 cuando se usaron ambos medios, comparados con LJ solo.

**CONCLUSIÓN :** El sistema MGIT ofrece un mayor rendimiento y resultados más rápidos, con un costo relativamente alto. La gran proporción de NTM destaca la necesidad de pruebas rápidas de diagnóstico de las especies. Reducir al mínimo de la contaminación de los cultivos es un factor primordial en la rentabilidad de las pruebas.