

June 4, 2004

Participant
Centers for Disease Control and Prevention (CDC)
Susceptibility Testing of *Mycobacterium tuberculosis* and Nontuberculous Mycobacteria Performance
Evaluation Program

Subject: Analyses of Participant Laboratory Results for the January 2004 Shipment

Dear Participant:

Enclosed are analyses of laboratory test results reported to the Centers for Disease Control and Prevention (CDC) by participant laboratories for strains of *Mycobacterium tuberculosis* complex and the nontuberculous mycobacteria (NTM), *M. chelonae-abscessus* group (*M. abscessus*), shipped in January 2004. Participant laboratories received either four *M. tuberculosis* complex strains only or four *M. tuberculosis* strains and one NTM culture. Testing results were received and analyzed from 141 of 153 (92.2%) laboratories participating in this shipment.

The enclosed aggregate report is prepared in a format that will allow laboratories to compare their results with results obtained by other participants for the same strain using the same method, drug, and concentration. The first three pages contain descriptive information about the participant laboratories. We encourage you to circulate this report to personnel who are involved with drug susceptibility testing, reporting, or interpretation for *M. tuberculosis* and NTM.

The NTM strain in this performance evaluation is intended to provide an assessment of the various methods, drugs, and interpretations that are reported by laboratories that perform drug susceptibility testing for these different strains. The test results for the NTM strain also provide information on interlaboratory agreement with different test methods and will assist with efforts to develop standard methods for NTM drug susceptibility testing. By reporting these practices and test results, CDC is neither recommending nor endorsing these testing practices. Some of the test results reported by participants may, in fact, provide inappropriate or misleading information to the clinician. A consensus report by the American Thoracic Society and the National Committee for Clinical Laboratory Standards (NCCLS) approved standard are referenced to provide participants with recommendations for NTM test methods and drugs that have clinical relevance.

If you have any comments or suggestions on the results in this report or have questions regarding the changes in this program, you may call me at (770) 488-8133.

Sincerely yours,

Bereneice M. Madison, Ph.D.
Division of Laboratory Systems
Public Health Practice Program Office

Enclosures

Analyses of the January 2004 Performance Evaluation Results for *M. tuberculosis* complex and Nontuberculous Mycobacteria Drug Susceptibility Testing Reported to the Centers for Disease Control and Prevention by Participating Laboratories

This report is an analysis of 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. abscessus* strain shipped in January 2004. Participant laboratories received either four *M. tuberculosis* complex strains only or four *M. tuberculosis* complex strains and one NTM strain. Testing results were received and analyzed from 141 of 153 (92.2%) laboratories participating in this shipment.

Descriptive Information on Participant Laboratories

Figure 1 shows the laboratory classification reported by 141 of the participants. Participants consisted of 76 health departments, 45 hospitals, 15 independents, and 5 "other" type of laboratories.

Figure 2 provides the distribution of the annual volume of *M. tuberculosis* isolates tested for drug susceptibilities by participating laboratories in calendar year 2003.

Figure 3 lists the biosafety levels reported by participant laboratories for *M. tuberculosis*. All laboratories are strongly encouraged to consult the CDC/NIH manual, Biosafety in Microbiological and Biomedical Laboratories (4th edition) for recommendations and to determine their correct biosafety level.

Figure 4 provides a breakdown of the test procedures used by the participating laboratories for *M. tuberculosis* drug susceptibility testing. Participants were asked to check test methods used. Some methods, such as the proportion method with Lowenstein-Jensen (LJ) media, may reflect procedures used by international participants. The 'other' methods listed were microtiter, BacT/ALERT, TREK ESP and Colorimetric method for determining MICs.

Figure 5 provides information on the test procedures used by the participating laboratories testing *M. abscessus*.

M. tuberculosis Complex Strains Test Results:

The aggregate test results are provided in separate tables, representing strains A, B, C, and D to facilitate comparison among laboratories. Table 1 for the *M. tuberculosis* complex strains A, B, C, and D is constructed to include the results for the radiometric (BACTEC), agar proportion (AP), Lowenstein Jensen (LJ) proportion, MGIT and other methods at each concentration of drug. 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.

In Table 1 the concentrations recommended by CDC and the NCCLS for the primary (isoniazid, rifampin, pyrazinamide, and ethambutol) and secondary (streptomycin, ethionamide, kanamycin, capreomycin, and p-amino-salicylic acid) antituberculosis drugs are highlighted for the conventional and radiometric methods. Participants should note that the new NCCLS approved standard (Susceptibility Testing of Mycobacteria, Nocardiae, and Other Aerobic Actinomycetes; Approved Standard, NCCLS document 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. Participants should note that these recommended

combinations 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 (1-4). When two concentrations are highlighted, such as for isoniazid and ethambutol, the lower concentration is the critical concentration that should always be included to determine whether the *M. tuberculosis* isolate is resistant.

Strain A (*M. bovis*) was reported as resistant to pyrazinamide 100 µg/ml by all laboratories performing the test. Isoniazid (INH) 0.1 µg/ml was reported resistant by 13.3 % (12/90) of laboratories using BACTEC 460TB and by 3.7% (1/27) of laboratories with the MGIT method. For laboratories performing agar proportion method, 3.0% (1/33) reported resistance to INH at 0.2 µg/ml. Laboratories performing Lowenstein Jensen proportion and other methods did not detect resistance to isoniazid.

Strains B and C were the same isolate **sent in duplicate**. The isolates were reported as resistant to INH (91 reports at 0.1 µg/ml and 28 reports at 0.4 µg/ml) by all laboratories performing BACTEC 460TB and also for MGIT (27 and 12 reports at the above concentrations). For laboratories performing LJ method, resistance was detected at both 0.2 and 1.0 µg/ml INH. However, of those performing AP method 97.1 % (34/35) and 97.3% (36/37) of laboratories detected resistance at 0.2 and 1.0 µg/ml INH. For laboratories performing AP at INH 5.0 µg/ml INH, 60% (3/5) detected resistance. Both **strains B and C** were reported as susceptible by all laboratories testing rifampin by all methods to the recommended critical concentrations of this drug. Similarly, both isolates were susceptible to EMB based on agreement among laboratories and test methods. However there was significant variability among laboratories on the detection of resistance to both streptomycin and PAS at the recommended concentrations for testing within and between various test methods.

For **strain B**, 55% (11/20) of laboratories performing MGIT detected resistance with **streptomycin** at 1.0 µg/ml, while 67.6% (25/37) laboratories detected resistance with AP for streptomycin at 2.0 µg/ml, and 44% (33/75) detected resistance using the BACTEC 460TB method. At higher drug concentrations, most laboratories reported susceptible results; 96.3% (26/27) for streptomycin at 10.0 µg/ml with AP and 94.1% (16/17) for streptomycin at 6.0 µg/ml using BACTEC 460TB. For **strain C**, of laboratories performing MGIT, 70% (14/20) detected resistance with **streptomycin** 1.0 µg/ml, while 60% (21/35) of laboratories detected resistance with AP for streptomycin at 2.0 µg/ml and 38% (29/76) detected resistance using the BACTEC 460TB method. Agreement on susceptible results among laboratories and methods at higher concentrations was 92.3% (24/26) for streptomycin at 10.0 µg/ml with AP, and 100% (16/16) for streptomycin at 6.0 µg/ml for laboratories using BACTEC 460TB.

For **strain B** with **PAS**, 73.6% (14/19) of laboratories reported resistance to 2.0 µg/ml with AP, while 60% (3/5) reported resistance at 10 µg/ml. All (2/2) laboratories reported resistance at 4.0 µg/ml with BACTEC 460, and all (2/2) reported resistance with LJ proportion at 1.0 µg/ml. For **strain C**, 61% (11/18) of laboratories reported resistance to 2.0 µg/ml with AP, while 60% (3/5) reported resistance at 10 µg/ml, and all laboratories performing BACTEC 460TB (2/2) and LJ (2/2) reported resistance to PAS.

For **strain B**, 44% (33/75) of laboratories detected resistance to **PZA** at 100 µg/ml with BACTEC 460TB, and 69.6% (16/23) detected resistance with MGIT. With **strain C**, 68.9% (51/74) reported resistance with BACTEC 460TB, and 65.2% (15/23) of laboratories reported resistance with MGIT.

Strain B/C was cultured from a 41 year old male in 2001 from the Republic of Korea, who came to the US in April 2001. He was suspected of having TB and a bronchial washing was performed in July; his AFB smear was positive and the direct PCR test for *M.tb* was positive. The patient was seen by a private doctor in the U.S. and treated with INH, rifampin, EMB and

PZA. After the susceptibility testing was reported, INH was dropped. The patient was treated with the remaining three drugs, rifampin, EMB, and PZA until May 1, 2002. Follow-up cultures were negative.

Strain B/C demonstrates problems with reproducibility between laboratories and methods for streptomycin and PAS during treatment. While both streptomycin and PAS are secondary drugs, PAS is rarely used for treatment of tuberculosis in the U.S. BACTEC 460TB MICs on strain B/C with streptomycin revealed the following results: streptomycin 6 µg/ml = susceptible; streptomycin 3 µg/ml = susceptible; streptomycin 2 µg/ml = resistant (Borderline); streptomycin 1 µg/ml = resistant.

Strain D was a fully susceptible strain but was reported as resistant to INH (0.2 and 1.0 µg/ml) by 3.2% (1/32) of laboratories using AP. Similarly 3.9% (1/26) of laboratories reported resistance to EMB at 5.0 µg/ml; 3.2% (1/32) of laboratories using AP reported resistance to streptomycin at 2.0 µg/ml and 5% (1/20) of laboratories using MGIT reported resistance to 1.0 µg/ml. For PAS 7.2% (1/14) reported resistance to 2.0 µg/ml with AP, while all laboratories performing LJ (2/2) and BACTEC 460TB (1/1) reported the strain as susceptible.

Our providing test results for all drugs that are reported to CDC should not be construed as a recommendation or endorsement for testing particular drugs or 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 the consultation of 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 was isolated from a heart transplant recipient with chronic renal failure on immunosuppressive therapy who developed cellulitis in his lower extremities. The infection was unresponsive to routine antibiotic therapy with penicillins, clindamycin, cephalosporins, and ciprofloxacin. Gram stain of the leg tissue biopsy revealed numerous PMNs and a moderate amount of Gram positive beaded bacilli. Routine culture on blood and chocolate agar at 72 hours revealed smooth, non-pigmented colonies confirmed by Gram stain as beaded Gram positive bacilli. Modified Kinyoun's stain revealed acid-fast bacilli. The isolate was identified as *M. abscessus*.

Strain E, *M. abscessus* was found to be susceptible to clarithromycin and to cefoxitin, amikacin and tobramycin by E-Test as shown in Table 2. Minimum inhibitory concentrations performed by microtiter and E-test shown in Table 3 also confirmed that the culture is susceptible to clarithromycin, cefoxitin and tobramycin. One laboratory obtained a susceptible result of 1.0 µg/ml for ciprofloxacin by microtiter technique. Other antimicrobial agents recommended by NCCLS guidelines (Table 8) for testing against rapid growers include doxycycline and sulfamethoxazole. **Strain E** is resistant to the latter agents.

Mycobacterium abscessus formerly known as *M. chelonae* subspecies *abscessus* is a member of the rapid growing mycobacteria which cause localized soft tissue infections and may disseminate in patients with impaired immune function. In reviewing the susceptibility pattern of Strain E, it does not match that of *M. chelonae* based on drug susceptibility testing studies performed by colleagues at the University of Texas at Tyler on rapid growing mycobacteria. Strain E has a susceptibility pattern of *M. abscessus* since a "diagnostic" laboratory feature of *M. chelonae* is its resistance to cefoxitin (MICs \geq 256 µg/ml) (9,10).

It should be noted that the recent NCCLS document recommends that MICs to imipenem should not be reported for *M. chelonae* or *M. abscessus* due to the inconsistency and nonreproducibility of results when testing this agent against the *M. chelonae/M. abscessus* group (6,11).

Diseases caused by *M. abscessus* and other rapid growing mycobacteria can be obtained through CDC's Public Health Information System (PHLIS) (Web site: www.cdc.gov/ncidod/dbmd/phlisdata) which receives voluntary reports of nontuberculous species suspected to be involved in disease (7).

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.

Special thanks to the following persons for reviewing this report: Nancy G. Warren, Ph.D., Pennsylvania Department of Health; Richard Wallace, M.D., Ph.D., and Barbara Brown-Elliott, M.S., University of Texas at Tyler, TX; Beverly Metchock, CDC; Wendy Gross, M.S., TB Reference Laboratory, West Haven, CT.

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. Tenover (ed.) Manual of Clinical Microbiology, 8th ed. American Society for 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.
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. Tenover (ed.) Manual of Clinical Microbiology, 8th ed. American Society for Microbiology, Washington, D.C.
5. **American Thoracic Society.** 1997. Diagnosis and treatment of disease caused by nontuberculous mycobacteria. Am. J. Respir. Crit. Care Med. 156:S1-S25.
6. **NCCLS.** 2003. Susceptibility Testing of Mycobacteria, Nocardia, and Other Aerobic Actinomycetes; Approved Standard. M24-A; Vol. 23, No. 18. Wayne, PA.
7. **Morbidity and Mortality Weekly Report.** 2004. *Mycobacterium chelonae* infections associated with face lifts-New Jersey, 2002-2003. MMWR 53(09);192-194 (March 12, 2004).
8. **Wallace, R.J., D.Tanner, P. J. Brennan, B.A. Brown.** 1993. Clinical trial of clarithromycin for cutaneous (disseminated) infection due to *Mycobacterium chelonae*. Ann. Intern. Med. 119:482-486.
9. **Brown-Elliott, B. A., R. J. Wallace, Jr.** 2002. Clinical and taxonomic status of pathogenic nonpigmented or late-pigmenting rapidly growing mycobacteria. Clin. Micro. Rev. 15:716-746.

10. **Wallace, R. J. Jr., B. A. Brown, G. O. Onyi.** 1991 Susceptibilities of *Mycobacterium fortuitum* biovar. *fortuitum* and the two subgroups of *Mycobacterium chelonae* to imipenem, cefmetazole, and amoxicillin-clavulanic acid. *Antimicrob. Agents Chemother.* 35:773-775.
11. **Woods, G. L., J. S. Bergmann, F. G. Witebsky, G. A. Fahle, A. Wanger, B. Boulet, M. Plaunt, B. A. Brown, R. J. Wallace, Jr.** 1999. Multisite reproducibility of results obtained by the broth microdilution method for susceptibility testing of *Mycobacterium abscessus*, *Mycobacterium chelonae*, and *Mycobacterium fortuitum*. *J. Clin. Microbiol.* 37:1676-1682.

Figure 1. Primary Classification of Participating Laboratories

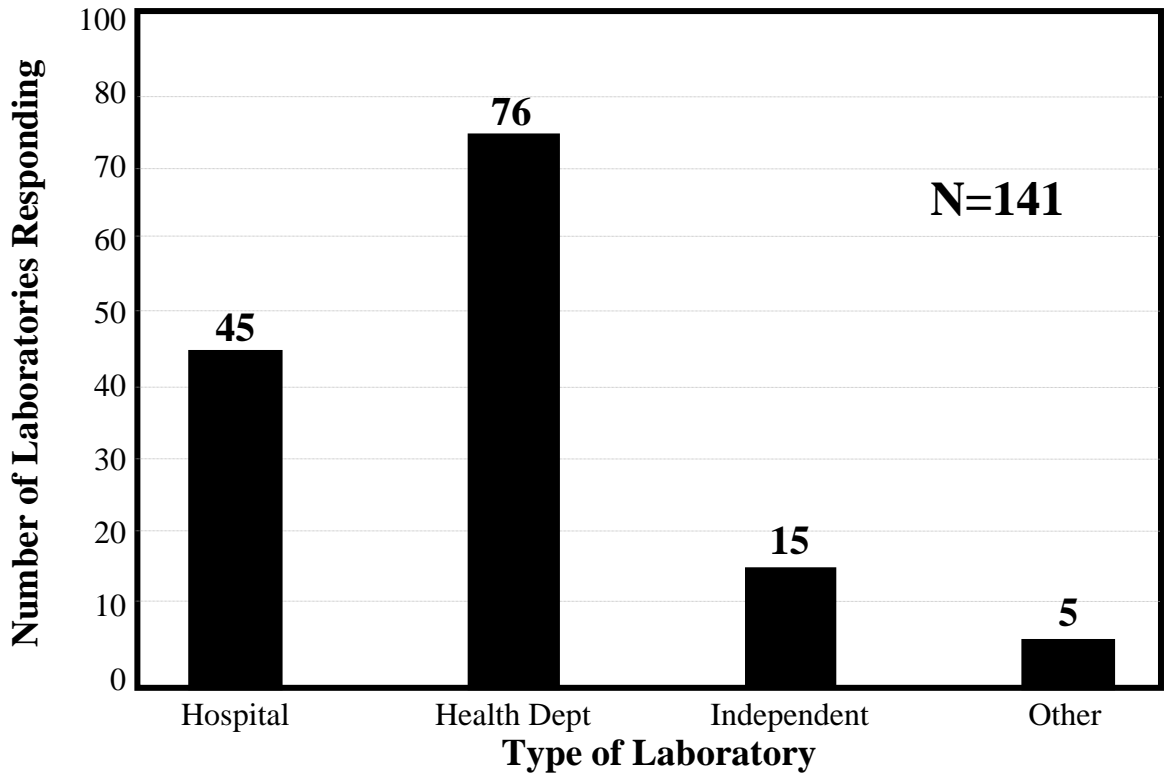
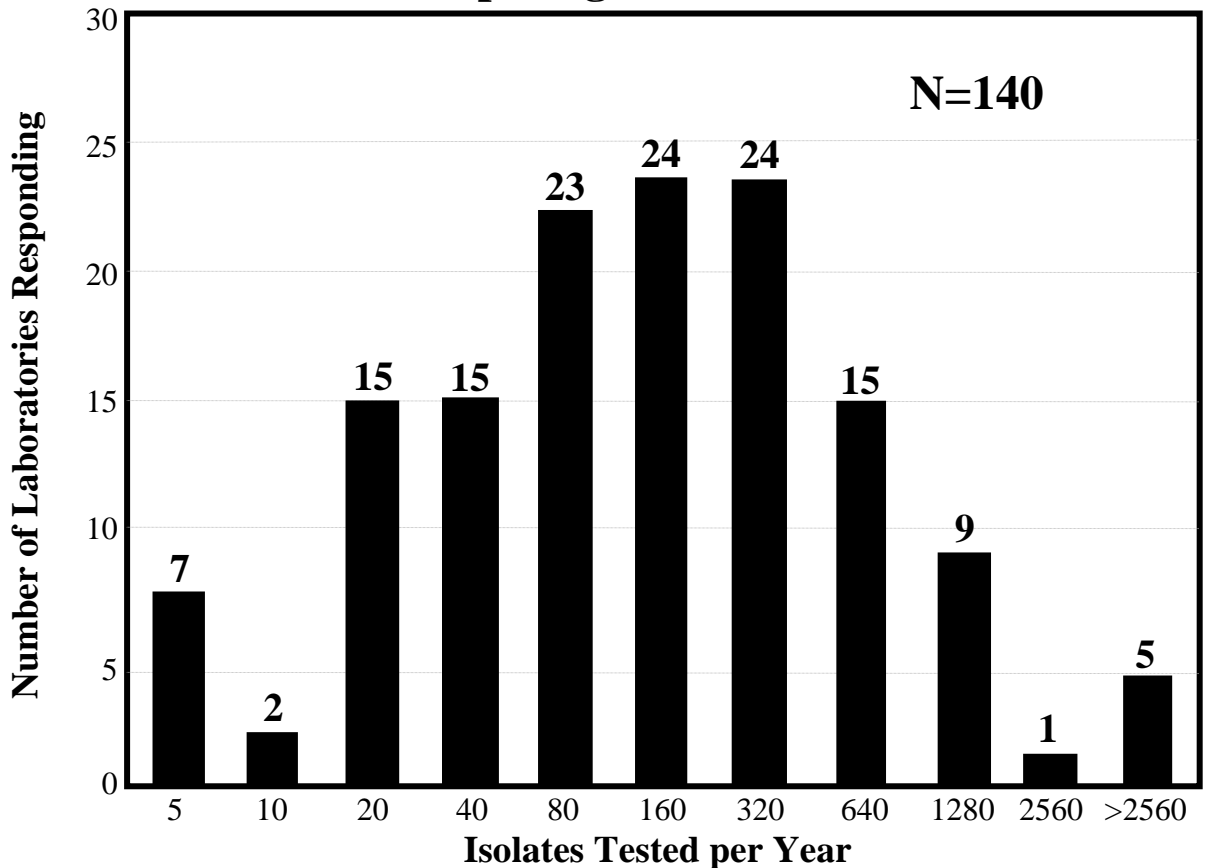
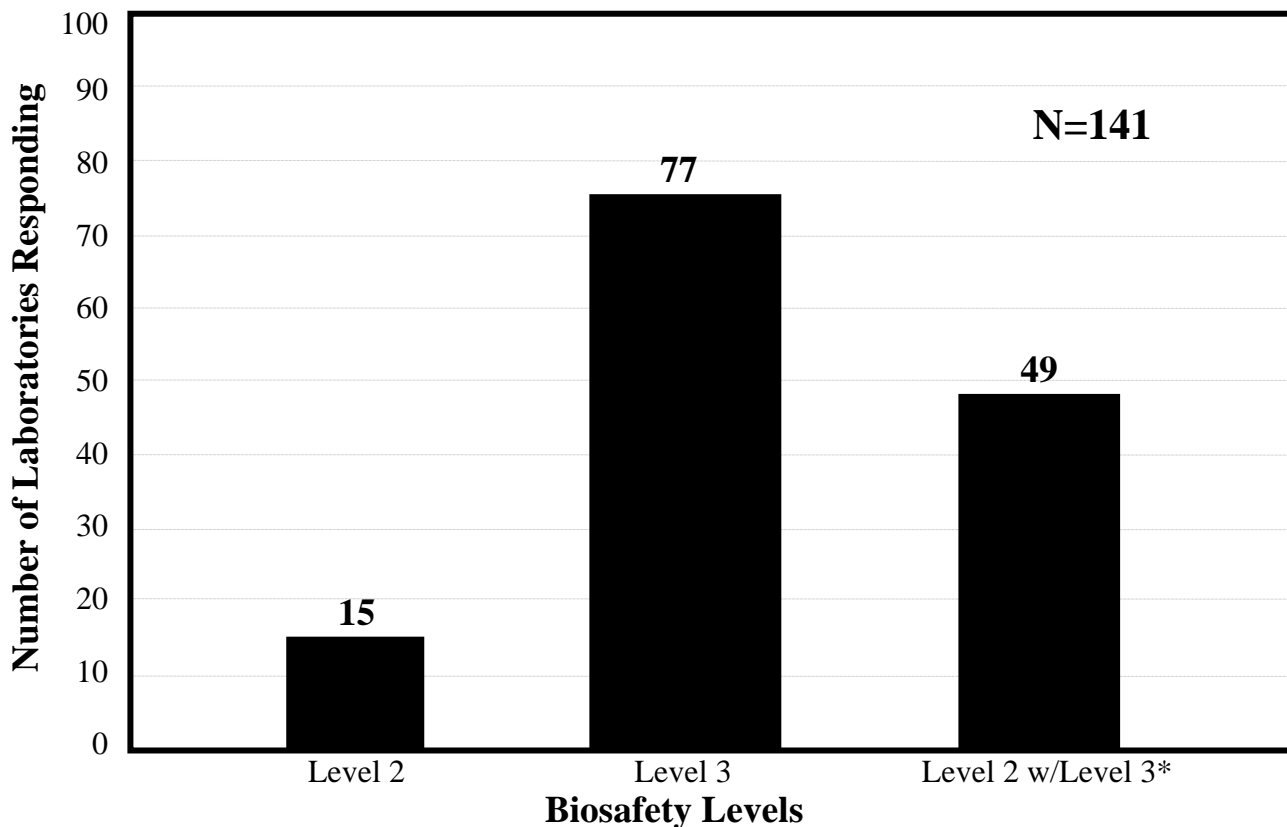


Figure 2. 2003 Annual Volume of *M. tuberculosis* Isolates for Participating Laboratories



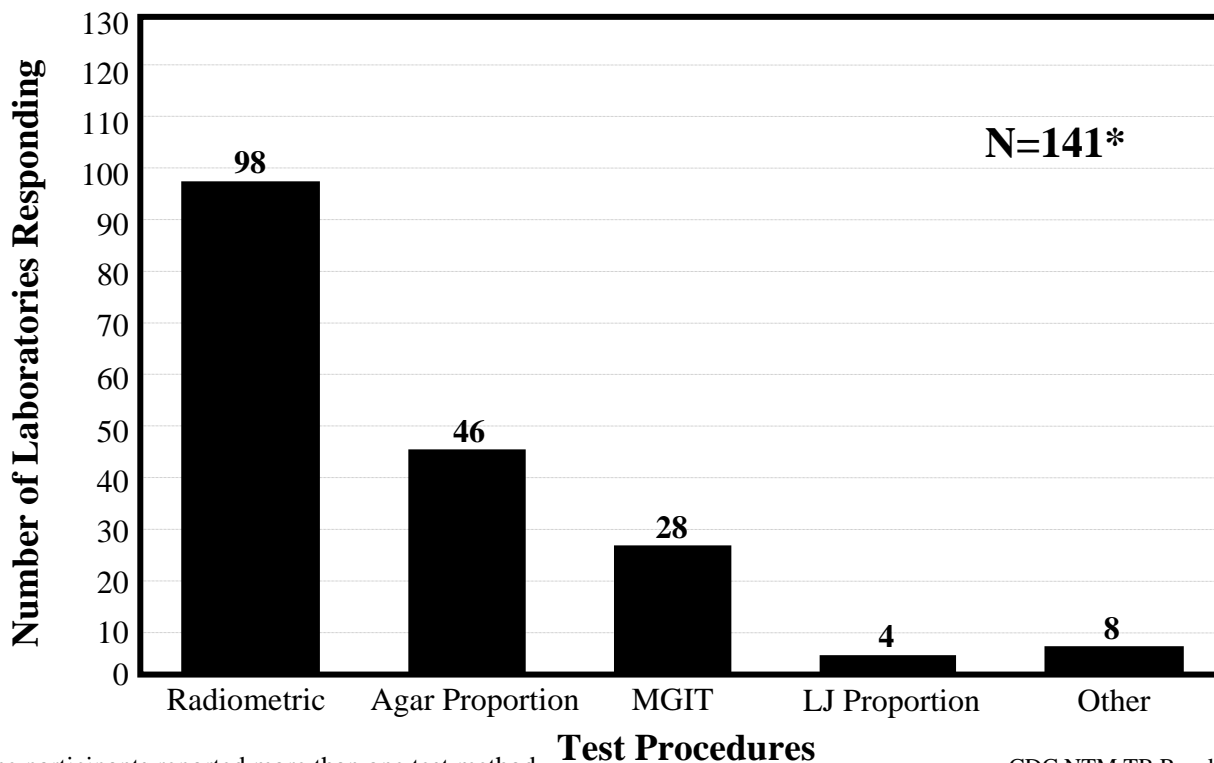
Group labels indicate upper limit of the group.

Figure 3. Biosafety Levels of Participating Laboratories for *M. tuberculosis*



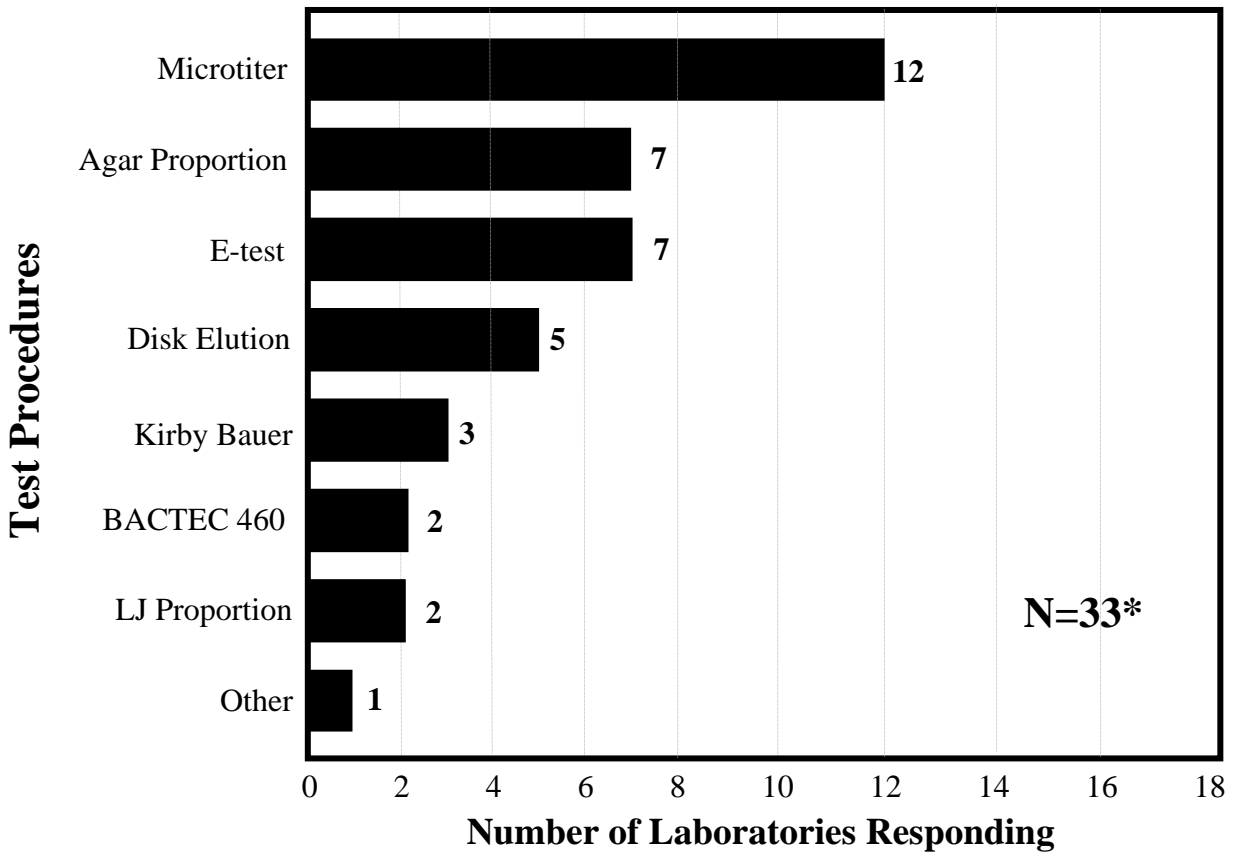
* Biosafety level 2 for facilities with level 3 containment equipment

Figure 4. Test Procedures used by Laboratories for *M. tuberculosis*



* Some participants reported more than one test method

Figure 5. Test Procedures used by Laboratories for Strain E - *M. abscessus*



* Some participants reported more than one test method

Table 1. Participant Results for Culture A, *M. bovis*

DRUG	Conc.	Test Method														
		Agar Prop. Results			BACTEC Results			LJ Prop. Results			MGIT Results			Other Tests Results		
		S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum
Isoniazid	0.03													1		1
Isoniazid	0.06													1		1
Isoniazid	0.09													1		1
Isoniazid	0.10				78	12	90				26	1	27	4		4
Isoniazid	0.12	1		1										1		1
Isoniazid	0.20	32	1	33	2		2	3		3						
Isoniazid	0.25													1		1
Isoniazid	0.40				26		26				9		9	2		2
Isoniazid	1.00	33		33	2		2	1		1						
Isoniazid	5.00	5		5												
Rifampin	0.06													1		1
Rifampin	0.12													1		1
Rifampin	0.25													1		1
Rifampin	0.50				1		1							1		1
Rifampin	0.90													1		1
Rifampin	1.00	35		35	6		6				26		26	4		4
Rifampin	2.00				90		90				1		1			
Rifampin	5.00	4		4												
Rifampin	40.00							3		3						
Pyrazinamide	100.00		1	1		75	75		1	1		23	23		1	1
Pyrazinamide	300.00					1	1								1	1
Pyrazinamide	900.00					1	1									
Ethambutol	1.00														1	1
Ethambutol	1.80													1		1
Ethambutol	2.00							3		3				1		1
Ethambutol	2.50				79	1	80				1		1			
Ethambutol	3.75				2		2									
Ethambutol	4.00				1		1							1		1
Ethambutol	5.00	31		31	7		7				26		26	4		4
Ethambutol	7.50	4		4	13		13									
Ethambutol	8.00													1		1
Ethambutol	10.00	11		11												
Streptomycin	0.25													1		1
Streptomycin	0.50													1		1
Streptomycin	1.00										20		20	3		3
Streptomycin	2.00	32		32	75	1	76				1		1			
Streptomycin	2.50				1		1									
Streptomycin	4.00	1		1	2		2	3		3	3		3			
Streptomycin	6.00				16		16									
Streptomycin	10.00	23		23	1		1									
Ethionamide	1.00	1		1												
Ethionamide	1.25				1	2	3									
Ethionamide	2.50					1	1									
Ethionamide	5.00	20	2	22	1		1									
Ethionamide	10.00	5		5												
Ethionamide	40.00							1		1						
Kanamycin	5.00	11		11	4		4									
Kanamycin	6.00	15		15												
Kanamycin	40.00							1		1						

Table 1. Participant Results for Culture A, *M. bovis*

DRUG	Conc.	Test Method														
		Agar Prop. Results			BACTEC Results			LJ Prop. Results			MGIT Results			Other Tests Results		
		S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum
Capreomycin	1.25				2		2									
Capreomycin	5.00				3		3									
Capreomycin	10.00	17		17												
Capreomycin	40.00							1		1						
Cycloserine	25.00	1		1												
Cycloserine	30.00	10		10					1	1						
Cycloserine	50.00	1		1												
Cycloserine	60.00	1		1												
p-Aminosalicylic acid	0.50							1		1						
p-Aminosalicylic acid	1.00							1		1						
p-Aminosalicylic acid	2.00	15		15												
p-Aminosalicylic acid	4.00				1		1									
p-Aminosalicylic acid	8.00	2		2												
p-Aminosalicylic acid	10.00	3		3												
Amikacin	1.00				1		1									
Amikacin	2.00	1		1	2		2									
Amikacin	2.50				1		1									
Amikacin	4.00	1		1	1		1									
Amikacin	6.00	5		5												
Amikacin	8.00				1		1									
Amikacin	12.00	1		1												
Ofloxacin	1.00	2		2	1		1									
Ofloxacin	2.00	7		7	7		7	1		1						
Ofloxacin	4.00	2		2	2		2									
Ofloxacin	8.00				1		1									
Ciprofloxacin	1.00	1		1	4		4									
Ciprofloxacin	2.00	9		9	2		2									
Ciprofloxacin	4.00				1		1									
Levofloxacin	0.30	1		1												
Levofloxacin	1.00				1		1									
Levofloxacin	2.00				4		4									
Levofloxacin	8.00				1		1									
Rifabutin	0.10	1		1												
Rifabutin	0.50	2		2												
Rifabutin	1.00	2		2	1		1									
Rifabutin	2.00	5		5												
Clofazimine	0.50	1		1	1		1									
Clofazimine	1.00	1		1												

Table 1. Participant Results for Culture B, *M. tuberculosis*

DRUG	Conc.	Test Method															
		Agar Prop. Results			BACTEC Results			LJ Prop. Results			MGIT Results			Other Tests Results			
		S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum	
Isoniazid	0.03															1	1
Isoniazid	0.06															1	1
Isoniazid	0.09															1	1
Isoniazid	0.10		1	1		90	90					27	27			4	4
Isoniazid	0.12															1	1
Isoniazid	0.20		36	36		3	3		4	4							
Isoniazid	0.25															1	1
Isoniazid	0.40					28	28					11	11			2	2
Isoniazid	1.00		38	38		2	2		2	2							
Isoniazid	2.00				1	1	2										
Isoniazid	2.50					1	1										
Isoniazid	5.00	1	4	5	2		2										
Isoniazid	10.00							1		1							
Isoniazid	100.00							1		1							
Rifampin	0.06														1		1
Rifampin	0.12														1		1
Rifampin	0.25														1		1
Rifampin	0.50				1		1										
Rifampin	0.90														1		1
Rifampin	1.00	40		40	5		5		1	1	26		26	4		4	
Rifampin	2.00				90		90				1		1				
Rifampin	5.00	5		5	1		1	1		1							
Rifampin	40.00							3		3							
Rifampin	50.00							1		1							
Pyrazinamide	100.00		1	1	42	33	75	2		2	7	16	23	1		1	
Pyrazinamide	300.00													1		1	
Pyrazinamide	400.00							1		1							
Ethambutol	1.00							1		1					1		1
Ethambutol	1.80													1		1	
Ethambutol	2.00							4		4				1		1	
Ethambutol	2.50				80		80				1		1				
Ethambutol	3.75				2		2										
Ethambutol	4.00				1		1							1		1	
Ethambutol	5.00	36		36	6		6	1		1	26		26	3	1	4	
Ethambutol	7.50	4		4	13		13										
Ethambutol	8.00										1		1	1		1	
Ethambutol	10.00	13		13													
Streptomycin	0.25															1	1
Streptomycin	0.50															1	1
Streptomycin	1.00							1		1	9	11	20	2	1	3	
Streptomycin	2.00	12	25	37	42	33	75				1		1				
Streptomycin	2.50					1	1										
Streptomycin	4.00	1		1	4		4	2	1	3	4		4				
Streptomycin	5.00							1		1							
Streptomycin	6.00				16	1	17										
Streptomycin	10.00	26	1	27	2		2	1		1							

Table 1. Participant Results for Culture B, *M. tuberculosis*

DRUG	Conc.	Test Method														
		Agar Prop. Results			BACTEC Results			LJ Prop. Results			MGIT Results			Other Tests Results		
		S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum
Ethionamide	1.00	1		1												
Ethionamide	1.25				1	3	4									
Ethionamide	2.50				2	1	3									
Ethionamide	5.00	26		26	3		3									
Ethionamide	10.00	5		5												
Ethionamide	20.00							1		1						
Ethionamide	40.00							2		2						
Kanamycin	2.50				1		1									
Kanamycin	5.00	13		13	6		6									
Kanamycin	6.00	17		17												
Kanamycin	40.00							1		1						
Capreomycin	0.50														1	1
Capreomycin	1.00													1		1
Capreomycin	1.25				3		3									
Capreomycin	2.50				2		2									
Capreomycin	5.00				5		5									
Capreomycin	10.00	19	1	20												
Capreomycin	40.00							1		1						
Cycloserine	20.00							1		1						
Cycloserine	25.00	1		1												
Cycloserine	30.00	13		13				1		1						
Cycloserine	40.00							1		1						
Cycloserine	50.00	1		1												
Cycloserine	60.00	2		2	1		1									
p-Aminosalicylic acid	0.50							1	1	2						
p-Aminosalicylic acid	1.00								2	2						
p-Aminosalicylic acid	2.00	5	14	19												
p-Aminosalicylic acid	4.00					2	2									
p-Aminosalicylic acid	8.00	1	1	2		1	1									
p-Aminosalicylic acid	10.00	2	3	5												
Amikacin	0.50													1		1
Amikacin	1.00	1		1	1		1							1		1
Amikacin	2.00	2		2	2		2									
Amikacin	2.50				1		1									
Amikacin	4.00	2		2	1		1									
Amikacin	5.00				1		1									
Amikacin	6.00	6		6												
Amikacin	8.00				1		1									
Amikacin	12.00	2		2												
Ofloxacin	0.50														1	1
Ofloxacin	1.00	4		4	1		1							1		1
Ofloxacin	1.25				1		1									
Ofloxacin	2.00	9		9	10		10	1		1						
Ofloxacin	4.00	3		3	2		2									
Ofloxacin	8.00				1		1									
Ciprofloxacin	0.50													1		1
Ciprofloxacin	1.00	2		2	4		4							1		1
Ciprofloxacin	2.00	11		11	3		3									
Ciprofloxacin	2.50				1		1									
Ciprofloxacin	4.00				1		1									

Table 1. Participant Results for Culture B, *M. tuberculosis*

DRUG	Conc.	Test Method														
		Agar Prop. Results			BACTEC Results			LJ Prop. Results			MGIT Results			Other Tests Results		
		S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum
Levofloxacin	0.30	1		1												
Levofloxacin	1.00				1		1									
Levofloxacin	2.00				4		4									
Levofloxacin	8.00				1		1									
Rifabutin	0.10	1		1												
Rifabutin	0.50	3		3	1		1									
Rifabutin	1.00	3		3	2		2									
Rifabutin	2.00	6		6												
Clofazimine	0.50	1		1	2		2									
Clofazimine	1.00	1		1											1	1
Clofazimine	2.00													1		1

Table 1. Participant Results for Culture C, *M. tuberculosis*

DRUG	Conc.	Test Method																
		Agar Prop. Results			BACTEC Results			LJ Prop. Results			MGIT Results			Other Tests Results				
		S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum		
Isoniazid	0.03															1	1	
Isoniazid	0.06															1	1	
Isoniazid	0.09															1	1	
Isoniazid	0.10		1	1		91	91					27	27			4	4	
Isoniazid	0.12															1	1	
Isoniazid	0.20	1	34	35		3	3		4	4								
Isoniazid	0.25															1	1	
Isoniazid	0.40					28	28					12	12			2	2	
Isoniazid	1.00	1	36	37		3	3		2	2								
Isoniazid	2.00				1	1	2											
Isoniazid	2.50					1	1											
Isoniazid	5.00	2	3	5	2		2											
Isoniazid	10.00								1		1							
Isoniazid	100.00								1		1							
Rifampin	0.06															1	1	
Rifampin	0.12															1	1	
Rifampin	0.25															1	1	
Rifampin	0.50				1		1											
Rifampin	0.90															1	1	
Rifampin	1.00	39		39	6		6		1	1	25		25		4		4	
Rifampin	2.00				90		90				1		1					
Rifampin	5.00	5		5	1		1		1		1							
Rifampin	40.00								3		3							
Rifampin	50.00									1	1							
Pyrazinamide	100.00		1	1	23	51	74		2		2	8	15	23		1	1	
Pyrazinamide	300.00															1	1	
Pyrazinamide	400.00								1		1							
Ethambutol	1.00								1		1					1	1	
Ethambutol	2.00								4		4					1	1	
Ethambutol	2.50				80		80					1		1				
Ethambutol	3.75				2		2											
Ethambutol	4.00				1		1									1	1	
Ethambutol	5.00	34	1	35	7		7		1		1	26		26		4	4	
Ethambutol	7.50	4		4	13		13											
Ethambutol	8.00															1	1	
Ethambutol	10.00	12		12														
Streptomycin	0.25																1	1
Streptomycin	0.50															1	1	
Streptomycin	1.00								1		1	6	14	20		3		3
Streptomycin	2.00	14	21	35	47	29	76					1		1				
Streptomycin	2.50					1	1											
Streptomycin	4.00	1		1	3		3		2	1	3	3	1	4				
Streptomycin	5.00								1		1							
Streptomycin	6.00				16		16											
Streptomycin	10.00	24	2	26	2		2		1		1							

Table 1. Participant Results for Culture C, *M. tuberculosis*

DRUG	Conc.	Test Method														
		Agar Prop. Results			BACTEC Results			LJ Prop. Results			MGIT Results			Other Tests Results		
		S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum
Ethionamide	1.00	1		1												
Ethionamide	1.25				4	2	6									
Ethionamide	2.50				1	2	3									
Ethionamide	5.00	25		25	3		3									
Ethionamide	10.00	5		5												
Ethionamide	20.00							1		1						
Ethionamide	40.00							2		2						
Kanamycin	2.50				1		1									
Kanamycin	5.00	12	1	13	7		7									
Kanamycin	6.00	16		16												
Kanamycin	40.00							1		1						
Capreomycin	0.50														1	1
Capreomycin	1.00													1		1
Capreomycin	1.25				4		4									
Capreomycin	2.50				2		2									
Capreomycin	5.00				5		5									
Capreomycin	10.00	19	1	20												
Capreomycin	40.00							1		1						
Cycloserine	20.00							1		1						
Cycloserine	25.00	1		1												
Cycloserine	30.00	13		13				1		1						
Cycloserine	40.00							1		1						
Cycloserine	50.00	1		1												
Cycloserine	60.00	2		2	1		1									
p-Aminosalicylic acid	0.50								2	2						
p-Aminosalicylic acid	1.00								2	2						
p-Aminosalicylic acid	2.00	7	11	18		1	1									
p-Aminosalicylic acid	4.00					2	2									
p-Aminosalicylic acid	8.00	1	1	2		1	1									
p-Aminosalicylic acid	10.00	2	3	5												
Amikacin	0.50													1		1
Amikacin	1.00	1		1	1		1							1		1
Amikacin	2.00	2		2	2		2									
Amikacin	2.50				1		1									
Amikacin	4.00	2		2	1		1									
Amikacin	5.00				1		1									
Amikacin	6.00	6		6												
Amikacin	8.00				1		1									
Amikacin	12.00	2		2												
Ofloxacin	0.50														1	1
Ofloxacin	1.00	4		4	1		1							1		1
Ofloxacin	1.25				1		1									
Ofloxacin	2.00	8		8	11		11	1		1						
Ofloxacin	4.00	3		3	2		2									
Ofloxacin	8.00				1		1									
Ciprofloxacin	0.50													1		1
Ciprofloxacin	1.00	2		2	4		4							1		1
Ciprofloxacin	2.00	11		11	3		3									
Ciprofloxacin	2.50				1		1									
Ciprofloxacin	4.00				1		1									

Table 1. Participant Results for Culture C, *M. tuberculosis*

DRUG	Conc.	Test Method														
		Agar Prop. Results			BACTEC Results			LJ Prop. Results			MGIT Results			Other Tests Results		
		S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum
Levofloxacin	0.60	1		1												
Levofloxacin	1.00				1		1									
Levofloxacin	2.00				4		4									
Levofloxacin	8.00				1		1									
Rifabutin	0.10	1		1												
Rifabutin	0.50	3		3	2		2									
Rifabutin	1.00	3		3	2		2									
Rifabutin	2.00	6		6												
Clofazimine	0.50	1		1	2		2									
Clofazimine	1.00	1		1										1		1
Clofazimine	2.00													1		1

Table 1. Participant Results for Culture D, *M. tuberculosis*

DRUG	Conc.	Test Method														
		Agar Prop. Results			BACTEC Results			LJ Prop. Results			MGIT Results			Other Tests Results		
		S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum
Isoniazid	0.03													1		1
Isoniazid	0.06													1		1
Isoniazid	0.09													1		1
Isoniazid	0.10				89		89				27		27	4		4
Isoniazid	0.12	1		1										1		1
Isoniazid	0.20	31	1	32	2		2	4		4						
Isoniazid	0.25													1		1
Isoniazid	0.40				24		24				8		8	2		2
Isoniazid	1.00	31	1	32	2		2	1		1						
Isoniazid	5.00	4		4												
Isoniazid	10.00							1		1						
Isoniazid	100.00							1		1						
Rifampin	0.06													1		1
Rifampin	0.12													1		1
Rifampin	0.25													1		1
Rifampin	0.50				1		1							1		1
Rifampin	0.90													1		1
Rifampin	1.00	34		34	6		6		1	1	26		26	4		4
Rifampin	2.00				90		90				1		1			
Rifampin	5.00	4		4				1		1						
Rifampin	40.00							3		3						
Rifampin	50.00							1		1						
Pyrazinamide	100.00	1		1	77		77	1	1	2	23		23	1		1
Pyrazinamide	300.00													1		1
Pyrazinamide	400.00								1	1						
Ethambutol	1.00							1		1					1	1
Ethambutol	1.80													1		1
Ethambutol	2.00							4		4				1		1
Ethambutol	2.50				81		81				1		1			
Ethambutol	3.75				2		2									
Ethambutol	4.00				1		1							1		1
Ethambutol	5.00	30		30	7		7	1		1	25	1	26	4		4
Ethambutol	7.50	4		4	13		13									
Ethambutol	8.00										1		1	1		1
Ethambutol	10.00	11		11												
Streptomycin	0.25														1	1
Streptomycin	0.50													1		1
Streptomycin	1.00							1		1	19	1	20	3		3
Streptomycin	2.00	31	1	32	77		77				1		1			
Streptomycin	2.50				1		1									
Streptomycin	4.00	1		1	2		2	3		3	3		3			
Streptomycin	5.00							1		1						
Streptomycin	6.00				16		16									
Streptomycin	10.00	23		23	1		1	1		1						
Ethionamide	1.00	1		1												
Ethionamide	1.25				3		3									
Ethionamide	2.50				1		1									
Ethionamide	5.00	20		20	1		1									
Ethionamide	10.00	5		5												
Ethionamide	20.00							1		1						
Ethionamide	40.00							2		2						

Table 1. Participant Results for Culture D, *M. tuberculosis*

DRUG	Conc.	Test Method														
		Agar Prop. Results			BACTEC Results			LJ Prop. Results			MGIT Results			Other Tests Results		
		S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum
Kanamycin	5.00	10	1	11	4		4									
Kanamycin	6.00	13		13												
Kanamycin	40.00							1		1						
Capreomycin	0.50														1	1
Capreomycin	1.00													1		1
Capreomycin	1.25				2		2									
Capreomycin	5.00				2		2									
Capreomycin	10.00	16		16												
Capreomycin	40.00							1		1						
Cycloserine	20.00							1		1						
Cycloserine	25.00	1		1												
Cycloserine	30.00	10		10				1		1						
Cycloserine	40.00							1		1						
Cycloserine	50.00	1		1												
p-Aminosalicylic acid	0.50							2		2						
p-Aminosalicylic acid	1.00							2		2						
p-Aminosalicylic acid	2.00	13	1	14												
p-Aminosalicylic acid	4.00				1		1									
p-Aminosalicylic acid	8.00	2		2												
p-Aminosalicylic acid	10.00	3		3												
Amikacin	0.50													1		1
Amikacin	1.00				1		1							1		1
Amikacin	2.00	1		1	2		2									
Amikacin	4.00	1		1	1		1									
Amikacin	6.00	5		5												
Amikacin	8.00				1		1									
Amikacin	12.00	1		1												
Ofloxacin	0.50														1	1
Ofloxacin	1.00	2		2										1		1
Ofloxacin	2.00	7		7	7		7	1		1						
Ofloxacin	4.00	2		2	2		2									
Ofloxacin	8.00				1		1									
Ciprofloxacin	0.50													1		1
Ciprofloxacin	1.00	1		1	3		3							1		1
Ciprofloxacin	2.00	9		9	2		2									
Ciprofloxacin	4.00				1		1									
Levofloxacin	1.00				1		1									
Levofloxacin	2.00				3		3									
Levofloxacin	8.00				1		1									
Rifabutin	0.10	1		1												
Rifabutin	0.50	2		2												
Rifabutin	1.00	2		2												
Rifabutin	2.00	5		5												
Clofazimine	0.50	1		1												
Clofazimine	1.00	1		1											1	1
Clofazimine	2.00													1		1

Table 2. Participant Results for Culture E, *M. abscessus*

DRUG	Conc.	Test Method																				
		Agar Prop. Results			BACTEC Results			LJ Proportion Results			E-Test Results			Disk Elution Results			Kirby Bauer Results			Other Results		
		S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum
Amikacin	6.00		1	1							1		1		1	1						
Amikacin	12.00		2	2										1		1						
Amikacin	18.00													1		1						
Amikacin	30.00	2		2										1	1	2	2	1	3		1	1
Azithromycin	15.00																1		1			
Clarithromycin	0.09										1		1									
Clarithromycin	1.00							1		1												
Clarithromycin	3.00		1	1										3		3						
Clarithromycin	4.00	1		1																		
Clarithromycin	9.00	1		1																		
Clarithromycin	15.00																2		2			
Ciprofloxacin	1.00														1	1						
Ciprofloxacin	2.00		3	3											3	3						
Ciprofloxacin	5.00																	2	2		1	1
Ciprofloxacin	8.00		1	1																		
Cycloserine	40.00							1		1												
Cefoxitin	12.00										1		1									
Cefoxitin	18.00														1	1						
Cefoxitin	30.00	4		4										1	2	3		3	3		1	1
Doxycycline	5.00		1	1																		
Doxycycline	6.00		2	2											4	4						
Doxycycline	30.00																	2	2			
Ethambutol	2.00							1		1												
Ethambutol	2.50						2		2													
Ethambutol	5.00		1	1				1		1												
Gentamicin	4.00		1	1																		
Gentamicin	10.00													1		1						
Imipenem	4.00														1	1						
Imipenem	8.00													1	1	2						
Imipenem	10.00																	2	2		1	1
Isoniazid	0.10						2		2													
Isoniazid	0.20		1	1																		
Isoniazid	1.00		1	1						1		1										
Isoniazid	100.00									1		1										
Kanamycin	6.00		1	1																		
Kanamycin	12.00		1	1																		
Kanamycin	20.00							1		1												
Kanamycin	30.00													1		1						
Minocycline	6.00		1	1																		
Minocycline	30.00																	1	1		1	1
Ofloxacin	4.00		1	1																		
Ofloxacin	5.00																	1	1			
p-Aminosalicyli	0.50									1		1										
p-Aminosalicyli	1.00									1		1										
p-Aminosalicyli	2.00		1	1																		
Pyrazinamide	400.00									1		1										

Table 2. Participant Results for Culture E, *M. abscessus*

DRUG	Conc.	Test Method																				
		Agar Prop. Results			BACTEC Results			LJ Proportion Results			E-Test Results			Disk Elution Results			Kirby Bauer Results			Other Results		
		S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum
Rifampin	1.00		1	1																		
Rifampin	2.00				2	2																
Rifampin	5.00							1	1													
Rifampin	40.00							1	1													
Rifampin	50.00							1	1													
Streptomycin	2.00		1	1	2	2																
Streptomycin	4.00							1	1													
Streptomycin	10.00		1	1										1	1							
Streptomycin	100.00							1	1													
Sulfamethoxaz	100.00																			1	1	
Ethionamide	5.00		1	1																		
Ethionamide	10.00		1	1																		
Ethionamide	40.00							1	1													
Trimethoprim-S	1.25																	1	1			
Trimethoprim-S	25.00																			1	1	
Trimethoprim-S	30.00		1	1										2	2							
Tobramycin	4.00										1		1									
Tobramycin	6.00		1	1																		
Tobramycin	8.00		1	1										1	1	2						
Tobramycin	10.00																1	1		1	1	
Vancomycin	30.00													1	1							

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

DRUG	Test Method	MIC	Susceptible	Resistant	Intermediate	Sum
Amikacin	E-test	4.00	1			1
Amikacin	E-test	12.00	2			2
Amikacin	E-test	16.00	1			1
Amikacin	Microtiter	<2.00	1			1
Amikacin	Microtiter	>2.00		1		1
Amikacin	Microtiter	4.00	4			4
Amikacin	Microtiter	≤8.00	3			3
Amikacin	Microtiter	32.00			1	1
Amikacin	Microtiter	64.00		1		1
Augmentin	Microtiter	32.00		1		1
Azithromycin	Microtiter	>2.00		1		1
Azithromycin	Microtiter	4.00	1			1
Azithromycin	Microtiter	<16.00	1			1
Cefmetazole	Microtiter	>64.00		1		1
Cefoxitin	Agar proportion	>20.00		1		1
Cefoxitin	E-test	16.00	1			1
Cefoxitin	E-test	>256.00		3		3
Cefoxitin	Microtiter	32.00			5	5
Cefoxitin	Microtiter	64.00		1	1	2
Ciprofloxacin	E-test	4.00		1		1
Ciprofloxacin	E-test	>32.00		2		2
Ciprofloxacin	Microtiter	1.00	1			1
Ciprofloxacin	Microtiter	≥8.00	1	6		7
Ciprofloxacin	Microtiter	≥16.00		2		2
Ciprofloxacin	Microtiter	32.00		1		1
Clarithromycin	E-test	0.12	2			2
Clarithromycin	E-test	0.19	1			1
Clarithromycin	E-test	1.00	1			1
Clarithromycin	E-test	1.25	1			1
Clarithromycin	E-test	<2.00	1			1
Clarithromycin	Microtiter	<0.06	2			2
Clarithromycin	Microtiter	≤0.12	2			2
Clarithromycin	Microtiter	≤0.25	4			4
Clarithromycin	Microtiter	≥1.00	1	1		2
Clarithromycin	Microtiter	2.00	2			2
Clarithromycin	Microtiter	>64.00		1		1
Doxycycline	E-test	>256.00		4		4
Doxycycline	Microtiter	>16.00		1		1
Doxycycline	Microtiter	>32.00		3		3
Doxycycline	Microtiter	>64.00		3		3
Doxycycline	Microtiter	>128.00		1		1
Doxycycline	Microtiter	>256.00		1		1
Gatifloxacin	Microtiter	>8.00			1	1
Gatifloxacin	Microtiter	>16.00			1	1
Gatifloxacin	Microtiter	>4.00		1		1
Gentamicin	Microtiter	8.00			1	1
Imipenem	Agar proportion	>20.00		1		1
Imipenem	E-test	8.00		1		1
Imipenem	E-test	>32.00		2		2
Imipenem	Microtiter	8.00			2	2
Imipenem	Microtiter	>16.00			1	1
Imipenem	Microtiter	32.00		1		1

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

DRUG	Test Method	MIC	Susceptible	Resistant	Intermediate	Sum
Levofloxacin	E-test	>32.00		2		2
Levofloxacin	Microtiter	>4.00		1		1
Levofloxacin	Microtiter	>64.00			1	1
Minocycline	Microtiter	>8.00		1		1
Minocycline	Microtiter	>16.00		1		1
Minocycline	Microtiter	>32.00		1		1
Minocycline	Microtiter	>64.00		1		1
Ofloxacin	Microtiter	32.00		1		1
Ofloxacin	Microtiter	>64.00	1			1
Rifabutin	Microtiter	32.00		1		1
Rifabutin	Microtiter	>64.00	1			1
Rifampin	Microtiter	>4.00		1		1
Sulfamethoxazole	Agar proportion	>5.00		1		1
Sulfamethoxazole	Microtiter	>64.00		5		5
Sulfamethoxazole	Microtiter	128.00		1		1
Tetracycline	Microtiter	>64.00		1		1
Tobramycin	E-test	3.00	1			1
Tobramycin	E-test	4.00	1			1
Tobramycin	Microtiter	4.00	4			4
Tobramycin	Microtiter	8.00			3	3
Tobramycin	Microtiter	>16.00		2		2
Trimethoprim-Sulfamethoxazole	E-test	>32.00		2		2
Trimethoprim-Sulfamethoxazole	Microtiter	4.00		1		1
Trimethoprim-Sulfamethoxazole	Microtiter	>8.00		2		2
Trimethoprim-Sulfamethoxazole	Microtiter	>16.00		1		1
Trimethoprim-Sulfamethoxazole	Microtiter	>32.00	1			1
Vancomycin	Microtiter	>64.00			1	1