

December 3, 1999

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 July 1999 Shipment

Dear Participant:

Enclosed are analyses of laboratory test results reported to the Centers for Disease Control and Prevention (CDC) by participant laboratories for the strains of *Mycobacterium tuberculosis*, *M. kansasii*, and *M. avium* complex shipped in July 1999. Participant laboratories received either 3 *M. tuberculosis* strains or all five *M. tuberculosis* and nontuberculous mycobacteria (NTM) strains. Testing results were received and analyzed from 144 of 155 (92.9%) of laboratories participating in this shipment. 10 of the participating laboratories are located in countries other than the U.S.A.

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 addition of NTM strains to 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 NTM strains 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 is referenced to provide participants with recommendations for NTM test methods and drugs that have clinical relevance.

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If you have any comment or suggestions on the results in this report or have questions regarding the changes in this program, you may call me at (770) 488-8076.

Sincerely yours,

John C. Ridderhof, Dr.P.H.
Science Administrator
Division of Laboratory Systems
Public Health Practice Program Office

Enclosures

Analyses of the July 1999 Performance Evaluation Results for *M. tuberculosis* 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 3 strains of *Mycobacterium tuberculosis*, 1 strain of *M. kansasii*, and 1 strain of *M. avium* complex shipped in July 1999. Participant laboratories either received 3 *M. tuberculosis* or all five *M. tuberculosis* and NTM strains. Testing results were received and analyzed from 144 of 155 (92.9%) laboratories participating in this shipment.

Descriptive Information on Participant laboratories

Figure 1 shows the laboratory classification reported by 142 of the participants. Participants consisted of 75 health departments, 51 hospitals, 12 independents, and 4 “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 1998.

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](#) (3rd 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 all of the test methods used. Some methods, such as the proportion method with Lowenstein-Jensen media, may reflect procedures used by international participants. Figure 5 provides a breakdown of the test procedures used by the participating laboratories for *M. kansasii*. Figure 6 provides a breakdown of the test procedures used by the participating laboratories for *M. avium* complex.

M. tuberculosis test results:

The aggregate test results are provided in separate tables, representing cultures P, Q, R, S, and T, to facilitate comparison among laboratories. Table 1 for the *M. tuberculosis* cultures P, Q, and R is constructed to include the results for the radiometric (BACTEC), agar proportion and Lowenstein Jensen (LJ) proportion 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 (tentative standard) for the primary (isoniazid, rifampin, pyrazinamide, ethambutol, and streptomycin) and secondary (ethionamide, kanamycin, capreomycin, cycloserine, p-amino-salicylic acid) antituberculosis drugs are highlighted for the conventional and radiometric method. 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 (1-6). When two concentrations are highlighted, such as for isoniazid, ethambutol and streptomycin, the lower concentration is the critical concentration that should always be included to determine whether the *M. tuberculosis* isolate is resistant.

Strain P was resistant to isoniazid and pyrazinamide, strain Q was resistant to isoniazid, and strain R was resistant to rifampin. For strain P, 100% (43/43) of participants detected isoniazid resistance at the critical concentration (0.2 Fg/ml) in the agar proportion method, and 98.2% (109/111) detected isoniazid resistance at the equivalent concentration (0.1 Fg/ml) with the BACTEC method. This isoniazid resistance was also detected by 100% (4/4) of participants with the critical concentration (0.2 Fg/ml) in the LJ proportion method. Although strain P was expected to have resistance to the higher concentration of isoniazid, only 51.1% (23/45) of participants detected resistance at the high concentration (1.0 Fg/ml) in agar proportion and 70.4% (19/27) of participants detected resistance at the high concentration (0.4 Fg/ml) in the BACTEC method. 96.5% (85/88) of participants detected pyrazinamide resistance with the BACTEC method.

For strain Q, 100% (44/44) detected isoniazid resistance at the critical concentration (0.2 Fg/ml) in the agar proportion method, 97.3% (107/110) detected isoniazid resistance at the equivalent concentration (0.1 Fg/ml) with the BACTEC method, and 75% (3/4) detected isoniazid resistance with the critical concentration (0.2 Fg/ml) in the LJ proportion method. For strain Q, 23.8% (20/84) of participants also detected pyrazinamide resistance with the BACTEC method. This pyrazinamide resistance in strain Q was unexpected.

For strain R, 60.4% (29/48) of participants detected rifampin resistance using the agar proportion method, 89.6% (103/115) detected rifampin resistance using the BACTEC method, and 66.7% (2/3) detected rifampin resistance with the critical concentration (40.0 Fg/ml) in the LJ proportion method. Strain R was resistant to the quinolone drugs, ciprofloxacin and ofloxacin. A preliminary recommendation (11) is to test ofloxacin at 2.0 Fg/ml in BACTEC or 2.0 Fg/ml in agar proportion.

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 *M. tuberculosis*. 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:

The aggregate test results are provided in Tables 2 and 4 for culture S, *M. kansasii* and Tables 3 and 5 for culture T, *M. avium* complex to facilitate comparison among laboratories. Tables 2 and 3, for *M. kansasii* and *M. avium* complex, respectively, represent either single or multiple drug concentrations with “breakpoint” susceptibility test results. In Tables 3 and 4, the participant laboratories reported an interpretation of either susceptibility or resistance for each drug concentration that was reported. Tables 4 and 5 represent all minimum inhibitory concentrations (MICs) susceptibility test results, for *M. kansasii* and *M. avium* complex, respectively, reported by participant laboratories. Tables 4 and 5 include all the quantitative MIC test results, regardless of whether the laboratory provided a test interpretation of resistant or susceptible for the reported MIC.

A total of 49 participants provided test results on strain S, *M. kansasii*: 44 participants reported breakpoint test results and 8 participants reported MIC test results. Table 2, representing all of the breakpoint susceptibility test results for *M. kansasii*, includes results reported for the agar proportion, BACTEC, and Disk elution test methods. Most participants reporting results for *M. kansasii* used the agar proportion and BACTEC methods and reported the concentrations of primary drugs recommended for *M. tuberculosis*. The American Thoracic Society (ATS) recommendations (9) state, “Routine susceptibility testing of *M. kansasii* should include only rifampin, because currently used resistance breakpoints for isoniazid and streptomycin often give misleading results and methods for the other drugs have not been established.” Strain S was resistant to rifampin. There was 96.2% and 100% agreement for rifampin resistance with the concentrations of drug recommended for *M. tuberculosis* in the agar proportion (25/26) and BACTEC (9/9) methods for this strain of *M. kansasii*, respectively. Although there are no standard methods, the ATS recommendations further state that a rifampin-resistant isolate could be tested against ciprofloxacin or ofloxacin, clarithromycin, ethambutol, streptomycin and a sulfonamide (e.g. sulfamethoxazole).

A total of 32 participants reported testing results for strain T, *M. avium* complex: 20 participants reported breakpoint test results and 15 participants reported MIC test results. Table 3, representing all of the breakpoint susceptibility test results for *M. avium* complex, includes results reported for the agar proportion, BACTEC, disk elution, and LJ proportion methods. Some participants reporting results for *M. avium* complex used the methods outlined above with concentrations of primary drugs recommended for *M. tuberculosis* (8). The American Thoracic Society (ATS) recommendations (9) for *M. avium* complex state, “Susceptibility testing with rifabutin and the antituberculosis drugs is not recommended. Routine testing against clarithromycin should not be performed, but that test should be performed on isolates from patients who have failed prior macrolide therapy or prophylaxis. Minimal inhibitory concentration of >32 Fg/ml is the recommended resistance breakpoint.” Strain T was resistant to clarithromycin. For strain T, 86.7% (13/15) of the breakpoint susceptibility and 100% (15/15) of MIC interpretations provided for clarithromycin and azithromycin were reported as resistant. The clarithromycin MICs results reported for strain I ranged from >8 Fg/ml to >256 Fg/ml with 9/13 participants reporting an MIC \geq 32 Fg/ml.

Many laboratories perform drug susceptibility testing for NTM in the absence of clinical studies demonstrating the efficacy of particular drugs and/or drug concentrations and methods (8,9). The addition of NTM strains to this performance evaluation program should not be interpreted as recommendations 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.

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Figure 1. Primary Classification of Participating Laboratories

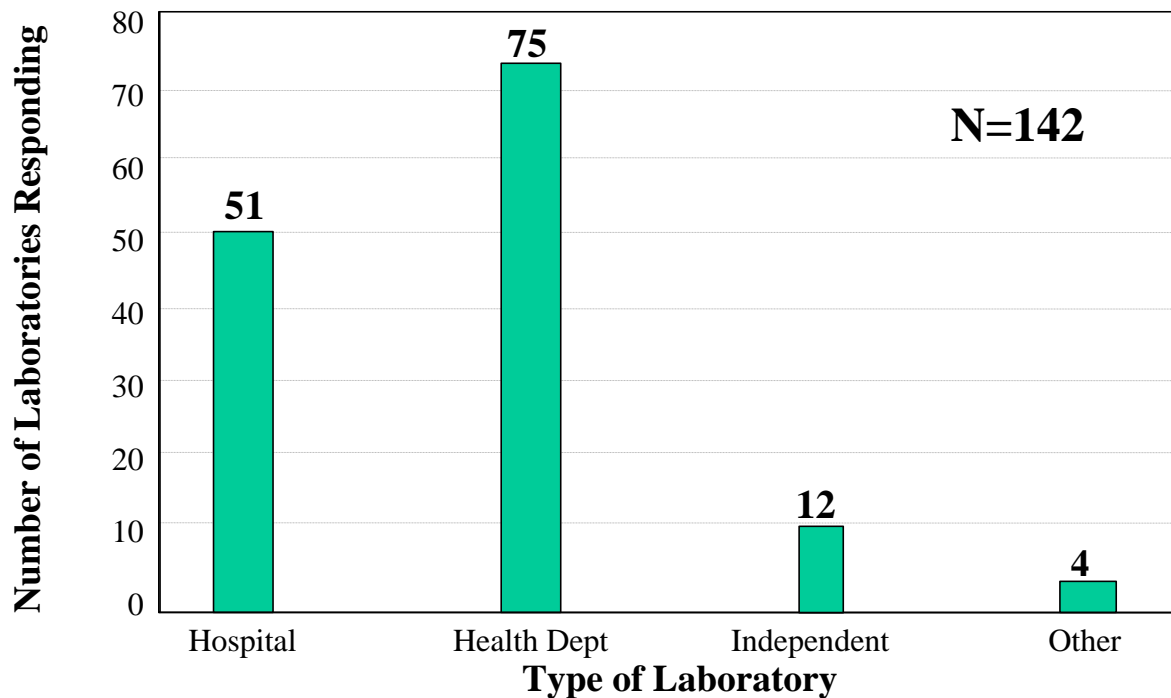
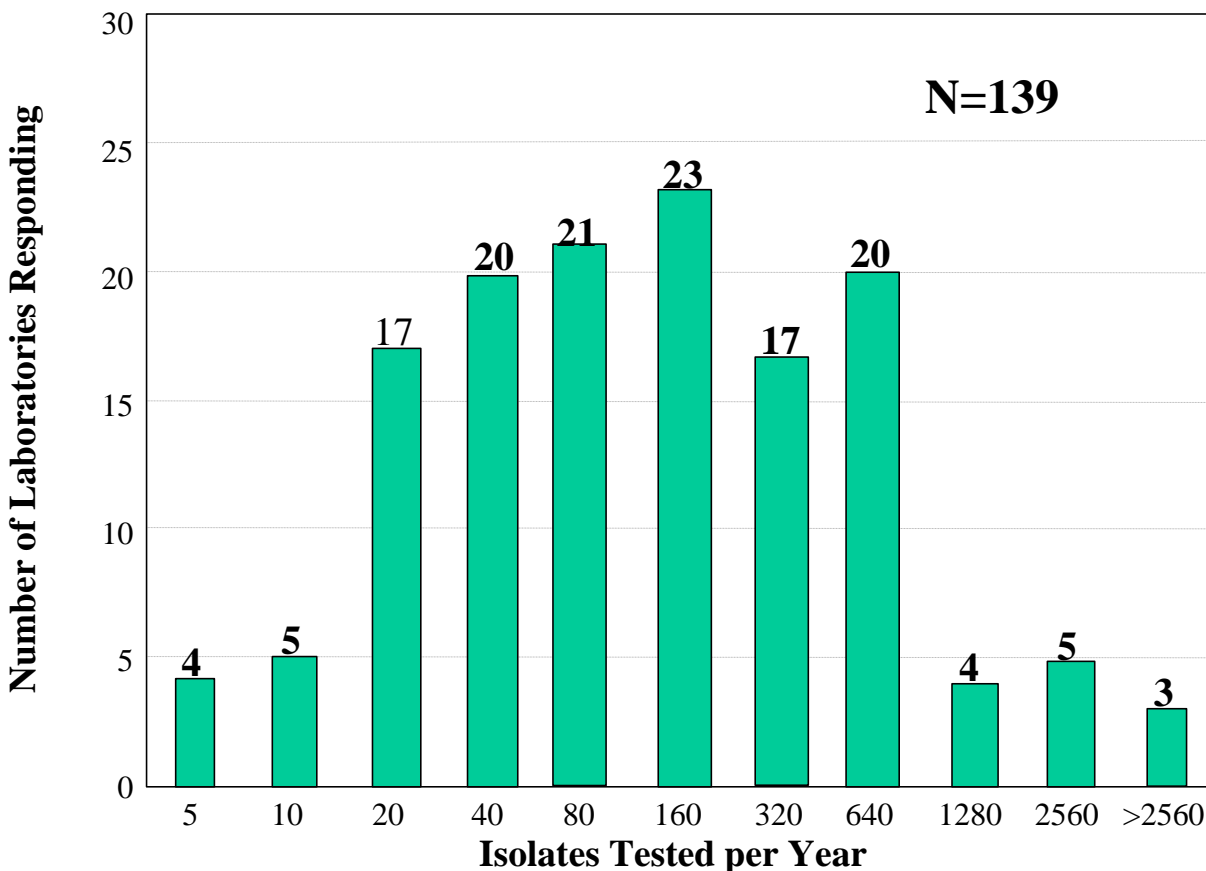
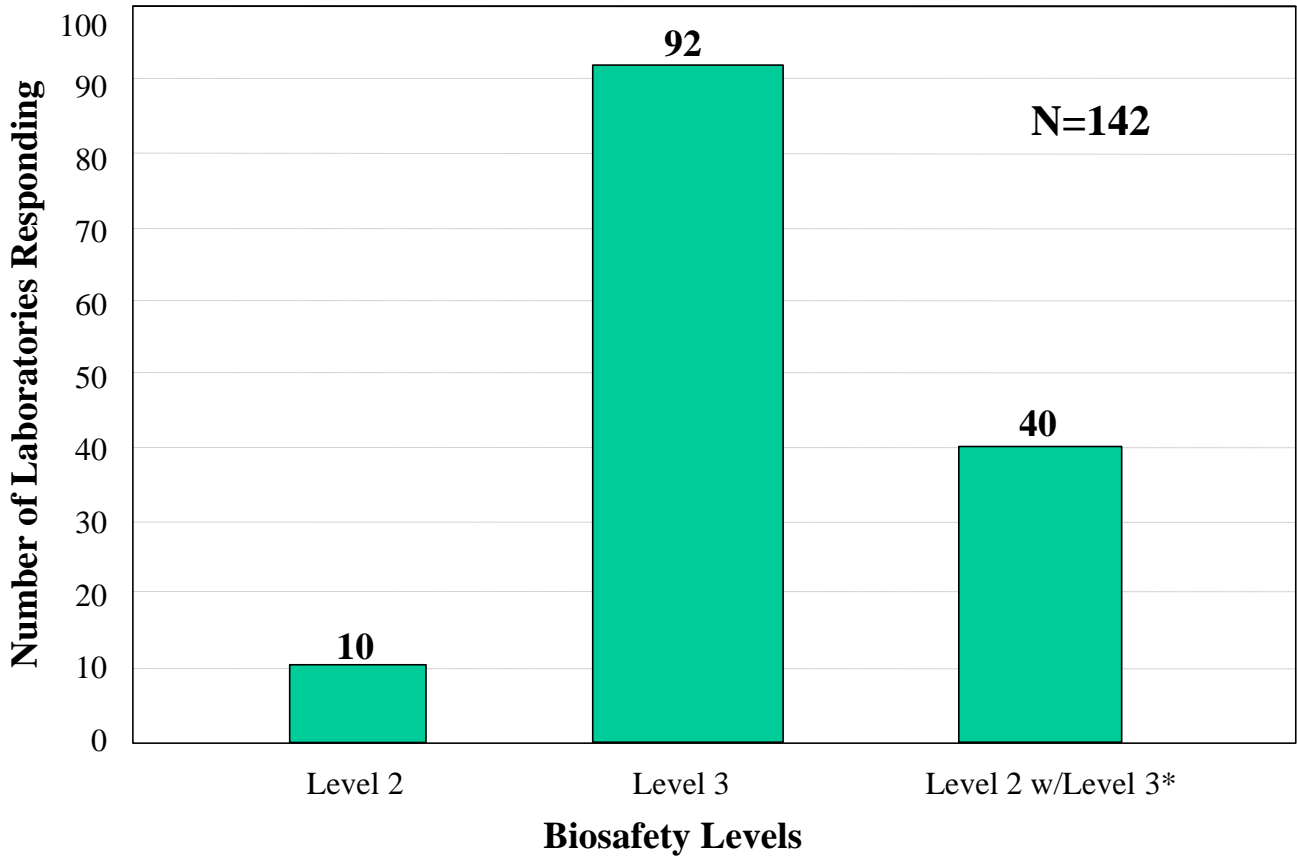


Figure 2. 1998 Annual Volume of *M. tuberculosis* Isolates for Participating Laboratories



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*

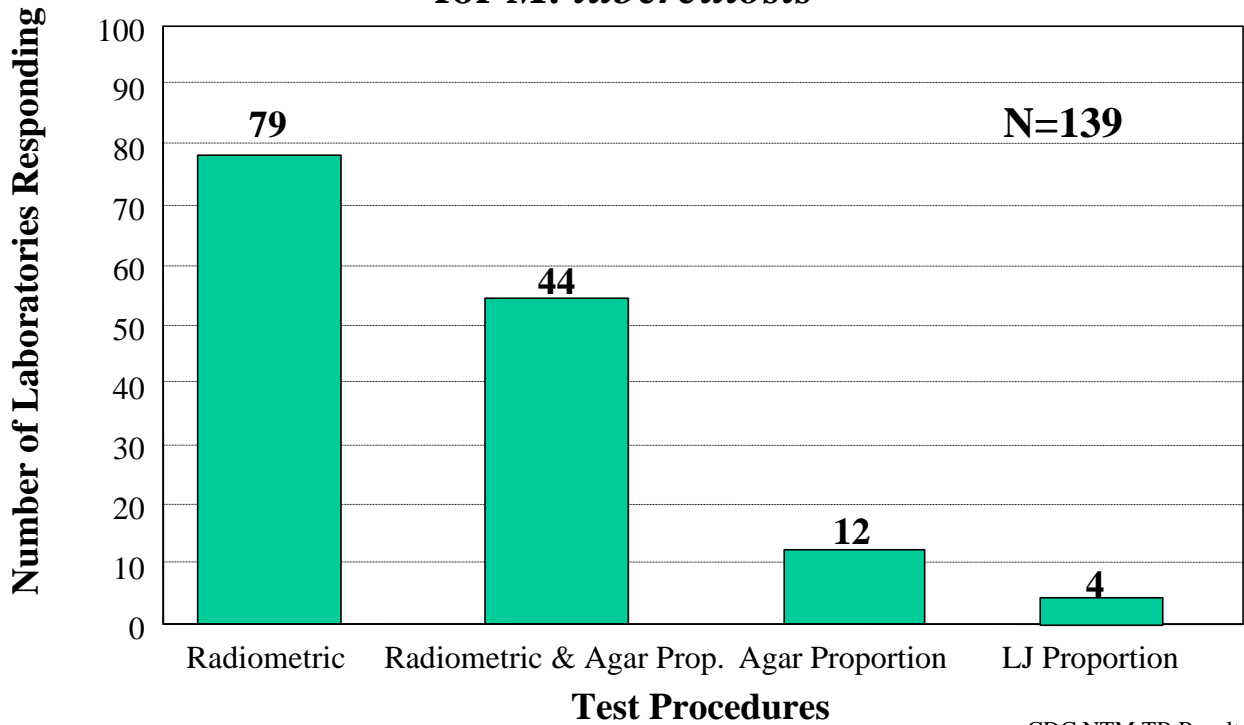
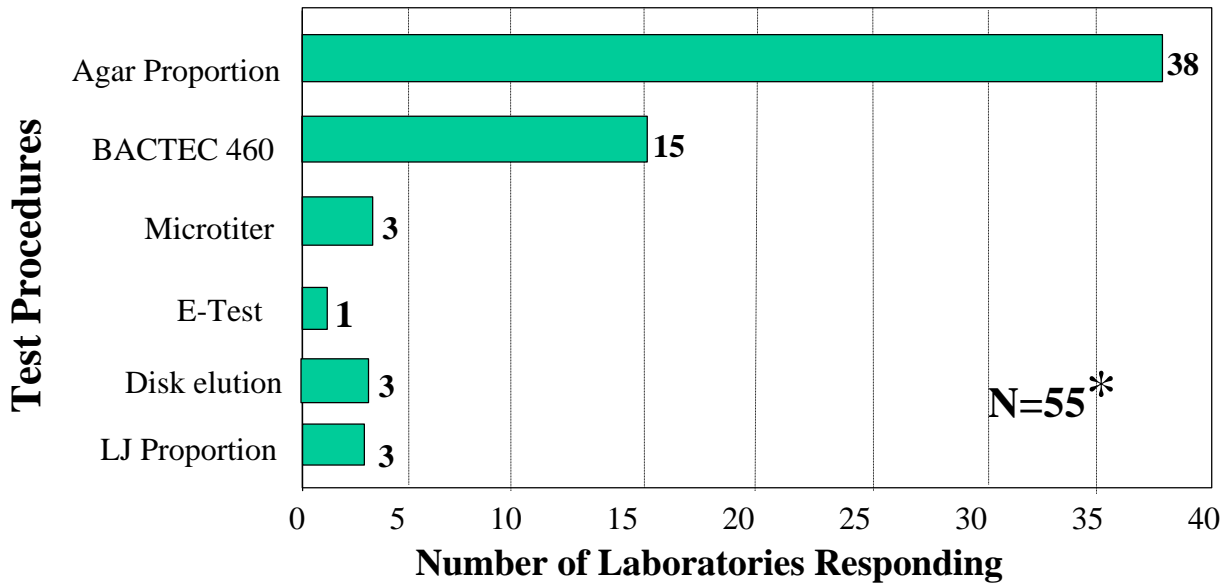
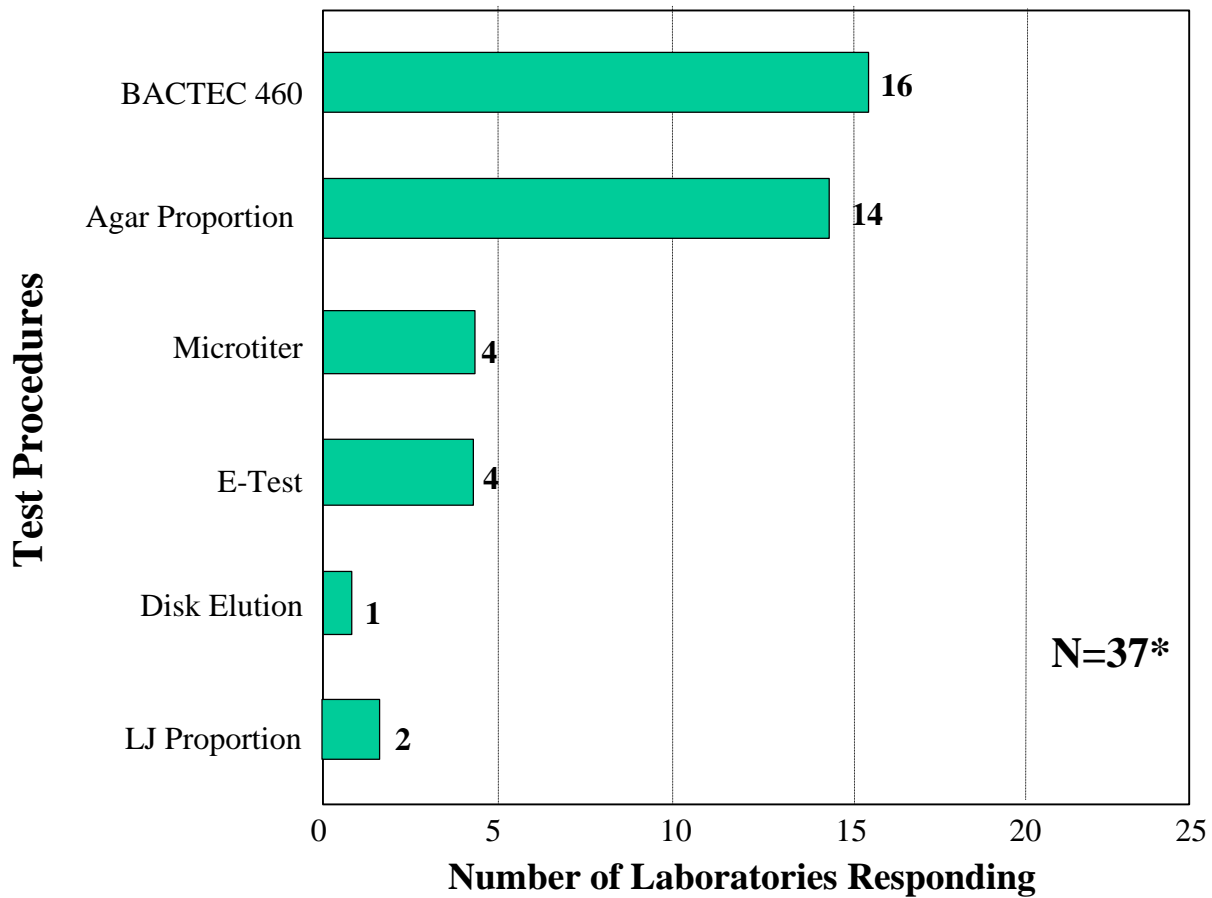


Figure 5. Test Procedures used by Laboratories for Strain S - *M. kansasii*



* Some participants reported more than one test method

Figure 6. Test Procedures used by Laboratories for Strain T - *M. avium* complex



* Some participants reported more than one test method

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

DRUG	Conc.	Test Method									DRUG	Conc.	Test Method								
		Agar Prop. Results			BACTEC Results			LJ Prop. Results					Agar Prop. Results			BACTEC Results			LJ Prop. Results		
		S	R	Sum	S	R	Sum	S	R	Sum			S	R	Sum	S	R	Sum	S	R	Sum
Isoniazid	0.01				1	1					Capreomycin	0.50				1	1				
Isoniazid	0.10		1	1	2	109	111				Capreomycin	1.00				1	1				
Isoniazid	0.20		43	43	7	7			4	4	Capreomycin	1.25				1	1				
Isoniazid	0.40				8	19	27				Capreomycin	2.00				1	1				
Isoniazid	0.50								1	1	Capreomycin	2.50				2	2				
Isoniazid	1.00	22	23	45	5	4	9	1	1	2	Capreomycin	5.00	1		1	4	4				
Isoniazid	2.00	1	1	2	2		2				Capreomycin	10.00	22		22						
Isoniazid	5.00	3	2	5	2		2				Cycloserine	25.00	2		2						
Isoniazid	10.00								2	2	Cycloserine	30.00	13		13			1	1	2	
Isoniazid	80.00								1	1	Cycloserine	50.00	1		1	1	1				
Rifampin	1.00	48		48	8		8		1	1	Cycloserine	60.00	1		1						
Rifampin	2.00				114	1	115				p-Aminosalicylic acid	0.50				1	1	1	1		
Rifampin	5.00	7		7					1	1	p-Aminosalicylic acid	1.00				1	1	1	1		
Rifampin	40.00								4	4	p-Aminosalicylic acid	2.00	16		16	1	1				
Pyrazinamid	10.00				1		1				p-Aminosalicylic acid	4.00				1	1				
Pyrazinamid	25.00		2	2	1		1				p-Aminosalicylic acid	5.00	1		1						
Pyrazinamid	50.00				1		1				p-Aminosalicylic acid	8.00	3		3						
Pyrazinamid	100.00				3	85	88		1	1	p-Aminosalicylic acid	10.00	4		4						
Pyrazinamid	300.00				1		1				Amikacin	1.00				1	1				
Ethambutol	1.00								1	1	Amikacin	2.00	1		1	2	2				
Ethambutol	2.00								4	4	Amikacin	2.50				1	1				
Ethambutol	2.50				103	3	106				Amikacin	4.00	2		2	1	1				
Ethambutol	3.75				2		2				Amikacin	5.00	1		1						
Ethambutol	4.00				1		1				Amikacin	6.00	8		8						
Ethambutol	5.00	40		40	8		8	1	1		Amikacin	12.00	2		2						
Ethambutol	6.00	1		1							Amikacin	18.00	1		1						
Ethambutol	7.50	5	1	6	12		12				Amikacin	30.00	1		1						
Ethambutol	10.00	16		16							Ofloxacin	0.50				1	1				
Streptomycin	1.00								1	1	Ofloxacin	1.00	8		8	1	1	2			
Streptomycin	2.00	44		44	105		105				Ofloxacin	1.25	1		1						
Streptomycin	2.50				1		1				Ofloxacin	2.00	5		5	5	5	1	1		
Streptomycin	3.00				1		1				Ofloxacin	4.00	2		2	1	1				
Streptomycin	4.00				1		1	4	4		Ciprofloxacin	0.50	1		1						
Streptomycin	6.00				17		17				Ciprofloxacin	1.00	6		6	4	4				
Streptomycin	10.00	33		33					1	1	Ciprofloxacin	2.00	13		13	1	1				
Ethionamide	0.50				1		1				Levofloxacin	2.00				1	1				
Ethionamide	1.00				1		1				Rifabutin	0.25	1		1						
Ethionamide	1.25				1		1				Rifabutin	0.50	1		1						
Ethionamide	2.00				1		1				Rifabutin	1.00	2		2	2	2				
Ethionamide	2.50				1		1				Rifabutin	2	5		5						
Ethionamide	5.00	34		34	3		3				Clofazimine	0.12				1	1				
Ethionamide	10.00	4		4	1		1				Clofazimine	0.25				1	1				
Ethionamide	20.00								1	1	Clofazimine	0.50				1	1				
Ethionamide	30.00								1	1	Clofazimine	1.00	2		2						
Kanamycin	2.50				1		1				Thiacetazon	2.00							1	1	
Kanamycin	5.00	14		14	3		3														
Kanamycin	6.00	24		24																	
Kanamycin	40.00								1	1											

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

DRUG	Conc.	Test Method									DRUG	Conc.	Test Method								
		Agar Prop. Results			BACTEC Results			LJ Prop. Results					Agar Prop. Results			BACTEC Results			LJ Prop. Results		
		S	R	Sum	S	R	Sum	S	R	Sum			S	R	Sum	S	R	Sum	S	R	Sum
Isoniazid	0.01				1	1					Kanamycin	2.50				1	1				
Isoniazid	0.10		1	1	3	107	110				Kanamycin	5.00	14	14		3	3				
Isoniazid	0.20	44	44		3	4	7	1	3	4	Kanamycin	6.00	24	24							
Isoniazid	0.40				27	27					Kanamycin	40.00							1	1	
Isoniazid	0.50							1	1		Capreomycin	0.50				1	1				
Isoniazid	1.00	47	47		8	1	9	2	2		Capreomycin	1.25				1	1				
Isoniazid	2.00	1	1	2							Capreomycin	2.00				1	1				
Isoniazid	5.00	5	5		1	1					Capreomycin	2.50				2	2				
Isoniazid	10.00							2	2		Capreomycin	5.00	1	1		4	4				
Isoniazid	80.00							1	1		Capreomycin	10.00	22	22							
Rifampin	1.00	48	1	49	8	8			1	1	Cycloserine	25.00	2	2							
Rifampin	2.00				115	115					Cycloserine	30.00	13	13					3	3	
Rifampin	5.00	7	7					1	1		Cycloserine	50.00	1	1	1	1					
Rifampin	40.00							4	4		Cycloserine	60.00	1	1							
Pyrazinamid	10.00				1	1					p-Aminosalicylic acid	0.50				1	1	1	1		
Pyrazinamid	25.00	2	2		1	1					p-Aminosalicylic acid	1.00				1	1	1	1		
Pyrazinamid	50.00					1	1				p-Aminosalicylic acid	2.00	16	16		1	1				
Pyrazinamid	100.00				64	20	84	2	2		p-Aminosalicylic acid	4.00				1	1				
Pyrazinamid	300.00				1	1					p-Aminosalicylic acid	5.00	1	1							
Pyrazinamid	400.00							1	1		p-Aminosalicylic acid	8.00	3	3							
Ethambutol	1.00							1	1		p-Aminosalicylic acid	10.00	4	4							
Ethambutol	2.00							4	4		Amikacin	1.00				1	1				
Ethambutol	2.50				109	109					Amikacin	2.00	1	1		2	2				
Ethambutol	3.75				2	2					Amikacin	2.50				1	1				
Ethambutol	4.00				1	1					Amikacin	4.00	2	2		1	1				
Ethambutol	5.00	40	40		8	8		1	1		Amikacin	5.00	1	1							
Ethambutol	6.00	1	1								Amikacin	6.00	8	8							
Ethambutol	7.50	7	7		12	12					Amikacin	12.00	2	2							
Ethambutol	10.00	15	15								Amikacin	18.00	1	1							
Streptomycin	1.00							1	1		Amikacin	30.00	1	1							
Streptomycin	2.00	45	45		105	105					Ofloxacin	1.00	8	8		2	2				
Streptomycin	2.50				1	1					Ofloxacin	1.25	1	1							
Streptomycin	3.00				1	1					Ofloxacin	2.00	5	5		5	5	1	1		
Streptomycin	4.00				1	1		4	4		Ofloxacin	4.00	2	2		1	1				
Streptomycin	6.00				17	17					Ciprofloxacin	0.50	1	1							
Streptomycin	10.00	34	34					1	1		Ciprofloxacin	1.00	6	6		4	4				
Ethionamide	0.50				1	1					Ciprofloxacin	2.00	13	13		1	1				
Ethionamide	1.00				1	1					Levofloxacin	2.00				1	1				
Ethionamide	1.25				1	1					Rifabutin	0.25	1	1							
Ethionamide	2.00				1	1					Rifabutin	0.50	1	1							
Ethionamide	2.50				1	1					Rifabutin	1.00	2	2		2	2				
Ethionamide	5.00	28	6	34	2	1	3				Rifabutin	2.00	5	5							
Ethionamide	10.00	5	5		1	1					Clofazimine	0.25				1	1				
Ethionamide	20.00							1	1		Clofazimine	0.50				1	1				
Ethionamide	30.00							1	1		Clofazimine	1.00	2	2							
											Thiacetazon	2.00							1	1	

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

DRUG	Conc.	Test Method									DRUG	Conc.	Test Method									
		Agar Prop. Results			BACTEC Results			LJ Prop. Results					Agar Prop. Results			BACTEC Results			LJ Prop. Results			
		S	R	Sum	S	R	Sum	S	R	Sum			S	R	Sum	S	R	Sum	S	R	Sum	
Isoniazid	0.01				1		1				Kanamycin	5.00	14		14	3		3				
Isoniazid	0.10	1		1	110	1	111				Kanamycin	6.00	23		23							
Isoniazid	0.20	41		41	6		6	4		4	Kanamycin	40.00							1			1
Isoniazid	0.40				25		25				Capreomycin	0.50					1		1			
Isoniazid	0.50							1		1	Capreomycin	1.00				1		1				
Isoniazid	1.00	42		42	8		8	2		2	Capreomycin	1.25				1		1				
Isoniazid	2.00	1	1	2							Capreomycin	2.00				1		1				
Isoniazid	5.00	5		5							Capreomycin	2.50				2		2				
Isoniazid	10.00							2		2	Capreomycin	5.00	1		1	3		3				
Isoniazid	80.00							1		1	Capreomycin	10.00	21		21							
Rifampin	1.00	19	29	48	2	6	8		1	1	Cycloserine	25.00	1		1							
Rifampin	2.00				12	103	115				Cycloserine	30.00	13		13				3			3
Rifampin	5.00	8		8		2	2		1	1	Cycloserine	50.00				1		1				
Rifampin	10.00					1	1				Cycloserine	60.00	1		1							
Rifampin	40.00							1	2	3	p-Aminosalicylic acid	0.50					1	1	1		1	1
Pyrazinamid	10.00				1		1				p-Aminosalicylic acid	1.00					1	1	1		1	1
Pyrazinamid	25.00	2		2	1		1				p-Aminosalicylic acid	2.00	15		15		1	1				
Pyrazinamid	50.00				1		1				p-Aminosalicylic acid	4.00					1	1				
Pyrazinamid	100.00				87	1	88	2		2	p-Aminosalicylic acid	5.00	1		1							
Pyrazinamid	300.00				1		1				p-Aminosalicylic acid	8.00	3		3							
Pyrazinamid	400.00							1		1	p-Aminosalicylic acid	10.00	4		4							
Ethambutol	1.00							1		1	Amikacin	1.00				1		1				
Ethambutol	2.00							4		4	Amikacin	2.00	1		1	2		2				
Ethambutol	2.50				109		109				Amikacin	4.00	2		2	1		1				
Ethambutol	3.75				2		2				Amikacin	5.00	1		1							
Ethambutol	4.00				1		1				Amikacin	6.00	7		7							
Ethambutol	5.00	37		37	8		8	1		1	Amikacin	12.00	2		2							
Ethambutol	6.00	1		1							Amikacin	18.00	1		1							
Ethambutol	7.50	6		6	12		12				Amikacin	30.00	1		1							
Ethambutol	10.00	13		13							Ofloxacin	0.50				1		1				
Streptomycin	1.00							1		1	Ofloxacin	1.00		8	8	1		1				
Streptomycin	2.00	43		43	105		105				Ofloxacin	1.25		1	1							
Streptomycin	2.50				1		1				Ofloxacin	2.00		4	4		5	5		1		1
Streptomycin	3.00				1		1				Ofloxacin	4.00		2	2		1	1				
Streptomycin	4.00				1		1	4		4	Ciprofloxacin	0.50		1	1							
Streptomycin	6.00				17		17				Ciprofloxacin	1.00		6	6		3	3				
Streptomycin	10.00	32		32				1		1	Ciprofloxacin	2.00	2	11	13		1	1				
Ethionamide	0.50				1		1				Ciprofloxacin	4.00					1	1				
Ethionamide	1.00				1		1				Levofloxacin	2.00				1		1				
Ethionamide	1.25				1		1				Rifabutin	0.25		1	1							
Ethionamide	2.00				1		1				Rifabutin	0.50	1		1							
Ethionamide	5.00	33		33	3		3				Rifabutin	1.00	2		2	1	1	2				
Ethionamide	10.00	5		5	1		1				Rifabutin	2.00	5		5							
Ethionamide	20.00								1	1	Clofazimine	0.12				1		1				
Ethionamide	30.00							1		1	Clofazimine	0.25				1		1				
											Clofazimine	1.00	2		2							
											Thiacetazon	2.00									1	1

**Table 2. Participant Results for Culture S,
*M. kansasii***

DRUG	Conc.	Test Method											
		Agar Proportion			BACTEC			Disk Elution			LJ Proportion		
		Results			Results			Results			Results		
		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	2									
Amikacin	5.00	1		1									
Amikacin	6.00	4		4									
Amikacin	12.00	1		1									
Amikacin	32.00	1		1									
Azithromycin	0.50					1	1						
Azithromycin	1.00					1	1						
Azithromycin	3.00	1		1									
Clofazimine	1.00	1		1									
Clarithromycin	1.00	1		1							1		1
Clarithromycin	3.00	5		5									
Clarithromycin	4.00	1		1									
Clarithromycin	10.00	1		1									
Capreomycin	5.00				1		1						
Capreomycin	10.00	4	3	7									
Ciprofloxacin	0.50	1		1									
Ciprofloxacin	1.00	2	1	3									
Ciprofloxacin	2.00	10		10									
Cycloserine	30.00	5		5									
Cycloserine	60.00	1		1									
Cefoxitin	4.00					1	1						
Cefoxitin	8.00					1	1						
Cefoxitin	32.00		1	1									
Doxycycline	2.00					1	1						
Doxycycline	4.00					1	1						
Ethambutol	1.00										1		1
Ethambutol	2.00										1		1
Ethambutol	2.50				2	1	3						
Ethambutol	3.75				1		1						
Ethambutol	5.00	17	4	21	1		1	2		2			
Ethambutol	7.50	3		3	1		1						
Ethambutol	10.00	2	1	3				1		1			
Imipenem	8.00	1		1									
Isoniazid	0.10					5	5						
Isoniazid	0.20		17	17					2	2		1	1
Isoniazid	0.40					1	1						
Isoniazid	1.00		17	17					2	2		1	1
Isoniazid	2.00		1	1									
Isoniazid	5.00		4	4									
Isoniazid	80.00											1	1
Kanamycin	5.00		4	4		1	1						
Kanamycin	6.00	2	6	8									

**Table 2. Participant Results for Culture S,
*M. kansasii***

DRUG	Conc.	Test Method											
		Agar Proportion			BACTEC			Disk Elution			LJ Proportion		
		S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum
Ofloxacin	0.50					1	1						
Ofloxacin	1.00	1	1	2	1		1						
Ofloxacin	1.25	1		1									
Ofloxacin	2.00	3		3									
Ofloxacin	4.00	1		1									
Ofloxacin	10.25					1	1						
p-Aminosalicylic acid	2.00		4	4									
p-Aminosalicylic acid	8.00	1		1									
p-Aminosalicylic acid	10.00	1		1									
Pyrazinamide	100.00											1	1
Pyrazinamide	400.00											1	1
Rifabutin	1.00		1	1									
Rifabutin	2.00	1	1	2									
Rifampin	1.00	1	25	26		1	1		2	2			
Rifampin	2.00		1	1		9	9						
Rifampin	5.00		1	1					1	1		1	1
Rifampin	40.00											3	3
Streptomycin	2.00	17	7	24	5		5	1	1	2			
Streptomycin	4.00											3	3
Streptomycin	10.00	9		9				2		2			
Sparfloxacin	2.00	1		1									
Ethionamide	5.00	11		11	1		1						
Ethionamide	10.00	3		3									
Trimethoprim-Sulfamethoxaz	30.00	1		1									

**Table 3. Participant Results for Culture T,
M. avium complex**

DRUG	Conc.	Test Method											
		Agar Proportion			BACTEC			Disk Elution			LJ Proportion		
		Results			Results			Results			Results		
	S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum	
Amikacin	2.00				2		2						
Amikacin	4.00				1		1						
Amikacin	6.00	2		2									
Amikacin	8.00				3		3						
Amikacin	12.00	1		1									
Amikacin	32.00	1		1									
Azithromycin	3.00		1	1									
Clofazimine	0.06					1	1						
Clofazimine	0.25				1		1						
Clofazimine	1.00	2		2									
Clofazimine	2.00				1		1						
Clarithromycin	2.00					1	1						
Clarithromycin	3.00		2	2									
Clarithromycin	4.00	1		1		2	2						
Clarithromycin	8.00				1		1						
Clarithromycin	9.00		2	2									
Clarithromycin	16.00				1		1						
Clarithromycin	32.00		1	1		2	2						
Clarithromycin	64.00					1	1						
Capreomycin	5.00				1		1						
Capreomycin	10.00	1	2	3									
Ciprofloxacin	1.00	1		1	1		1						
Ciprofloxacin	1.25				1		1						
Ciprofloxacin	2.00	4		4									
Ciprofloxacin	4.00				1		1						
Ciprofloxacin	8.00				1		1						
Cycloserine	30.00	3		3									
Cefoxitin	32.00	1		1									
Ethambutol	2.00					2	2					2	2
Ethambutol	2.50					2	2						
Ethambutol	4.00					1	1						
Ethambutol	5.00		4	4				1		1			
Ethambutol	7.50		2	2									
Ethambutol	8.00				1	1	2						
Ethambutol	10.00		2	2				1		1			
Imipenem	8.00	1		1									
Isoniazid	0.10					1	1						
Isoniazid	0.20		6	6				1		1		1	1
Isoniazid	0.40					1	1						
Isoniazid	1.00		5	5				1		1		1	1
Kanamycin	5.00	2		2	1		1						
Kanamycin	6.00	2		2									

**Table 3. Participant Results for Culture T,
M. avium complex**

DRUG	Conc.	Test Method												
		Agar Proportion			BACTEC			Disk Elution			LJ Proportion			
		S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum	
Ofloxacin	1.25		1	1										
Ofloxacin	2.00		2	2										
Ofloxacin	4.00	1		1										
p-Aminosalicylic acid	2.00	1		1										
Pyrazinamide	100.00											1	1	
Pyrazinamide	400.00											1	1	
Rifabutin	0.12				1		1							
Rifabutin	0.25				2		2							
Rifabutin	0.50				1		1							
Rifabutin	1.00	1	1	2	2		2							
Rifabutin	2.00	1		1	1		1							
Rifampin	1.00	5	3	8				1	1					
Rifampin	2.00				2		2							
Rifampin	5.00							1	1			1	1	
Rifampin	40.00											2		2
Streptomycin	2.00	4	4	8	2		2		1	1		1	1	2
Streptomycin	4.00													
Streptomycin	10.00	2		2					1	1				
Ethionamide	2.50		1	1										
Ethionamide	5.00		2	2		1	1							
Ethionamide	10.00		1	1										

Table 4. Minimum Inhibitory Concentrations for Strain S, *M. kansasii*

DRUG	Test Method	MIC	Interpretation			Sum
			S	R	None	
Amikacin	BACTEC 460	≤2.00	1			1
Amikacin	E-test	1.50	1			1
Amikacin	Microtiter	8.00			1	1
Amikacin	Microtiter	16.00		1		1
Amikacin	Microtiter	≤0.50	1			1
Azithromycin	Microtiter	≤0.50	1			1
Clofazimine	BACTEC 460	≤0.60	1			1
Clarithromycin	BACTEC 460	2.00	1			1
Clarithromycin	BACTEC 460	≤2.00	2			2
Clarithromycin	E-test	≤0.01	1			1
Clarithromycin	Microtiter	0.25	1		1	2
Clarithromycin	Microtiter	≤0.13	1			1
Capreomycin	Agar proportion	>16.00		1		1
Ciprofloxacin	BACTEC 460	2.00	1			1
Ciprofloxacin	BACTEC 460	≤1.00	1			1
Ciprofloxacin	E-test	0.38	1			1
Ciprofloxacin	Microtiter	2.00			1	1
Ciprofloxacin	Microtiter	4.00		1		1
Ciprofloxacin	Microtiter	≤0.50	1			1
Cycloserine	Agar proportion	>32.00		1		1
Cefoxitin	E-test	12.00	1			1
Ethambutol	Agar proportion	>8.00		1		1
Ethambutol	BACTEC 460	2.00	1			1
Ethambutol	BACTEC 460	≤2.00	1			1
Ethambutol	Microtiter	1.00	1			1
Ethambutol	Microtiter	4.00			1	1
Imipenem	E-test	>32.00		1		1
Isoniazid	Agar proportion	>4.00		1		1
Isoniazid	BACTEC 460	2.00	1			1
Isoniazid	Microtiter	>16.00		1	1	2
Kanamycin	Agar proportion	>16.00		1		1
Minocycline	E-test	32.00		1		1
Minocycline	Microtiter	32.00		1		1
Ofloxacin	BACTEC 460	≤1.00	1			1
Ofloxacin	Microtiter	≤0.50	1			1
Rifabutin	BACTEC 460	>2.00		2		2
Rifabutin	Microtiter	8.00		1	1	2
Rifabutin	Microtiter	16.00		1		1
Rifabutin	Microtiter	>8.00		1		1

Table 4. Minimum Inhibitory Concentrations for Strain S, *M. kansasii*

DRUG	Test Method	MIC	Interpretation			Sum
			S	R	None	
Rifampin	Agar proportion	>4.00		1		1
Rifampin	BACTEC 460	>8.00		1		1
Rifampin	Microtiter	>16.00			1	1
Rifampin	Microtiter	>64.00		1		1
Streptomycin	Agar proportion	8.00	1			1
Streptomycin	BACTEC 460	≤2.00	1			1
Sulfamethoxazole	Microtiter	2.00	1			1
Ethionamide	Agar proportion	8.00	1			1

Table 5. Minimum Inhibitory Concentrations for Strain T, *M. avium* complex

DRUG	Test Method	MIC	Interpretation			Sum
			S	R	None	
Amikacin	BACTEC 460	≤2.00	3			3
Amikacin	BACTEC 460	≤4.00	1			1
Amikacin	E-test	>1.00		1		1
Amikacin	Microtiter	2.00			1	1
Amikacin	Microtiter	≤0.50	1			1
Azithromycin	BACTEC 460	>256.00		1		1
Azithromycin	Microtiter	>32.00		1		1
Clofazimine	BACTEC 460	≤0.06	3			3
Clofazimine	BACTEC 460	≤0.60	1			1
Clofazimine	Microtiter	2.00		1		1
Clarithromycin	BACTEC 460	32.00		1		1
Clarithromycin	BACTEC 460	>8.00		1		1
Clarithromycin	BACTEC 460	>16.00		1		1
Clarithromycin	BACTEC 460	>32.00		3		3
Clarithromycin	E-test	>256.00		4		4
Clarithromycin	Microtiter	32.00		1		1
Clarithromycin	Microtiter	>8.00		1		1
Clarithromycin	Microtiter	>16.00		1		1
Capreomycin	Agar proportion	>16.00		1		1
Ciprofloxacin	BACTEC 460	1.00	1			1
Ciprofloxacin	BACTEC 460	≤1.00	3			3
Ciprofloxacin	BACTEC 460	≤2.00	1			1
Ciprofloxacin	E-test	0.12	1			1
Ciprofloxacin	E-test	8.00		1		1
Ciprofloxacin	E-test	>256.00		1		1
Ciprofloxacin	Microtiter	0.25	1			1
Ciprofloxacin	Microtiter	≤0.50	1			1
Cycloserine	Agar proportion	>32.00		1		1
Cefoxitin	E-test	>256.00		2		2
Ethambutol	Agar proportion	>8.00		1		1
Ethambutol	BACTEC 460	8.00		2	1	3
Ethambutol	BACTEC 460	>8.00		3		3
Ethambutol	E-test	>256.00		2		2
Ethambutol	Microtiter	8.00		1		1
Imipenem	E-test	12.00		1		1
Isoniazid	Agar proportion	>4.00		1		1
Isoniazid	Microtiter	>16.00			1	1
Kanamycin	Agar proportion	>16.00		1		1
Kanamycin	BACTEC 460	≤2.00	1			1
Minocycline	E-test	48.00		1		1
Ofloxacin	Microtiter	≤0.50	1			1

Table 5. Minimum Inhibitory Concentrations for Strain T, *M. avium* complex

DRUG	Test Method	MIC	Interpretation			Sum
			S	R	None	
Rifabutin	BACTEC 460	0.50	1			1
Rifabutin	BACTEC 460	≤0.12	1			1
Rifabutin	BACTEC 460	≤0.50	2			2
Rifabutin	Microtiter	≤0.03	1			1
Rifabutin	Microtiter	≤0.50	1			1
Rifampin	Agar proportion	>4.00		1		1
Rifampin	BACTEC 460	0.50	1			1
Rifampin	BACTEC 460	≤0.50	3			3
Rifampin	BACTEC 460	≤1.00	1			1
Rifampin	E-test	1.00	1			1
Rifampin	Microtiter	0.13	1			1
Streptomycin	Agar proportion	16.00	1			1
Streptomycin	BACTEC 460	≤2.00	4			4
Ethionamide	Agar proportion	>8.00		1		1
Ethionamide	BACTEC 460	>4.00		1		1