Analyses of January 2006 *M. tuberculosis* and Nontuberculous Mycobacteria Drug Susceptibility Test Results Reported by Participating Laboratories

This report analyzes the laboratory test results reported to the Centers for Disease Control and Prevention (CDC) by participant laboratories for the four *Mycobacterium tuberculosis* complex and one *M. mucogenicum* strain shipped in January 2006. Participant laboratories received either four *M. tuberculosis* complex strains only or four *M. tuberculosis* complex strains and one nontuberculous mycobacteria (NTM) strain. Testing results were received and analyzed from 139 of 146 (95.2%) laboratories participating in this shipment. Of the laboratories submitting results, 67 (48.2%) reported via the online data entry system.

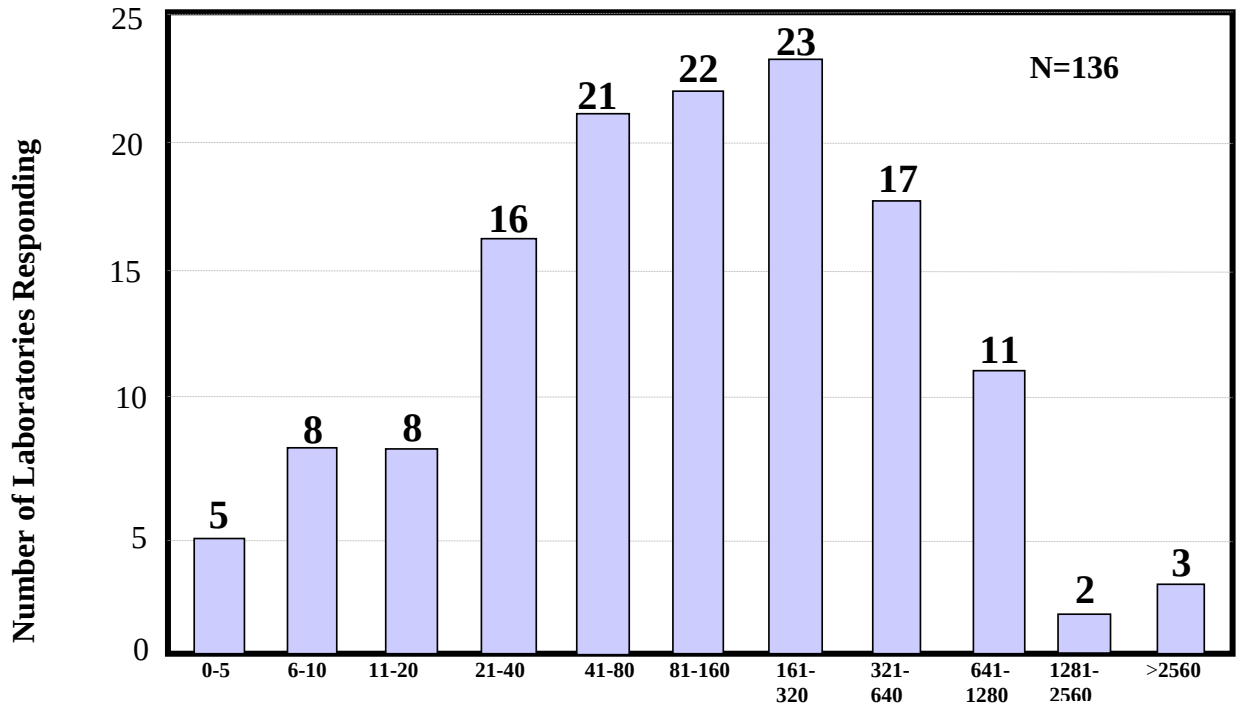
Descriptive Information on Participant Laboratories

Laboratory classifications reported by the 139 participants are:

- 82 (59.0%) health departments,
- 39 (28.1%) hospitals,
- 13 (9.4%) independent laboratories, and
- 5 (3.6%) "other" type of laboratories.

Figure 1 shows the distribution of the annual volume of *M.tuberculosis* susceptibility testing by participants. The numbers on top of the bars indicate the number of laboratories at the upper limit of that group.

Figure 1: Distribution of the Annual Volume of *M. tuberculosis* Isolates Tested for Drug Susceptibility by Participating Laboratories in Calendar Year 2005.



According to the annual volume of testing reported, some laboratories perform less than one drug susceptibility test per month. Laboratories performing these low testing volumes may want to consider referring drug susceptibility tests to other facilities.

The biosafety levels (BSL) reported by participant laboratories for handling *M. tuberculosis* are:

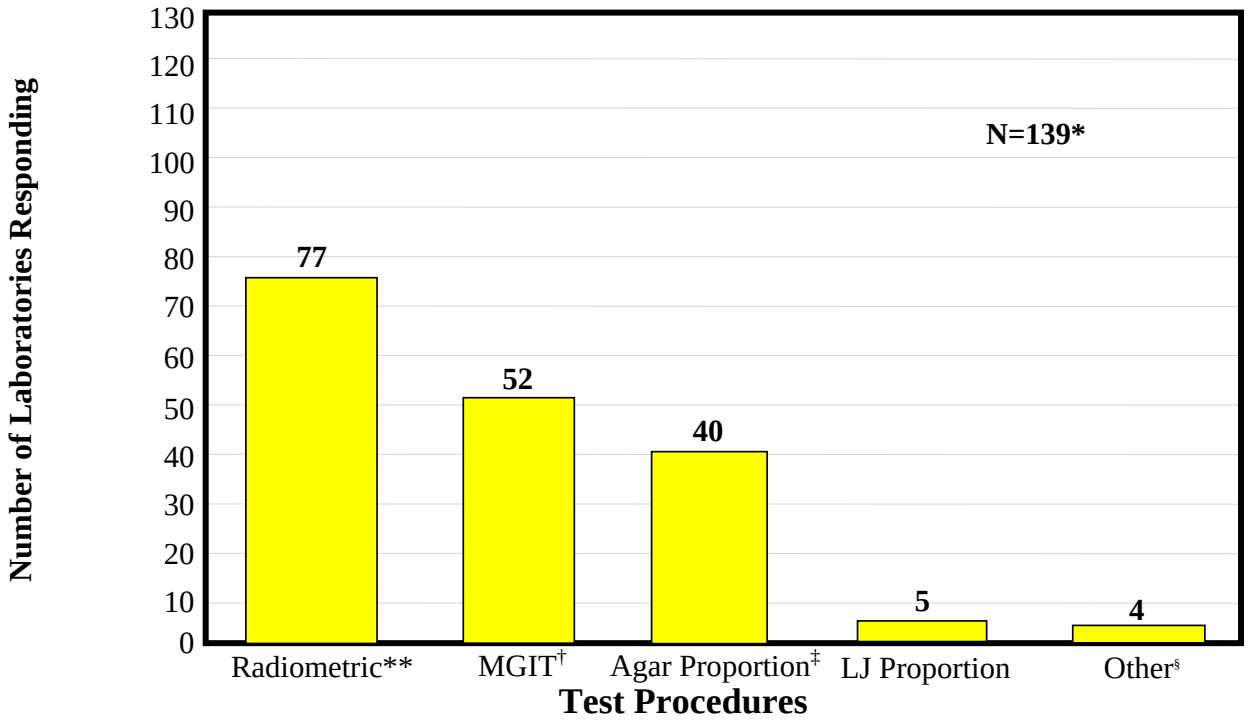
- BSL-3, 80 participants,
- BSL-2 with facilities with level 3 containment equipment, 47 participants,
- BSL-2, 11 participants,
- One laboratory reported that they did not know the BSL level of the laboratory.

All laboratories are strongly encouraged to consult the CDC/NIH manual, Biosafety in Microbiological and Biomedical Laboratories (4th Edition), which can be accessed on the web at http://www.cdc.gov/od/ohs/biosfty/bmbl4/bmbl4toc.htm, for recommendations and to determine their correct BSL level.

Laboratory Test Procedures

Figure 2 shows the number of laboratories by type of procedure used for drug susceptibility testing.

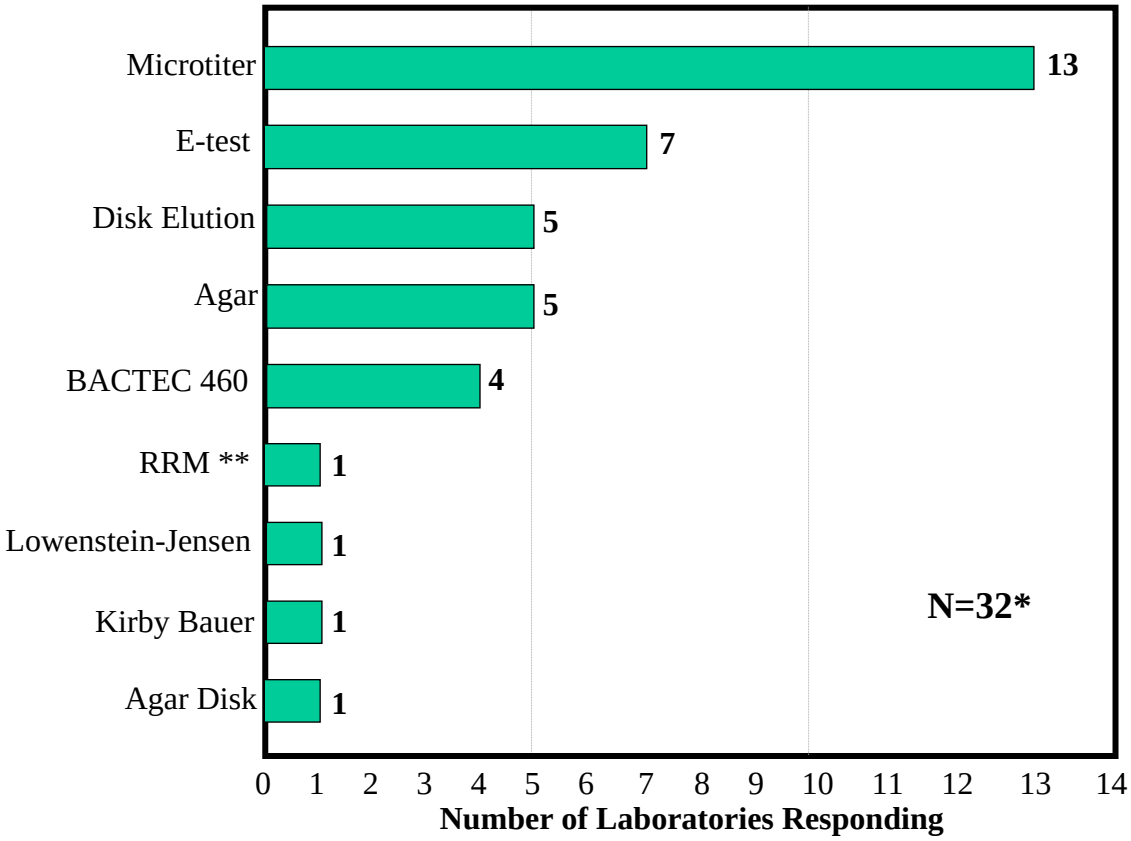
Figure 2: Procedures Used by the Participating Laboratories for *M. tuberculosis* Drug Susceptibility Testing



* Some participants reported more than one test method.
** Radiometric is BACTEC 460TB
† MGIT, Mycobacteria Growth Indicator Tube (BACTEC MGIT 960)
‡ Agar proportion using Middlebrook 7H10 or 7H11 medium.
§ Other methods listed were microtiter, BacT/ALERT, TREK ESP and Colorimetric method for determining MICs.

Some methods, such as the LJ proportion, reflect procedures used by international participants.
Thirty-two laboratories performed susceptibility testing on *M. mucogenicum*. Figure 3 shows the procedures used.

Figure 3: Procedures Used by Participating Laboratories Testing Strain T, *M. mucogenicum*



*Some participants reported more than one test method. Therefore the total is greater than the number of laboratories reporting results.
**RRM resistance ratio method

***M. tuberculosis* Complex Strains Test Results**:

To facilitate comparison among laboratories the aggregate test results are provided in Tables 1.0 through 1.3, at the end of this document representing strains A, B, C and D. The tables for the *M. tuberculosis* complex strains A, B, C, and D include the results for the radiometric (BACTEC), agar proportion (AP), Lowenstein-Jensen (L-J) proportion, MGIT and other methods at each concentration of drug.

In the tables, the concentrations recommended by CDC and the Clinical and Laboratory Standards Institute (CLSI) for the primary [isoniazid (INH), rifampin (RIF), pyrazinamide (PZA), and ethambutol (EMB)] and secondary [streptomycin (SM), ethionamide (THA), kanamycin (KM), capreomycin (CM), and p-amino-salicylic acid (PAS)] antituberculosis drugs are highlighted for the conventional and radiometric methods.

The CDC and CLSI recommendations reflect the critical concentrations of antituberculosis drugs in 7H10 agar and those concentrations for the BACTEC method that directly correlate with the critical concentrations in the conventional method. [1, 2, 3, 4] When two concentrations are highlighted, such as for isoniazid and ethambutol, the lower value is the critical concentration which should always be included for determining whether the *M. tuberculosis* isolate is resistant.

Strain A, *M. tuberculosis*- resistant to streptomycin at 2.0 µg/ml and ofloxacin at 2.0 µg/ml by both the agar proportion and BACTEC methods. See Table 1.0.

Of the 90 laboratories that tested Streptomycin at 2.0 µg/ml;

- 100% (31/31) detected resistance with agar proportion,
- 98.3% (58/59) detected resistance with BACTEC 460TB, while
- 94.9% (37/39) detected resistance with an equivalent concentration (1.0 µg/ml) with MGIT.

Of the 22 laboratories that tested ofloxacin, which was used as the class representative for the fluoroquinolones, 21 (95.5%) reported resistance at most concentrations tested and by most methods used.

Both streptomycin and fluoroquinolones are used as secondary drugs for the treatment of tuberculosis caused by the *Mycobacterium tuberculosis* complex.

Strain B, *M. tuberculosis*-resistant INH at 0.2 µg/ml and 1.0 µg/ml by the agar proportion method. See Table 1.1

Isoniazid has two recommended concentrations for the AP method (0.2 µg/ml and 1.0 µg/ml) and equivalent concentrations for BACTEC 460TB and MGIT (0.1 µg/ml and 0.4 µg/ml).

For participants using agar proportion, resistance was reported by:

- 100% (33/33) at 0.2 µg/ml and
- 100% (36/36) at 1.0 µg/ml.

For participants using BACTEC 460, resistance was reported by:

- 100% (68/68) at 0.1 µg/ml and
- 100% (22/22) at 0.4 µg/ml.

For participants using MGIT:

- 98.0% (48/49) detected resistance at 0.1 µg/ml and
- 95.2% (20/21) detected resistance at 0.4 µg/ml.

Strain C, *M. tuberculosis,* resistant to rifampin at 2.0 µg/ml by the BACTEC method. See Table 1.2.

One hundred thirty-nine participants reported results for strain C:

- 100% (67/67) using BACTEC 460TB at 2.0 µg/ml, and
- 100% (36/36) of the participant laboratories reported resistance to rifampin at the equivalent concentration of 1.0 µg/ml by the agar proportion method, and
- 100% (44/44) using MGIT reported resistance at 1.0 µg/ml .

All laboratories testing rifampin reported this isolate to be resistant at all concentrations and by all method used.

Strain D, *Mycobacterium tuberculosis*, fully susceptible. See table 1.3.

Please note that Strain D, originally thought to be a pure culture of *M. tuberculosis*, fully susceptible to all drugs tested, was identified later as a mixed culture. The culture vial contained *M. tuberculosis* contaminated with a rapid-grower, identified by several laboratories as *Mycobacterium fortuitum*. This was unintentional for this shipment, as CDC had instructed its contractors to send only pure a culture to participant laboratories.

Of the 139 laboratories that reported results, 14.4% (20/139) reported that the culture was contaminated with the rapid grower. Therefore, strain D is reported for reference purposes only. No further analysis is presented. Although many laboratories that reported contamination also reported susceptibility results. Additionally, a number of laboratories reported resistance to first line anti-tuberculosis drugs with the liquid culture method.

> *Some suggested purity check methods are as follows: (1) When the agar proportion method is used, careful attention should be paid to the colony morphology of the organism to ensure that it is consistent with that expected for the identified organism.*
> *(2) A day prior to setting up a susceptibility test on an organism growing in a liquid medium, inoculate a chocolate agar plate. If no growth is observed after overnight incubation, it is unlikely that any contaminating non-acid-fast organism is present.*
> *(3) When susceptibility testing is set up in a liquid medium for a slowly growing mycobacterium from a culture growing in a liquid medium, no additional purity check (to assure that only one mycobacterial species is present) need be done if the mycobacterium is susceptible to all drugs tested (in the case of a member of the Mycobacterium tuberculosis complex [MTBC]), or if the susceptibility pattern is that which would be expected for the species being tested (in the case of another species of slowly growing mycobacterium). If the organism is resistant to any of the drugs tested (in the case of a member of the MTBC), or if the susceptibility pattern is different from that which would be expected for the species being tested (in the case of another species of slowly growing mycobacterium), then a subculture should be performed from at least one of the vials containing an anti-mycobacterial agent to which the organism is unexpectedly resistant, to assure that the culture is pure and that the colonial morphology is consistent with that to be expected for the identified organism.*[(5)]

Interestingly, antituberculosis drugs are not generally used to treat disease caused by rapidly growing mycobacteria. Rapid growers should be tested against antibacterial drugs, including amikacin, doxycycline, imipenem, fluoroquinolones, a sulfonamide, cefoxitin, and clarithromycin.[(6)]

Note: Our providing test results for all drugs that are reported to CDC by participant laboratories should not be construed as a recommendation or endorsement for testing particular drug concentrations with patient isolates of the *M. tuberculosis* complex. It is assumed that some of the drugs are being tested for research purposes or potential use in the few referral institutions that may treat patients with *M. tuberculosis* isolates resistant to almost all standard drugs. Laboratories should not add drugs to their testing regimen without consulting physicians having expertise in treating multi-drug resistant tuberculosis. Laboratories may contact their local TB control program for referrals of physicians with experience and expertise in treating multi-drug resistant tuberculosis.

Nontuberculous Mycobacteria Test Results:

Strain E, *M. mucogenicum*

Case History:

A 53-year-old female presented to the hospital with fever, chills, generalized arthralgias and no identified cause of these symptoms. Radiological evaluation indicated a left-sided pneumonia without pleural effusion. A complete medical examination and laboratory evaluation indicated that she had a $CD4^+$ T lymphocytopenia (CD4 count of 315 cells/mm^2). A bone marrow biopsy was obtained by aspiration, cultured onto Löwenstein-Jensen medium and grew acid-fast colonies. These were identified as *Mycobacterium mucogenicum* by restriction endonuclease analysis of the 65-kDa hsp gene and high performance liquid chromatography. *M. mucogenicum* has been identified as a water contaminant in hospitals and has been implicated in cases of nosocomial infections.[8]

Antimicrobial agents recommended for testing *M. mucogenicum* are found in Table 8 in the CLSI Guidelines.[7] Some laboratories still continue to test the first line TB drugs which is contrary to the recommendations made by the American Thoracic Society.

> *The addition of NTM strains to this performance evaluation program should not be interpreted as a recommendation for laboratories to adopt NTM drug susceptibility testing, especially if the laboratory has limited experience with these tests and methods. We encourage laboratories that perform NTM drug susceptibility testing to consult recommendations, references, and physicians with expertise in infectious diseases when selecting test methods, drugs, and test interpretations.*

Acknowledgments

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Tables

The test results are listed in the appropriate (susceptible or resistant) columns with a corresponding total number of tests (Sum) column provided as a denominator for determining the level of consensus. This report contains all results reported by participating laboratories, including many drug concentrations with only one result.

Participants should note that the Clinical and Laboratory Standards Institute (previously known as NCCLS) approved standard "Susceptibility Testing of Mycobacteria, Nocardiae, and Other Aerobic Actinomycetes," M24-A (ISBN 1-56238-500-3) NCCLS, 940 West Valley Road, Suite 1400, Wayne, Pennsylvania 19087-1898, USA, 2003 recommends testing streptomycin as a secondary drug and also adds ofloxacin and rifabutin to the list of recommended secondary drugs.

Concentrations are listed in micrograms per milliliter, µg/ml.

Table 1.0: Participant Results for culture A, *M. tuberculosis* resistant to streptomycin and ciprofloxacin at 2.0 µg/ml

		Test Method														
		AP Results			BACTEC Results			LJ Prop Results			MGIT Results			Other Tests Results		
DRUG	Conc	S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum
Isoniazid	0.05													1		1
Isoniazid	0.10				66	1	67				47	1	48	2		2
Isoniazid	0.12	1		1												
Isoniazid	0.20	31		31	4		4	5		5	1		1	1		1
Isoniazid	0.40				19		19				14		14	1		1
Isoniazid	0.50							1		1						
Isoniazid	1.00	32		32	2		2	3		3	1		1			
Isoniazid	5.00	4		4							1		1			
Isoniazid	10.00							2		2						
Isoniazid	100.00							1		1						
Rifampin	0.5				2		2									
Rifampin	1.0	33		33	8		8	1		1	49		49	1		1
Rifampin	2.0				66		66									
Rifampin	5.0	4		4				1		1						
Rifampin	8.0				1		1							1		1
Rifampin	16.0													1		1
Rifampin	32.0													1		1
Rifampin	40.0							4		4						
Rifampin	50.0							1		1						
Pyrazinamide	64.00														1	1
Pyrazinamide	99.00				1		1									
Pyrazinamide	100.00				57		57		1	1	39	1	40	1		1
Pyrazinamide	300.0				1		1									
Pyrazinamide	400.0								1	1						
Ethambutol	1.00							1		1						
Ethambutol	1.60													1		1
Ethambutol	2.00				1		1	5		5						
Ethambutol	2.50				59	1	60									
Ethambutol	3.20													1		1
Ethambutol	4.00				2		2									
Ethambutol	5.00	29		29	8	1	9	1		1	49		49	1		1
Ethambutol	6.40													1		1
Ethambutol	7.50	2		2	11		11									
Ethambutol	8.00													1		1
Ethambutol	10.00	11		11												
Streptomycin	1.0					2	2		1	1	2	37	39			
Streptomycin	2.0		31	31	1	58	59									
Streptomycin	4.0		1	1		3	3		4	4		9	9			
Streptomycin	5.0							1		1						
Streptomycin	6.0				2	13	15									
Streptomycin	7.5														1	1
Streptomycin	10.0	5	20	25	1	1	2	1		1						
Streptomycin	15.00														1	1
Streptomycin	30.00														1	1
Streptomycin	50.00				1		1									

Table 1.0: Participant Results for Culture A, *M. tuberculosis* resistant to streptomycin and ciprofloxacin at 2 µg/ml

		Test Method														
		AP Results			BACTEC Results			LJ Prop Results			MGIT Results			Other Tests Results		
DRUG	Conc	S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum
Ethionamide	1.00															
Ethionamide	1.25				1		1									
Ethionamide	2.00				1		1									
Ethionamide	2.50				3		3									
Ethionamide	4.00				1		1									
Ethionamide	5.00	21		21	2		2				1		1			
Ethionamide	10.00	3		3										1		1
Ethionamide	20.00							1		1				1		1
Ethionamide	40.00							1		1				1		1
Kanamycin	5.00	9		9	3		3									
Kanamycin	5.00															
Kanamycin	6.00	13		13												
Kanamycin	10.00							1		1						
Kanamycin	20.00							1		1						
Kanamycin	40.00							1		1						
Capreomycin	0.50													1		1
Capreomycin	1.00													1		1
Capreomycin	1.25				3		3									
Capreomycin	5.00				2		2									
Capreomycin	10.00	16		16												
Capreomycin	12.50														1	1
Capreomycin	25.00													1		1
Capreomycin	40.00							1		1						
Capreomycin	50.00													1		1
Cycloserine	12.00													1		1
Cycloserine	20.00							1		1						
Cycloserine	24.00													1		1
Cycloserine	25.00	1		1												
Cycloserine	30.00	10		10				1		1						
Cycloserine	40.00							1		1						
Cycloserine	48.00													1		1
Cycloserine	60.00	1		1												
p-Aminosalicyclic acid	0.50							1		1						
p-Aminosalicyclic acid	1.00							2		2						
p-Aminosalicyclic acid	2.00	15	1	16												
p-Aminosalicyclic acid	4.00				2	1	3									
p-Aminosalicyclic acid	8.00	2		2												
p-Aminosalicyclic acid	10.00	4		4												
Amikacin	0.50													1		1
Amikacin	1.00	1		1	2		2							1		1
Amikacin	2.00	1		1	2		2									
Amikacin	2.50				1		1									
Amikacin	4.00	3		3	1		1									
Amikacin	5.00				1		1									
Amikacin	6.00	5		5												
Amikacin	7.50														1	1
Amikacin	8.00				2		2									
Amikacin	12.00	2		2												
Amikacin	15.00													1		1
Amikacin	20.00	1		1												
Amikacin	30.00													1		1

Table 1.0: Participant Results for Culture A, *M. tuberculosis*, resistant to streptomycin and ciprofloxacin at 2 µg/ml

		Test Method														
		AP Results			BACTEC Results			LJ Prop Results			MGIT Results			Other Tests Results		
DRUG	Conc	S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum
Ofloxacin	0.50														1	1
Ofloxacin	1.00		3	3		2	2									
Ofloxacin	1.25														1	1
Ofloxacin	2.00		10	10		5	5		1	1	1		1			
Ofloxacin	2.50														1	1
Ofloxacin	4.00		2	2		1	1									
Ofloxacin	5.00														1	1
Ofloxacin	8.00		1	1		1	1								1	1
Ofloxacin	10.00		1	1												
Ciprofloxacin	0.50														1	1
Ciprofloxacin	1.00		2	2	1	1	2									
Ciprofloxacin	2.00		3	3												
Ciprofloxacin	1.60														1	1
Ciprofloxacin	2.00	2	7	9		3	3									
Ciprofloxacin	3.20														1	1
Ciprofloxacin	4.00		1	1											1	1
Ciprofloxacin	6.40														1	1
Ciprofloxacin	8.00					1	1									
Clarithromycin	6.00													1		1
Clarithromycin	12.00													1		1
Clarithromycin	24.00													1		1
Clofazamine	0.06				2		2									
Clofazamine	0.12				2		2									
Clofazamine	0.25				2		2									
Clofazamine	0.50				3		3							1		1
Clofazamine	1.00													1		1
Clofazamine	17.50														1	1
Clofazamine	35.00														1	1
Clofazamine	70.00													1		1
Rifabutin	0.50	4		4												
Rifabutin	1.00	2		2												
Rifabutin	2.00	4		4												
Rifabutin	20.00							1		1						
Rifabutin	32.00													1		1
Levofloxacin	2.00					3	3									
Levofloxacin	8.00					1	1									
Moxifloxacin	1.00		1	1												
Moxifloxacin	2.00								1	1						
Prothionamide	40.00							1		1						
Ansamycin	1.00	1		1	1		1									

Table 1.1: Participant Results for Culture B, *M. tuberculosis*-resistant at 0.2 and 1.0 µg/ml.

		Test Method														
		AP Results			BACTEC Results			LJ Prop Results			MGIT Results			Other Tests Results		
DRUG	Conc	S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum
Isoniazid	0.05													1		1
Isoniazid	0.10					68	68				1	48	49	2		2
Isoniazid	0.12		1	1												
Isoniazid	0.20		33	33		5	5		5	5		1	1		2	2
Isoniazid	0.40					22	22				1	20	21		1	1
Isoniazid	0.50								1	1						
Isoniazid	1.00		36	36		4	4	1	2	3		1	1		1	1
Isoniazid	1.00															
Isoniazid	1.00															
Isoniazid	1.00															
Isoniazid	1.00															
Isoniazid	2.00					2	2									
Isoniazid	5.00	1	3	4	1		1				1		1			
Isoniazid	10.00				1		1	2		2						
Isoniazid	100.00							1		1						
Rifampin	0.5				2		2									
Rifampin	1.0	36		36	8		8	1		1	49	1	50	2		2
Rifampin	2.0				65		65									
Rifampin	5.0	4		4				1		1						
Rifampin	5.0															
Rifampin	8.0				1		1							1		1
Rifampin	16.0													1		1
Rifampin	32.0													1		1
Rifampin	40.0							4		4						
Rifampin	50.0							1		1						
Pyrazinamide	64.0													1		1
Pyrazinamide	99.0				1		1									
Pyrazinamide	100.0				58		58		1	1	39	2	41	1		1
Pyrazinamide	300.0				1		1									
Pyrazinamide	400.0								1	1						
Ethambutol	1.00							1		1						
Ethambutol	1.60													1		1
Ethambutol	2.00				1		1	5		5						
Ethambutol	2.50				60		60									
Ethambutol	3.20													1		1
Ethambutol	4.00				2		2									
Ethambutol	5.00	33		33	9		9	1		1	49	1	50	2		2
Ethambutol	6.40													1		1
Ethambutol	7.50	2		2	11		11									
Ethambutol	7.50															
Ethambutol	8.00													1		1
Ethambutol	10.00	11		11										1		1
Streptomycin	1.0				2		2	1		1	40		40			
Streptomycin	2.0	33		33	59	1	60							1		1
Streptomycin	4.0	1		1	2		2	4		4	6		6			
Streptomycin	5.0							1		1						
Streptomycin	6.00				12		12									
Streptomycin	7.50													1		1
Streptomycin	10.00	25		25	1		1	1		1				1		1
Streptomycin	15.00													1		1
Streptomycin	30.00													1		1
Streptomycin	50.00				1		1									

Table 1.1: Participant Results for Culture B, *M. tuberculosis*-isoniazid resistant at 0.2 and 1.0 µg/m

		Test Method														
		AP Results			BACTEC Results			LJ Prop Results			MGIT Results			Other Tests Results		
DRUG	Conc	S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum
Ethionamide	1.00				1		1									
Ethionamide	1.25				2	1	3									
Ethionamide	2.00				1		1									
Ethionamide	2.50				2	1	3									
Ethionamide	2.50															
Ethionamide	4.00				1		1									
Ethionamide	5.00	24		24	2		2				1		1			
Ethionamide	5.00															
Ethionamide	5.00															
Ethionamide	10.00	3		3										1		1
Ethionamide	20.00							1		1				1		1
Ethionamide	40.00							1		1				1		1
Kanamycin	5.00	10		10	5		5									
Kanamycin	6.00	14		14										1		1
Kanamycin	10.00							1		1						
Kanamycin	20.00							1		1						
Kanamycin	40.00							1		1						
Capreomycin	0.50													1		1
Capreomycin	1.00													1		1
Capreomycin	1.25				4		4									
Capreomycin	5.00				2		2									
Capreomycin	10.00	17		17												
Capreomycin	12.50													1		1
Capreomycin	25.00													1		1
Capreomycin	40.00							1		1						
Capreomycin	50.00													1		1
Cycloserine	12.00													1		1
Cycloserine	20.00							1		1						
Cycloserine	24.00													1		1
Cycloserine	25.00	1		1												
Cycloserine	30.00	10		10				1		1						
Cycloserine	40.00							1		1						
Cycloserine	48.00													1		1
Cycloserine	60.00	1		1												
p-Aminosalicylic acid	0.50								1		1					
p-Aminosalicylic acid	1.00								2		2					
p-Aminosalicylic acid	2.00	16		16										1		1
p-Aminosalicylic acid	4.00				3		3									
p-Aminosalicylic acid	8.00	2		2												
p-Aminosalicylic acid	10.0	4		4												
Amikacin	0.50													1		1
Amikacin	1.00	1		1	2		2							1		1
Amikacin	2.00	1		1	2		2									
Amikacin	2.50				1		1									
Amikacin	4.00	3		3	1		1									
Amikacin	5.00				1		1									
Amikacin	6.00	5		5										1		1
Amikacin	7.50													1		1
Amikacin	8.00				2		2									
Amikacin	12.00	2		2												
Amikacin	15.00													1		1
Amikacin	20.00	1		1												

Table 1.1: Participant Results for Culture B, *M. tuberculosis*-isoniazid resistant at 0.2 and 1.0 µg/m

		Test Method														
		AP Results			BACTEC Results			LJ Prop Results			MGIT Results			Other Tests Results		
DRUG	Conc	S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum
Ofloxacin	0.50													1		1
Ofloxacin	1.00	3		3	2		2									
Ofloxacin	1.00															
Ofloxacin	1.25													1		1
Ofloxacin	2.00	11		11	7		7	1		1	1		1			
Ofloxacin	2.50													1		1
Ofloxacin	4.00	2		2	1		1									
Ofloxacin	5.00													1		1
Ofloxacin	8.00	1		1	1		1							1		1
Ofloxacin	10.00	1		1												
Ciprofloxacin	0.50			0			0							1		1
Ciprofloxacin	1.00	3		3	2		2						0			0
Ciprofloxacin	2.00															
Ciprofloxacin	1.60			0			0							1		1
Ciprofloxacin	2.00	9		9	3		3									
Ciprofloxacin	3.20			0			0							1		1
Ciprofloxacin	4.00	1		1			0							1		1
Ciprofloxacin	6.40			0			0							1		1
Ciprofloxacin	8			0	1		1									
Clarithromycin	6.00			0			0							1		1
Clarithromycin	12.00			0			0							1		1
Clarithromycin	24			0			0							1		1
Clofazamine	0.06			0		2	2									
Clofazamine	0.12			0	1	1	2									
Clofazamine	0.25			0	2		2									
Clofazamine	0.50			0	4		4							1		1
Clofazamine	1.00	1		1			0							1		1
Clofazamine	17.50			0			0							1		1
Clofazamine	35.00			0			0							1		1
Clofazamine	70			0			0							1		1
Levofloxacin	2.00			0	3		3									
Levofloxacin	8			0	1		1									
Moxifloxacin	1.00	1		1			0									
Moxifloxacin	2			0			0	1		1						
Rifabutin	0.50	4		4	2		2							1		1
Rifabutin	1.00	2		2			0							1		1
Rifabutin	2.00	5		5			0									
Rifabutin	20.00			0			0	1		1						
Rifabutin	32			0			0							1		1
Prothionamide	40			0			0	1		1						
Ansamycin	1.00	1		1	1		1									

Table 1.2: Participant Results for Culture C, *M. tuberculosis*, resistant to rifampin at 2 ug/ml.

		Test Method														
		AP Results			BACTEC Results			LJ Prop Results			MGIT Results			Other Tests Results		
DRUG	Conc	S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum
Isoniazid	0.05													1		1
Isoniazid	0.10				66	1	67				41	2	43	2		2
Isoniazid	0.12	1		1												
Isoniazid	0.20	31		31	4		4	4		4	1		1	2		2
Isoniazid	0.40				19		19				12		12	1		1
Isoniazid	0.50							1		1						
Isoniazid	1.00	33		33	2		2	2		2	1		1	1		1
Isoniazid	5.00	3		3							1		1			
Isoniazid	10.00							2		2						
Isoniazid	100.00							1		1						
Rifampin	0.50					2	2									
Rifampin	1.00		36	36		9	9		1	1		44	44		2	2
Rifampin	2.00					67	67									
Rifampin	5.00		4	4		2	2		1	1						
Rifampin	8.00					1	1								1	1
Rifampin	10.00					2	2									
Rifampin	16.00														1	1
Rifampin	32.00														1	1
Rifampin	40.00								4	4						
Rifampin	50.00								1	1						
Pyrazinamide	64.00													1		1
Pyrazinamide	99.00				1		1									
Pyrazinamide	100.00				58		58	1		1	35	3	38	1		1
Pyrazinamide	300.00				1		1									
Pyrazinamide	400.00							1		1						
Ethambutol	1.00							1		1						
Ethambutol	1.60													1		1
Ethambutol	2.00				1		1	4		4						
Ethambutol	2.50				60		60									
Ethambutol	3.20													1		1
Ethambutol	4.00				2		2									
Ethambutol	5.00	32		32	9		9	1		1	43	1	44	2		2
Ethambutol	6.40													1		1
Ethambutol	7.50	2		2	11		11									
Ethambutol	8.00													1		1
Ethambutol	10.00	11		11										1		1
Streptomycin	1.00				2		2	1		1	34	1	35			
Streptomycin	2.00	32		32	60	1	61							1		1
Streptomycin	4.00	1		1	2		2	4		4	5		5			
Streptomycin	5.00							1		1						
Streptomycin	6.00				12		12									
Streptomycin	7.50													1		1
Streptomycin	10.00	24		24	1		1	1		1				1		1
Streptomycin	15.00													1		1
Streptomycin	30.00													1		1
Streptomycin	50.00				1		1									

Table 1.2: Participant Results for Culture C. *M. tuberculosis*, resistant to rifampin at 2.0 ug/ml.

		Test Method														
		AP Results			BACTEC Results			LJ Prop Results			MGIT Results			Other Tests Results		
DRUG	Conc	S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum
Ethionamide	1.0					1	1									
Ethionamide	1.25				2	1	3									
Ethionamide	2.00				1		1									
Ethionamide	2.50				3		3									
Ethionamide	4.00				1		1									
Ethionamide	5.00	25		25	2		2				1		1			
Ethionamide	10.00	2		2										1		1
Ethionamide	20.00							1		1				1		1
Ethionamide	40.00							1		1				1		1
Kanamycin	2.50				1		1									
Kanamycin	5.00	9		9	5		5									
Kanamycin	6.00	14		14										1		1
Kanamycin	10.00							1		1						
Kanamycin	20.00							1		1						
Kanamycin	40.00							1		1						
Capreomycin	0.50													1		1
Capreomycin	1.00													1		1
Capreomycin	1.25				4		4									
Capreomycin	2.50				1		1									
Capreomycin	5.00				2		2									
Capreomycin	10.00	16		16												
Capreomycin	12.50														1	1
Capreomycin	25.00													1		1
Capreomycin	40.00							1		1						
Capreomycin	50.00													1		1
Cycloserine	12.00													1		1
Cycloserine	20.00							1		1						
Cycloserine	24.00													1		1
Cycloserine	25.00	1		1												
Cycloserine	30.00	11		11				1		1						
Cycloserine	40.00							1		1						
Cycloserine	48.00													1		1
Cycloserine	60.00	1		1												
p-Aminosalicylic acid	0.5							1		1						
p-Aminosalicylic acid	1.0							2		2						
p-Aminosalicylic acid	2.0	16		16										1		1
p-Aminosalicylic acid	4.0				3		3									
p-Aminosalicylic acid	8.0	2		2												
p-Aminosalicylic acid	10.0	4		4												
Amikacin	0.50													1		1
Amikacin	1.00	1		1	2		2							1		1
Amikacin	2.00	1		1	2		2									
Amikacin	2.50				1		1									
Amikacin	4.00	2		2	1		1									
Amikacin	5.00				1		1									
Amikacin	6.00	5		5										1		1
Amikacin	7.50														1	1
Amikacin	8.00				2		2									
Amikacin	12.00	2		2												
Amikacin	15.00													1		1
Amikacin	20.00	1		1												

Table 1.2: Participant Results for Culture C, *M. tuberculosis*, resistant to rifampin at 2 ug/ml.

		Test Method														
		AP Results			BACTEC Results			LJ Prop Results			MGIT Results			Other Tests Results		
DRUG	Conc	S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum
Ofloxacin	0.50													1		1
Ofloxacin	1.00	3		3	2		2									
Ofloxacin	1.25				1		1							1		1
Ofloxacin	2.00	11		11	6		6	1		1						
Ofloxacin	2.5													1		1
Ofloxacin	4.0	2		2	1		1									
Ofloxacin	4.0															
Ofloxacin	5.0													1		1
Ofloxacin	8.0	1		1	1		1							1		1
Ofloxacin	10.0	1		1												
Azithromycin	3.00		1	1												
Ciprofloxacin	0.50			0			0							1		1
Ciprofloxacin	1.00	3		3	2		2						0			0
Ciprofloxacin	1.25				1		1									
Ciprofloxacin	2.00															
Ciprofloxacin	1.60			0			0							1		1
Ciprofloxacin	2.00	8		8	3		3									
Ciprofloxacin	3.20			0			0							1		1
Ciprofloxacin	4.00	1		1			0							1		1
Ciprofloxacin	6.40			0			0							1		1
Ciprofloxacin	8.00			0	1		1									
Clarithromycin	3.00	1		1			0									
Clarithromycin	6.00			0			0							1		1
Clarithromycin	12.00			0			0							1		1
Clarithromycin	24.00			0			0							1		1
Clofazamine	0.06			0	2		2									
Clofazamine	0.12			0	2		2									
Clofazamine	0.25			0	2		2									
Clofazamine	0.50			0	3		3							1		1
Clofazamine	1.00	1		1			0							1		1
Clofazamine	17.50			0			0							1		1
Clofazamine	35.00			0			0							1		1
Clofazamine	70.00			0			0							1		1
Levofloxacin	2.00			0	3		3									
Levofloxacin	8.00			0	1		1									
Moxifloxacin	1.00	1		1			0									
Moxifloxacin	2.00			0			0	1		1						
Rifabutin	0.05					1	1									
Rifabutin	0.25					1	1									
Rifabutin	0.50		4	4		4	4								1	1
Rifabutin	1.00		2	2												
Rifabutin	2.00		4	4												
Rifabutin	20.00			0			0		1	1						
Rifabutin	32.00			0			0								1	1
Prothionamide	40.00			0			0	1		1						
Ansamycin	1.00			0		1	1									

Table 1.3: Participant Results for Culture D, *M. tuberculosis*, fully susceptible.

		Test Method														
		AP Results			BACTEC Results			LJ Prop Results			MGIT Results			Other Tests Results		
DRUG	Conc	S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum
Isoniazid	0.05													1		1
Isoniazid	0.10				53	3	56				36	6	42	2		2
Isoniazid	0.12	1		1												
Isoniazid	0.20	23		23	2	2	4	2		2	1		1	1		1
Isoniazid	0.40				15	1	16				12		12	1		1
Isoniazid	1.00	24		24	2		2	1		1	1		1			
Isoniazid	5.00	2		2												
Isoniazid	10.00							1		1						
Isoniazid	100.00							1		1						
Rifampin	0.50				1		1									
Rifampin	1.00	25		25	6	1	7				41	2	43	1		1
Rifampin	2.00				54	2	56									
Rifampin	5.00	3		3												
Rifampin	8.00													1		1
Rifampin	16.00													1		1
Rifampin	32.00													1		1
Rifampin	40.00							2		2						
Rifampin	50.00							1		1						
Pyrazinamide	64.00													1		1
Pyrazinamide	99.00				1		1									
Pyrazinamide	100.00				44	3	47		1	1	33	1	34	1		1
Pyrazinamide	300.00				1		1									
Pyrazinamide	400.00								1	1						
Ethambutol	1.00															
Ethambutol	1.60													1		1
Ethambutol	2.00				1		1	3		3						
Ethambutol	2.50				50	1	51									
Ethambutol	3.20													1		1
Ethambutol	4.00				1		1									
Ethambutol	5.00	21	1	22	7	1	8	1		1	43		43	1		1
Ethambutol	6.40													1		1
Ethambutol	7.50	2		2	9	1	10							1		1
Ethambutol	10.00	7		7												
Streptomycin	1.00				2		2				30	4	34			
Streptomycin	2.00	22		22	46	3	49									
Streptomycin	4.00	1		1	1		1	2		2	5		5			
Streptomycin	6.00				11		11									
Streptomycin	7.50													1		1
Streptomycin	10.00	18		18	1		1									
Streptomycin	15.00													1		1
Streptomycin	30.00													1		1
Streptomycin	50.00				1		1									
Ethionamide	2.50															
Ethionamide	5.00	14		14	1		1									
Ethionamide	10.00	3		3										1		1
Ethionamide	20.00							1		1				1		1
Ethionamide	40.00							1		1				1		1

Table 1.3: Participant Results for Culture D, *M. tuberculosis*, fully susceptible.

		Test Method														
		AP Results			BACTEC Results			LJ Prop Results			MGIT Results			Other Tests Results		
DRUG	Conc	S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum
Kanamycin	5.00	5		5												
Kanamycin	6.00	8		8												
Kanamycin	10.00							1		1						
Kanamycin	20.00							1		1						
Kanamycin	40.00							1		1						
Capreomycin	0.50													1		1
Capreomycin	1.00													1		1
Capreomycin	1.25				1		1									
Capreomycin	5.00				1		1									
Capreomycin	10.00	11		11												
Capreomycin	12.50													1		1
Capreomycin	25.00													1		1
Capreomycin	40.00							1		1						
Capreomycin	50.00													1		1
Cycloserine	12.00													1		1
Cycloserine	24.00													1		1
Cycloserine	25.00	1		1												
Cycloserine	30.00	6		6				1		1						
Cycloserine	48.00													1		1
Cycloserine	60.00	1		1												
p-Aminosalicylic acid	1.00							1		1						
p-Aminosalicylic acid	2.00	10		10												
p-Aminosalicylic acid	4.00				1		1									
p-Aminosalicylic acid	8.00	2		2												
p-Aminosalicylic acid	10.00	2		2												
Amikacin	0.50													1		1
Amikacin	1.00													1		1
Amikacin	2.00				1		1									
Amikacin	4.00	2		2												
Amikacin	5.00				1		1									
Amikacin	6.00	5		5												
Amikacin	7.50													1		1
Amikacin	8.00				1		1									
Amikacin	12.00	2		2												
Amikacin	15.00													1		1
Amikacin	20.00	1		1												
Amikacin	30.00													1		1
Ofloxacin	0.50													1		1
Ofloxacin	1.00	1		1												
Ofloxacin	1.25													1		1
Ofloxacin	2.00	7		7	1		1	1		1	1		1			
Ofloxacin	2.50													1		1
Ofloxacin	4.00	1		1												
Ofloxacin	5.00													1		1
Ofloxacin	8.00	1		1	1		1							1		1
Ofloxacin	10.00	1		1												

Table 1.3: Participant Results for D, *M. tuberculosis*, fully susceptible.

		Test Method														
		AP Results			BACTEC Results			LJ Prop Results			MGIT Results			Other Tests Results		
DRUG	Conc	S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum
Ciprofloxacin	0.50													1		1
Ciprofloxacin	1.00	1		1												
Ciprofloxacin	1.60													2		2
Ciprofloxacin	2.00	6		6	2		2									
Ciprofloxacin	3.20													1		1
Ciprofloxacin	4.00	1		1										1		1
Ciprofloxacin	6.40													1		1
Ciprofloxacin	8.00				1		1									
Clarithromycin	6.00														1	1
Clarithromycin	12.00													1		1
Clarithromycin	24.00													1		1
Clofazamine	0.06					1	1									
Clofazamine	0.12				1		1									
Clofazamine	0.25				1		1									
Clofazamine	0.50				1		1							1		1
Clofazamine	1.00	1		1										1		1
Clofazamine	17.50													1		1
Clofazamine	35.00													1		1
Clofazamine	70.00													1		1
Levofloxacin	2.00				2		2									
Levofloxacin	8.00				1		1									
Moxifloxacin	1.00	1		1												
Moxifloxacin	2.00							1		1						
Rifabutin	0.50	2		2										1		1
Rifabutin	1.00	1		1										1		1
Rifabutin	2.00	3		3												
Rifabutin	20.00							1		1						
Rifabutin	32.00													1		1
Prothionamide	40.00							1		1						

Table 2: Participant Results for Culture E, *M. mucogenicum*

		Test Method														
		AP Results			BACTEC Results			LJ Prop Results			MGIT Results			Other Tests Results		
DRUG	Conc	S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum
Amikacin	1.00				1		1									
Amikacin	2.00				1		1									
Amikacin	4.00				1		1									
Amikacin	6.00	1		1												
Amikacin	8.00				1		1									
Amikacin	12.00	1		1												
Amikacin	15.00														1	1
Amikacin	30.00	1		1										1		1
Clarithromycin	3.00	1		1												
Clarithromycin	4.00	1		1												
Clarithromycin	15.00													1		1
Ciprofloxacin	1.00	1		1												
Ciprofloxacin	2.00	1		1	1		1									
Ciprofloxacin	5.00													1		1
Cefoxitin	30.00	2		2										1		1
Doxycycline	6.00		2	2												
Ethambutol	1.00							1		1						
Ethambutol	16.00													1		1
Ethambutol	25.00				2		2									
Ethambutol	4.00				1		1									
Ethambutol	5.00	1		1												
Ethambutol	75.00				1	1	2									
Ethambutol	75.00															
Ethambutol	10.00	1		1												
Imipenem	10.00		1	1										1		1
Isoniazid	1.00					4	4									
Isoniazid	2.00		1	1											1	1
Isoniazid	1.00		2	2												
Isoniazid	100.00								1	1						
Minocycline	6.00		1	1												
Minocycline	30.00														1	1
Ofloxacin	1.00				1		1									
Ofloxacin	2.00				1		1									
Ofloxacin	25.00													1		1
Ofloxacin	4.00				1		1									
Ofloxacin	5.00													1		1
Rifabutin	1.00		1	1												
Rifampin	5.00					1	1									
Rifampin	1.00		2	2												
Rifampin	2.00				1	3	4									
Rifampin	5.00								1	1						
Rifampin	8.00				1		1									
Rifampin	16.00														1	1
Rifampin	32.00														1	1
Rifampin	50.00								1	1						

Table 2: Participant Results for Culture E, *M. mucogenicum*

		Test Method														
		AP Results			BACTEC Results			LJ Prop Results			MGIT Results			Other Tests Results		
DRUG	Conc	S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum
Streptomycin	2.00		1	1	1	1	2									
Streptomycin	4.00				1		1									
Streptomycin	6.00				1	1	2									
Streptomycin	10.00		1	1												
Streptomycin	30.00														1	1
Streptomycin	100.00								1	1						
Sulfamethoxazole	100.00													1		1
Trimethoprim-Sulfamethoxazole	15.00													1		1
Trimethoprim-Sulfamethoxazole	30.00	1		1												
Tobramycin	6.00		1	1												
Tobramycin	8.00		1	1												
Ciprofloxacin	0.50														1	1
Ciprofloxacin	1.00		2	2	1	1	2						0			0
Ciprofloxacin	2.00		3	3												
Ciprofloxacin	1.60														1	1
Ciprofloxacin	2.00	2	7	9		3	3									
Ciprofloxacin	3.20														1	1
Ciprofloxacin	4.00		1	1											1	1
Ciprofloxacin	6.40														1	1
Ciprofloxacin	8.00					1	1									
Clarithromycin	6.00													1		1
Clarithromycin	12.00													1		1
Clarithromycin	24.00													1		1
Clofazamine	0.06				2		2									
Clofazamine	0.12				2		2									
Clofazamine	0.25				2		2									
Clofazamine	0.50				3		3							1		1
Clofazamine	1.00													1		1
Clofazamine	17.50														1	1
Clofazamine	35.00														1	1
Clofazamine	70.00													1		1
Rifabutin	0.50	4		4												
Rifabutin	1.00	2		2												
Rifabutin	2.00	4		4												
Rifabutin	20.00							1		1						
Rifabutin	32.00													1		1
Levofloxacin	2.00					3	3									
Levofloxacin	8.00					1	1									
Moxifloxacin	1.00		1	1												
Moxifloxacin	2.00								1	1						
Prothionamide	40.00							1		1						
Ansamycin	1.00	1		1	1		1									

Table 3: Minimum Inhibitory Concentrations for Culture E, *M. mucogenicum*

DRUG	Test Method	MIC	Susceptible	Resistant	Intermediate	Sum
Amikacin	AP	≤2.50	1			1
Amikacin	E-test	0.19	1			1
Amikacin	E-test	1.00	1			1
Amikacin	E-test	≤16.00	1			1
Amikacin	Microtiter	≤0.50	3			3
Amikacin	Microtiter	≤1.00	7			7
Amikacin	Microtiter	4.00	2			2
Amikacin	Microtiter	≤8.00	1			1
Amikacin	Microtiter	32.00			1	1
Azithromycin	Microtiter	≤0.50	1			1
Azithromycin	Microtiter	≤1.00	1			1
Azithromycin	Microtiter	<16.00	1			1
Clarithromycin	AP	≤0.16	1			1
Clarithromycin	E-test	≤0.02	1			1
Clarithromycin	E-test	0.04	1			1
Clarithromycin	E-test	0.05	1			1
Clarithromycin	E-test	0.25	1			1
Clarithromycin	E-test	≤1.00	1			1
Clarithromycin	Microtiter	≤0.06	1			1
Clarithromycin	Microtiter	≤0.12	6			6
Clarithromycin	Microtiter	≤0.13	2			2
Clarithromycin	Microtiter	<0.25	4			4
Ciprofloxacin	E-test	0.02	2			2
Ciprofloxacin	E-test	≤1.00	1			1
Ciprofloxacin	Microtiter	0.25	3			3
Ciprofloxacin	Microtiter	≤0.50	1			1
Ciprofloxacin	Microtiter	≥0.50	5			5
Ciprofloxacin	Microtiter	<1.00	2			2
Cefoxitin	AP	≤10.00	1			1
Cefoxitin	E-test	2.00	1			1
Cefoxitin	E-test	3.00	1			1
Cefoxitin	E-test	≤8.00	1			1
Cefoxitin	Microtiter	≤8.00	7			7
Cefoxitin	Microtiter	<16.00	5			5
Doxycycline	AP	≥5.00		1		1
Doxycycline	E-test	6.00			1	1
Doxycycline	E-test	≥16.00		1		1
Doxycycline	E-test	≥256.00		2		2
Doxycycline	Microtiter	≤1.00	1			1
Doxycycline	Microtiter	4.00			1	1
Doxycycline	Microtiter	8.00			1	1
Doxycycline	Microtiter	>16.00		3		3
Imipenem	AP	20.00		1		1
Imipenem	E-test	0.12	1			1
Imipenem	E-test	0.50	1			1
Imipenem	E-test	≤4.00	1			1
Imipenem	Microtiter	≤0.50	3			3
Imipenem	Microtiter	≤1.00	5			5
Imipenem	Microtiter	≤2.00	1			1
Imipenem	Microtiter	4.00	1			1

Table 3: Minimum Inhibitory Concentrations for Culture E, *M. mucogenicum* - Continued

DRUG	Test Method	MIC	Susceptible	Resistant	Intermediate	Sum
Minocycline	E-test	24.00		1		1
Minocycline	Microtiter	≤1.00	1			1
Minocycline	Microtiter	2.00	1		1	2
Minocycline	Microtiter	4.00			1	1
Ofloxacin	Microtiter	≥1.00	1			1
Ofloxacin	Microtiter	<2.00	1			1
Rifabutin	Microtiter	≥8.00		1		1
Rifabutin	Microtiter	<16.00		1		1
Rifampin	Microtiter	>4.00		1		1
Sulfamethoxazole	E-test	≤2.00	1			1
Sulfamethoxazole	Microtiter	9.50	1			1
Sulfamethoxazole	Microtiter	32.00		1		1
Sulfamethoxazole	Microtiter	≥64.00		1		1
Sulfamethoxazole	Microtiter	>128.00		1		1
Trimethoprim-Sulfamethoxazole	AP	≤0.60	1			1
Trimethoprim-Sulfamethoxazole	E-test	0.01	1			1
Trimethoprim-Sulfamethoxazole	E-test	0.05	1			1
Trimethoprim-Sulfamethoxazole	E-test	0.06	1			1
Trimethoprim-Sulfamethoxazole	Microtiter	≤0.50	3			3
Trimethoprim-Sulfamethoxazole	Microtiter	1.00	1			1
Tobramycin	E-test	2.00	1			1
Tobramycin	Microtiter	≤2.00	1		1	2
Tobramycin	Microtiter	4.00	3			3
Tobramycin	Microtiter	16.00		2		2

REFERENCES

[1] **Inderlied, C.B. and G. E. Pfyffer.** 2003. "Susceptibility Test Methods: Mycobacteria." P. 1149-1177. In Murray, P.R., E.J.Baron, J.H.Jorgensen, M.A. Pfaller and R.H. Yolken (ed.) Manual of Clincal Microbiology, 8th ed. American Society of Microbiology, Washington, D. C.

[2] **Kent, P.T and G.P. Kubica**. 1985. Public Health Mycobacteriology: A Guide for the Level III Laboratory. Centers for Disease Control, Atlanta, GA.

[3] **Siddiqi, S.H., J.E. Hawkins, and A. Laszlo.** 1985. Interlaboratory drug susceptibility testing of Mycobacterium tuberculosis by a radiometric procedure and two conventional methods. J. Clin. Microbiol. 22:919-923.

[4] **Pfyffer, G.E., Brown-Elliott, B. A., Wallace, Richard J. Jr. 2003.** Mycobacterium: General Characteristics, Isolation and Staining Procedures, p. 532-559. In Murray, P.R., E.J. Baron, J.H.Jorgensen, M.A. Pfaller and R.H. Yolken (ed.) Manual of Clinical Microbiology, 8th ed. American Society for Microbiology, Washington, D.C.

[5] **NCCLS**. 2003. Susceptibility Testing of Mycobacteria, Nocardia, and Other Aerobic Actinomycetes; Approved Standard. M24-A; Vol. 23, No. 18, pages 18-19. Wayne, PA.

[6] **Centers for Disease Control and Prevention.** June 24, 2005. Morbidity and Mortality Weekly Report. MMWR:54 (No. 24):605-608.

[7] **NCCLS.** 2003. Susceptibility Testing of Mycobacteria, Nocardia, and Other Aerobic Actinomycetes; Approved Standard. M24-A; Vol. 23, No. 18. Wayne, PA.

[8] **Kline S, Cameron S, Streifel A, Yakrus MA, Kairis F, Peacock K, Besser J, Cooksey RC.** 2004. An outbreak of bacteremias associated with Mycobacterium mucogenicum in a hospital water supply. Infect Control Hosp Epidemiol. 25(12):1042-9.

[9] **American Thoracic Society**. 1997. Diagnosis and treatment of disease caused by nontuberculous mycobacteria. Am. J. Respir. Crit. Care Med. 156:S1-S25.