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Tuberculosis

Drug resistance in Canada

2007

Reported susceptibility results of the Canadian Tuberculosis Laboratory Surveillance System

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INTRODUCTION

Drug-resistant strains of tuberculosis (TB) pose a serious threat to TB prevention and control efforts. Although drug-resistant TB has not yet been identified as a major problem in Canada, the potential exists due to the increase and ease of international travel. In response, Tuberculosis Prevention and Control (TBPC) in collaboration with the Canadian Tuberculosis Laboratory Technical Network (CTLTN) (see Appendix 1) and participating laboratories (representing all provinces and territories) established the Canadian Tuberculosis Laboratory Surveillance System (CTBLSS) to monitor TB drug resistance patterns in Canada.

Every year laboratories report to TBPC the results of anti-tuberculosis drug susceptibility testing for every patient for whom a culture grows or a bacterial isolate is received from another lab, within the previous calendar year. TBPC subsequently produces this annual report.

METHODS

TBPC maintains the CTBLSS which contains drug susceptibility test results of *Mycobacterium tuberculosis* (MTB) and other TB species (*M. africanum, M. canetti, M. caprae, M. microti, M. pinnipedii or M. bovis).* It also contains MTB complex (MTBC) isolates as laboratories report identification of isolates either at the complex level (MTBC) or at the species level. Isolates identified as *Mycobacterium bovis* BCG are included in the CTBLSS but are excluded from this report. *M. bovis* (BCG) is intrinsically resistant to pyrazinamide (PZA) and the identity of the majority of these isolates can be inferred from the history of recent vaccination.

Data are collected either through manual completion of a standard reporting form (Appendix 2) or by electronic transmission. Information collected includes sex, year of birth, province/territory from which the specimen originated, province/territory where the tests were performed, and susceptibility results. Some provinces perform drug testing for other provinces/territories. British Columbia tests British Columbia and Yukon isolates; Alberta tests Alberta, Northwest Territories and Nunavut isolates, and Nova Scotia tests isolates for Nova Scotia and Prince Edward Island. All other provinces report only their own isolate susceptibility results.

Every effort is made to eliminate duplicate specimen results or results from two specimens taken from the same person. In the event that a duplicate record is found, only the most recent susceptibility result is included for analysis.

Results presented are for first-line drugs routinely tested for resistance, typically isoniazid (INH), rifampin (RMP), pyrazinamide (PZA) and ethambutol (EMB). Although streptomycin (SM) was reclassified in 2005 as a second-line anti-TB drug in Canada, it will continue to be reported in the same format for provinces/territories that routinely test for SM resistance. As well, not all isolates are tested for resistance to all drugs. For example some provinces do no routinely test for PZA. Therefore, the percentage of isolates showing resistance to a particular drug is expressed as the number of isolates resistant to the drug over the total number of isolates tested for sensitivity to that particular drug.

Resistance patterns that are described in this report include: a) mono-resistance which is resistance to one of the first line drugs (INH, RMP, EMB, or PZA); b) poly resistance defined as resistance to two or more first-line drugs not including the isoniazid and rifampin combination; c) multidrug-resistant tuberculosis (MDR-TB) is resistance to at least isoniazid and rifampin; and finally d) extensively drug-resistant TB (XDR-TB),

defined as resistance to at least rifampin and isoniazid and further resistance to any fluoroquinolone, and to at least one of three injectable second-line drugs (amikacin, capreomycin and kanamycin).

Historically, results for second-line drugs were submitted to TBPC but only from some jurisdictions. Starting with this report, a more comprehensive reporting of susceptibility testing results for second-line anti-tuberculosis drugs has been carried out, but only for those isolates that were identified as MDR-TB. Second-line drug testing varies between jurisdictions, but typically testing is done for amikacin or kanamycin, capreomycin, clofazimine, ethionamide, ofloxacin, para-amino salicylic acid and rifabutin.

Prior to 2007, all specimens received in the laboratories between the January 1 and December 31 were included in the annual report. However, this resulted in delayed reporting of results for specimens that were received in the lab in late December but only grew in January or early February. Thus starting in 2007 any culture that grows or isolate received by a lab as of December 31 will be submitted and counted for that calendar year, otherwise the result will be recorded in the next year's set. For example, if a specimen is received on December 20, 2007 and the culture grows only in January 2008 it would be considered a 2008 isolate. With this approach the majority of results will be ready by January 31 of each subsequent year. Initially, there may be a slightly larger than expected decrease in the number of isolates reported between 2006 and 2007. This difference is expected to reverse by 2008.

Laboratories perform routine susceptibility testing of MTB or MTBC to first-line anti-tuberculous drugs using either the radiometric proportion method BACTEC® 460 or the non-radiometric fluorometric proportion method MGIT® 960. New Brunswick, Newfoundland and Labrador, Nova Scotia, Ontario and Saskatchewan use MGIT® 960. All other provinces/territories used BACTEC® 460. Four laboratories conduct second-line testing: Alberta, Ontario, Quebec and the National Reference Centre for Mycobacteriology (NRCM) in Manitoba. Table A lists the first-line and second-line anti-tuberculosis drugs and the critical concentrations in *mg/L* used by the participating laboratories.

All members of the CTLTN participate in the NRCM (National Microbiology Laboratory) proficiency testing program. In addition to this national initiative, a number of laboratories also participate in other select external proficiency programs such as College of American Pathologists, Quality Management Program – Laboratory Services, United States Centers for Disease Control and Prevention Drug Susceptibility Testing or New York State Department of Health. All testing methods including drug selection and concentrations are done in compliance with the recommended laboratory standards detailed in the Clinical and Laboratory Standards Institute document.[1]

The information presented in this report represents the most up to date information available as of March, 2008. The historic record is reviewed annually and adjustments are made to the tables as new/updated information becomes available.

Table A: Critical concentrations for routine testing of anti-tuberculosis drugs			
First-line anti-tuberculosis drugs			
Anti-tuberculosis drugs	**Critical concentrations* (mg/L)**		**Comments**
	BACTEC® 460	**MGIT® 960****	
Isoniazid (INH)	0.1	0.1	When resistance to INH is found at the 0.1 mg/L, tests are repeated with INH 0.4mg/L to determine the level of resistance. Regardless, the isolate will be reported as resistant using the 0.1 mg/L cut off level.
Rifampin (RMP)	2.0	1.0	
Ethambutol (EMB)	2.5	5.0	
Pyrazinamide (PZA)	100.0	100.0	Routine testing **is not** performed for isolates from British Columbia, Saskatchewan.
Second-line anti-tuberculosis drugs			
Anti-tuberculosis drugs	**Critical concentrations* (mg/L)**		**Comments**
Streptomycin (SM)	2.0	1.0	Routine testing **is** performed for isolates from British Columbia, Alberta and Saskatchewan. For 2007 approximately 60% of isolates from Manitoba were also tested. There is also a high concentration for SM which is 6.0 mg/L in BACTEC® 460.
	Concentrations tested* (mg/L)**		
Amikacin (AMK)	1.0		
Capreomycin (CAP)	1.25		
Ethionamide (ETH)	1.25		
Kanamycin (KAN)	5.0		
Para-amino salicylic acid (PAS)	2.0		
Ofloxacin (OFLOX)	2.0		
Rifabutin (RIF)	0.5		

* Critical concentrations: the lowest concentration of drug that will inhibit 95% of wild strains of MTB that have never been exposed to drugs while at the same time not inhibiting strains of MTB that have been isolated from patients who are not responding to therapy and that are considered resistant.

** MGIT® 960 concentrations are pending approval from the Clinical and Laboratory Standards Institute (CLSI).

*** Most of the second-line drugs were not used at the time of the development of the Proportion Method and the definition of the critical concentrations. For the current report we are using the "concentrations tested" and suggest caution to be exercised when interpreting results. Concentrations are for the BACTEC® 460.

RESULTS

For 2007, 1,271 reports were received. Of these, five were *Mycobacterium bovis* (BCG) and were excluded from the analysis. Between 1998 and 2006 the annual rate of decline in the number of isolates submitted was 0.6%. Between 2006 and 2007 the decrease in the number of isolates reported was 9%. This was due in part to the change in methodology, where only those reports with known results as of December 31st of the year are reported as opposed to the results for all samples received in the lab in a given year.

There were no reports received from Prince Edward Island. New Brunswick, Newfoundland and Labrador, Northwest Territories, Nova Scotia, Nunavut and Yukon reported that all isolates tested were susceptible to all first-line anti-tuberculous drugs. For the remaining provinces some resistance was reported.

Of the 1,266 isolates included for analysis, 139 (11.0%) were resistant to at least one of the anti-tuberculosis drugs tested: INH, RMP, EMB, PZA or SM. Of the isolates tested, 8.7% demonstrated INH resistance. Eleven isolates (0.9%) were MDR-TB and were reported from British Columbia, Ontario and Quebec.

Demographic information on individual patients from whom the isolates originated is limited in this laboratory-based surveillance system. The age of the individual was known for 1,236 isolates. Of these, 35% were between the ages of 25 and 44. For 1,213 isolates, the sex of the individual was known, and of these, 55% were male.

Second-line drug testing was done for all MDR-TB isolates to determine the extent of XDR-TB. Resistance to second-line drugs was reported: 14% of those tested for amikacin were resistant, 18% were resistant to capreomycin, 25% were resistant to kanamycin (only 4 isolates tested) and 9% were resistant to ofloxacin. There were no cases that met the accepted definition of XDR-TB. For each of the MDR-TB cases identified, second-line drugs tested and the results of the testing are given in the Table B.

A retrospective review of all reported TB isolates tested between 1998 and 2007 identified 170 that were classified as MDR-TB representing 1.2% of all data in the CTBLSS. Table C provides a summary of the isolates that were tested and of those the number and the percentage that were identified as MDR-TB. Table D presents the provincial/territorial distribution of MDR-TB cases.

Table B: Second line resistance pattern for MDR-TB cases reported in 2007

Province/ territory	Amikacin	Capreo-mycin	Clofazi-mine	Ethion-amide	Kana-mycin	Ofloxacin	Levoflox-acin	PAS	Rifabutin	Strepto-mycin
British Columbia	NA	Sensitive	NA	Resistant	Sensitive	Resistant	NA	Resistant	Resistant	Resistant
British Columbia	NA	Resistant	NA	Resistant	Resistant	Sensitive	NA	Sensitive	Resistant	Sensitive
Ontario	Resistant	Resistant	Sensitive	Resistant	NA	Sensitive	NA	Sensitive	Resistant	Resistant
Ontario	Sensitive	Sensitive	Sensitive	Resistant	NA	Sensitive	NA	Sensitive	Resistant	Resistant
Ontario	Sensitive	Sensitive	Sensitive	Sensitive	NA	Sensitive	NA	Sensitive	Resistant	Sensitive
Ontario	Sensitive	Sensitive	Sensitive	Resistant	NA	Sensitive	NA	Sensitive	Resistant	Resistant
Ontario	Sensitive	Sensitive	Sensitive	Sensitive	NA	Sensitive	NA	Sensitive	Resistant	Resistant
Ontario	Sensitive	Sensitive	Sensitive	Sensitive	NA	Sensitive	NA	Sensitive	Resistant	Sensitive
Ontario	Sensitive	Sensitive	Sensitive	Resistant	NA	Sensitive	NA	Sensitive	Resistant	Resistant
Quebec	NA	Sensitive	NA	Sensitive	Sensitive	Sensitive	Sensitive	Sensitive	Resistant	Resistant
Quebec	NA	Sensitive	NA	Sensitive	Sensitive	Sensitive	Sensitive	Sensitive	Resistant	Sensitive

NA: Isolate was not tested

Table C: Total number of isolates tested and number and percentage identified as MDR-TB, Canada – 1998-2007

Year	Total number of Isolates	Annual percentage change	MDR-TB (%)
1998	1,461		18 (1.2)
1999	1,415	↓ 3.1	18 (1.3)
2000	1,491	↑ 5.4	15 (1.0)
2001	1,476	↓ 1.0	15 (1.0)
2002	1,419	↓ 3.9	22 (1.6)
2003	1,408	↓ 0.8	21 (1.6)
2004	1,379	↓ 2.1	12 (0.9)
2005	1,336	↓ 3.1	22 (1.6)
2006	1,389	↑ 4.0	16 (1.2)
2007	1,266	↓ 8.9	11 (0.9)
TOTAL	**14,040**		**170 (1.2)**

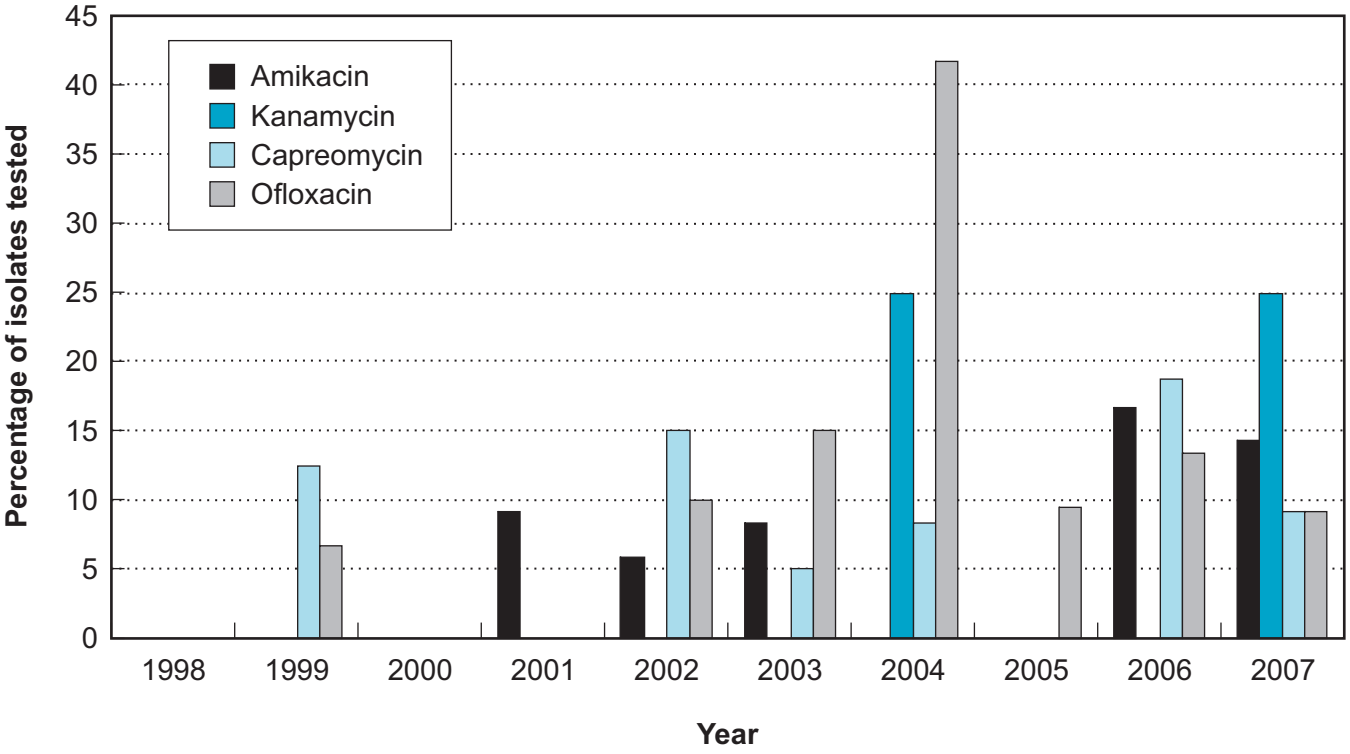
Table D: Provincial/territorial breakdown of identified MDR-TB isolates: 1998- 2007

Province	Count	Percent (%)
Alberta	9	5.3
British Columbia	34	20.0
Manitoba	10	5.9
Nunavut	1	0.6
Ontario	102	60.0
Quebec	14	8.2
TOTAL	**170**	**100.0**

Figure A shows, of the 170 MDR-TB isolates identified between 1998 and 2007, the number that had any resistance to the second-line drugs used to define XDR-TB cases, (amikacin, capreomycin, kanamycin and ofloxacin), measured as a percentage of the total number of isolates tested against the drug. Between 1998 and 2007 there appears to be a greater percentage of the isolates tested that show some resistance to one or more to the second-line drugs; however the numbers are small and any interpretation must be made with caution. Only 2 of the 170 MDR-TB isolates met the definition of XDR-TB, one case reported in 2003 and the second reported in 2006. There were no cases reported in 2007.

Figure A

Trend in drug resistance patterns over time for MDR-TB isolates tested for second-line drug resistance: Canada 1998 – 2007



DISCUSSION

Susceptibility results were reported for 1,266 isolates in 2007. The percentage of isolates demonstrating any type of drug resistance was 11.0%. The proportion of isolates classified as MDR-TB decreased slightly from 1.2% in 2006 to 0.9% in 2007. The average annual percentage of reported MDR-TB since 1998 was 1.2%. There were no XDR-TB cases in 2007.

Seventy-seven percent of the reported laboratory TB isolates in Canada in 2007 originated from British Columbia, Ontario and Quebec which have consistently reported the majority of isolates and MDR-TB in the ten years of data collection. Since the initiation of this laboratory-based surveillance system the Atlantic Provinces, Northwest Territories, Saskatchewan and Yukon have not reported any MDR-TB isolates.

Extensively drug-resistant tuberculosis is a growing international concern. As of February 2008, 45 countries, including Canada, have reported the presence of XDR-TB cases. Because XDR-TB is resistant to the best first- and second-line drugs, treatment options are seriously limited. In order to continue surveillance of XDR-TB in Canada, all MDR-TB isolates will be routinely tested for resistance to second-line antibiotics.

The results observed to date in this surveillance system are consistent with international data. In the latest report of the Global TB Drug Resistance Surveillance Project jointly conducted by the World Health Organization (WHO) and the International Union Against Tuberculosis and Lung Disease (IUATLD),[2] the global population weighted percentage for any resistance among new cases was reported as 17% and for previously treated

cases was 35.0%. In Canada* for 2007, the percentage of isolates showing any resistance was 11.0%.

The global estimated population weighted mean of MDR-TB as reported for 2006 in the WHO/IUALTD drug resistance report is 4.8% (95% CLs, 4.6-6.0).[2] In Canada for 2007 the percentage of isolates that were identified as MDR-TB was 0.9%.

LIMITATIONS

Sensitivity testing for anti-tuberculosis drugs is not uniform across the country. Therefore, there are limitations in interpreting the data, particularly the percentage of isolates that are resistant to SM and PZA.

Usually only isolates with MDR-TB or other extensive resistance patterns will receive drug sensitivity testing to selected second-line drugs. Other isolates may be resistant to a fluoroquinolone, because of widespread use for respiratory infections, but not be MDR-TB. This limits the understanding of the emergence of second-line resistance within Canada.

More epidemiological information on the TB cases from which the isolates were submitted is desirable to examine more critically drug resistance patterns in Canada. However, this information is difficult to collect as isolates are often submitted to the laboratories with only the sex and year of birth of the individual. As well, no differentiation can be made between primary and secondary/acquired drug resistance from the data. The annual *Tuberculosis in Canada* report (http://www.phac-aspc.gc.ca/tbpc-latb/surv_e.html) includes additional drug resistance data for each reported TB case.

CONCLUSIONS

With growing worldwide concern regarding resistance and with the emergence of extensively drug-resistant tuberculosis, this surveillance system is vital in providing the necessary data in a timely fashion to monitor trends in TB drug resistance in Canada. The surveillance data collected to date indicate that the presence of TB drug resistance in this country is below the global average.

REFERENCES

1. National Committee for Laboratory Standards. *Susceptibility testing of mycobacteria, Nocardiae, and other aerobic actinomycetes: approved standard M24-A*. Wayne PA, National Committee for Clinical Laboratory Standards, 2003.
2. The WHO/IUALTD Global Project on Anti-tuberculosis drug Resistance Surveillance 2002-2007. *Anti-Tuberculosis Drug Resistance in the World: Fourth Global Report* (WHO/HTM/TB/2008.394) Geneva: World Health Organization, 2008.

* Unlike the WHO/IUATLD that provide the prevalence of TB drug resistance for both new and retreated cases, this report presents only overall incidence - isolates are not separated into new and retreated cases.

Figure 1
Reported TB drug resistance in Canada by province/territory – 2007

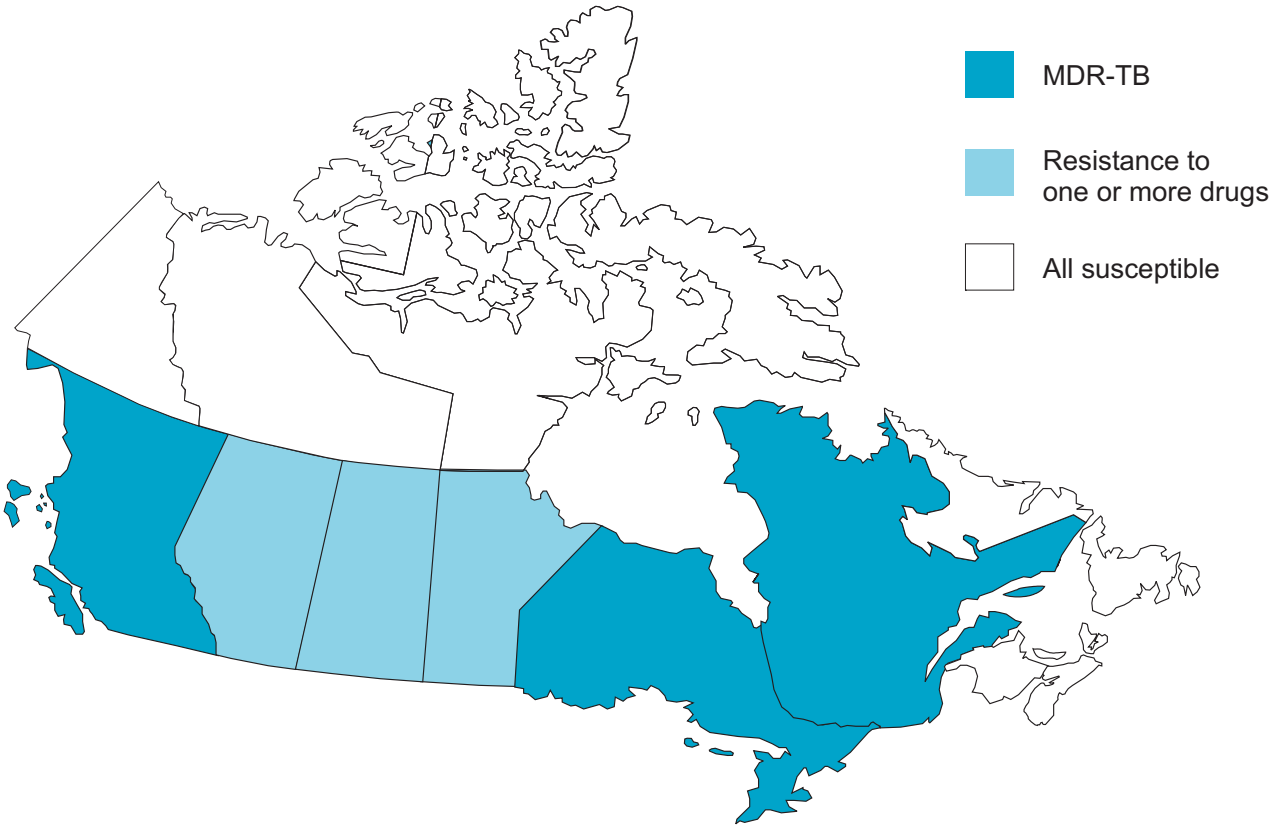


Figure 2
Reported *Mycobacterium tuberculosis* isolates in Canada by province/territory– 2007

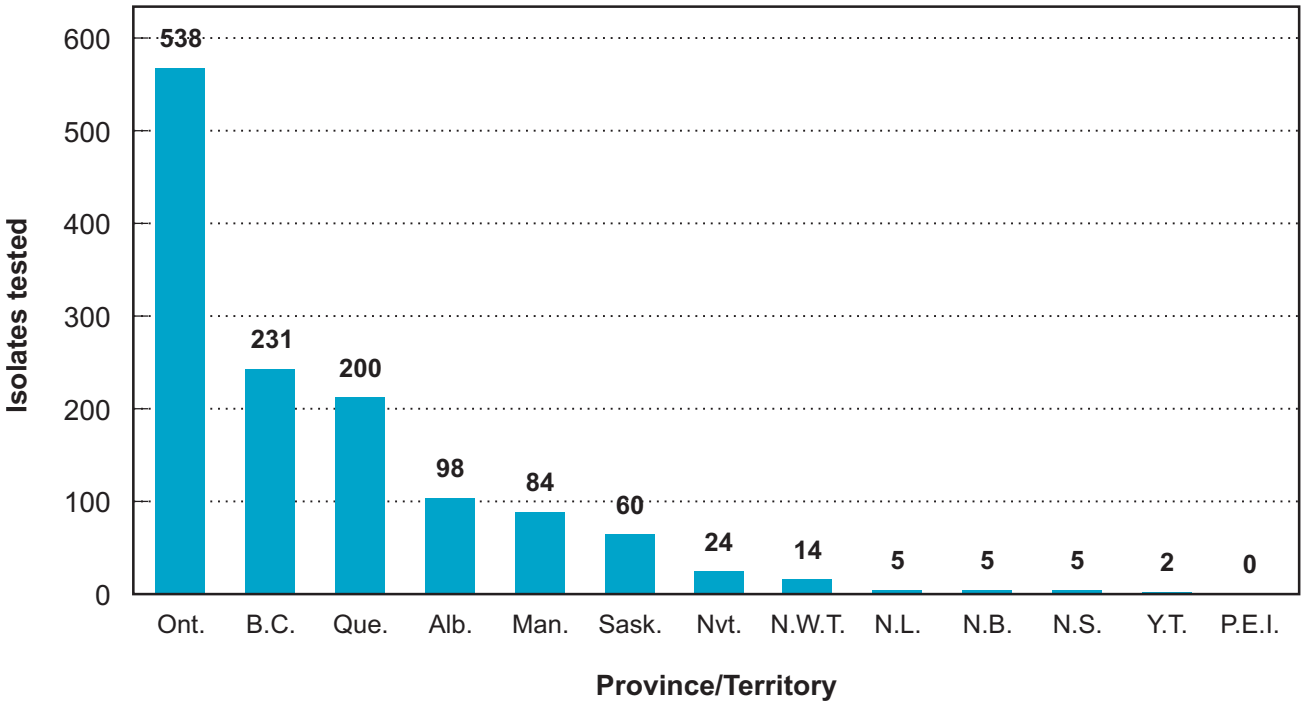
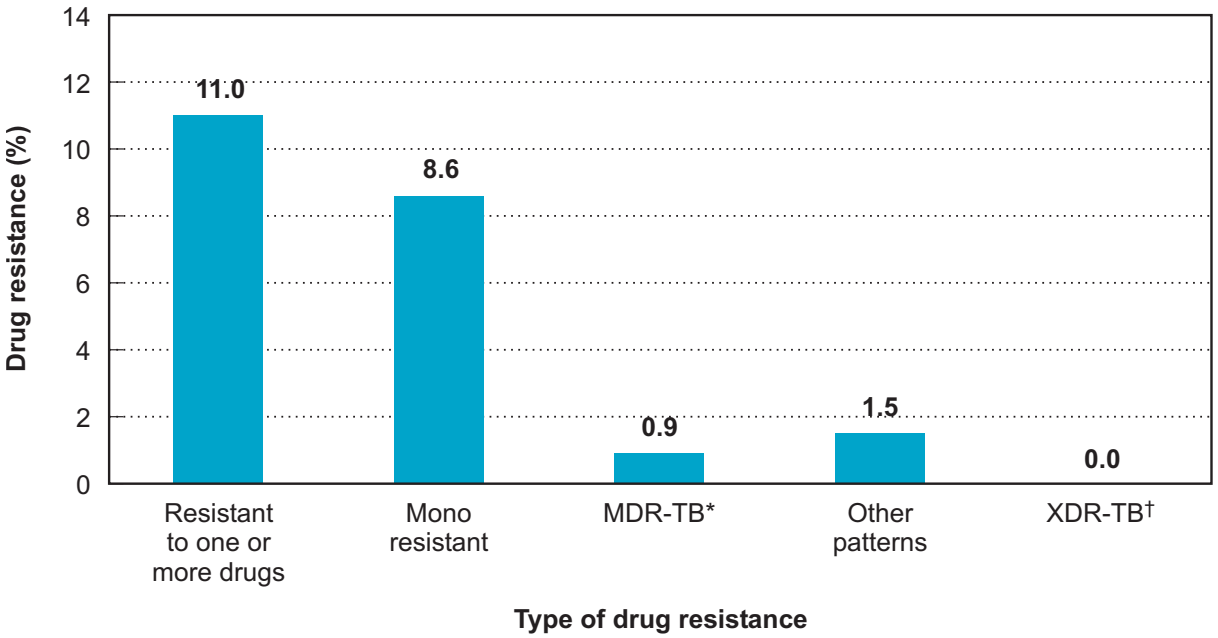


Figure 3
Overall pattern of reported TB drug resistance in Canada – 2007



* Multidrug-resistant TB (MDR-TB) is resistance to at least isoniazid and rifampin.

† Extensively drug-resistant TB (XDR-TB) is MDR-TB plus resistance to any fluoroquinolone and at least 1 of 3 injectable second-line drugs: amikacin, capreomycin and kanamycin.

Figure 4
Reported TB drug resistance in Canada by type of drug – 2007

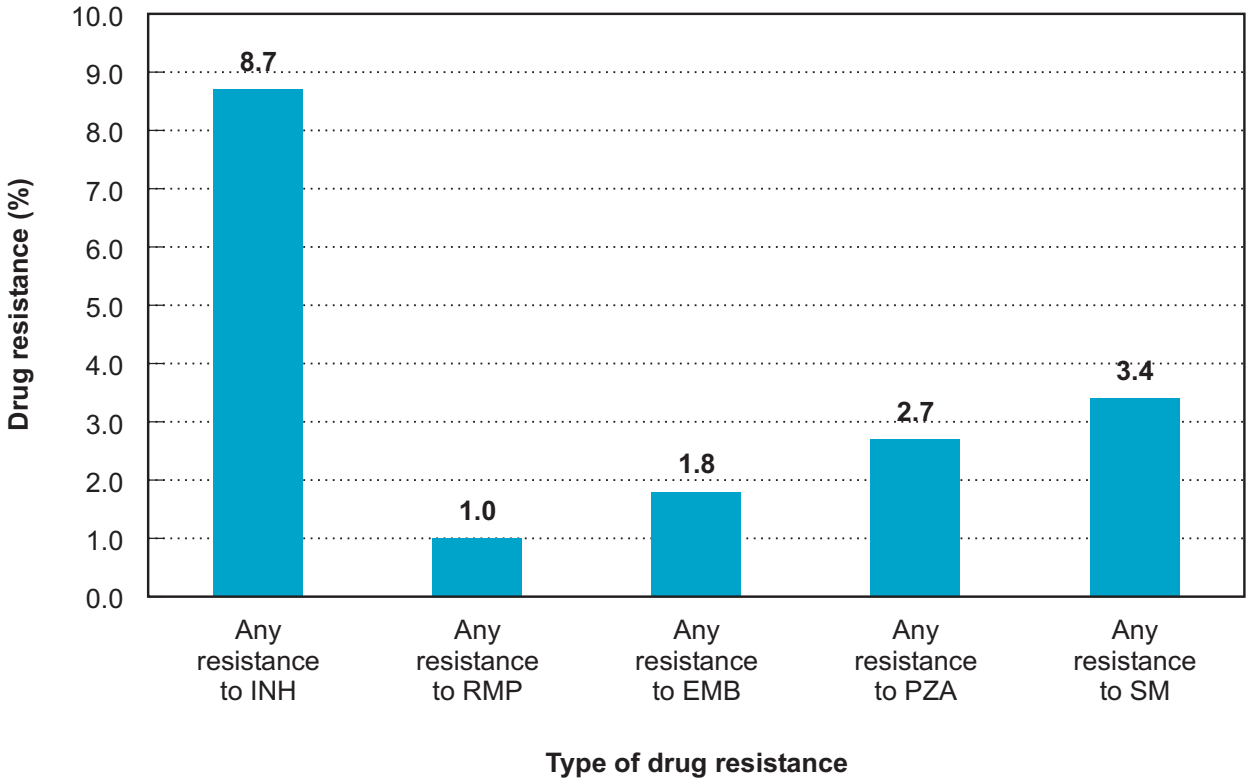
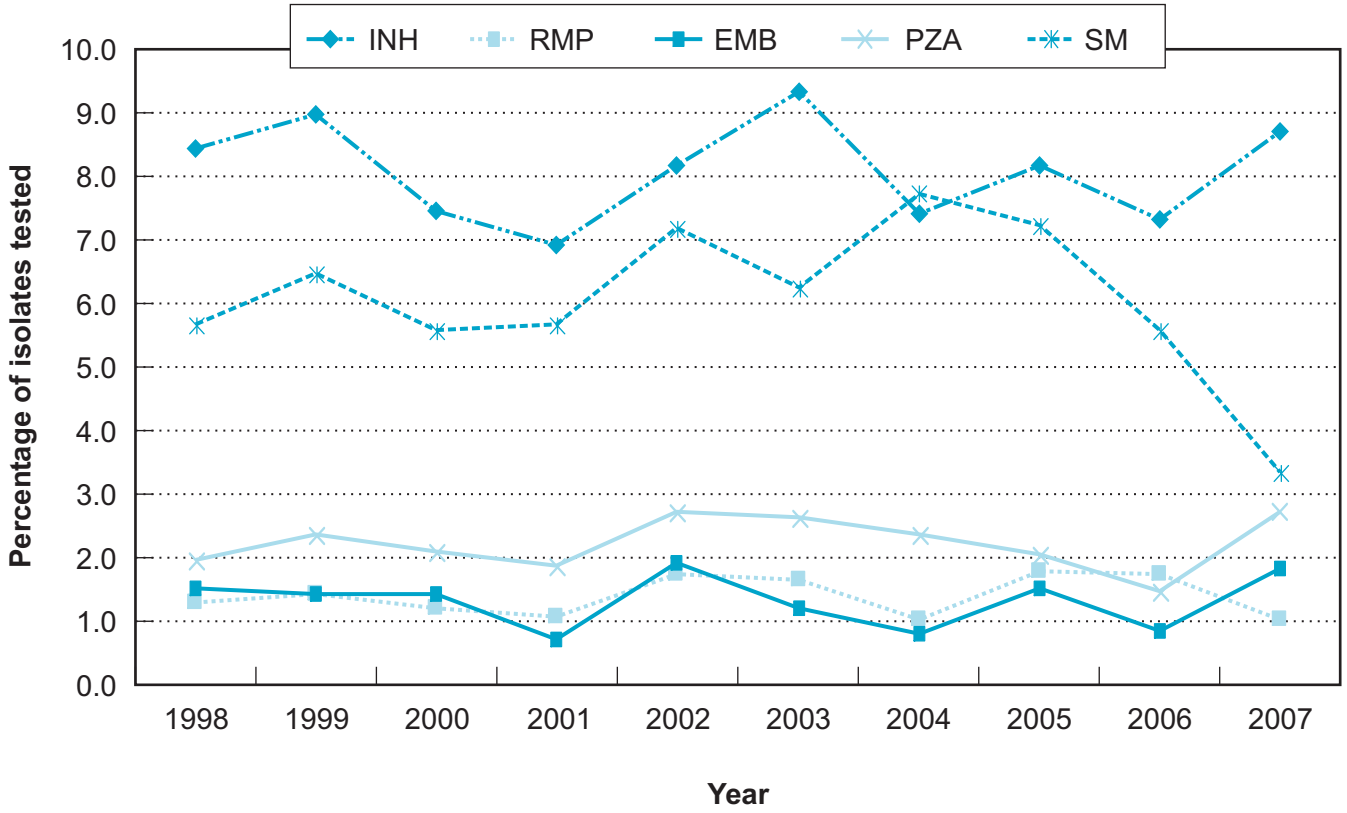


Figure 5

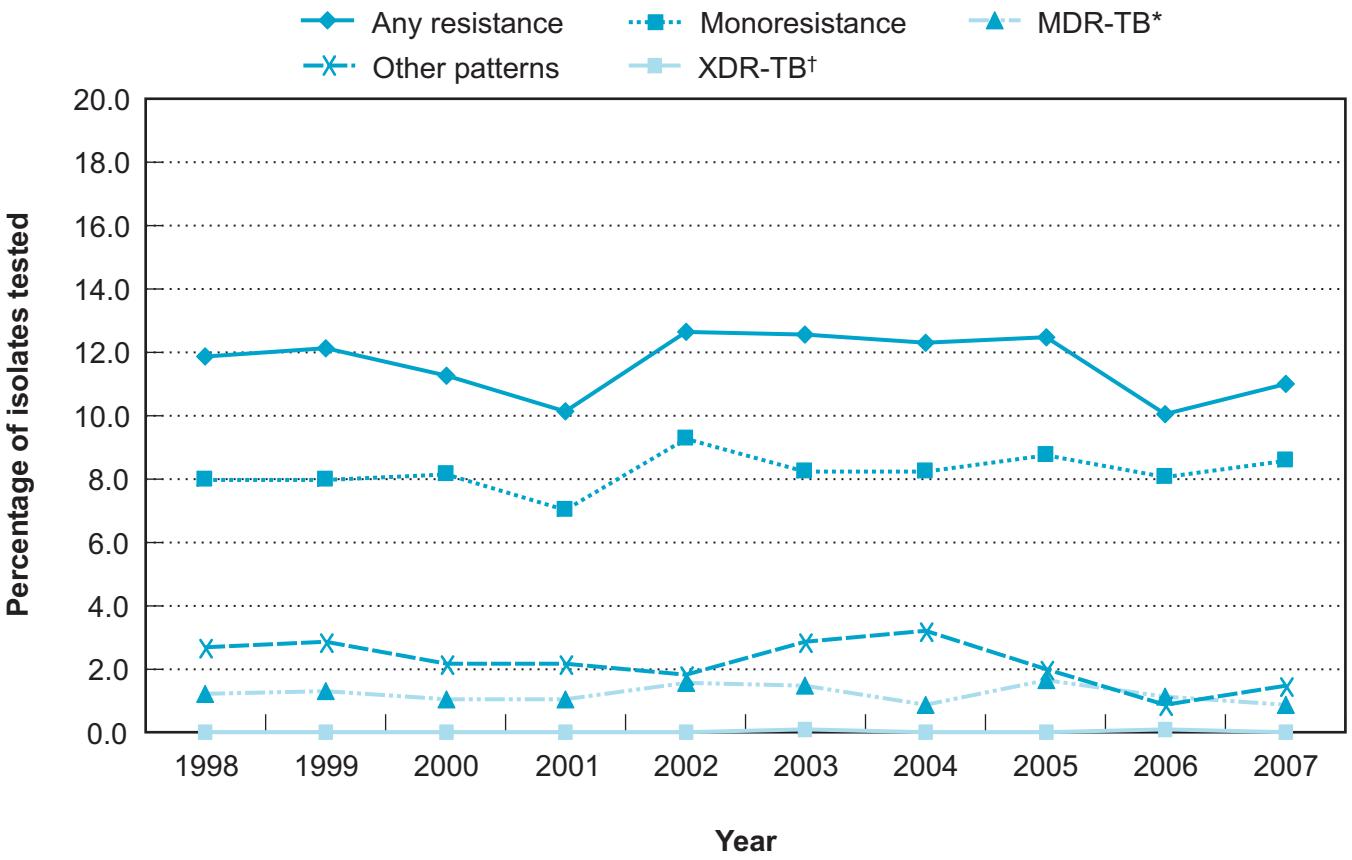
Any resistance by type of drug in Canada as a percentage of the number of isolates tested – 1998-2007



NOTE: Since the Canadian reclassification of streptomycin from a first-line to a second-line drug in 2005, dramatic changes in the susceptibility patterns to streptomycin may be observed as fewer jurisdictions are routinely testing this susceptibility.

Figure 6

Overall pattern of reported TB drug resistance in Canada as a percentage of isolates tested – 1998-2007



* Multidrug-resistant TB (MDR-TB) is resistance to at least isoniazid and rifampin.

† Extensively drug-resistant TB (XDR-TB) is MDR-TB plus resistance to any fluoroquinolone and at least 1 of 3 injectable second-line drugs: amikacin, capreomycin, and kanamycin.

Table 1. Overall pattern of reported TB drug resistance in Canada – 1998-2007

	1998 Total (%)	1999 Total (%)	2000 Total (%)	2001 Total (%)	2002 Total (%)	2003 Total (%)	2004 Total (%)	2005 Total (%)	2006 Total (%)	2007 Total (%)
Total number of isolates	1,461 (100.0)	1,415 (100.0)	1,491 (100.0)	1,476 (100.0)	1,419 (100.0)	1,408 (100.0)	1,379 (100.0)	1,336 (100.0)	1,389 (100.0)	1,266 (100.0)
Isolates susceptible	**1,288 (88.2)**	**1,243 (87.8)**	**1,323 (88.7)**	**1,326 (89.8)**	**1,240 (87.4)**	**1,231 (87.4)**	**1,209 (87.7)**	**1,170 (87.6)**	**1,249 (89.9)**	**1,127 (89.0)**
Any resistance*										
INH	123 (8.4)	127 (9.0)	111 (7.4)	102 (6.9)	116 (8.2)	132 (9.4)	102 (7.4)	109 (8.2)	101 (7.3)	110 (8.7)
RMP	19 (1.3)	20 (1.4)	18 (1.2)	16 (1.1)	25 (1.8)	23 (1.6)	14 (1.0)	24 (1.8)	24 (1.7)	13 (1.0)
EMB	22 (1.5)	20 (1.4)	21 (1.4)	10 (0.7)	27 (1.9)	17 (1.2)	11 (0.8)	20 (1.5)	12 (0.9)	23 (1.8)
PZA	24 (2.0)	28 (2.5)	24 (2.1)	22 (2.0)	31 (2.7)	29 (2.6)	26 (2.4)	22 (2.1)	16 (1.5)	27 (2.7)
SM†	82 (5.7)	72 (6.5)	65 (5.6)	68 (5.7)	74 (7.2)	73 (6.3)	89 (7.7)	79 (7.3)	25 (4.1)	16 (3.4)
Resistance to one or more drugs	173 (11.8)	172 (12.2)	168 (11.3)	150 (10.2)	179 (12.6)	177 (12.6)	170 (12.3)	166 (12.4)	140 (10.1)	139 (11.0)
Monoresistance	116 (7.9)	113 (8.0)	121 (8.1)	103 (7.0)	131 (9.2)	116 (8.2)	114 (8.3)	117 (8.8)	112 (8.1)	109 (8.6)
MDR-TB‡	18 (1.2)	18 (1.3)	15 (1.0)	15 (1.0)	22 (1.6)	21 (1.5)	12 (0.9)	22 (1.6)	16 (1.2)	11 (0.9)
Other patterns	39 (2.7)	41 (2.9)	32 (2.1)	32 (2.2)	26 (1.8)	40 (2.8)	44 (3.2)	27 (2.0)	12 (0.9)	19 (1.5)
XDR-TB§	- (-)	- (-)	- (-)	- (-)	- (-)	1 (0.1)	0 (-)	0 (-)	1 (0.1)	0 (-)
XDR-TB pattern‖										
AM & CM & ETA & OFL & RBT **	- (-)	- (-)	- (-)	- (-)	- (-)	1 (0.1)	0 (-)	0 (-)	1 (0.1)	0 (-)

* Not all isolates were tested for resistance to all drugs; percentage reflects the total number of isolates actually tested.

† Since the Canadian reclassification of streptomycin from a first-line to a second-line drug in 2005, dramatic changes in the susceptibilty patterns to streptomycin may be observed as fewer jurisdictions are routinely testing this susceptibility.

‡ MDR-TB bacteria are resistant to at least isoniazid and rifampin.

§ XDR-TB: Extensively drug-resistant TB is MDR-TB plus resistance to any fluoroquinolone and at least 1 of 3 injectable second-line drugs: capreomycin, kanamycin and amikacin.

‖ The XDR-TB isolates are also included in the MDR-TB count to maintain historical continuity.

** AM = Amikacin; CM = Capreomycin; OFL = Ofloxacin; ETA = Ethionamide; RBT = Rifatubin.

Table 2. Reported *Mycobacterium tuberculosis* isolates by "reporting" and "originating" province/territory, Canada – 2007

Reporting province	CANADA	Originating Province/Territory												
		N.L.	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.	Y.T.	N.W.T.	Nvt.
Number of isolates	**1,266**	**5**	**0**	**5**	**5**	**200**	**538**	**84**	**60**	**98**	**231**	**2**	**14**	**24**
N.L.	**5**	5	0	0	0	0	0	0	0	0	0	0	0	0
N.S.	**5**	0	0	5	0	0	0	0	0	0	0	0	0	0
N.B.	**5**	0	0	0	5	0	0	0	0	0	0	0	0	0
Que.	**200**	0	0	0	0	200	0	0	0	0	0	0	0	0
Ont.	**538**	0	0	0	0	0	538	0	0	0	0	0	0	0
Man.	**83**	0	0	0	0	0	0	83	0	0	0	0	0	0
Sask.	**59**	0	0	0	0	0	0	0	59	0	0	0	0	0
Alta.	**137**	0	0	0	0	0	0	0	1	98	0	0	14	24
B.C.	**234**	0	0	0	0	0	0	1	0	0	231	2	0	0

Table 3. Reported MDR-TB isolates by province/territory, Canada – 2007

	CANADA	Originating Province/Territory												
		N.L.	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.	Y.T.	N.W.T.	Nvt.
Total number of isolates tested	**1,266**	**5**	**0**	**5**	**5**	**200**	**538**	**84**	**60**	**98**	**231**	**2**	**14**	**24**
Total number of MDR-TB isolates*	**11**	**0**	**0**	**0**	**0**	**2**	**7**	**0**	**0**	**0**	**2**	**0**	**0**	**0**
INH & RMP	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0
INH & RMP & SM	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0
INH, RMP & EMB	**4**	0	0	0	0	2	2	0	0	0	0	0	0	0
INH, RMP & PZA	**1**	0	0	0	0	0	1	0	0	0	0	0	0	0
INH, RMP, PZA, EMB	**5**	0	0	0	0	0	4	0	0	0	1	0	0	0
INH, RMP, EMB & SM	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0
INH, RMP, PZA & SM	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0
INH, RMP, EMB, PZA & SM	**1**	0	0	0	0	0	0	0	0	0	1	0	0	0

* MDR-TB is defined as resistance to at least INH and RMP.

NOTE: Since the Canadian reclassification of streptomycin from a first-line to a second-line drug in 2005, dramatic changes in the susceptibilty patterns to streptomycin may be observed as fewer jurisdictions are routinely testing this susceptibility.

Table 4. Reported TB drug resistance by sex and age group, Canada – 2007

Age Group		Isolates	Any Resistance	MDR-TB	XDR-TB
		Number (%)	Number (%)	Number (%)	Number (%)
Total		**1,266 (100)**	**139 (100)**	**11 (100)**	**0 (0.0)**
0-4	Males	12 (0.9)	1 (0.7)	0 (0.0)	0 (0.0)
	Females	2 (0.2)	0 (0.0)	0 (0.0)	0 (0.0)
	Unknown	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
	Total	**14 (1.1)**	**1 (0.7)**	**0 (0.0)**	**0 (0.0)**
5-14	Males	9 (0.7)	1 (0.7)	0 (0.0)	0 (0.0)
	Females	5 (0.4)	0 (0.0)	0 (0.0)	0 (0.0)
	Unknown	1 (0.1)	0 (0.0)	0 (0.0)	0 (0.0)
	Total	**15 (1.2)**	**1 (0.7)**	**0 (0.0)**	**0 (0.0)**
15-24	Males	67 (5.3)	7 (5.0)	0 (0.0)	0 (0.0)
	Females	84 (6.6)	12 (8.6)	4 (36.4)	0 (0.0)
	Unknown	3 (0.2)	0 (0.0)	0 (0.0)	0 (0.0)
	Total	**154 (12.2)**	**19 (13.7)**	**4.0 (36.4)**	**0 (0.0)**
25-34	Males	97 (7.7)	9 (6.5)	1 (9.1)	0 (0.0)
	Females	110 (8.7)	10 (7.2)	2 (18.2)	0 (0.0)
	Unknown	7 (0.6)	2 (1.4)	0 (0.0)	0 (0.0)
	Total	**214 (16.9)**	**21 (15.1)**	**3 (27.3)**	**0 (0.0)**
35-44	Males	127 (10.0)	14 (10.1)	1 (9.1)	0 (0.0)
	Females	89 (7.0)	11 (7.9)	0 (0.0)	0 (0.0)
	Unknown	8 (0.6)	1 (0.7)	0 (0.0)	0 (0.0)
	Total	**224 (17.7)**	**26 (18.7)**	**1 (9.1)**	**0 (0.0)**
45-54	Males	98 (7.7)	11 (7.9)	0 (0.0)	0 (0.0)
	Females	62 (4.9)	7 (5.0)	0 (0.0)	0 (0.0)
	Unknown	6 (0.5)	1 (0.7)	0 (0.0)	0 (0.0)
	Total	**166 (13.1)**	**19 (13.7)**	**0 (0.0)**	**0 (0.0)**
55-64	Males	72 (5.7)	8 (5.8)	2 (18.2)	0 (0.0)
	Females	45 (3.6)	6 (4.3)	0 (0.0)	0 (0.0)
	Unknown	2 (0.2)	0 (0.0)	0 (0.0)	0 (0.0)
	Total	**119 (9.4)**	**14 (10.1)**	**2 (18.2)**	**0 (0.0)**
65-74	Males	72 (5.7)	9 (6.5)	1 (9.1)	0 (0.0)
	Females	50 (3.9)	4 (2.9)	0 (0.0)	0 (0.0)
	Unknown	7 (0.6)	2 (1.4)	0 (0.0)	0 (0.0)
	Total	**129 (10.2)**	**15 (10.8)**	**1 (9.1)**	**0 (0.0)**
75+	Males	107 (8.5)	8 (5.8)	0 (0.0)	0 (0.0)
	Females	90 (7.1)	6 (4.3)	0 (0.0)	0 (0.0)
	Unknown	4 (0.3)	0 (0.0)	0 (0.0)	0 (0.0)
	Total	**201 (15.9)**	**14 (10.1)**	**0 (0.0)**	**0 (0.0)**
Unknown	Males	8 (0.6)	2 (1.4)	0 (0.0)	0 (0.0)
	Females	7 (0.6)	1 (0.7)	0 (0.0)	0 (0.0)
	Unknown	15 (1.2)	6 (4.3)	0 (0.0)	0 (0.0)
	Total	**30 (2.4)**	**9 (6.5)**	**0 (0.0)**	**0 (0.0)**
Total	**Males**	**669 (52.8)**	**70 (50.4)**	**5 (45.5)**	**0 (0.0)**
	Females	**544 (43.0)**	**57 (41.0)**	**6 (54.5)**	**0 (0.0)**
	Unknown	**53 (4.2)**	**12 (8.6)**	**0 (0.0)**	**0 (0.0)**

Table 5. Reported results for routine drug susceptibility testing of *Mycobacterium tuberculosis* isolates, Alberta – 1998-2007

	1998 Total (%)	1999 Total (%)	2000 Total (%)	2001 Total (%)	2002 Total (%)	2003 Total (%)	2004 Total (%)	2005 Total (%)	2006 Total (%)	2007 Total (%)
Total number of isolates tested for INH, RMP, SM, EMB and PZA*	**119 (100.0)**	**117 (100.0)**	**104 (100.0)**	**91 (100.0)**	**108 (100.0)**	**92 (100.0)**	**96 (100.0)**	**129 (100.0)**	**104 (100.0)**	**98 (100.0)**
Isolates susceptible	**107 (89.9)**	**110 (94.0)**	**92 (88.5)**	**79 (86.8)**	**94 (87.0)**	**75 (81.5)**	**83 (86.5)**	**104 (80.6)**	**92 (88.5)**	**90 (91.8)**
Isolates resistant to one or more drugs	**12 (10.1)**	**7 (6.0)**	**12 (11.5)**	**12 (13.2)**	**14 (13.0)**	**17 (18.5)**	**13 (13.5)**	**25 (19.4)**	**13 (12.5)**	**8 (8.2)**
Monoresistance	**9 (7.6)**	**6 (5.1)**	**7 (6.7)**	**8 (8.8)**	**12 (11.1)**	**10 (10.9)**	**7 (7.3)**	**14 (10.9)**	**9 (8.6)**	**6 (6.1)**
INH	4 (3.4)	2 (1.7)	2 (1.9)	5 (5.5)	6 (5.6)	5 (5.4)	4 (4.2)	3 (2.3)	4 (3.8)	3 (3.1)
RMP	–	–	–	–	–	–	–	–	–	–
EMB	–	–	1 (1.0)	–	–	–	–	–	–	–
PZA	–	–	1 (1.0)	–	–	2 (2.2)	2 (2.1)	–	1 (1.0)	1 (1.0)
SM	5 (4.2)	4 (3.4)	3 (2.9)	3 (3.3)	6 (5.6)	3 (3.3)	1 (1.0)	11 (8.5)	4 (3.8)	2 (2.0)
MDR-TB†	**1 (0.8)**	**0 (0.0)**	**0 (0.0)**	**0 (0.0)**	**0 (0.0)**	**1 (1.1)**	**2 (2.1)**	**4 (3.1)**	**1 (1.0)**	**0 (0.0)**
INH & RMP	–	–	–	–	–	1 (1.1)	–	–	–	–
INH & RMP & SM	–	–	–	–	–	–	–	1 (0.8)	–	–
INH & RMP & EMB	–	–	–	–	–	–	1 (1.0)	1 (0.8)	–	–
INH & RMP & EMB & PZA	–	–	–	–	–	–	–	1 (0.8)	–	–
INH & RMP & EMB & SM	–	–	–	–	–	–	1 (1.0)	–	1 (1.0)	–
INH & SM & EMB & RMP & PZA	1 (0.8)	–	–	–	–	–	–	1 (0.8)	–	–
Other Patterns	**2 (1.7)**	**1 (0.9)**	**5 (4.8)**	**4 (4.4)**	**2 (1.9)**	**6 (6.5)**	**4 (4.2)**	**7 (5.4)**	**3 (2.9)**	**2 (2.0)**
INH & SM	1 (0.8)	1 (0.9)	3 (2.9)	2 (2.2)	1 (0.9)	4 (4.3)	3 (3.1)	7 (5.4)	3 (2.9)	2 (2.0)
INH & SM & EMB	–	–	1 (1.0)	–	–	1 (1.1)	–	–	–	–
INH & SM & PZA	1 (0.8)	–	1 (1.0)	2 (2.2)	1 (0.9)	1 (1.1)	1 (1.0)	–	–	–

* Includes 2, *M.africanum* in 2007.

† MDR-TB is defined as resistance to at least INH and RMP.

NOTE: Since the Canadian reclassification of streptomycin from a first-line to a second-line drug in 2005, dramatic changes in the susceptibilty patterns to streptomycin may be observed as fewer jurisdictions are routinely testing this susceptibility.

Table 6. Reported results for routine drug susceptibility testing of *Mycobacterium tuberculosis* isolates, British Columbia – 1998-2007

	1998 Total (%)	1999 Total (%)	2000 Total (%)	2001 Total (%)	2002 Total (%)	2003 Total (%)	2004 Total (%)	2005 Total (%)	2006 Total (%)	2007 Total (%)
Total number of isolates tested for INH, RMP, SM, EMB and PZA*	**237 (100.0)**	**244 (100.0)**	**277 (100.0)**	**332 (100.0)**	**259 (100.0)**	**291 (100.0)**	**263 (100.0)**	**204 (100.0)**	**275 (100.0)**	**231 (100.0)**
Isolates susceptible	**212 (89.5)**	**224 (91.8)**	**245 (88.4)**	**297 (89.5)**	**228 (88.0)**	**259 (89.0)**	**226 (85.9)**	**179 (87.7)**	**250 (90.9)**	**206 (89.2)**
Isolates resistant to one or more drugs	**25 (10.5)**	**20 (8.2)**	**32 (11.6)**	**35 (10.5)**	**31 (12.0)**	**32 (11.0)**	**37 (14.1)**	**25 (12.5)**	**25 (9.1)**	**25 (10.8)**
Monoresistance	**17 (7.2)**	**15 (6.1)**	**23 (8.3)**	**22 (6.6)**	**25 (9.7)**	**18 (6.2)**	**23 (8.7)**	**18 (8.8)**	**17 (6.2)**	**15 (6.5)**
INH	14 (5.9)	11 (4.5)	13 (4.7)	12 (3.6)	12 (4.6)	12 (4.1)	8 (3.0)	9 (4.4)	1 (0.4)	8 (3.5)
RMP	1 (0.4)	1 (0.4)	1 (0.4)	1 (0.3)	2 (0.8)	–	–	2 (1.0)	6 (2.2)	–
EMB	–	1 (0.4)	1 (0.4)	–	2 (0.8)	1 (0.3)	1 (0.4)	4 (2.0)	3 (1.1)	3 (1.3)
PZA†	–	–	–	–	1 (3.8)§	–	3 (9.4)§	–	–	–
SM	2 (0.8)	2 (0.8)	8 (2.9)	9 (2.7)	8 (3.1)	5 (1.7)	11 (4.2)	3 (1.5)	7 (2.5)	4 (1.7)
MDR-TB‡	**2 (0.8)**	**1 (0.4)**	**5 (1.8)**	**8 (2.4)**	**2 (0.8)**	**6 (2.1)**	**2 (0.8)**	**4 (2.0)**	**2 (0.7)**	**2 (0.9)**
INH & RMP	–	–	–	4 (1.2)	–	–	–	–	1 (0.4)	–
INH & RMP & EMB	–	–	1 (0.4)	–	–	–	1 (0.4)	–	–	–
INH & RMP & SM	1 (0.4)	–	2 (0.7)	2 (0.6)	–	1 (0.3)	–	–	–	–
INH & RMP & PZA	–	–	–	–	–	1 (0.3)	–	–	–	–
INH & RMP & EMB & PZA	–	–	–	–	1 (0.4)	2 (0.7)	1 (0.4)	–	–	1 (0.4)
INH & RMP & SM & EMB	1 (0.4)	1 (0.4)	2 (0.7)	1 (0.3)	–	–	–	2 (1.0)	–	–
INH & RMP & EMB & SM	–	–	–	–	–	–	–	–	–	–
INH & RMP & SM & PZA	–	–	–	–	–	–	–	1 (0.5)	–	–
INH & RMP & SM & EMB & PZA	–	–	–	1 (0.3)	1 (0.4)	2 (0.7)	–	1 (0.5)	1 (0.4)	1 (0.4)
Other Patterns	**6 (2.5)**	**4 (1.6)**	**4 (1.4)**	**5 (1.5)**	**4 (1.5)**	**8 (2.7)**	**12 (4.6)**	**3 (1.5)**	**6 (2.2)**	**8 (3.5)**
INH & EMB	1 (0.4)	1 (0.4)	–	–	–	–	1 (0.4)	–	–	1 (0.4)
INH & SM	5 (2.1)	2 (0.8)	2 (0.7)	5 (1.5)	3 (1.2)	7 (2.4)	5 (1.9)	2 (1.0)	6 (2.2)	5 (2.2)
INH & PZA	–	–	–	–	1 (0.4)	1 (0.3)	3 (1.1)	–	–	–
RMP & PZA	–	–	–	–	–	–	2 (0.8)	–	–	–
INH & SM & EMB	–	1 (0.4)	2 (0.7)	–	–	–	–	1 (0.5)	–	1 (0.4)
EMB & SM	–	–	–	–	–	–	–	–	–	1 (0.4)
INH & SM & PZA	–	–	–	–	–	–	1 (0.4)	–	–	–

* Includes 1 *M. bovis* isolate for each 2002, 2003, 2006 and 2007.

† Routine testing for PZA not conducted.

‡ MDR-TB is defined as resistance to at least INH and RMP.

§ Not all isolates were tested for resistance to all drugs; percentage reflects the total number of isolates actually tested.

Table 7. Reported results for routine drug susceptibility testing of *Mycobacterium tuberculosis* isolates, Manitoba – 1998-2007

	1998 Total (%)	1999 Total (%)	2000 Total (%)	2001 Total (%)	2002 Total (%)	2003 Total (%)	2004 Total (%)	2005 Total (%)	2006 Total (%)	2007 Total (%)
Total number of isolates tested for INH, RMP, EMB, SM and PZA*	**106 (100.0)**	**100 (100.0)**	**102 (100.0)**	**110 (100.0)**	**114 (100.0)**	**122 (100.0)**	**122 (100.0)**	**94 (100.0)**	**119 (100.0)**	**84 (100.0)**
Isolates susceptible	**98 (92.5)**	**89 (89.0)**	**94 (92.2)**	**101 (91.8)**	**106 (93.0)**	**114 (93.4)**	**120 (98.4)**	**89 (94.7)**	**110 (92.4)**	**74 (88.1)**
Isolates resistant to one or more drugs	**8 (7.5)**	**11 (11.0)**	**8 (7.8)**	**9 (8.2)**	**8 (7.0)**	**8 (6.6)**	**2 (1.6)**	**5 (5.3)**	**9 (7.6)**	**10 (11.9)**
Monoresistance	**4 (3.8)**	**6 (6.0)**	**6 (5.9)**	**6 (5.5)**	**4 (3.5)**	**7 (5.7)**	**2 (1.6)**	**5 (5.3)**	**9 (7.6)**	**9 (10.6)**
INH	2 (1.9)	3 (3.0)	6 (5.9)	2 (1.8)	3 (2.6)	3 (2.5)	–	2 (2.1)	6 (5.0)	8 (9.4)
PZA	–	–	–	–	1 (0.9)	1 (0.8)	1 (0.8)	–	–	1 (1.2)
SM	2 (1.9)	3 (3.0)	–	4 (3.8)‡	–	3 (2.6)‡	1 (0.8)	3 (3.2)	3 (2.5)	0 (0.0)
MDR-TB†	**2 (1.9)**	**2 (2.0)**	**–**	**2 (1.8)**	**3 (2.6)**	**1 (0.8)**	**0 (0.0)**	**0 (0.0)**	**0 (0.0)**	**0 (0.0)**
INH & RMP	–	1 (1.0)	–	1 (0.9)	1 (0.9)	1 (0.8)	–	–	–	–
INH & EMB & RMP & PZA	–	–	–	–	1 (0.9)	–	–	–	–	–
INH & EMB & RMP	1 (0.9)	–	–	–	–	–	–	–	–	–
INH & SM & EMB & RMP & PZA	1 (0.9)	–	–	1 (0.9)	1 (0.9)	–	–	–	–	–
INH & SM & RMP & PZA	–	1 (1.0)	–	–	–	–	–	–	–	–
Other Patterns	**2 (1.9)**	**3 (3.0)**	**2 (2.0)**	**1 (0.9)**	**1 (0.9)**	**0 (0.0)**	**0 (0.0)**	**0 (0.0)**	**0 (0.0)**	**1 (1.2)**
INH & PZA	–	–	–	–	1 (0.9)	–	–	–	–	–
INH & SM	2 (1.9)	1 (1.0)	2 (2.0)	1 (0.9)	–	–	–	–	–	–
INH & SM & EMB	–	1 (1.0)	–	–	–	–	–	–	–	–
INH & SM & PZA	–	1 (1.0)	–	–	–	–	–	–	–	–
INH & EMB	–	–	–	–	–	–	–	–	–	1 (1.2)

* Includes 1 *M. bovis* isolate for 2002.

† MDR-TB is defined as resistance to at least INH and RMP.

‡ Not all isolates were tested for resistance to all drugs; percentage reflect the total number of isolates actually tested.

NOTE: Since the Canadian reclassification of streptomycin from a first-line to a second-line drug in 2005, dramatic changes in the susceptibilty patterns to streptomycin may be observed as fewer jurisdictions are routinely testing this susceptibility.

Table 8. Reported results for routine drug susceptibility testing of *Mycobacterium tuberculosis* isolates, New Brunswick – 1998-2007

	1998 Total (%)	1999 Total (%)	2000 Total (%)	2001 Total (%)	2002 Total (%)	2003 Total (%)	2004 Total (%)	2005 Total (%)	2006 Total (%)	2007 Total (%)
Total number of isolates tested for INH, RMP, EMB, SM and PZA*	10 (100.0)	12 (100.0)	9 (100.0)	10 (100.0)	10 (100.0)	14 (100.0)	11 (100.0)	5 (100.0)	3 (100.0)	5 (100.0)
Isolates susceptible	9 (90.0)	12 (100.0)	9 (100.0)	10 (100.0)	9 (90.0)	13 (92.9)	10 (90.9)	4 (80.0)	3 (100.0)	5 (100.0)
Isolates resistant to one or more drugs	1 (10.0)	–	–	–	1 (10.0)	1 (7.1)	1 (9.1)	1 (20.0)	–	–
Monoresistance	1 (10.0)	–	–	–	1 (10.0)	1 (7.1)	1 (9.1)	1 (20.0)	–	–
INH	1 (10.0)	–	–	–	1 (10.0)	1 (7.1)	1 (9.1)	–	–	–
PZA	–	–	–	–	–	–	–	1 (20.0)	–	–

* Routine testing for SM not conducted. Includes 1 *M. africanum* isolate for 2007.

Table 9. Reported results for routine drug susceptibility testing of *Mycobacterium tuberculosis* isolates, Newfoundland and Labrador – 1998-2007

	1998 Total (%)	1999 Total (%)	2000 Total (%)	2001 Total (%)	2002 Total (%)	2003 Total (%)	2004 Total (%)	2005 Total (%)	2006 Total (%)	2007 Total (%)
Total number of isolates tested for INH, RMP, EMB, SM and PZA	8 (100.0)	9 (100.0)	11 (100.0)	9 (100.0)	4 (100.0)	6 (100.0)	8 (100.0)	6 (100.0)	11 (100.0)	5 (100.0)
Isolates susceptible	8 (100.0)	9 (100.0)	11 (100.0)	9 (100.0)	4 (100.0)	4 (66.7)	8 (100.0)	5 (83.3)	11 (100.0)	5 (100.0)
Isolates resistant to one or more drugs	–	–	–	–	–	2 (33.3)	–	1 (16.7)	–	–
Monoresistance	–	–	–	–	–	2 (33.3)	–	1 (16.7)	–	–
INH	–	–	–	–	–	1 (16.7)	–	1 (16.7)	–	–
RMP	–	–	–	–	–	1 (16.7)	–	–	–	–

Table 10. Reported results for routine drug susceptibility testing of *Mycobacterium tuberculosis* isolates, Northwest Territories – 1998-2007

	1998 Total (%)	1999 Total (%)	2000 Total (%)	2001 Total (%)	2002 Total (%)	2003 Total (%)	2004 Total (%)	2005 Total (%)	2006 Total (%)	2007 Total (%)
Total number of isolates tested for INH, RMP, EMB, SM and PZA	**27 (100.0)**	**11 (100.0)**	**8 (100.0)**	**6 (100.0)**	**3 (100.0)**	**11 (100.0)**	**10 (100.0)**	**6 (100.0)**	**4 (100.0)**	**14 (100.0)**
Isolates susceptible	**27 (100.0)**	**11 (100.0)**	**8 (100.0)**	**6 (100.0)**	**3 (100.0)**	**11 (100.0)**	**10 (100.0)**	**6 (100.0)**	**3 (66.7)**	**14 (100.0)**
Monoresistance	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**1 (33.3)**	**–**
INH	–	–	–	–	–	–	–	–	1 (33.3)	–

Table 11. Reported results for routine drug susceptibility testing of *Mycobacterium tuberculosis* isolates, Nova Scotia – 1998-2007

	1998 Total (%)	1999 Total (%)	2000 Total (%)	2001 Total (%)	2002 Total (%)	2003 Total (%)	2004 Total (%)	2005 Total (%)	2006 Total (%)	2007 Total (%)
Total number of isolates tested for INH, RMP, EMB, SM and PZA*	**9 (100.0)**	**8 (100.0)**	**4 (100.0)**	**7 (100.0)**	**10 (100.0)**	**6 (100.0)**	**9 (100.0)**	**7 (100.0)**	**8 (100.0)**	**5 (100.0)**
Isolates susceptible	**8 (88.9)**	**7 (87.5)**	**4 (100.0)**	**7 (100.0)**	**9 (90.0)**	**6 (100.0)**	**9 (100.0)**	**6 (85.7)**	**8 (100.0)**	**5 (100.0)**
Isolates resistant to one or more drugs	**1 (11.1)**	**1 (12.5)**	**–**	**–**	**1 (10.0)**	**–**	**–**	**1 (14.3)**	**–**	**–**
Monoresistance	**1 (11.1)**	**1 (12.5)**	**–**	**–**	**1 (10.0)**	**–**	**–**	**1 (14.3)**	**–**	**–**
INH	1 (11.1)	1 (12.5)	–	–	–	–	–	–	–	–
PZA	–	–	–	–	1 (10.0)	–	–	1 (14.3)	–	–

* Routine testing for SM not conducted.

Table 12. Reported results for routine drug susceptibility testing of *Mycobacterium tuberculosis* isolates, Nunavut* – 1998-2007

	1998 Total (%)	1999 Total (%)	2000 Total (%)	2001 Total (%)	2002 Total (%)	2003 Total (%)	2004 Total (%)	2005 Total (%)	2006 Total (%)	2007 Total (%)
Total number of isolates tested for INH, RMP, SM, EMB and PZA†	**N/A**	**15 (100.0)**	**29 (100.0)**	**31 (100.0)**	**22 (100.0)**	**4 (100.0)**	**16 (100.0)**	**27 (100.0)**	**37 (100.0)**	**24 (100.0)**
Isolates susceptible	**N/A**	**15 (100.0)**	**28 (96.6)**	**30 (96.8)**	**22 (100.0)**	**4 (100.0)**	**16 (100.0)**	**27 (100.0)**	**37 (100.0)**	**24 (100.0)**
Isolates resistant to one or more drugs	**N/A**	**–**	**1 (3.4)**	**1 (3.2)**	**–**	**–**	**–**		**–**	**–**
Monoresistance	**N/A**	**–**	**1 (3.4)**	**–**	**–**	**–**	**–**		**–**	**–**
INH		–	1 (3.4)	–	–	–	–		–	–
MDR-TB‡	**N/A**	**–**	**–**	**1 (3.2)**	**–**	**–**	**–**		**–**	**–**
INH & RMP		–	–	1 (3.2)	–	–	–		–	–

* Note: Nunavut began reporting in 1999.
† Routine testing for SM not conducted when isolate tested by Quebec (n=13 for 1999, n=28 for 2000 and n=30 for 2001, n=11 for 2002)
‡ MDR-TB is defined as resistance to at least INH and RMP.

Table 13. Reported results for routine drug susceptibility testing of *Mycobacterium tuberculosis* isolates, Ontario – 1998-2007

	1998 Total (%)	1999 Total (%)	2000 Total (%)	2001 Total (%)	2002 Total (%)	2003 Total (%)	2004 Total (%)	2005 Total (%)	2006 Total (%)	2007 Total (%)
Total number of isolates tested for INH, RMP, EMB, SM and PZA*	**629 (100.0)**	**589 (100.0)**	**599 (100.0)**	**588 (100.0)**	**586 (100.0)**	**592 (100.0)**	**599 (100.0)**	**553 (100.0)**	**567 (100.0)**	**538 (100.0)**
Isolates susceptible	**538 (85.5)**	**489 (83.0)**	**519 (86.6)**	**518 (88.1)**	**492 (84.0)**	**508 (85.8)**	**502 (83.8)**	**466 (84.3)**	**504 (88.9)**	**466 (86.6)**
Isolates resistant to one or more drugs	**91 (14.5)**	**100 (17.0)**	**80 (13.4)**	**70 (11.9)**	**94 (16.0)**	**84 (14.2)**	**97 (16.2)**	**87 (15.7)**	**63 (11.1)**	**72 (13.4)**
Monoresistance	**55 (8.7)**	**57 (9.7)**	**52 (8.7)**	**46 (7.8)**	**61 (10.4)**	**46 (7.8)**	**63 (10.5)**	**57 (10.3)**	**49 (8.7)**	**61 (11.3)**
INH	34 (5.4)	34 (5.8)	23 (3.8)	20 (3.4)	30 (5.1)	24 (4.0)	23 (3.8)	29 (5.2)	39(6.9)	50 (9.3)
RMP	–	–	–	–	–	1 (0.2)	–	–	1 (0.2)	1 (0.2)
EMB	4 (0.6)	–	1 (0.2)	1 (0.2)	1 (0.2)	–	–	–	–	1 (0.2)
PZA	6 (1.0)	4 (0.7)	12 (2.0)	7 (1.2)	5 (0.9)	3 (0.5)	3 (0.5)	7(1.3)	9 (1.6)	9 (1.7)
SM	11 (1.7)	19 (3.2)	16 (2.7)	16 (2.7)	25 (4.3)	18 (3.0)	37 (6.2)	21 (3.8)	–	–

continued…

Table 13. Reported results for routine drug susceptibility testing of *Mycobacterium tuberculosis* isolates, Ontario – 1998-2007 *(continued)*

	1998 Total (%)	1999 Total (%)	2000 Total (%)	2001 Total (%)	2002 Total (%)	2003 Total (%)	2004 Total (%)	2005 Total (%)	2006 Total (%)	2007 Total (%)
MDR-TB†	**11 (1.7)**	**13 (2.2)**	**9 (1.5)**	**3 (0.5)**	**16 (2.7)**	**12 (2.0)**	**7 (1.2)**	**13 (2.4)**	**11 (1.9)**	**7 (1.3)**
INH & RMP	2 (0.3)	3 (0.5)	1 (0.2)	–	2 (0.3)	3 (0.5)	4 (0.7)	3 (0.5)	4 (0.7)	–
INH & RMP & EMB	–	1 (0.2)	2 (0.3)	1 (0.2)	1 (0.2)	1 (0.2)	–		2 (0.3)	1 (0.2)
INH & RMP & SM	1 (0.2)	3 (0.5)	3 (0.5)	–	2 (0.3)	1 (0.2)	–	2 (0.4)	4 (0.7)	–
INH & RMP & PZA	–	1 (0.2)	–	–	–	2 (0.3)	1 (0.2)	1 (0.2)	–	1 (0.2)
INH & RMP & EMB & PZA	–	–	–	1 (0.2)	1 (0.2)	1 (0.2)	–	–	–	5 (0.2)
INH & RMP & SM & EMB	2 (0.3)	–	2 (0.3)	–	5 (0.9)	–	–	4 (0.7)	–	–
INH & RMP & SM & PZA	–	–	1 (0.2)	–	–	–	1 (0.2)	–	1 (0.2)	–
INH & RMP & SM & EMB & PZA	6 (1)	5 (0.8)	–	1 (0.2)	5 (0.9)	4 (0.7)	1 (0.2)	3 (0.5)	–	–
Other Patterns	**25 (4)**	**30 (5.1)**	**19 (3.2)**	**21 (3.6)**	**17 (2.9)**	**26 (4.4)**	**27 (4.5)**	**17 (3.1)**	**3 (0.5)**	**4 (0.7)**
INH & EMB	2 (0.3)	4 (0.7)	2 (0.3)	–	1 (0.2)	2 (0.3)	1 (0.2)	1 (0.2)	–	1 (0.2)
INH & PZA	–	–	–	2 (0.3)	–	–	1 (0.2)	–	–	2 (0.4)
INH & SM	20 (3.2)	20 (3.4)	14 (2.3)	16 (2.7)	13 (2.2)	18 (3.1)	23 (3.8)	15 (2.7)	–	–
SM & PZA	–	–	–	–	–	1 (0.2)	–	–	–	–
EMB & RMP	–	–	2 (0.3)	–	–	–	–	–	–	1 (0.2)
EMB & PZA	–	–	–	–	–	–	–	–	–	–
INH & SM & EMB	2 (0.3)	4 (0.7)	1 (0.2)	3 (0.5)	2 (0.3)	3 (0.5)	2 (0.3)	1 (0.2)	3 (0.5)	–
INH & SM & PZA	1 (0.2)	2 (0.3)	–	–	–	1 (0.2)	–	–	–	–
INH & EMB & PZA	–	–	–	–	–	1 (0.2)	–	–	–	–
INH & SM & EMB & PZA	–	–	–	–	1 (0.2)	–	–	–	–	–

* Includes 1 *M. bovis* isolate for 1999, 2 *M. bovis* isolates for 2000, 2 *M. bovis* isolates for 2001, 1 *M. bovis* isolate for 2002,1 *M. bovis* isolate for each 2003, 2004 and 2005 and 4 M. bovis for 2006.

† MDR-TB is defined as resistance to at least INH and RMP.

NOTE: Since the Canadian reclassification of streptomycin from a first-line to a second-line drug in 2005, dramatic changes in the susceptibilty patterns to streptomycin may be observed as fewer jurisdictions are routinely testing this susceptibility.

Table 14. Reported results for routine drug susceptibility testing of *Mycobacterium tuberculosis* isolates, Prince Edward Island – 1998-2007

	1998 Total (%)	1999 Total (%)	2000 Total (%)	2001 Total (%)	2002 Total (%)	2003 Total (%)	2004 Total (%)	2005 Total (%)	2006 Total (%)	2007 Total (%)
Total number of isolates tested for INH, RMP, EMB, SM and PZA*	**2 (100.0)**	**2 (100.0)**	**3 (100.0)**	**2 (100.0)**	**1 (100.0)**	**2 (100.0)**	**1 (100.0)**	**1 (100.0)**	**0 (0.0)**	**0 (0.0)**
Isolates susceptible	**2 (100.0)**	**2 (100.0)**	**3 (100.0)**	**1 (50.0)**	**1 (100.0)**	**2 (100.0)**	**1 (100.0)**	**1 (100.0)**	**0 (0.0)**	**0 (0.0)**
Isolates resistant to one or more drugs	**–**	**–**	**–**	**1 (50.0)**	**–**	**–**	**–**	**–**	**–**	**–**
Monoresistance	**–**	**–**	**–**	**1 (50.0)**	**–**	**–**	**–**	**–**	**–**	**–**
PZA	–	–	–	1 (50.0)	–	–	–	–	–	–

* Includes 1 *M. bovis* isolate for 2001.

* Routine testing for SM not conducted.

Table 15. Reported results for routine drug susceptibility testing of *Mycobacterium tuberculosis* isolates, Quebec – 1998-2007

	1998 Total (%)	1999 Total (%)	2000 Total (%)	2001 Total (%)	2002 Total (%)	2003 Total (%)	2004 Total (%)	2005 Total (%)	2006 Total (%)	2007 Total (%)
Total number of isolates tested for INH, RMP, EMB, SM and PZA*	**264 (100.0)**	**268 (100.0)**	**278 (100.0)**	**221 (100.0)**	**247(100.0)**	**219 (100.0)**	**207 (100.0)**	**226 (100.0)**	**201 (100.0)**	**200 (100.0)**
Isolates susceptible	**231 (87.5)**	**236 (88.1)**	**249 (89.6)**	**202 (91.4)**	**222 (89.9)**	**187 (85.4)**	**190 (91.8)**	**207 (91.6)**	**173 (86.1)**	**177 (88.5)**
Isolates resistant to one or more drugs	**33 (12.5)**	**32 (11.9)**	**29 (10.4)**	**19 (8.6)**	**25 (10.1)**	**32 (14.6)**	**17 (8.2)**	**19 (8.4)**	**28 (13.9)**	**23 (11.5)**
Monoresistance	**28 (10.6)**	**28 (10.4)**	**28 (10.1)**	**18 (8.1)**	**23 (9.3)**	**31 (14.2)**	**15 (7.2)**	**18 (8.0)**	**26 (12.9)**	**17 (8.5)**
INH	9 (3.4)	17 (6.3)	19 (6.8)	14 (6.3)	13 (5.3)	25 (11.4)	11 (5.3)	14 (6.2)	21 (10.4)	12 (6.0)
RMP	–	1 (0.4)	–	–	1 (0.4)	–	–	–	1 (0.5)	1 (0.5)
PZA	6 (2.3)	10 (3.7)	9 (3.2)	4 (1.8)	9 (3.6)	6 (2.7)	4 (1.9)	4 (1.8)	4 (2.0)	4 (2.0)
SM†	13 (4.9)	–	–	–	–	–	–	–	–	–
MDR-TB‡	**2 (0.8)**	**2 (0.7)**	**1 (0.4)**	**1 (0.5)**	**1 (0.4)**	**1 (0.5)**	**1 (0.5)**	**1 (0.4)**	**2 (1.0)**	**2 (1.0)**
INH & RMP	–	1 (0.4)	–	1 (0.5)	–	1 (0.5)	1 (0.5)	–	–	–
INH & RMP & EMB	1 (0.4)	–	1 (0.4)	–	1 (0.4)	–	–	–	2 (1.0)	2 (1.0)
INH & RMP & SM	1 (0.4)	–	–	–	–	–	–	–	–	–
INH & RMP & PZA	–	–	–	–	–	–	–	1 (0.4)	–	–
INH & RMP & EMB & PZA	–	1 (0.4)	–	–	–	–	–	–	–	–
Other Patterns	**3 (1.1)**	**2 (0.7)**	**0 (0.0)**	**0 (0.0)**	**1 (0.4)**	**0 (0.0)**	**1 (0.5)**	**0 (0.0)**	**0 (0.0)**	**4 (2.0)**
INH & SM	2 (0.8)	–	–	–	–	–	–	–	–	–
RMP & SM	–	–	–	–	–	–	–	–	–	–
INH & EMB	–	–	–	–	1 (0.4)	–	1 (0.5)	–	–	3 (1.5)
INH & PZA	1 (0.4)	2 (0.7)	–	–	–	–	–	–	–	1 (0.5)

* Includes *M. bovis* isolates: 1 in 1998, 1 in 1999, 2 in 2000, 1 in 2001, 1 in 2002, 1 in 2003, 2 in 2004, 2 in 2006 and 1 in 2007; *M. caprae*: 1 in 2002; 1 in 2006; *M. africanum*: 1 in 2003, 1 in 2005, 1 in 2006 and 2 in 2007.

† Routine testing for SM not conducted in Quebec effective January 1, 1999.

‡ MDR-TB is defined as resistance to at least INH and RMP.

Table 16. Reported results for routine drug susceptibility testing of *Mycobacterium tuberculosis* isolates, Saskatchewan – 1998-2007

	1998 Total (%)	1999 Total (%)	2000 Total (%)	2001 Total (%)	2002 Total (%)	2003 Total (%)	2004 Total (%)	2005 Total (%)	2006 Total (%)	2007 Total (%)
Total number of isolates tested for INH, RMP, EMB, SM and PZA*	**49 (100.0)**	**40 (100.0)**	**64 (100.0)**	**68 (100.0)**	**56 (100.0)**	**46 (100.0)**	**34 (100.0)**	**75 (100.0)**	**58 (100.0)**	**60 (100.0)**
Isolates susceptible	**47 (95.9)**	**39 (97.5)**	**58 (90.6)**	**65 (95.6)**	**51 (91.1)**	**45 (97.8)**	**31 (91.2)**	**73 (97.3)**	**57 (98.3)**	**59 (98.3)**
Isolates resistant to one or more drugs	**2 (4.1)**	**1 (2.5)**	**6 (9.4)**	**3 (4.4)**	**5 (8.9)**	**1 (2.2)**	**3 (8.8)**	**2 (2.7)**	**1 (1.7)**	**1 (1.7)**
Monoresistance	**1 (2)**	**–**	**4 (6.3)**	**2 (2.9)**	**4 (7.1)**	**1 (2.2)**	**3 (8.8)**	**2 (2.7)**	**1 (1.7)**	**1 (1.7)**
INH	1 (2)	–	2 (3.1)	2 (2.9)	3 (5.4)	1 (2.2)	2 (5.9)	2 (2.7)	1 (1.7)	1 (1.7)
EMB	–	–	1 (1.6)	–	1 (1.8)	–	–	–	–	–
SM	–	–	1 (1.6)	–	–	–	1 (2.9)	–	–	–
Other Patterns	**1 (2.0)**	**1 (2.5)**	**2 (3.1)**	**1 (1.5)**	**1 (1.8)**	**–**	**–**	**–**	**–**	**–**
INH & EMB	–	–	1 (1.6)	–	1 (1.8)	–	–	–	–	–
INH & SM	1 (2.0)	1 (2.5)	1 (1.6)	1 (1.5)	–	–	–	–	–	–

* Routine testing for PZA not conducted.

NOTE: Since the Canadian reclassification of streptomycin from a first-line to a second-line drug in 2005, dramatic changes in the susceptibilty patterns to streptomycin may be observed as fewer jurisdictions are routinely testing this susceptibility.

Table 17. Reported results for routine drug susceptibility testing of *Mycobacterium tuberculosis* isolates, Yukon Territory – 1998-2007

	1998 Total (%)	1999 Total (%)	2000 Total (%)	2001 Total (%)	2002 Total (%)	2003 Total (%)	2004 Total (%)	2005 Total (%)	2006 Total (%)	2007 Total (%)
Total number of isolates tested for INH, RMP, EMB, SM and PZA*	**1 (100.0)**	**–**	**3 (100.0)**	**1 (100.0)**	**–**	**1 (100.0)**	**3 (100.0)**	**2 (100.0)**	**2 (100.0)**	**2 (100.0)**
Isolates susceptible	**1 (100.0)**	**–**	**3 (100.0)**	**1 (100.0)**	**–**	**1 (100.0)**	**3 (100.0)**	**2 (100.0)**	**2 (100.0)**	**2 (100.0)**

* Routine testing for PZA not conducted.

Appendix 1

Participating Laboratories of the Canadian Tuberculosis Laboratory Surveillance System

Alberta **(Alberta, Northwest Territories and Nunavut)**	Cary Shandro Mycobacteriology Provincial Laboratory of Public Health Dr. Greg Tyrrell Medical Microbiologist Provincial Laboratory of Public Health Dr. Jutta Preiksaitis Director Provincial Laboratory of Public Health
British Columbia **(British Columbia and Yukon Territory)**	Dr. Mabel Rodrigues, Ph.D. Section Supervisor TB B.C. Centre for Disease Control Dr. Patrick Tang Medical Microbiologist B.C. Centre for Disease Control Dr. Judy L. Isaac-Renton Director, Provincial Laboratory B.C. Centre for Disease Control
Manitoba	Assunta Rendina, MLT Charge technologist, Mycobacteriology section Clinical Microbiology Diagnostic Services of Manitoba Dr. Godfrey Harding Medical Director Clinical Microbiology Diagnostic Services of Manitoba
New Brunswick	Hope MacKenzie Microbiology Laboratory Department of Laboratory Medicine Dr. Glenna Hardy Medical Microbiologist Department of Laboratory Medicine Dr. Anne O'Brien Clinical Head Department of Laboratory Medicine Saint John Regional Hospital

Newfoundland and Labrador	Sandra B. March, MSc ART Clinical Microbiologist Newfoundland Public Health Laboratory Dr. Sam Ratnam Director Newfoundland Public Health Laboratory
Northwest Territories **(see also Alberta)**	Evelyn Smith Supervisor, Bacteriology Stanton Territorial Hospital Mr. Robin Greig Manager Therapeutic & Diagnostic Services
Nova Scotia **(Nova Scotia and Prince Edward Island)**	Carol Pelton, Tech II, MLT Division of Medical Microbiology Department of Pathology & Laboratory Medicine Queen Elizabeth II Health Sciences Centre Dr. David Haldane Director of Special Pathogens and Microbiology Queen Elizabeth II Health Sciences Centre Dr. Kevin Forward Director Department of Public Health Pathology & Laboratory Medicine Queen Elizabeth II Health Sciences Centre
Ontario	Pamela Chedore, MLT Head, Mycobacteriology Laboratory Branch: Ministry of Health and Longterm Care Dr. Frances Jamieson Medical Microbiologist Laboratory Branch: Ministry of Health and Longterm Care Mr. Nicholas Paul Manager Direct Services Laboratory Branch: Ministry of Health and Longterm Care

Quebec		Louise Thibert, MSc Head, Mycobacteriology and Aerobic Actinomycetes Laboratoire de santé publique du Québec Institut national de santé publique du Québec Dr. Anne-Marie Bourgeault Director Laboratoire de santé publique du Québec Institut national de santé publique du Québec
Saskatchewan	*North:*	Colleen Foster Clinical Microbiology Royal University Hospital Saskatoon, Saskatchewan Dr. J. Blondeau Department Head Microbiology/Mycobacteriology Royal University Hospital Saskatoon, Saskatchewan
	South:	Elaine Schweitzer Clinical Services/Microbiology Saskatchewan Health Provincial Laboratory Dr. Paul Levett Microbiologist Saskatchewan Health Provincial Laboratory Dr. Greg Horsman Director Laboratory and Disease Control Services Saskatchewan Health
Federal		Joyce Wolfe, ART Program Manager, Mycobacteriology National Reference Centre for Mycobacteriology Public Health Agency of Canada

Appendix 2

Public Health Agency of Canada / Agence de santé publique du Canada

Serial No. - N° de série

The Canadian Tuberculosis Laboratory Surveillance System
M. TUBERCULOSIS COMPLEX ANTIMICROBIAL SUSCEPTIBILITY REPORTING FORM

Système de surveillance des laboratoires de tuberculose au Canada
RAPPORT SUR LA SENSIBILITÉ DES SOUCHES DU COMPLEXE M. TUBERCULOSIS AUX ANTIMICROBIENS

FOR INTERNAL USE ONLY - POUR USAGE INTERNE SEULEMENT

Date Rec'd at TBPC: / Date de réception au LATB: Y / A | M | D / J

TBPC Number: / Numéro du LATB:

Unique Source Laboratory ID No. - Identificateur unique du laboratoire déclarant:

Date specimen / culture received at laboratory: / Date de réception échantillon / culture au laboratoire: Y / A | M | D / J

Specie: / Espèce :
- ☐ M. tuberculosis (may include M. africanum or M. microti) / (peut inclure M. africanum et M. microti)
- ☐ M. bovis
- ☐ M. BCG bovis
- ☐ MTB Complex (species unknown) / Complexe MTB (espèce inconnu)

Have susceptibility test results been previously reported for this patient? - Des résultats d'antibiogramme ont-ils déjà été fournis pour ce patient?

☐ No / Non ☐ Yes / Oui → What is the **previous** Unique Source Laboratory ID No.? / Identificateur **antérieur**?

→ What is the **previous** Form No.? (If known) / N° de formulaire **antérieur**? (Si connu)

Note: Only DRUG TESTING RESULTS OF ONE ISOLATE are to be reported. No subsequent drug testing results for the same patient are to be reported unless the sensitivity pattern changes.

Note: Ne fournir que les RÉSULTATS POUR UNE SEULE SOUCHE par patient à moins d'un changement du profil de sensibilité.

1. Province / territory from which this report originates: / Province / territoire qui soumet ce rapport : ☐☐ (see code list) / (voir liste de codes)
2. Province / territory from which specimen originated: / Province / territoire d'où provient l'échantillon : ☐☐ (see code list) / (voir liste de codes)
3. Patient's date of birth: / Date de naissance du patient : Y / A | M | D / J (CCYY/MM/DD) / (SSAA/MM/JJ) ☐ Unknown / Inconnu
4. Patient's gender: / Sexe du patient : ☐ Male / Masculin ☐ Female / Féminin ☐ Unknown / Inconnu

PROV / TERR CODES PROV / TERR

10 = NFLD / TN	46 = MAN
11 = PEI / IPÉ	47 = SASK
12 = NS / NÉ	48 = ALTA / ALB
13 = NB	59 = BC / BC
24 = QUÉ / Qc	60 = YUK
35 = ONT	61 = NWT / TNO
	62 = NUN

5. **LABORATORY RESULTS / RÉSULTATS DE LABORATOIRE**

Antituberculous Drugs / Agents Antituberculeux	Concentration (if different from on file) / Concentration (si autre que spécifiée)	Results (check appropriate box for every drug) / Résultats (cocher la case pertinente pour chaque antibiotique)		
		Sensitive / Sensible	Resistant / Résistant	Other (specify) / Autre (préciser)
SM (Streptomycin) / (Streptomycine)	mg / L	☐	☐	
INH (Isoniazid) / (Isoniazide)	mg / L	☐	☐	
RMP (Rifampin) / (Rifampicine)	mg / L	☐	☐	
EMB (Ethambutol)	mg / L	☐	☐	
PZA (Pyrazinamide)	mg / L	☐	☐	
2nd line drugs (specify) / Antibiotiques de 2e ligne (préciser)	**Concentration**	Sensitive / Sensible	Resistant / Résistant	Other (specify) / Autre (préciser)
1.	mg / L	☐	☐	
2.	mg / L	☐	☐	
3.	mg / L	☐	☐	
4.	mg / L	☐	☐	
5.	mg / L	☐	☐	
6.	mg / L	☐	☐	

6. **Comments - Commentaires**

HC/SC 9061 (07-2000)

Copy 1 (White) - Reporting Laboratory
Copie 1 (Blanche) - Laboratoire déclarant

Copy 2 (Yellow) - Tuberculosis Prevention and Control (TBPC)
Copie 2 (Jaune) - Lutte anti-tuberculeuse (LATB)