September 9, 1998

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 February 1998 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. fortuitum* shipped in February 1998. Participant laboratories received either only the 3 *M. tuberculosis* strains or all five *M. tuberculosis* and nontuberculous mycobacteria (NTM) strains. Testing results were received and analyzed from 155 of 160 (96.9*%)* of laboratories participating in this shipment.

We would like to acknowledge and recognize the following individuals that have provided valuable consultation for this performance evaluation program and report:

Dr. Richard Wallace, University of Texas Health Center, Tyler, TX
Dr. Gail Woods, University of Texas Medical Branch, Galveston, TX
Dr. Jerry Mazurek, Division of Tuberculosis Elimination, NCHSTP/CDC
Dr. Beverly Metchock, Division of AIDS, STD, and TB Laboratory Research, NCID/CDC
Dr. Laurina Williams, Division of Laboratory Systems, PHPPO/CDC
Ron Fehd, Division of Laboratory Systems, PHPPO/CDC
Carl Cook, DynCorp Health Research Services Division, Durham, NC

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 all 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.

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 February 1998 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 1strain of *M. fortuitum* shipped in February 1998. Participant laboratories either received only the 3 *M. tuberculosis* or all five *M. tuberculosis* and NTM strains. Testing results were received and analyzed from 155 of 160 (96.9%) participating laboratories in this shipment.

Descriptive Information on Participant laboratories

Figure 1 shows the laboratory classification reported by 154 of the participants. Participants consisted of 74 health departments, 66 hospitals, 13 independents, and 1 "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 1997.

There were 66 of the 155 participants (42.6%) that indicated they perform some drug susceptibility testing for NTM. Table 1 provides information on the number of participants that indicated they test each species of NTM. Table 1 also provides the distribution of the annual volumes of each NTM species isolates tested for drug susceptibilities by participating laboratories in calendar year 1997.

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 lists the biosafety levels reported by participant laboratories for working with rapidly growing NTM cultures and figure 5 lists the biosafety levels reported by participant laboratories for working with slow growing NTM cultures.

Figure 6 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. Figure 7 provides a breakdown of the test procedures used by the participating laboratories for *M.kansasii.* Figure 8 provides a breakdown of the test procedures used by the participating laboratories for *M.fortuitum.*

M.tuberculosis test results:

The aggregate test results are provided in separate tables, representing cultures A, B, C, D and E, to facilitate comparison among laboratories. Table 2 for the *M. tuberculosis* cultures A, B, and C

is constructed to include the results for both the radiometric (BACTEC) and conventional (agar) 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 2 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.

Both cultures A and B are strains of *M. tuberculosis* that were obtained from the World Health Organization and International Union against Tuberculosis and Lung Disease (WHO/IUATLD) quality assurance programme for drug susceptibility testing (7). The WHO/IUATLD have a program very similar to the CDC performance evaluation program, and we are sharing strains to assess the comparability of susceptibility testing results received from laboratories in different countries and with different test methods. Strain A was resistant to isoniazid and ethambutol and strain B was resistant to streptomycin.

For strain A, 96% (48/50) of participants using the conventional method and 99.1% (115/116) using the BACTEC method detected isoniazid resistance among the 155 CDC participants. 100% of the 22 WHO/IUATLD participants detected isoniazid resistance. For ethambutol and strain A, 97.9% (46/47) of participants using the conventional method and 98.2% (108/110) using the BACTEC method detected ethambutol resistance among the 155 CDC participants. 100% of the 22 WHO/IUATLD participants detected ethambutol resistance. Isoniazid and ethambutol resistance for the CDC participants was determined at the critical concentrations of drug for both the conventional and BACTEC methods. An additional 23.9% (11/46) of CDC participants using the conventional method and 4/22 (18.2%) of the WHO/IUATLD participants detected streptomycin resistance for strain A.

For strain B, 77.3% (17/22) of WHO/IUATLD participants detected streptomycin resistance. Among CDC participants, 97.7% (43/44) detected streptomycin resistance at the critical concentration (2 Fg/ml) in the conventional method, and 83.8% (93/111) detected streptomycin resistance at the equivalent concentration (2 Fg/ml) with the BACTEC method. An additional 12% (13/108) of CDC participants detected ethambutol resistance using the BACTEC method.

Strain C was isoniazid resistant; however, there were discrepant results for detection of resistance to isoniazid. Isoniazid resistance was reported by 36/47 (76.6%) of participants at 0.2 Fg/ml with the conventional method and by 90/115 (78.3%) of participants with the BACTEC equivalent concentration of 0.1 Fg/ml.

The provision of 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 the purpose of research or for 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 with expertise in the treatment of 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 3 and 4 for culture D, *M. kansasii* and Tables 5 and 6 for culture E, *M. fortuitum* to facilitate comparison among laboratories. Tables 3 and 5, for *M. kansasii* and *M. fortuitum* respectively, represent either single or multiple drug concentrations with "breakpoint" susceptibility test results. In tables 3 and 5, the participant laboratories reported an interpretation of either susceptibility or resistance for each drug concentration that was reported. Tables 4 and 6 represent all minimum inhibitory concentrations (MICs) susceptibility test results, for *M. kansasii* and *M. fortuitum* respectively, reported by the participant laboratories. Tables 4 and 6 include all the quantitative MIC test results, regardless of whether the laboratory provided a test interpretation of resistant or susceptible for the reported MIC.

There were 49 participants that reported test results for *M. kansasii* among the 53 participants that indicated in Table 1 they perform drug susceptibility testing for *M. kansasii* in their laboratory. Table 3, representing all of the breakpoint susceptibility test results for *M. kansasii*, includes results reported for the conventional agar proportion, BACTEC, Microtiter, and Disk elution test methods. Most participants reporting results for *M. kansasii* used the conventional method 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." There was 100% agreement for rifampin susceptibility with the concentrations of drug recommended for *M. tuberculosis* in the conventional (28/28) and BACTEC (12/12) methods for this strain of *M. kansasii*. 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).

There were 28 participants that reported test results for *M. fortuitum* among the 38 participants that indicated in Table 1 they perform drug susceptibility testing for *M. fortuitum* in their laboratory. Table 5, representing all of the breakpoint susceptibility test results for *M. fortuitum*, includes results reported for the conventional agar proportion, BACTEC, E-test, Microtiter, Disk elution, and Kirby Bauer test methods. The ATS recommendations note that the "rapidly growing mycobacteria (*M. fortuitum, M. abscessus, M.chelonae*) should not be performed with

the antituberculosis agents. They should be tested against antibacterial drugs including amikacin, doxycycline, imipenem, the fluorinated quinolones, a sulfonamide, cefoxitin, and clarithromycin."

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

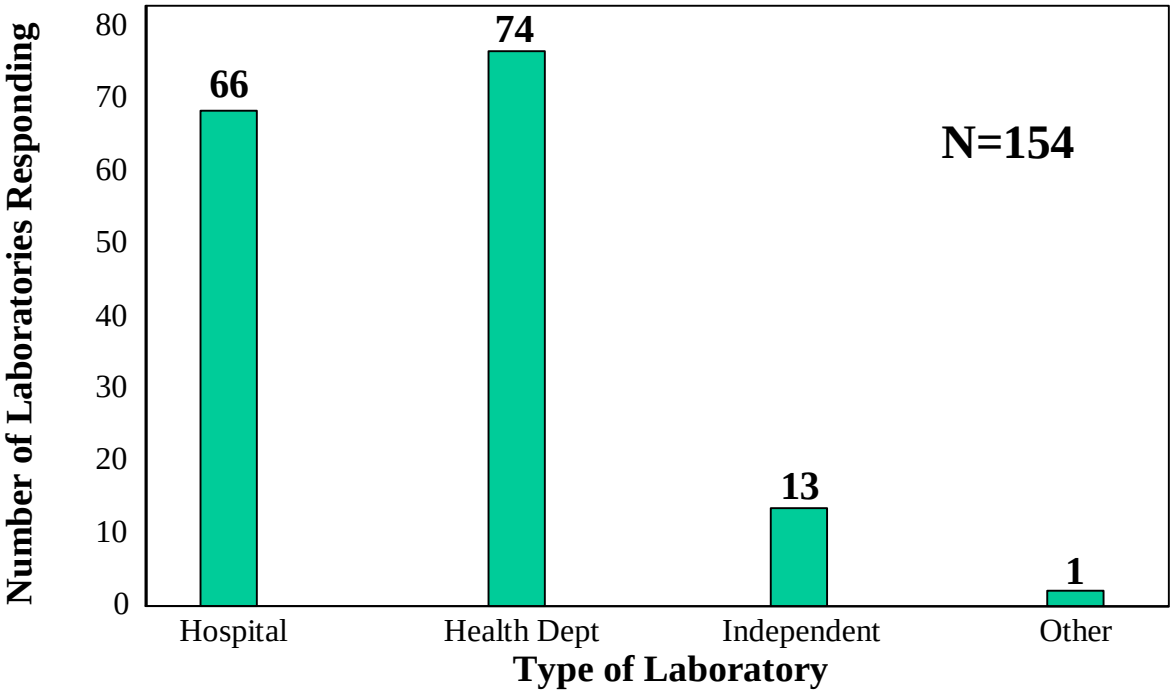
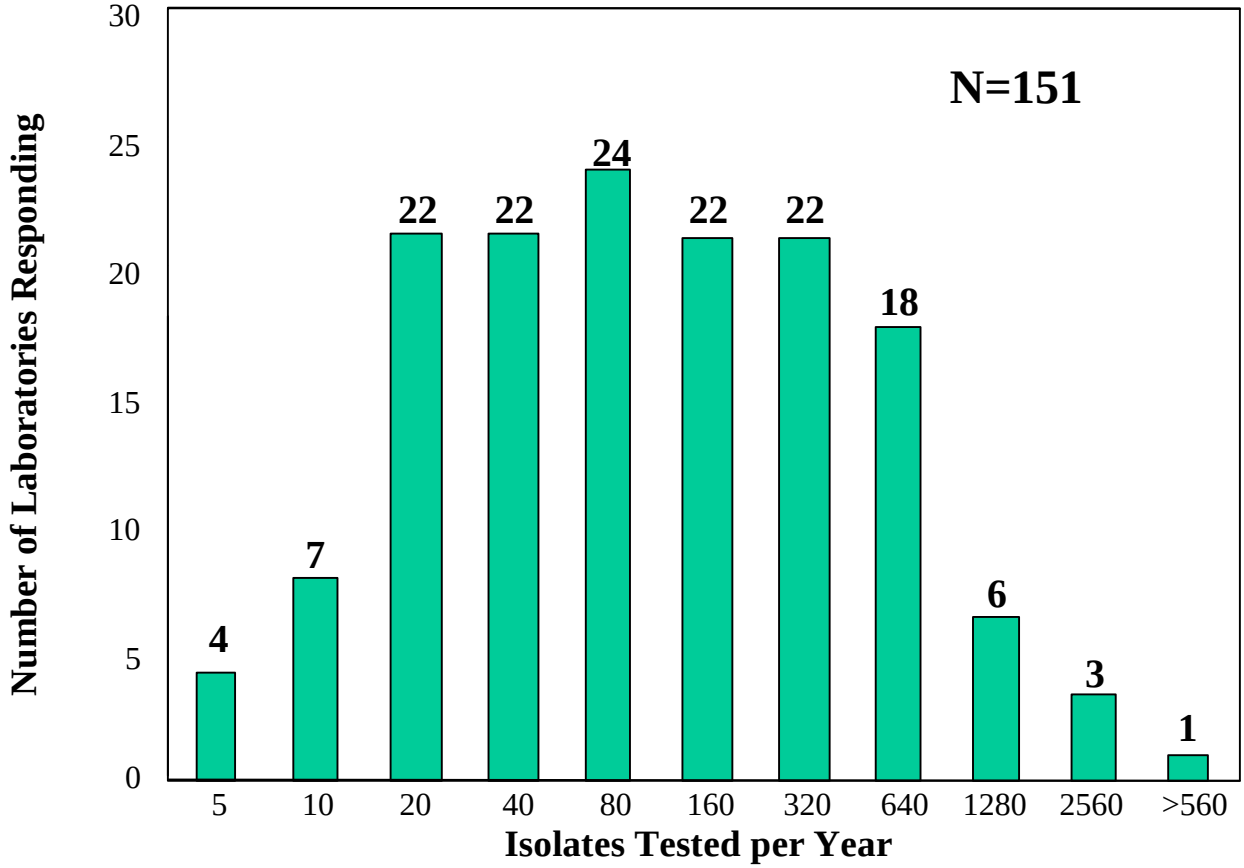
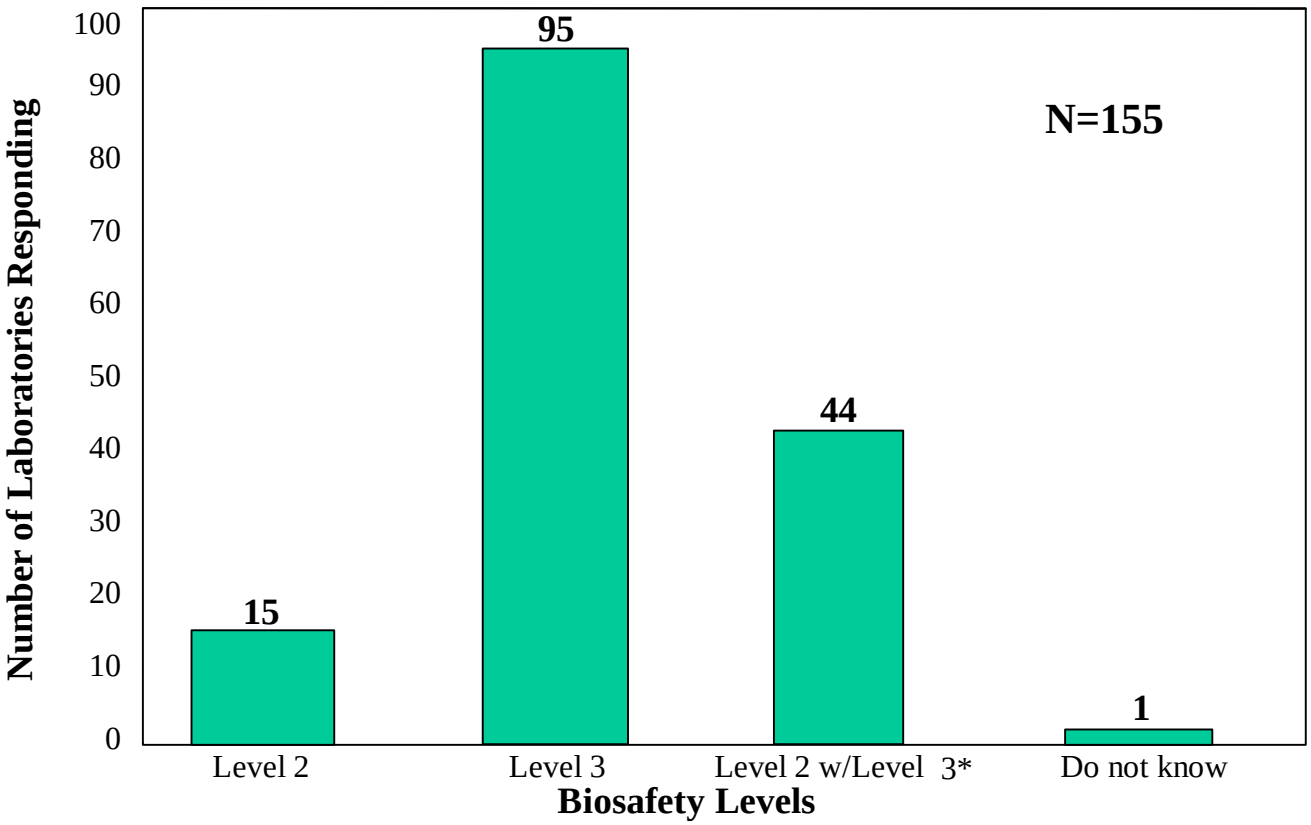


Figure 2. 1997 Annual Volume of *M. tuberculosis* Isolates for Participating Laboratories



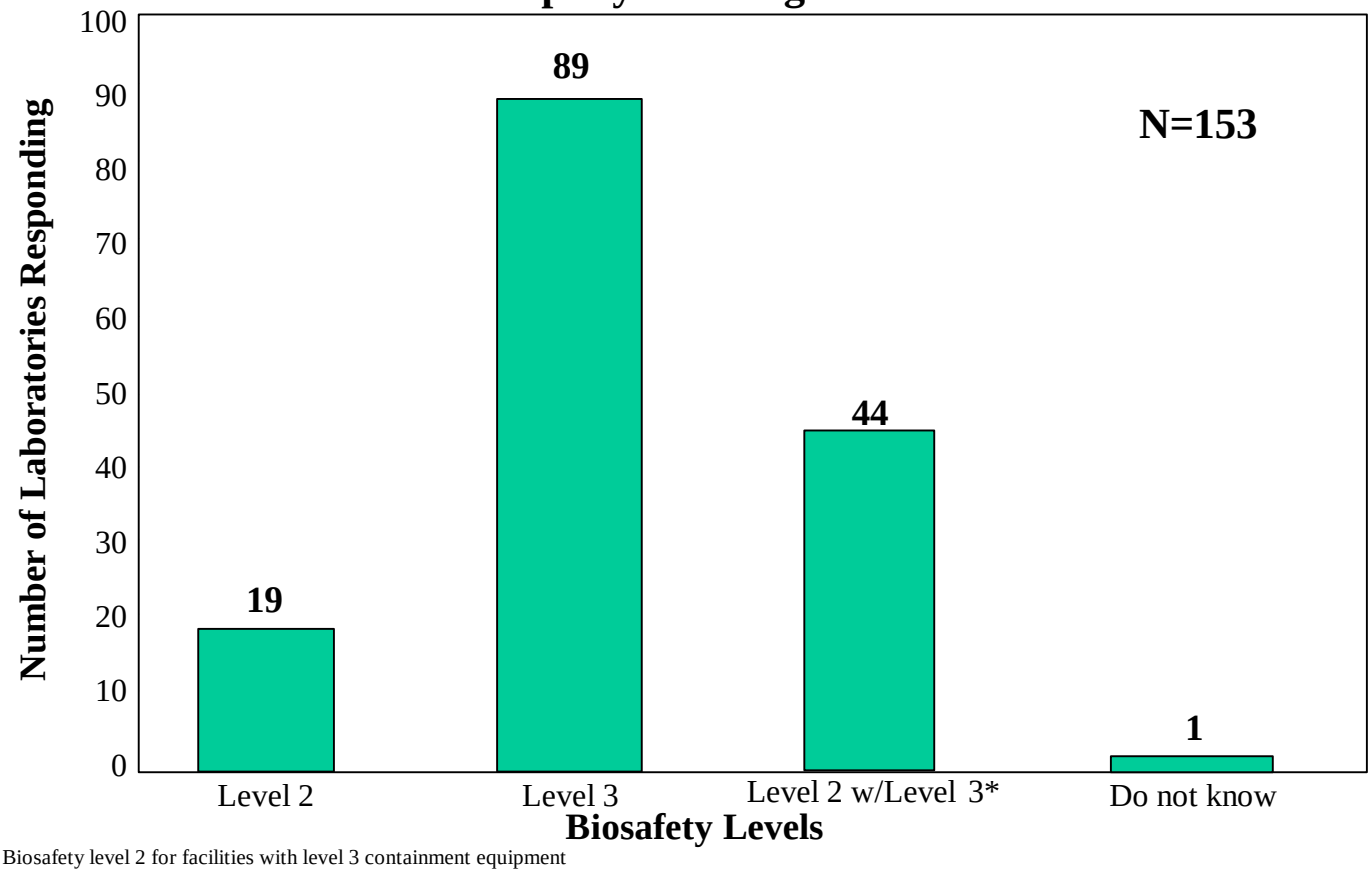
Group labels indicate upper limit of the group.

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



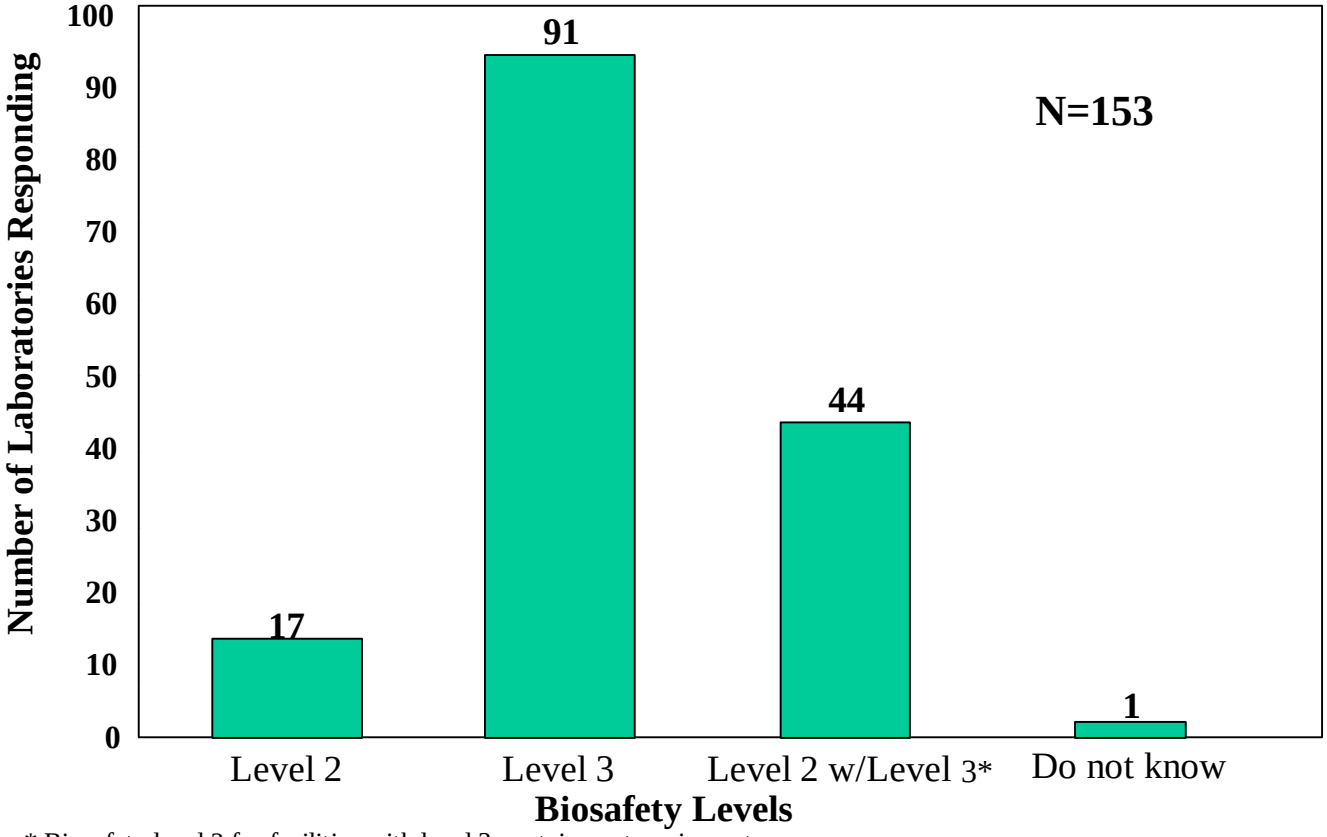
* Biosafety level 2 for facilities with level 3 containment equipment

Figure 4. Biosafety Levels of Participating Laboratories for Rapidly Growing NTM



* Biosafety level 2 for facilities with level 3 containment equipment

Figure 5. Biosafety Levels of Participating Laboratories for Slow Growing NTM



* Biosafety level 2 for facilities with level 3 containment equipment

Figure 6. Test Procedures used by Laboratories for M. *tuberculosis*

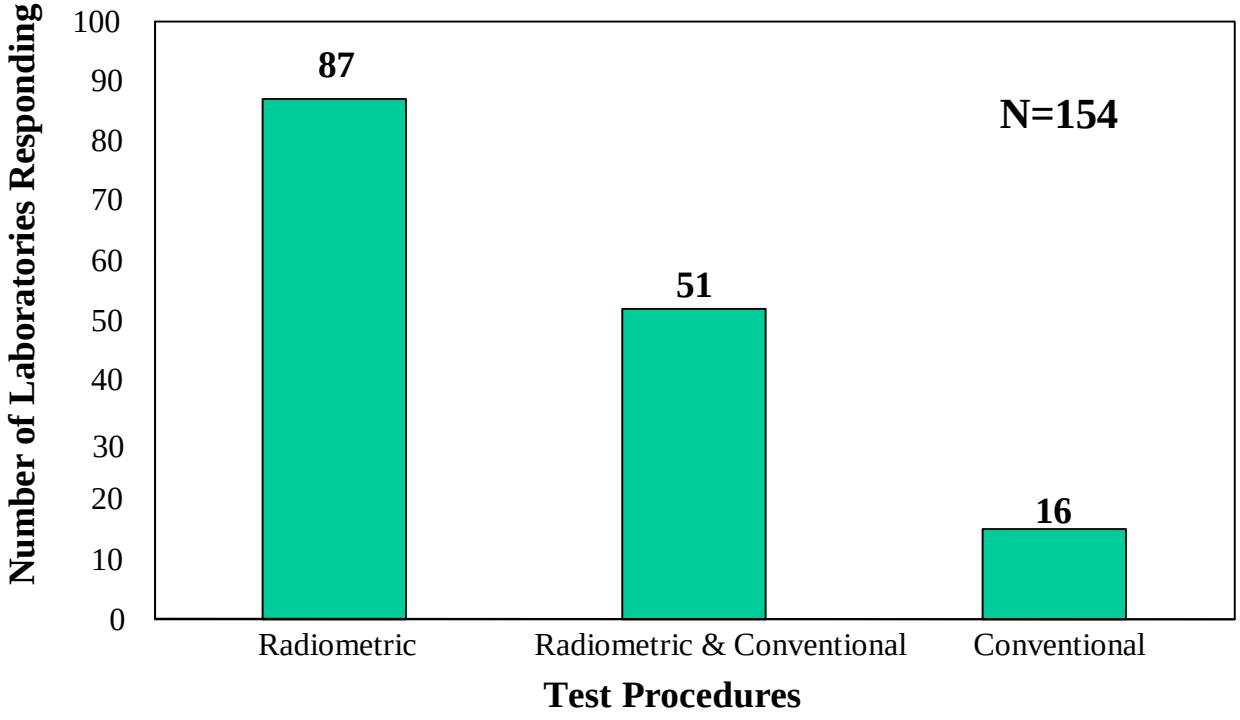


Figure 7. Test Procedures used by Laboratories for M. *Kansasii*

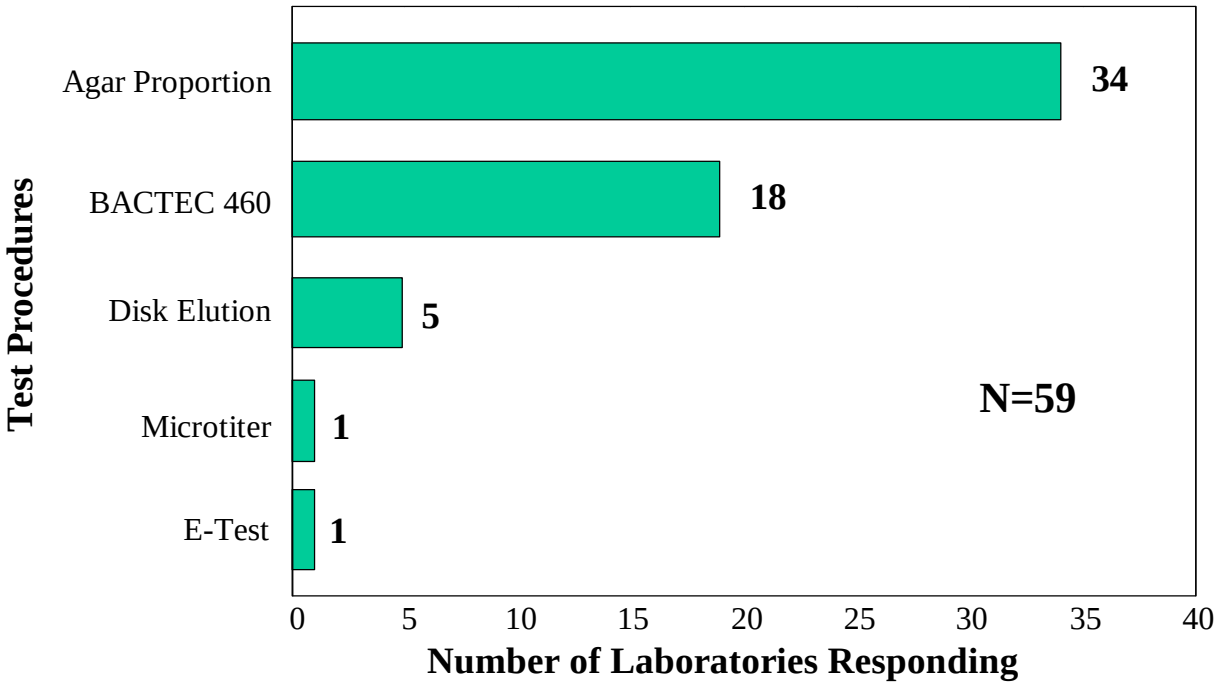


Figure 8. Test Procedures used by Laboratories for *M. fortuitum*

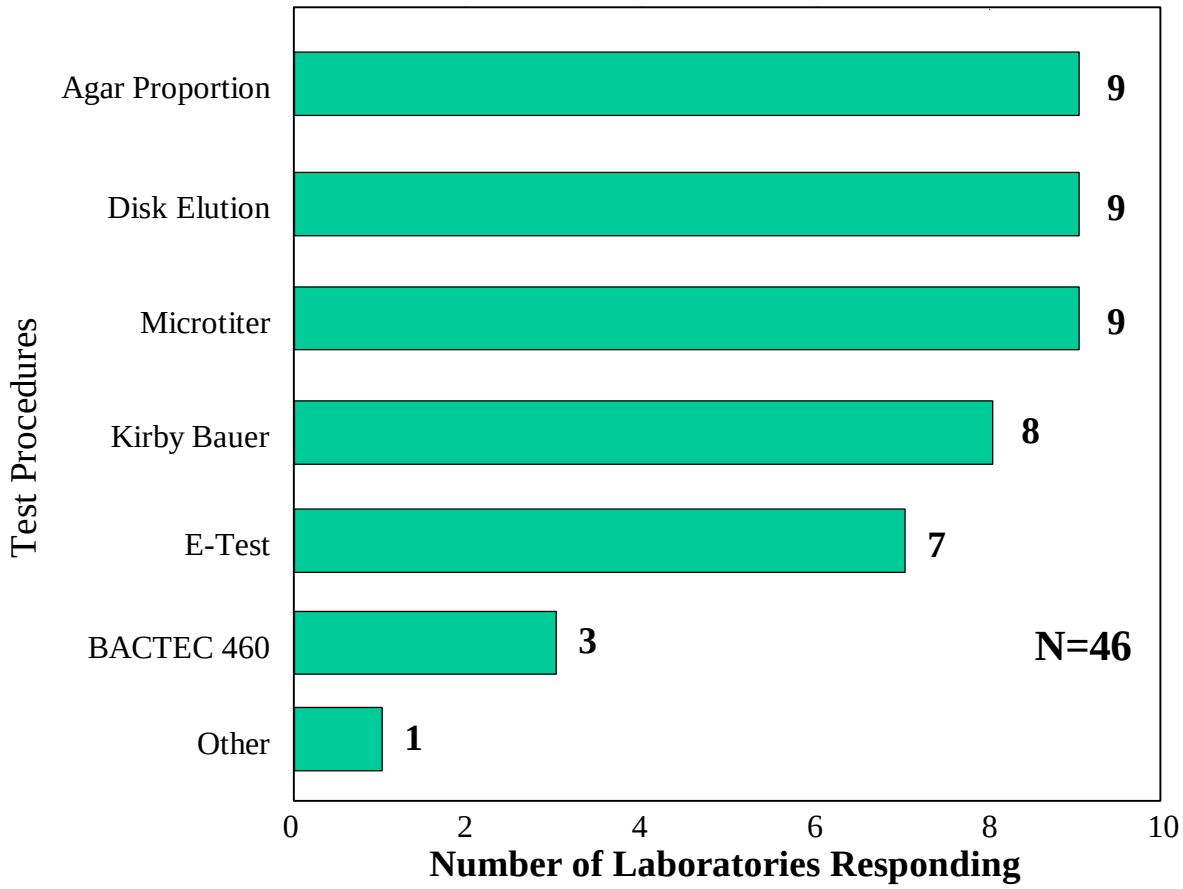


Table 1.
Participant Testing For NTM With Associated Annual Test Volumes

	Laboratories Testing NTM		Annual Volume of NTM Tests				
NTM	Number	% Testing NTM*	# Reporting	Minimum	Mean	Median	Maximum
M. kansasii	53	81.5	48	1	21	14	95
M. fortuitum	38	58.5	34	1	28	10	240
M. chelonai	37	56.9	30	1	24	5	360
M. marinum	37	56.9	35	1	9	5	46
M. avium complex	31	47.7	26	1	189	102	999
M. xenopi	31	47.7	26	1	11	4	83
M. abscessus	27	41.5	20	1	18	4.5	86
M. gordonae	15	23.1	14	1	27	11.5	100
M. terrae	15	23.1	12	1	4	2.5	15
M. genavense	4	6.2	1	1	1	1	1

*66 Participant laboratories reported testing NTM

Table 2. Participant Results for Culture A -- *M. tuberculosis*

		Test Method					
		Agar Proportion Results			BACTEC Results		
DRUG	Conc.	S	R	Sum	S	R	Sum
Isoniazid	0.01					4	4
Isoniazid	0.10				1	115	116
Isoniazid	0.20	2	48	50		7	7
Isoniazid	0.40					23	23
Isoniazid	1.00	1	45	46		9	9
Isoniazid	2.00		1	1		2	2
Isoniazid	5.00		6	6		1	1
Rifampin	0.50	1		1			
Rifampin	1.00	51		51	9		9
Rifampin	2.00				120		120
Rifampin	5.00	10		10	1		1
Pyrazinamide	25.00	1		1	1		1
Pyrazinamide	75.00				1		1
Pyrazinamide	100.00				99		99
Ethambutol	2.50				2	108	110
Ethambutol	3.75					1	1
Ethambutol	4.00					1	1
Ethambutol	5.00	1	46	47		9	9
Ethambutol	7.50		6	6	3	16	19
Ethambutol	10.00	7	10	17		1	1
Streptomycin	2.00	35	11	46	111		111
Streptomycin	2.50	1		1			
Streptomycin	3.00				1		1
Streptomycin	4.00				1		1
Streptomycin	5.00	1		1			
Streptomycin	6.00				23		23
Streptomycin	10.00	33		33	2		2
Ethionamide	1.25				1		1
Ethionamide	2.50				2		2
Ethionamide	5.00	36		36	4		4
Ethionamide	10.00	4		4	1		1
Kanamycin	5.00	13		13	2		2
Kanamycin	6.00	26		26			
Capreomycin	1.25				1		1
Capreomycin	2.50				2		2
Capreomycin	5.00	1		1	5		5
Capreomycin	10.00	19	1	20			

		Test Method					
		Agar Proportion Results			BACTEC Results		
DRUG	Conc.	S	R	Sum	S	R	Sum
Cycloserine	25.00	2		2			
Cycloserine	30.00	17		17			
Cycloserine	50.00	1		1			
Cycloserine	60.00	2		2			
p-Aminosalicylic ac	2.00	18	1	19			
p-Aminosalicylic ac	4.00				2		2
p-Aminosalicylic ac	8.00	4		4			
p-Aminosalicylic ac	10.00	3		3	1		1
Amikacin	1.00	1		1			
Amikacin	2.00				2		2
Amikacin	2.50				1		1
Amikacin	4.00	2		2	1		1
Amikacin	5.00	1		1	1		1
Amikacin	6.00	7		7			
Amikacin	12.00	1		1			
Amikacin	18.00	1		1			
Amikacin	30.00	1		1			
Ofloxacin	1.00	5	2	7	1	2	3
Ofloxacin	1.25	1		1		1	1
Ofloxacin	2.00	2		2	4	1	5
Ofloxacin	2.50				1		1
Ofloxacin	4.00	1		1			
Ofloxacin	48.00	1		1			
Ciprofloxacin	1.00	5	1	6	2	1	3
Ciprofloxacin	2.00	14	1	15	1		1
Ciprofloxacin	2.50				1		1
Rifabutin	0.50	2		2			
Rifabutin	1.00	1		1	2		2
Rifabutin	2.00	3		3	1		1

Table 2. Participant Results for Culture B -- *M. tuberculosis*

		Test Method					
		Agar Proportion Results			BACTEC Results		
DRUG	Conc.	S	R	Sum	S	R	Sum
Isoniazid	0.01				3		3
Isoniazid	0.10				116		116
Isoniazid	0.20	47		47	6		6
Isoniazid	0.40				23		23
Isoniazid	1.00	42		42	8		8
Isoniazid	2.00	1		1	1		1
Isoniazid	5.00	5		5			
Rifampin	0.50	1		1			
Rifampin	1.00	50		50	8		8
Rifampin	2.00				119		119
Rifampin	5.00	10		10			
Pyrazinamide	25.00	1		1	1		1
Pyrazinamide	100.00				98	1	99
Ethambutol	2.50				95	13	108
Ethambutol	3.75				1		1
Ethambutol	4.00				1		1
Ethambutol	5.00	44		44	8		8
Ethambutol	7.50	6		6	19	1	20
Ethambutol	10.00	14		14	1		1
Streptomycin	2.00	1	43	44	18	93	111
Streptomycin	2.50		1	1			
Streptomycin	3.00					1	1
Streptomycin	4.00					1	1
Streptomycin	5.00	1		1			
Streptomycin	6.00				18	5	23
Streptomycin	10.00	31	2	33	2		2
Ethionamide	1.25				1		1
Ethionamide	5.00	36		36	4		4
Ethionamide	10.00	4		4	1		1
Kanamycin	5.00	13		13	2		2
Kanamycin	6.00	25		25			
Capreomycin	1.25				1		1
Capreomycin	2.50				1		1
Capreomycin	5.00	1		1	4		4
Capreomycin	10.00	20		20			

		Test Method					
		Agar Proportion Results			BACTEC Results		
DRUG	Conc.	S	R	Sum	S	R	Sum
Cycloserine	25.00	2		2			
Cycloserine	30.00	15		15			
Cycloserine	50.00	1		1			
Cycloserine	60.00	1		1			
p-Aminosalicylic a	2.00	18		18			
p-Aminosalicylic a	4.00				1	1	2
p-Aminosalicylic a	8.00	3		3			
p-Aminosalicylic a	10.00	3		3	1		1
Amikacin	1.00	1		1			
Amikacin	2.00				2		2
Amikacin	4.00	2		2	1		1
Amikacin	5.00	1		1	1		1
Amikacin	6.00	6		6			
Amikacin	12.00	1		1			
Amikacin	18.00	1		1			
Amikacin	30.00	1		1			
Ofloxacin	1.00	7		7	2		2
Ofloxacin	1.25	1		1	1		1
Ofloxacin	2.00	3		3	6		6
Ofloxacin	4.00	1		1			
Ofloxacin	48.00	1		1			
Ciprofloxacin	1.00	6		6	2		2
Ciprofloxacin	2.00	14		14	2		2
Rifabutin	0.50	2		2			
Rifabutin	1.00	1		1	2		2
Rifabutin	2.00	3		3	1		1

Table 2. Participant Results for Culture C -- *M. tuberculosis*

		Test Method					
		Agar Proportion Results			BACTEC Results		
DRUG	Conc.	S	R	Sum	S	R	Sum
Isoniazid	0.01				1	3	4
Isoniazid	0.10				25	90	115
Isoniazid	0.20	11	36	47	3	3	6
Isoniazid	0.40				23		23
Isoniazid	1.00	43	1	44	8		8
Isoniazid	2.00	1		1	1		1
Isoniazid	5.00	5		5			
Rifampin	0.50	1		1			
Rifampin	1.00	50	1	51	8		8
Rifampin	2.00				119		119
Rifampin	5.00	10		10			
Pyrazinamide	25.00	1		1	1		1
Pyrazinamide	100.00				99		99
Ethambutol	2.50				109	2	111
Ethambutol	3.75				1		1
Ethambutol	4.00				1		1
Ethambutol	5.00	40	3	43	7		7
Ethambutol	7.50	6		6	20		20
Ethambutol	10.00	15		15	1		1
Streptomycin	2.00	47		47	110		110
Streptomycin	2.50	1		1			
Streptomycin	3.00				1		1
Streptomycin	4.00				1		1
Streptomycin	5.00	1		1			
Streptomycin	6.00				23		23
Streptomycin	10.00	32		32	2		2
Ethionamide	5.00	20	15	35	4		4
Ethionamide	10.00	2	2	4	1		1
Kanamycin	5.00	14		14	2		2
Kanamycin	6.00	23		23			
Capreomycin	2.50				1		1
Capreomycin	5.00	1		1	4		4
Capreomycin	10.00	20	1	21			

		Test Method					
		Agar Proportion Results			BACTEC Results		
DRUG	Conc.	S	R	Sum	S	R	Sum
Cycloserine	25.00	1	1	2			
Cycloserine	30.00	16		16			
Cycloserine	50.00	1		1			
Cycloserine	60.00	1		1			
p-Aminosalicylic	2.00	18		18			
p-Aminosalicylic	4.00				2		2
p-Aminosalicylic	8.00	3		3			
p-Aminosalicylic	10.00	3		3	1		1
Amikacin	1.00	1		1			
Amikacin	2.00				2		2
Amikacin	4.00	2		2	1		1
Amikacin	5.00	1		1	1		1
Amikacin	6.00	5		5			
Amikacin	12.00	1		1			
Amikacin	18.00	1		1			
Amikacin	30.00	1		1			
Ofloxacin	1.00	7		7	2		2
Ofloxacin	1.25	1		1	1		1
Ofloxacin	2.00	3		3	5		5
Ofloxacin	4.00	1		1			
Ofloxacin	48.00	1		1			
Ciprofloxacin	1.00	5		5	2		2
Ciprofloxacin	2.00	13		13	2		2
Rifabutin	0.50	2		2			
Rifabutin	1.00	1		1	2		2
Rifabutin	2.00	3		3	1		1

Table 3. Participant Results for Culture D,*M. kansasii*

		Test Method											
		Agar Proport.			BACTEC			E-Test			Microtiter		
		Results			Results			Results			Results		
DRUG	Conc.	S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum
Amikacin	4.00	2		2				1		1			
Amikacin	5.00	1		1									
Amikacin	6.00	2	1	3							1		1
Amikacin	8.00	1		1									
Amikacin	12.00	1		1							1		1
Amikacin	32.00	1		1									
Clarithromycin	0.50							1		1			
Clarithromycin	3.00	2		2							1		1
Clarithromycin	4.00	1		1									
Clarithromycin	6.00	2		2									
Clarithromycin	9.00	1		1									
Capreomycin	5.00				1		1						
Capreomycin	10.00	2	6	8									
Ciprofloxacin	1.00	1	1	2				1		1			
Ciprofloxacin	2.00	8	1	9	1		1				1		1
Ciprofloxacin	5.00										1		1
Cycloserine	30.00	5	1	6									
Cefoxitin	32.00		1	1									
Ethambutol	2.00					1	1	1		1			
Ethambutol	2.50				5	2	7						
Ethambutol	3.75				1		1						
Ethambutol	5.00	12	8	20							4	1	5
Ethambutol	7.50	4	1	5	2		2						
Ethambutol	10.00	5	2	7							1		1
Imipenem	8.00		1	1									
Isoniazid	0.10					8	8						
Isoniazid	0.20	2	22	24		1	1					5	5
Isoniazid	0.40					4	4						
Isoniazid	1.00	13	1	14	2		2	1		1	3		3
Isoniazid	2.00	1		1									
Isoniazid	5.00	3		3							1		1
Kanamycin	5.00	1	4	5									
Kanamycin	6.00		6	6								2	2
Kanamycin	16.00								1	1			
Ofloxacin	1.00	1		1									
Ofloxacin	1.25	1		1									
Ofloxacin	2.00	2		2									
p-Aminosalicylic acid	2.00	1	3	4								1	1
Pyrazinamide	100.00		1	1		1	1						
Rifabutin	1.00	1		1									
Rifabutin	2.00	2		2									
Rifampin	0.06							1		1			
Rifampin	1.00	28		28	3		3				4		4
Rifampin	2.00				12		12						
Rifampin	5.00	5		5							1		1
Streptomycin	2.00	12	12	24	9		9	1		1	1	3	4
Streptomycin	3.00				1		1						
Streptomycin	6.00				2		2						
Streptomycin	10.00	13		13							4		4
Ethionamide	5.00	12		12	1		1				1		1
Trimethoprim-Sulfamethoxazole	1.00										1		1

Table 4. Participant Minimum Inhibitory Concentrations (MIC) Test Results for *M. kansasii*

DRUG	TEST METHOD	INTERPRETATION			
		MIC	S	R	None*
Amikacin	BACTEC 460	4.0			1
Amikacin	Microtiter	4.0	1		
Clarithromycin	BACTEC 460	≤ 1.0	1		
Clarithromycin	BACTEC 460	≤ 2.0	1		
Clarithromycin	E-test	0.5	1		
Clarithromycin	Microtiter	0.5	1		
Capreomycin	Agar proportion	≥ 16.0		1	
Ciprofloxacin	BACTEC 460	2.0			1
Ciprofloxacin	Microtiter	1.0	1		
Cycloserine	Agar proportion	≥ 32.0		1	
Ethambutol	Agar proportion	≥ 8.0		1	
Ethambutol	BACTEC 460	6.0			1
Ethambutol	Microtiter	2.0	1		
Isoniazid	Agar proportion	4.0	1		
Isoniazid	BACTEC 460	≥ 0.1		1	
Isoniazid	Microtiter	1.0	1		
Kanamycin	Agar proportion	≥ 16.0		1	
Kanamycin	Microtiter	16.0		1	
Rifabutin	BACTEC 460	≤ 0.5			1
Rifampin	Agar proportion	≤ 1.0	1		
Rifampin	BACTEC 460	≤ 0.5	1		
Rifampin	Microtiter	≤ 0.06	1		
Streptomycin	Agar proportion	≤ 8.0	1		
Streptomycin	BACTEC 460	4.0			1
Streptomycin	Microtiter	2.0	1		
Ethionamide	Agar proportion	8.0	1		

* Some participants reported MIC results without a corresponding interpretation of susceptible or resistant

Table 5. Participant Results for Culture E,*M. fortuitum*

		Test Method																	
		Agar Proport.			BACTEC			E-Test			Microtiter			Disk elution			Kirby Bauer		
		Results			Results			Results			Results			Results			Results		
DRUG	Conc.	S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum
Amikacin	0.50										1		1						
Amikacin	1.50							1		1									
Amikacin	6.00													3		3			
Amikacin	12.00	1		1										2		2			
Amikacin	30.00													7		7	5		5
Amikacin	32.00	1		1															
Clarithromycin	3.00													3	2	5			
Clarithromycin	4.00		2	2							1		1						
Clarithromycin	15.00													1		1	2		2
Ciprofloxacin	0.01							1		1									
Ciprofloxacin	0.06										1		1						
Ciprofloxacin	1.00													1		1			
Ciprofloxacin	2.00	3		3										6		6			
Ciprofloxacin	5.00													1		1	3		3
Cycloserine	30.00		1	1															
Cefoxitin	16.00							1		1									
Cefoxitin	30.00		1	1										7	3	10	1	1	2
Cefoxitin	32.00		1	1															
Doxycycline	5.00														1	1			
Doxycycline	6.00		1	1											4	4			
Doxycycline	30.00													1		1		5	5
Doxycycline	32.00											1	1						
Ethambutol	2.50					2	2												
Ethambutol	5.00		3	3															
Ethambutol	7.50		1	1															
Ethambutol	10.00		2	2															
Erythromycin	3.00		1	1															
Erythromycin	15.00																	2	2
Erythromycin	32.00											1	1						
Gentamycin	4.00		1	1															
Gentamycin	8.00														1	1			
Gentamycin	10.00													1		1	1	1	2
Imipenem	2.00							1		1									
Imipenem	4.00										1		1						
Imipenem	8.00		1	1										6		6			
Imipenem	10.00		1	1										2		2	2	1	3

Table 5. Participant Results for Culture E,*M. fortuitum*, Continued

		Test Method																	
		Agar Proport.			BACTEC			E-Test			Microtiter			Disk elution			Kirby Bauer		
		Results			Results			Results			Results			Results			Results		
DRUG	Conc.	S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum	S	R	Sum
Isoniazid	0.10					2	2												
Isoniazid	0.20		5	5															
Isoniazid	1.00		3	3															
Isoniazid	5.00		1	1															
Kanamycin	12.00		1	1															
Kanamycin	24.00													1		1			
Kanamycin	30.00																2	1	3
Minocycline	6.00		1	1										1	1	2			
Minocycline	10.00													1		1			
Minocycline	30.00													2	1	3		1	1
PAS*	2.00		1	1															
Pyrazinamide	100.00		1	1															
Rifampin	1.00		4	4															
Rifampin	2.00					2	2												
Rifampin	5.00		1	1															
Streptomycin	2.00		5	5		2	2												
Streptomycin	10.00		4	4										1		1		3	3
Sulfamethoxazole	0.25																1		1
Sulfamethoxazole	60.00														1	1			
Sulfamethoxazole	300.00														1	1			
Tetracycline	6.00														1	1			
Ethionamide	5.00		1	1															
TMP/SMX**	0.02							1		1									
TMP/SMX**	0.05		1	1															
TMP/SMX**	10.00														1	1			
TMP/SMX**	20.00													1		1			
TMP/SMX**	25.00													1	1	2			
TMP/SMX**	30.00													3	1	4			
TMP/SMX**	160.00											1	1						
Tobramycin	6.00		1	1															
Tobramycin	8.00														4	4			
Tobramycin	10.00													1		1		4	4
Vancomycin	30.00													1		1	2	1	3

*p-Aminosalicylic acid
**Trimethoprim-Sulfamethoxazole

Table 6. Participant Minimum Inhibitory Concentration (MIC) results for culture E, *M. fortuitum*						
			INTERPRETATION			
DRUG	TEST METHOD	MIC	S	R	None*	SUM
Amikacin	Agar proportion	≤8.00	1			1
Amikacin	E-test	0.75	1			1
Amikacin	E-test	1.00	1			1
Amikacin	E-test	8.00	1			1
Amikacin	Microtiter	≤16.00	1			1
Amikacin	Microtiter	0.50	1			1
Amikacin	Microtiter	1.00	2			2
Amikacin	Microtiter	16.00	1			1
Clarithromycin	BACTEC 460	8.00			1	1
Clarithromycin	E-test	0.13	1			1
Clarithromycin	E-test	1.50			1	1
Clarithromycin	E-test	2.00			1	1
Clarithromycin	E-test	4.00		1		1
Clarithromycin	Microtiter	≤ 2.00	1			1
Clarithromycin	Microtiter	4.00	1		1	2
Clarithromycin	Microtiter	16.00		2		2
Capreomycin	Microtiter	4.00			1	1
Ciprofloxacin	Agar proportion	≤ 1.00	1			1
Ciprofloxacin	BACTEC 460	≤ 1.00	1			1
Ciprofloxacin	E-test	0.03	1			1
Ciprofloxacin	E-test	0.12	1			1
Ciprofloxacin	E-test	≥ 32.00		1		1
Ciprofloxacin	Microtiter	≤ 1.00	2			2
Ciprofloxacin	Microtiter	0.06	1			1
Ciprofloxacin	Microtiter	0.12	1		1	2
Cefoxitin	Agar proportion	≥ 16.00		1		1
Cefoxitin	E-test	8.00	1			1
Cefoxitin	E-test	≥ 64.00		1		1
Cefoxitin	E-test	≥ 256.00		1		1
Cefoxitin	Microtiter	8.00			1	1
Cefoxitin	Microtiter	32.00		1	1	2
Cefoxitin	Microtiter	64.00		1		1
Cefoxitin	Microtiter	≥16.00		1		1
Doxycycline	E-test	≥ 256.00		2		2
Doxycycline	Microtiter	8.00			1	1
Doxycycline	Microtiter	≥ 32.00		1		1
Erythromycin	Microtiter	≥ 4.00		1		1
Erythromycin	Microtiter	≥ 32.00		3		3
*Some participants reported MIC results without a corresponding interpretation of susceptible or resistant.						

Table 6. MIC results for culture E, *M. fortuitum* (cont)			INTERPRETATION			
DRUG	TEST METHOD	MIC	S	R	None*	SUM
Imipenem	E-test	2.00	1			1
Imipenem	E-test	16.00			1	1
Imipenem	E-test	≥ 32.00		1		1
Imipenem	Microtiter	4.00	3			3
Imipenem	Microtiter	8.00			1	1
Imipenem	Microtiter	≥ 8.00		1		1
Kanamycin	Microtiter	8.00	2			2
Minocycline	Microtiter	4.00			1	1
Minocycline	Microtiter	16.00		1		1
Minocycline	Microtiter	32.00		1		1
Rifampin	Microtiter	≥ 16.00		2		2
Sulfamethoxazole	Microtiter	4.00	1			1
Sulfamethoxazole	Microtiter	16.00	2			2
Sulfamethoxazole	Microtiter	≥ 64.00		1		1
Tetracycline	Agar proportion	≥ 4.00		1		1
Tetracycline	Microtiter	8.00			1	1
Trimethoprim-Sulfamethoxazole	E-test	≥ 32.00		1		1
Trimethoprim-Sulfamethoxazole	Microtiter	2.50			1	1
Trimethoprim-Sulfamethoxazole	Microtiter	≥ 160.00		1		1
Tobramycin	Microtiter	16.00		2		2
Tobramycin	Microtiter	≥ 8.00		1		1
Tobramycin	Microtiter	≥ 16.00		1		1
Vancomycin	Microtiter	≥ 16.00		1		1
*Some participants reported MIC results without a corresponding interpretation of susceptible or resistant.						