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Tuberculosis

Drug resistance in Canada

2006

Reported susceptibility results of the
Canadian Tuberculosis Laboratory
Surveillance System

Canada

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For more information, copies of this report or other reports, please contact:

Tuberculosis Prevention and Control
Community Acquired Infections Division
Centre for Infectious Disease Prevention and Control
Public Health Agency of Canada
100 Eglantine Driveway, Health Canada Building
A.L. 0603B, Tunney's Pasture
Ottawa, ON K1A 0K9

Internal Postal Address: 0603B
Telephone: (613) 941-0238
Facsimile: (613) 946-3902
Email: TB_1@ phac-aspc.gc.ca

This report can also be accessed on the internet at:

http://www.phac-aspc.gc.ca/tbpc-latb/surv_e.html

The following text, figures and tables were prepared by:

Edward Ellis, MD, MPH, FRCPC
Manager
Tuberculosis Prevention and Control

Derek Scholten, MSc
Epidemiologist
Tuberculosis Prevention and Control

Melissa Phypers, MSc
Senior Epidemiologist
Tuberculosis Prevention and Control

Victor Gallant, MA
Tuberculosis Database Manager
Tuberculosis Prevention and Control

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Cat. HP37-4/2006
ISBN 978-0-662-49834-6

Cat. HP37-4/2006E-PDF
ISBN 978-0-662-45075-7

This publication can be made available in alternative formats.

▶ ACKNOWLEDGEMENT

Tuberculosis Prevention and Control would like to acknowledge the members of the Canadian Tuberculosis Laboratory Technical Network and their teams for their contribution to and their participation in the Canadian Tuberculosis Laboratory Surveillance System (CTBLSS).



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► INTRODUCTION

Tuberculosis Prevention and Control (TBPC), Public Health Agency of Canada, in collaboration with the Canadian Tuberculosis Laboratory Technical Network and participating laboratories (representing all provinces and territories) (Appendix 1), established a laboratory-based national surveillance system (Canadian Tuberculosis Laboratory Surveillance System – CTBLSS) in 1998 to monitor tuberculosis (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 specimen or an isolate is received within the previous calendar year. TBPC subsequently produces this annual report.

► METHODS

The Canadian Tuberculosis Committee defines a laboratory confirmed case of tuberculosis as any individual with *Mycobacterium tuberculosis* complex demonstrated on culture, specifically *M. tuberculosis*, *M. africanum*, *M. canetti*, *M. caprae*, *M. microti*, *M. pinnipedii* or *M. bovis* [excluding *M. bovis* BCG strain]. Thus, to align the drug susceptibility report with the case report, the CTBLSS contains drug susceptibility test results of *Mycobacterium tuberculosis* (MTB) and other tuberculosis 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 drug susceptibility results. TBPC, in collaboration with the provinces/territories, makes every effort to eliminate duplicate specimens. Only the most recent susceptibility results for a given patient in the reporting year are included for analysis.

This report presents drug susceptibility data for TB isolates tested in 2006. As well, results from the retesting of all multidrug-resistant TB isolates (MDR-TB, isolates showing resistance to at least isoniazid and rifampicin, the two most powerful anti-TB drugs) for the years 2003 through 2006 in an effort to identify any extensively drug-resistant TB (XDR-TB) are also presented. XDR-TB is currently defined as resistance to at least rifampin and isoniazid (MDR-TB) with additional resistance to any fluoroquinolone, and to at least one of three injectable second-line drugs (capreomycin, kanamycin, and amikacin).

The historic record is reviewed annually and adjustments are made to ensure duplicate removal and account for late reporting and the availability of new/updated information. The information in this report is current to March 1, 2007.

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 test only their own isolates.

Laboratories perform routine susceptibility testing of MTB or MTBC to first-line anti-TB drugs using either the radiometric proportion method BACTEC® 460 or MGIT® 960. New Brunswick, Nova Scotia and Ontario used MGIT® 960; Saskatchewan, and Newfoundland and Labrador use a combination of both. All other provinces/territories used BACTEC® 460. Table A lists the first-line and second-line anti-TB drugs and the critical concentrations in mg/L used by the participating laboratories.

Historically, the CTBLSS collected susceptibility results for first-line drugs only. More recently results for second-line drug testing were also submitted to TBPC from some jurisdictions. Starting with this report, a more comprehensive reporting of susceptibility testing results for second-line anti-TB drugs has been carried out for those isolates that were reported as MDR-TB. Streptomycin (SM) was reclassified in 2005 as a second-line anti-TB drug in Canada. This reclassification has resulted in discontinuation of routine testing for resistance to SM in some jurisdictions. Thus, the number of isolates tested against SM will show a decrease in 2006 compared to previous years.

Four laboratories currently perform second-line drug resistance: the National Reference Centre for Mycobacteriology (NRCM), National Microbiology Laboratory (NML) in Manitoba as well as the provincial laboratories in Alberta, Ontario and Quebec. Second-line testing in Alberta is currently done by agar proportion. NRCM, Ontario and Quebec use BACTEC® 460.

This report presents data on various combinations of resistance patterns. Resistance to first-line drugs includes: a) mono-resistance which is resistance to one of the first-line drugs (isoniazid, rifampin, ethambutol or pyrazinamide); b) poly resistance, resistance to 2 or more first-line drugs; and c) MDR-TB, a special instance of poly resistance. In March of 2006, the World Health Organization (WHO) and the United States Centers for Disease Control and Prevention (CDC) reported a new form of resistance, extensively drug-resistant TB (XDR-TB).

In order to determine the incidence of XDR-TB in Canada, laboratories were asked to submit second-line drug susceptibility results for all MDR-TB isolates detected during the period 2003-2006. For this report, the number of isolates tested in the calendar year that met the definition of XDR-TB is reported at the national level only due to the small numbers. All XDR-TB cases are included in the MDR-TB counts and then reported as a subset of MDR-TB.

For the isolates tested for susceptibility to second-line drugs, not all were tested for all the drugs used in the WHO definition for XDR-TB. Certain assumptions were made in reviewing the results of second-line sensitivity. Resistance or sensitivity to either of the aminoglycosides (amikacin or kanamycin) was used in determining an XDR-TB diagnosis; drug sensitivity was considered equivalent so that a resistant result for amikacin would indicate resistance to kanamycin and vice versa. For some second-line drugs there is a lack of accepted standards for drug testing and the clinical interpretation of test results. Until such standards are in place, results should be interpreted cautiously.

As not all isolates were tested for resistance to all drugs, the proportion of isolates showing monoresistance is expressed as the number of isolates resistant to the drug over the total number of isolates tested for sensitivity to that particular drug. An adjustment based on this method has been made to all data starting from 1998. These proportions for 1998 through 2006 are reported in Table 1, and Tables 5-17.

Table A: Concentrations for testing of anti-tuberculosis drugs

First-line Anti-Tuberculosis Drugs			
Anti-TB 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, tests are repeated with INH 0.4mg/L to determine the level of resistance.
Rifampin (RMP)	2.0	1.0	
Ethambutol (EMB)	2.5	5.0	British Columbia uses a critical concentration of 2.5 mg/L.
Pyrazinamide (PZA)	100.0	100.0	Routine testing is not performed for isolates from British Columbia, Saskatchewan and the Yukon Territory.
Second-line Anti-Tuberculosis Drugs			
Anti-TB drugs	Critical Concentrations* (mg/L)		Comments
Streptomycin (SM)	2.0	1.0	There is also a high concentration for SM which is 6.0 in BACTEC 460.
	Critical Concentrations‡ (mg/L)		
	BACTEC 460†	Agar Proportion	
Amikacin (AM)	1.0	–	
Kanamycin (KM)	5.0	5.0	
Capreomycin (CM)	1.25	10.0	
Ethionamide (ETA)	1.25	5.0	
Rifabutin (RBT)	0.5	0.5	
Ofloxacin (OFL)	2.0	2.0	

* Critical concentrations: the lowest concentration of drug that will inhibit 95% (90% for PZA) 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.

† Concentrations are pending approval from the Clinical and Laboratory Standards Institute (CLSI).

‡ Most second-line drugs were not used at the time of development of the Proportion Method and definition of the critical concentrations. Therefore, for the current report, we are reporting the “concentrations tested” and suggest caution be exercised when interpreting results.

In 2006, a total of 10 laboratories participated in the proficiency for anti-microbial susceptibility testing of *M. tuberculosis* to isoniazid (INH), rifampin (RMP), ethambutol (EMB), pyrazinamide (PZA) and streptomycin (SM) conducted by the NRCM. Participant results are presented in Appendix 3.

► RESULTS

Of the 1,389 isolates in 2006 included for analysis, 140 (10.1%) were resistant to at least one of the antituberculosis drugs tested: INH, RMP, EMB, PZA or SM. INH resistance was present in 7.3% of isolates tested. Sixteen isolates (1.2%) were MDR-TB. One isolate (0.1%) was classified as XDR-TB according to the current definition. Fourteen isolates demonstrated resistance to three or more of the five anti-TB drugs tested.

MDR-TB isolates were reported from Alberta, British Columbia, Ontario and Quebec. Manitoba and Saskatchewan reported monoresistance but no MDR-TB. New Brunswick, Newfoundland, Northwest Territories, Nova Scotia, Nunavut, and Yukon Territory, reported that all isolates tested were susceptible to all the anti-TB drugs.

Between 2003 and 2006, there were a total of 5,511 isolates evaluated for drug susceptibility. Of these, 71 (1.3%) were classified as MDR-TB and of these, two (2.8%) isolates were XDR-TB, one in 2003 and the aforementioned one in 2006.

Demographic information on the individual patients from whom the isolates originated is limited in this laboratory-based surveillance system. Of the 1,375 isolates for which age at time of testing and/or sex of the patient was known, 33% were between the ages 25 and 44, males accounted for 56% of all the isolates and 59% of the drug resistant isolates.

► DISCUSSION

Susceptibility results were reported for 1,389 isolates in 2006. The percentage of isolates demonstrating any type of drug resistance was 10.1%, which is a decrease from previous years. The proportion of isolates that were monoresistant has remained stable but other polyresistant patterns have decreased. One reason for this is the reclassification of SM as a second-line drug in Canada and the resultant discontinuation of testing for SM resistance in some jurisdictions.

The proportion (1.2%) of isolates classified as MDR-TB in 2006 was within the range (0.9-1.6%) observed from 1998 through 2005.

Seventy-five percent of the reported TB isolates in Canada in 2006 originated from three provinces: British Columbia, Ontario and Quebec. These provinces have consistently reported the majority of isolates and MDR-TB in the nine 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.

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), the median prevalence of TB drug resistance among the participating countries was 10.5% (Range 0.0 – 57.1%) for new cases and 22.7% (Range 0.0 – 82.1%) for previously treated cases (as compared with 10.1% overall in Canada). The median prevalence of MDR-TB was 1.2% (Range 0.0 – 14.2%) for new cases and 7.6% (Range 0.0 – 58.3%) for previously treated cases (as compared with 1.2% overall in Canada)*.¹

XDR-TB is a growing international concern with 28 countries reporting XDR-TB cases as of March 1, 2007. In an early assessment of the frequency and distribution of XDR-TB cases, the CDC and the WHO surveyed an international network of TB laboratories. It was determined that between 2000—2004, of 17,690 TB isolates, 20% were MDR and

* Unlike IUATLD that provides the prevalence of TB drug resistance for both new and retreated cases, TBPC only reports overall prevalence as isolates are not separated into new and retreated.

2% were XDR. In addition, population-based data on drug susceptibility of TB isolates were obtained from the United States (for 1993—2004), Latvia (for 2000—2002), and South Korea (for 2004), where 4%, 19%, and 15% of MDR TB cases, respectively, were XDR.² While the incidence of XDR-TB in Canada from 2003 to 2006 was very low, (one case in 2003 and one in 2006), testing of all future MDR-TB isolates in Canada for XDR will be needed to monitor incidence.

▶ LIMITATIONS

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

More epidemiological information on the TB cases from which the isolates were submitted would be 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 case. 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 epidemiological data for the drug resistance TB cases.

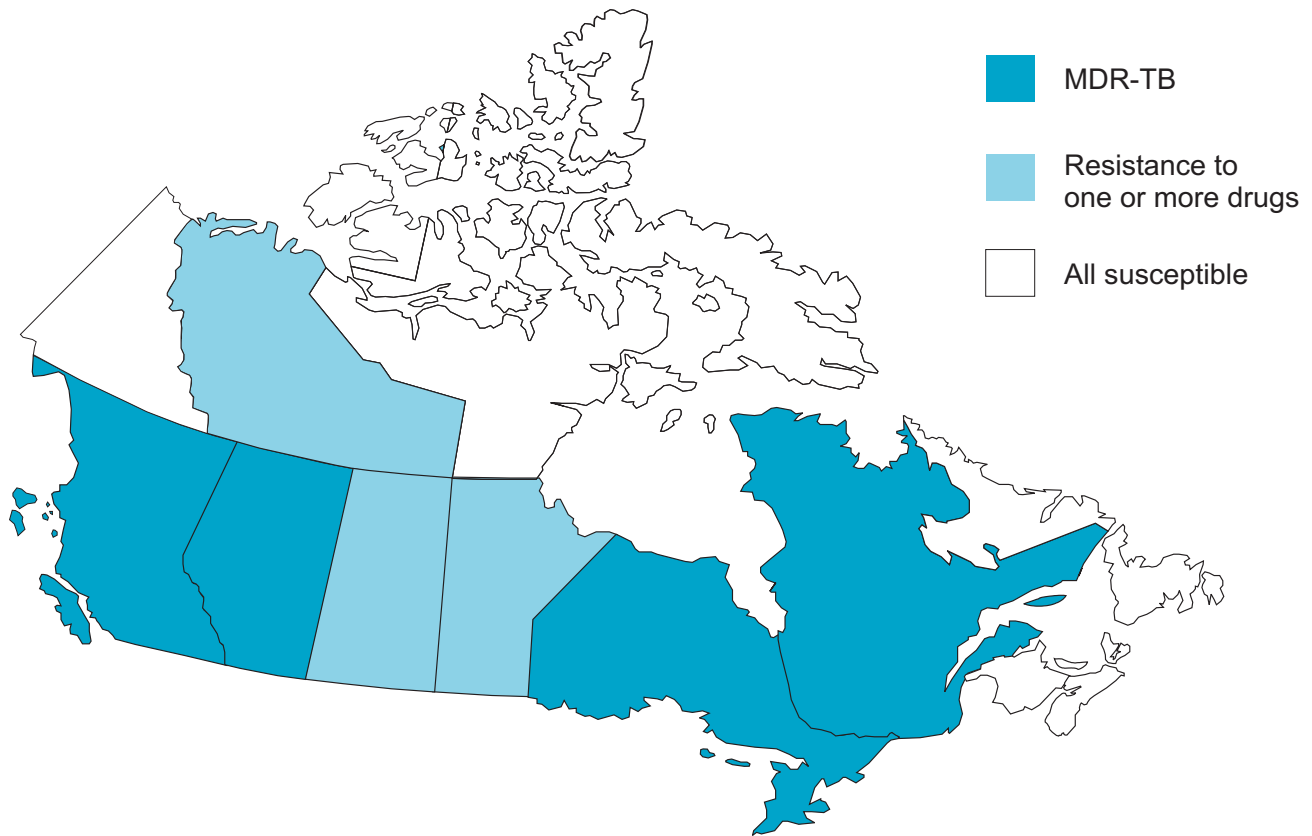
▶ CONCLUSIONS

With growing worldwide concern regarding TB drug resistance and with the emergence of XDR-TB, 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 similar to the global average.

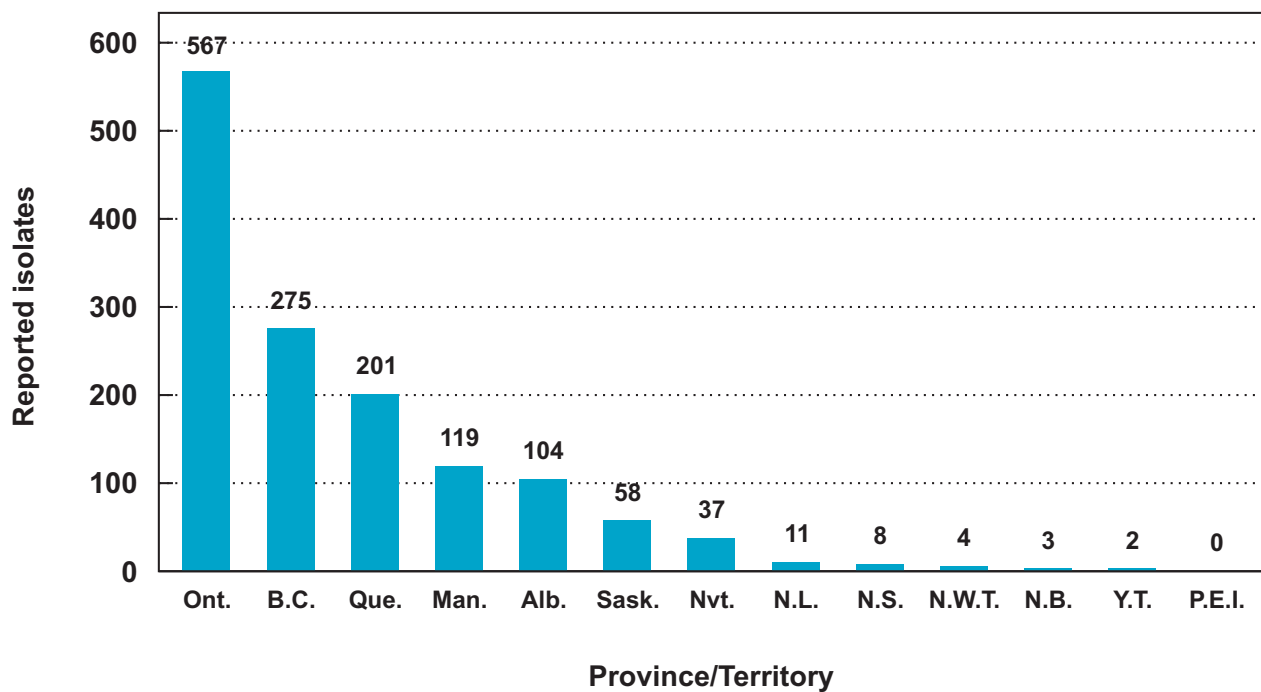
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2. Centers for Disease Control and Prevention. Emergence of *Mycobacterium tuberculosis* with extensive resistance to second-line drugs—worldwide, 2000-2004. *MMWR*. 2006; 55:301-305.

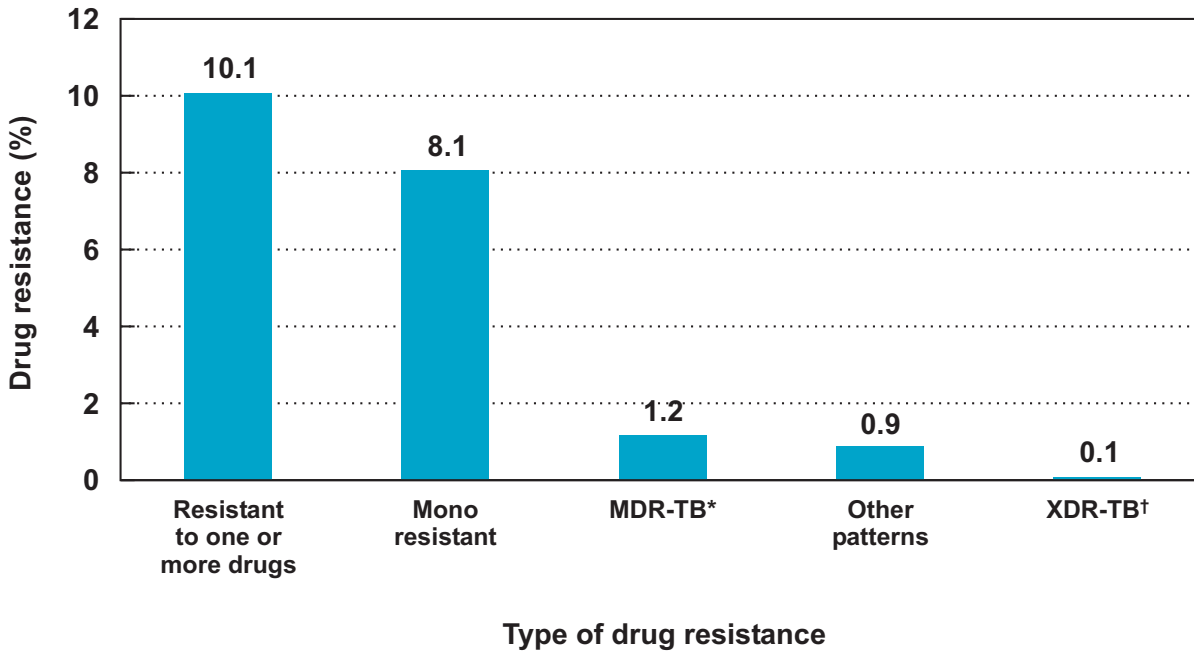
► **Figure 1**
Reported TB drug resistance in Canada by province/territory – 2006



► **Figure 2**
Reported *Mycobacterium tuberculosis* isolates in Canada by province/territory – 2006



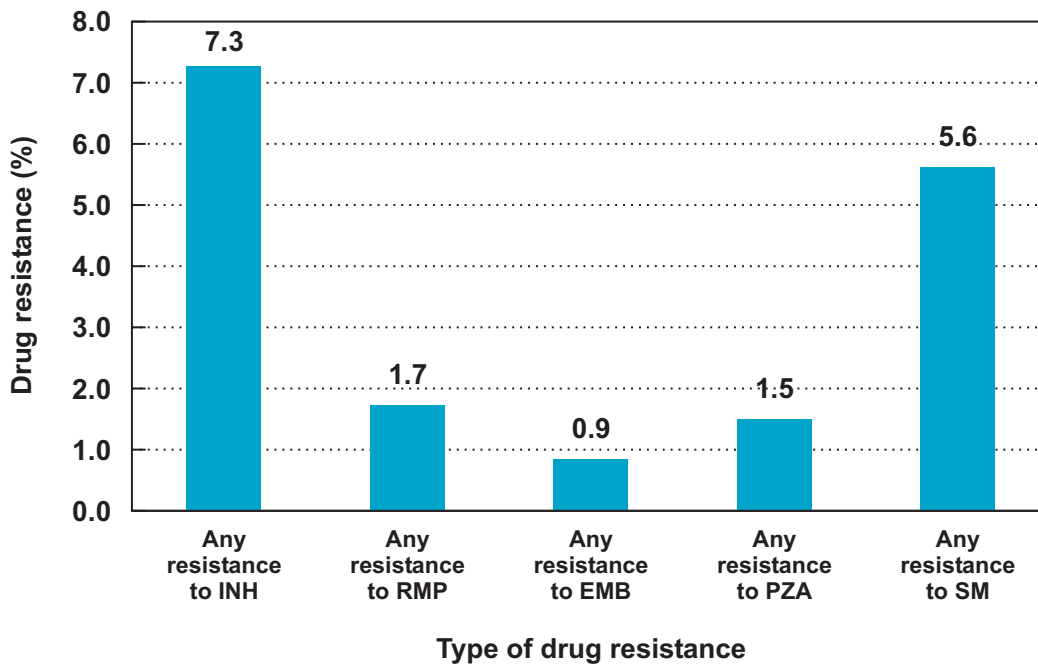
► **Figure 3**
Overall pattern of reported TB drug resistance in Canada – 2006



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

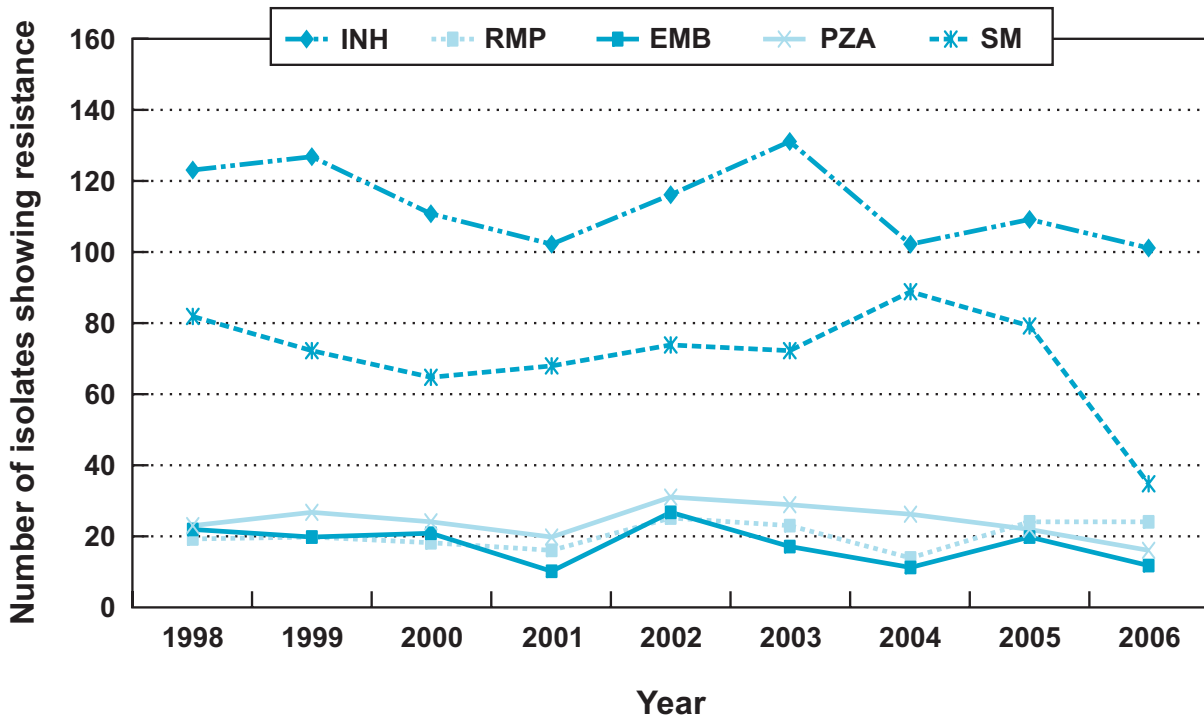
† Extensively drug resistant TB (XDR-TB) is MDR-TB plus resistance to any fluoroquinolone and at least 1 of 3 injectable second-line drugs: capreomycin, kanamycin and amikacin.

► **Figure 4**
Reported TB drug resistance in Canada by type of drug – 2006



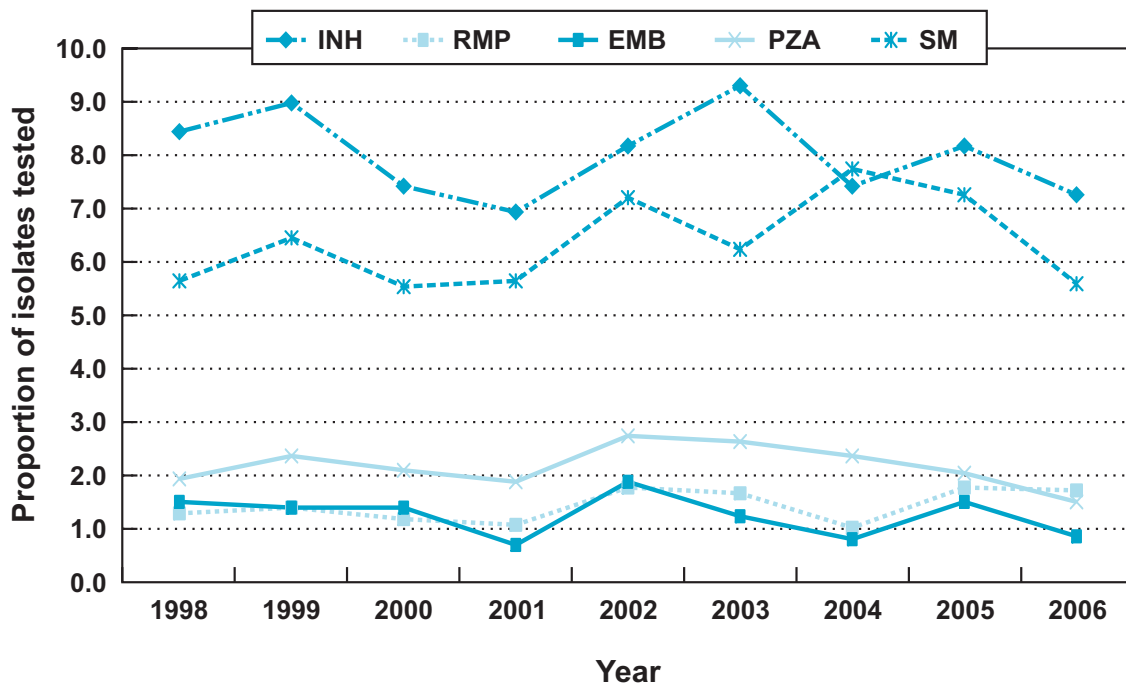
NOTE: Since the Canadian reclassification of streptomycin from a first-line to a second-line drug in 2005, dramatic changes in the susceptibility patterns to streptomycin may be observed as fewer jurisdictions are routinely testing this susceptibility.

► **Figure 5**
Any resistance by type of drug in Canada – 1998-2006



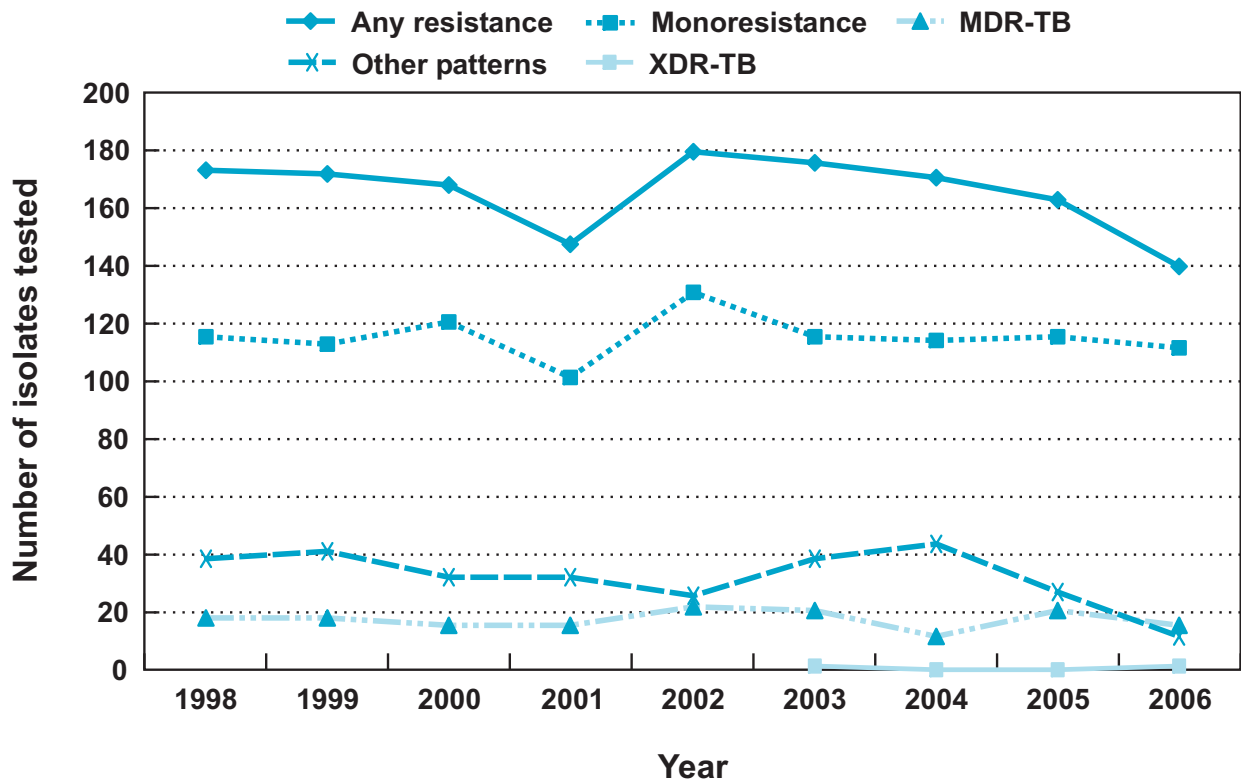
NOTE: Since the Canadian reclassification of streptomycin from a first-line to a second-line drug in 2005, dramatic changes in the susceptibility patterns to streptomycin may be observed as fewer jurisdictions are routinely testing this susceptibility.

► **Figure 6**
Any resistance by type of drug in Canada as a proportion of the number of isolates tested – 1998-2006



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 7**
Overall pattern of reported TB drug resistance in Canada – 1998-2006



► **Figure 8**
Overall pattern of reported TB drug resistance in Canada as a proportion of isolates tested – 1998-2006

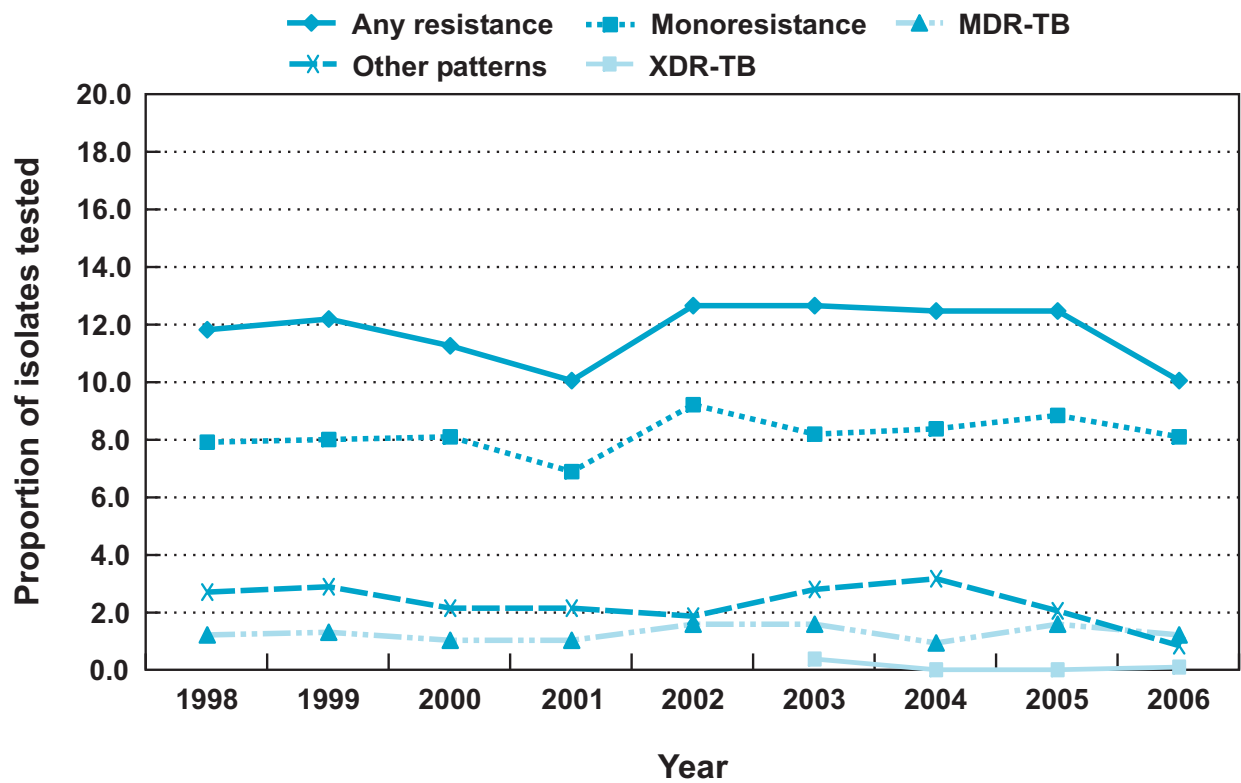


Table 1. Overall pattern of reported TB drug resistance in Canada – 1998-2006

	1998	1999	2000	2001	2002	2003	2004	2005	2006
Total number of isolates tested	1,461 (100.0)	1,415 (100.0)	1,491 (100.0)	1,476 (100.0)	1,420 (100.0)	1,407 (100.0)	1,379 (100.0)	1,336 (100.0)	1,389 (100.0)
Isolates susceptible	1,288 (88.2)	1,243 (87.8)	1,323 (88.7)	1,326 (89.8)	1,241 (87.4)	1,230 (87.4)	1,209 (87.7)	1,170 (87.6)	1,249 (89.9)
Any resistance*									
INH	123 (8.4)	127 (9.0)	111 (7.4)	102 (6.9)	116 (8.2)	131 (9.3)	102 (7.4)	109 (8.2)	101 (7.3)
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)
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)
PZA	23 (2.0)	28 (2.5)	24 (2.1)	22 (2.0)	31 (2.7)	28 (2.6)	26 (2.4)	22 (2.1)	16 (1.5)
SM†	82 (5.7)	72 (6.5)	65 (5.6)	68 (5.7)	74 (7.2)	72 (6.2)	89 (7.7)	79 (7.2)	35 (5.6)
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)
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)
MDR-TB‡	18 (1.2)	18 (1.3)	15 (1.0)	15 (1.0)	22 (1.5)	21 (1.5)	12 (0.9)	22 (1.6)	16 (1.2)
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)
XDR-TB§	- (-)	- (-)	- (-)	- (-)	- (-)	1 (0.1)	0 (-)	0 (-)	1 (0.1)
XDR-TB pattern 									
AM & CM & ETA & OFL & RBT **	- (-)	- (-)	- (-)	- (-)	- (-)	1 (0.1)	0 (-)	0 (-)	1 (0.1)

* 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 susceptibility patterns to streptomycin may be observed as fewer jurisdictions are routinely testing this susceptibility.

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

§ 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 = Rifabutin

Table 2. Reported *Mycobacterium tuberculosis* isolates by “reporting” and “originating” province/territory, Canada – 2006

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	1,389	11	0	8	3	201	567	119	58	104	275	2	4	37
N.L.	11	11	0	0	0	0	0	0	0	0	0	0	0	0
N.S.	8	0	0	8	0	0	0	0	0	0	0	0	0	0
N.B.	3	0	0	3	0	0	0	0	0	0	0	0	0	0
Que.	201	0	0	0	201	0	0	0	0	0	0	0	0	0
Ont.	567	0	0	0	0	567	0	0	0	0	0	0	0	0
Man.	119	0	0	0	0	0	119	0	0	0	0	0	0	0
Sask.	55	0	0	0	0	0	0	55	0	0	0	0	0	0
Alta.	149	0	0	0	0	0	0	3	104	1	0	0	4	37
B.C.	276	0	0	0	0	0	0	0	0	274	2	0	0	0

Table 3. Reported MDR-TB isolates by province/territory, Canada – 2006

	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	1,389	11	0	8	3	201	567	119	58	104	275	2	4	37
Total number of MDR-TB isolates*	16	0	0	0	0	2	11	0	0	1	2	0	0	0
INH & RMP	5	0	0	0	0	0	4	0	0	0	1	0	0	0
INH & RMP & SM	4	0	0	0	0	0	4	0	0	0	0	0	0	0
INH, RMP & EMB	2	0	0	0	0	0	2	0	0	0	0	0	0	0
INH, RMP & PZA	0	0	0	0	0	0	0	0	0	0	0	0	0	0
INH, RMP, PZA, EMB	0	0	0	0	0	0	0	0	0	0	0	0	0	0
INH, RMP, EMB & SM	3	0	0	0	0	2	0	0	0	1	0	0	0	0
INH, RMP, PZA & SM	1	0	0	0	0	0	1	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 susceptibility patterns to streptomycin may be observed as fewer jurisdictions are routinely testing this susceptibility.

Table 4. Reported TB drug resistance by gender and age group, Canada – 2006

Age Group		Isolates	Any Resistance	MDR-TB	XDR-TB
		Number (%)	Number (%)	Number (%)	Number (%)
Total		1,389 (100)	140 (100)	16 (100)	1 (100)
0-4	Males	6 (0.4)	0 (0.0)	0 (0.0)	0 (0.0)
	Females	9 (0.6)	0 (0.0)	0 (0.0)	0 (0.0)
	Unknown	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
	Total	15 (1.1)	0 (0.0)	0 (0.0)	0 (0.0)
5-14	Males	10 (0.7)	1 (0.7)	0 (0.0)	0 (0.0)
	Females	16 (1.2)	1 (0.7)	0 (0.0)	0 (0.0)
	Unknown	2 (0.1)	2 (1.4)	0 (0.0)	0 (0.0)
	Total	28 (2.0)	4 (2.9)	0 (0.0)	0 (0.0)
15-24	Males	110 (7.9)	15 (10.7)	1 (6.3)	0 (0.0)
	Females	93 (6.7)	12 (8.6)	1 (6.3)	0 (0.0)
	Unknown	4 (0.3)	1 (0.7)	0 (0.0)	0 (0.0)
	Total	207 (14.9)	28 (20.0)	2.0 (12.5)	0 (0.0)
25-34	Males	121 (8.7)	18 (12.9)	1 (6.3)	0 (0.0)
	Females	107 (7.7)	12 (8.6)	1 (6.3)	0 (0.0)
	Unknown	1 (0.1)	0 (0.0)	0 (0.0)	0 (0.0)
	Total	229 (16.5)	30 (21.4)	2 (12.5)	0 (0.0)
35-44	Males	117 (8.4)	12 (8.6)	5 (31.3)	1 (100.0)
	Females	110 (7.9)	6 (4.3)	2 (12.5)	0 (0.0)
	Unknown	2 (0.1)	0 (0.0)	0 (0.0)	0 (0.0)
	Total	229 (16.5)	18 (12.9)	7 (43.8)	1 (100.0)
45-54	Males	112 (8.1)	7 (5.0)	0 (0.0)	0 (0.0)
	Females	69 (5.0)	7 (5.0)	0 (0.0)	0 (0.0)
	Unknown	3 (0.2)	1 (0.7)	0 (0.0)	0 (0.0)
	Total	184 (13.2)	15 (10.7)	0 (0.0)	0 (0.0)
55-64	Males	65 (4.7)	7 (5.0)	0 (0.0)	0 (0.0)
	Females	50 (3.6)	4 (2.9)	0 (0.0)	0 (0.0)
	Unknown	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
	Total	115 (8.3)	11 (7.9)	0 (0.0)	0 (0.0)
65-74	Males	79 (5.7)	8 (5.7)	1 (6.3)	0 (0.0)
	Females	62 (4.5)	3 (2.1)	1 (6.3)	0 (0.0)
	Unknown	5 (0.4)	2 (1.4)	1 (6.3)	0 (0.0)
	Total	146 (10.5)	13 (9.3)	3 (18.8)	0 (0.0)
75+	Males	134 (9.6)	11 (7.9)	1 (6.3)	0 (0.0)
	Females	84 (6.0)	8 (5.7)	1 (6.3)	0 (0.0)
	Unknown	4 (0.3)	1 (0.7)	0 (0.0)	0 (0.0)
	Total	222 (16.0)	20 (14.3)	2 (12.5)	0 (0.0)
Unknown	Males	9 (0.6)	0 (0.0)	0 (0.0)	0 (0.0)
	Females	4 (0.3)	1 (0.7)	0 (0.0)	0 (0.0)
	Unknown	1 (0.1)	0 (0.0)	0 (0.0)	0 (0.0)
	Total	14 (1.0)	1 (0.7)	0 (0.0)	0 (0.0)
Total	Males	763 (54.9)	79 (56.4)	9 (56.3)	1 (100.0)
	Females	604 (43.5)	54 (38.6)	6 (37.5)	0 (0.0)
	Unknown	22 (1.6)	7 (5.0)	1 (6.3)	0 (0.0)

Table 5. Reported results for routine drug susceptibility testing of <i>Mycobacterium tuberculosis</i> isolates, Alberta – 1998-2006										
	1998	1999	2000	2001	2002	2003	2004	2005	2006	
	Total (%)	Total (%)	Total (%)	Total (%)	Total (%)	Total (%)	Total (%)	Total (%)	Total (%)	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)	
Isolates susceptible	107 (89.9)	110 (94.0)	92 (88.5)	79 (86.8)	94 (87)	75 (81.5)	83 (86.5)	104 (80.6)	91 (87.5)	
Isolates resistant to one or more drugs	12 (10.1)	7 (6.0)	12 (11.5)	12 (13.2)	14 (13)	17 (18.5)	13 (13.5)	25 (19.4)	13 (12.5)	
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)	
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)	
RMP	-	-	-	-	-	-	-	-	-	
EMB	-	-	1 (1)	-	-	-	-	-	-	
PZA	-	-	1 (1)	-	-	2 (2.2)	2 (2.1)	-	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)	
MDR-TB*	1 (0.8)	-	-	-	-	1 (1.1)	2 (2.1)	4 (3.1)	1 (1.0)	
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)	
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)	
INH & SM & EMB	-	-	1 (1)	-	-	1 (1.1)	-	-	-	
INH & SM & PZA	1 (0.8)	-	1 (1)	2 (2.2)	1 (0.9)	1 (1.1)	1 (1.0)	-	-	

*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 susceptibility patterns to streptomycin may be observed as fewer jurisdictions are routinely testing this susceptibility.

Table 6. Reported results for routine drug susceptibility testing of <i>Mycobacterium tuberculosis</i> isolates, British Columbia – 1998-2006										
	1998	1999	2000	2001	2002	2003	2004	2005	2006	
	Total (%)	Total (%)	Total (%)	Total (%)	Total (%)	Total (%)	Total (%)	Total (%)	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)	
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)	
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)	
Monoresistance										
INH	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)	
RMP	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)	
EMB	1 (0.4)	1 (0.4)	1 (0.4)	1 (0.3)	2 (0.8)	–	–	2 (1.0)	6 (2.2)	
PZA†	–	1 (0.4)	1 (0.4)	–	2 (0.8)	1 (0.3)	1 (0.4)	4	3 (1.1)	
SM	–	–	–	–	1 (3.8)§	–	3 (9.4)§	–	–	
	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)	
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)	
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)	–	–	
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)	
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)	
INH & EMB	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)	
INH & PZA	–	–	–	–	1 (0.4)	1 (0.3)	3 (1.1)	–	–	
RMP & PZA	–	–	–	–	–	–	2 (0.8)	–	–	
INH & SM & EMB	–	–	2 (0.7)	–	–	–	–	–	–	
INH & SM & PZA	–	1 (0.4)	–	–	–	–	–	1 (0.5)	–	
	–	–	–	–	–	–	1 (0.4)	–	–	

* includes 1 *M. bovis* isolate for 2002, 1 *M. bovis* isolate for 2003, and 1 *M. bovis* for 2006.

† 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.

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.

Table 7. Reported results for routine drug susceptibility testing of <i>Mycobacterium tuberculosis</i> isolates, Manitoba – 1998-2006										
	1998	1999	2000	2001	2002	2003	2004	2005	2006	
	Total (%)	Total (%)	Total (%)	Total (%)	Total (%)	Total (%)	Total (%)	Total (%)	Total (%)	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)	
Isolates susceptible	98 (92.5)	89 (89.0)	94 (92.2)	101 (91.8)	106 (93)	114 (93.4)	120 (98.4)	89 (94.7)	110 (92.4)	
Isolates resistant to one or more drugs	8 (7.5)	11 (11.0)	8 (7.8)	9 (8.2)	8 (7)	8 (6.6)	2 (1.6)	5 (5.3)	9 (7.6)	
Monoresistance										
INH	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)	
PZA	2 (1.9)	3 (3.0)	6 (5.9)	2 (1.8)	3 (2.6)	3 (2.5)	–	2 (2.1)	6 (5.0)	
SM	–	–	–	–	1 (0.9)	1 (0.8)	1 (0.8)	–	–	
	2 (1.9)	3 (3.0)	–	4 (3.8)‡	–	3 (2.6)‡	1 (0.8)	3 (3.2)	3 (2.5)	
MDR-TB†	2 (1.9)	2 (2.0)	–	2 (1.8)	3 (2.6)	1 (0.8)	–	–	–	
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)	1 (0.9)	1 (0.9)	–	–	–	–	
INH & PZA	–	–	–	–	1 (0.9)	–	–	–	–	
INH & SM	2 (1.9)	1 (1.0)	2 (2)	1 (0.9)	–	–	–	–	–	
INH & SM & EMB	–	1 (1.0)	–	–	–	–	–	–	–	
INH & SM & PZA	–	1 (1.0)	–	–	–	–	–	–	–	

* 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 susceptibility patterns to streptomycin may be observed as fewer jurisdictions are routinely testing this susceptibility.

Table 8. Reported results for routine drug susceptibility testing of <i>Mycobacterium tuberculosis</i> isolates, New Brunswick – 1998-2006										
	1998	1999	2000	2001	2002	2003	2004	2005	2006	
	Total (%)	Total (%)	Total (%)	Total (%)	Total (%)	Total (%)	Total (%)	Total (%)	Total (%)	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)	
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)	
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.

Table 9. Reported results for routine drug susceptibility testing of <i>Mycobacterium tuberculosis</i> isolates, Newfoundland and Labrador – 1998-2006										
	1998	1999	2000	2001	2002	2003	2004	2005	2006	
	Total (%)	Total (%)	Total (%)	Total (%)	Total (%)	Total (%)	Total (%)	Total (%)	Total (%)	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)	
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)	
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 – 1998-2006

	1998 Total (%)	1999 Total (%)	2000 Total (%)	2001 Total (%)	2002 Total (%)	2003 Total (%)	2004 Total (%)	2005 Total (%)	2006 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)
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)
Monoresistance	-	-	-	-	-	-	-	-	1 (33.3)
INH	-	-	-	-	-	-	-	-	1 (33.3)

Table 11. Reported results for routine drug susceptibility testing of *Mycobacterium tuberculosis* isolates, Nova Scotia – 1998-2006

	1998 Total (%)	1999 Total (%)	2000 Total (%)	2001 Total (%)	2002 Total (%)	2003 Total (%)	2004 Total (%)	2005 Total (%)	2006 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)
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)
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	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 <i>Mycobacterium tuberculosis</i> isolates, Nunavut* – 1998-2006										
	1998	1999	2000	2001	2002	2003	2004	2005	2006	
	Total (%)	Total (%)	Total (%)	Total (%)	Total (%)	Total (%)	Total (%)	Total (%)	Total (%)	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)	
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)	
Isolates resistant to one or more drugs	N/A	-	1 (3.4)	1 (3.2)	-	-	-	-	-	
Monoresistance	N/A	-	1 (3.4)	-	-	-	-	-	-	
INH	N/A	-	1 (3.4)	-	-	-	-	-	-	
MDR-TB	N/A	-	-	1 (3.2)	-	-	-	-	-	
INH & RMP	N/A	-	-	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)

Table 13. Reported results for routine drug susceptibility testing of *Mycobacterium tuberculosis* isolates, Ontario – 1998-2006

	1998	1999	2000	2001	2002	2003	2004	2005	2006
	Total (%)	Total (%)	Total (%)	Total (%)	Total (%)	Total (%)	Total (%)	Total (%)	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)
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)
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)
Monoresistance									
INH	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)
RMP	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)
EMB	–	–	–	–	–	1 (0.2)	–	–	1 (0.2)
PZA	4 (0.6)	–	1 (0.2)	1 (0.2)	1 (0.2)	–	–	–	–
SM	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)
	11 (1.7)	19 (3.2)	16 (2.7)	16 (2.7)	25 (4.3)	18 (3.0)	37 (6.2)	21 (3.8)	–
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)
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)
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)	–
INH & RMP & EMB & PZA	–	–	–	1 (0.2)	1 (0.2)	1 (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 (1.0)	5 (0.8)	–	1 (0.2)	5 (0.9)	4 (0.7)	1 (0.2)	3 (0.5)	–
Other Patterns	25 (4.0)	30 (5.1)	19 (3.2)	21 (3.6)	17 (2.9)	26 (4.4)	27 (4.5)	17 (3.1)	3 (0.5)
INH & EMB	2 (0.3)	4 (0.7)	2 (0.3)	–	1 (0.2)	2 (0.3)	1 (0.2)	1 (0.2)	–
INH & PZA	–	–	–	2 (0.3)	–	–	1 (0.2)	–	–
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)	–	–	–	–	–	–
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 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 susceptibility patterns to streptomycin may be observed as fewer jurisdictions are routinely testing this susceptibility.

Table 14. Reported results for routine drug susceptibility testing of <i>Mycobacterium tuberculosis</i> isolates, Prince Edward Island – 1998-2006											
	1998	1999	2000	2001	2002	2003	2004	2005	2006		
	Total (%)	Total (%)	Total (%)	Total (%)	Total (%)	Total (%)	Total (%)	Total (%)	Total (%)	Total (%)	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		
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		
Isolates resistant to one or more drugs	-	-	-	1 (50.0)	-	-	-	-	-		
Monoresistance	-	-	-	1 (50.0)	-	-	-	-	-		
PZA	-	-	-	1 (50.0)	-	-	-	-	-		
* Routine testing for SM not conducted.											

Table 15. Reported results for routine drug susceptibility testing of <i>Mycobacterium tuberculosis</i> isolates, Quebec – 1998-2006										
	1998	1999	2000	2001	2002	2003	2004	2005	2006	
	Total (%)	Total (%)	Total (%)	Total (%)	Total (%)	Total (%)	Total (%)	Total (%)	Total (%)	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)	
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)	
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)	
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)	
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)	
RMP	–	1 (0.4)	–	–	1 (0.4)	–	–	–	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)	
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)	
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)	
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)	–	–	1 (0.4)	–	1 (0.5)	–	–	
INH & SM	2 (0.8)	–	–	–	–	–	–	–	–	
INH & EMB	–	–	–	–	1 (0.4)	–	1 (0.5)	–	–	
INH & PZA	1 (0.4)	2 (0.7)	–	–	–	–	–	–	–	

* 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, and 2 in 2006; *M. caprae*: 1 in 2002, 1 in 2006; *M. africanum*: 1 in 2003, 1 in 2005 and 1 in 2006.

† 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 <i>Mycobacterium tuberculosis</i> isolates, Saskatchewan – 1998-2006										
	1998	1999	2000	2001	2002	2003	2004	2005	2006	
	Total (%)	Total (%)	Total (%)	Total (%)	Total (%)	Total (%)	Total (%)	Total (%)	Total (%)	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)	
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)	
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)	
Monoresistance	1 (2)	-	4 (6.3)	2 (2.9)	4 (7.1)	1 (2.2)	3 (8.8)	2 (2.7)	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)	
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 susceptibility patterns to streptomycin may be observed as fewer jurisdictions are routinely testing this susceptibility.

Table 17. Reported results for routine drug susceptibility testing of <i>Mycobacterium tuberculosis</i> isolates, Yukon Territory – 1998-2006										
	1998	1999	2000	2001	2002	2003	2004	2005	2006	
	Total (%)	Total (%)	Total (%)	Total (%)	Total (%)	Total (%)	Total (%)	Total (%)	Total (%)	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)	
Isolates susceptible	1 (100.0)	-	3 (100.0)	1 (100.0)	-	1 (100.0)	3 (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 (CTBLSS)**

**Alberta
(Alberta, Northwest Territories
and Nunavut)**

Cary Shandro
Mycobacteriology
Provincial Laboratory of Public Health
Edmonton, Alberta T6G 2J2

Dr. Greg Tyrrell
Medical Microbiologist
Provincial Laboratory of Public Health
Edmonton, Alberta T6G 2J2

Dr. Jutta Preiksaitis
Director
Provincial Laboratory of Public Health
Edmonton, Alberta T6G 2J2

**British Columbia
(British Columbia and Yukon Territory)**

Dr. Mabel Rodrigues, Ph.D.
Section Supervisor TB
B.C. Centre for Disease Control
Vancouver, British Columbia V5Z 4R4

Dr. Patrick Tang
Program Head/Microbiologist
TB/Mycobacteriology
B.C. Centre for Disease Control
Vancouver, British Columbia V5Z 4R4

Dr. Judy L. Isaac-Renton
Director, Provincial Laboratory
B.C. Centre for Disease Control
Vancouver, British Columbia V5Z 4R4

Manitoba

Assunta Rendina, MLT
Charge technologist, Mycobacteriology section
Clinical Microbiology
Diagnostic Services of Manitoba
Winnipeg, Manitoba R3C 3H8

Dr. Godfrey Harding
Medical Director
Clinical Microbiology
Diagnostic Services of Manitoba
Winnipeg, Manitoba R3C 3H8

Dr. James Karlowsky
Clinical Microbiologist
Clinical Microbiology
Diagnostic Services of Manitoba
Winnipeg, Manitoba R3C 3H8

New Brunswick

Hope MacKenzie
Microbiology Laboratory
Department of Laboratory Medicine
Saint John, New Brunswick E2L 4L2

Dr. Glenna Hardy
Medical Microbiologist
Department of Laboratory Medicine
Saint John, New Brunswick E2L 4L2

Dr. Anne O'Brien
Clinical Head
Department of Laboratory Medicine
Saint John, New Brunswick E2L 4L2

Newfoundland and Labrador

Sandra B. March, MSc ART
Clinical Microbiologist
Newfoundland & Labrador Public Health
Laboratory
St. John's, Newfoundland A1A 3Z9

Dr. Sam Ratnam
Director
Newfoundland & Labrador Public Health
Laboratory
St. John's, Newfoundland A1A 3Z9

Northwest Territories
(see also Alberta)

Evelyn Smith
Supervisor, Bacteriology
Stanton Territorial Hospital
Yellowknife, Northwest Territories X1A 2N1

Mr. Robin Greig
Manager
Therapeutic & Diagnostic Services
Yellowknife, Northwest Territories X1A 2N1

Nova Scotia
(Nova Scotia and Prince Edward Island)

Carol Pelton
Tech II, MLT
Division of Medical Microbiology
Department of Pathology & Laboratory Medicine
Halifax, Nova Scotia B3H 1V8

Dr David Haldane
Director of Special Pathogens and Microbiology
Halifax, Nova Scotia B3H 1V8

Dr. Kevin Forward
Director
Department of Public Health
Department of Pathology & Laboratory Medicine
Halifax, Nova Scotia B3H 1V8

Ontario

Pamela Chedore, MLT
Head, Mycobacteriology
Laboratory Branch
Ministry of Health and Longterm Care
Etobicoke, Ontario M9P 3T1

Dr. Frances Jamieson
Medical Microbiologist
Laboratory Branch
Ministry of Health and Longterm Care
Etobicoke, Ontario M9P 3T1

Mr. Nicholas Paul
Manager Direct Services
Laboratory Branch
Ministry of Health and Longterm Care
Etobicoke, Ontario M9P 3T1

Quebec		<p>Louise Thibert, MSc Head, Mycobacteriology and Aerobic Actinomycetes Laboratoire de sante publique du Québec Sainte-Anne-de-Bellvue, Quebec H9X 3R5</p> <p>Dr. Anne-Marie Bourgeault Director Laboratoire de sante publique du Québec Sainte-Anne-de-Bellvue, Quebec H9X 3R5</p>
<hr/>		
Saskatchewan	<i>North:</i>	<p>Colleen Foster Clinical Microbiology Royal University Hospital Saskatoon, Saskatchewan S7N 0W8</p> <p>Dr. J. Blondeau Department Head Microbiology/Mycobacteriology Royal University Hospital Saskatoon, Saskatchewan S7N 0W8</p>
	<i>South:</i>	<p>Elaine Schweitzer Clinical Services/Microbiology Provincial Laboratory Regina, Saskatchewan S4S 5W6</p> <p>Dr. Paul Levett Microbiologist Provincial Laboratory Regina, Saskatchewan S4S 5W6</p> <p>Dr. Greg Horsman Director Provincial Laboratory Regina, Saskatchewan S4S 5W6</p>
<hr/>		
Federal		<p>Joyce Wolfe, ART Head, Mycobacteriology National Reference Centre for Mycobacteriology Canadian Science Centre for Human and Animal Control Winnipeg, Manitoba R3E 3P6</p>

► 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		Unique Source Laboratory ID No. - Identificateur unique du laboratoire déclarant:			
Date Rec'd at TBPC: Date de réception au LATB: Y / A M D / J		Date specimen / culture received at laboratory: Date de réception échantillon / culture au laboratoire: Y / A M D / J			
TBPC Number: Numéro du LATB:					
Specie: Espèce: <input type="checkbox"/> M. tuberculosis (may include M. africanum or M. microti) (peut inclure M. africanum et M. microti) <input type="checkbox"/> M. bovis <input type="checkbox"/> M. BCG bovis <input type="checkbox"/> 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? <input type="checkbox"/> No / Non <input type="checkbox"/> Yes / Oui → What is the previous Unique Source Laboratory ID No.? / Identificateur antérieur? <input type="text"/> → What is the previous Form No.? (if known) / N° de formulaire antérieur? (Si connu) <input type="text"/>					
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:	<input type="text"/>	(see code list) (voir liste de codes)	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	
2	Province / territory from which specimen originated: Province / territoire d'où provient l'échantillon:	<input type="text"/>	(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) <input type="checkbox"/> Unknown / Inconnu		
4	Patient's gender: Sexe du patient:	<input type="checkbox"/> Male / Masculin <input type="checkbox"/> Female / Féminin <input type="checkbox"/> Unknown / Inconnu			
5	LABORATORY RESULTS RÉSULTATS DE LABORATOIRE	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)		
	Antituberculous Drugs Agents Antituberculeux		Sensitive / Sensible	Resistant / Résistant	Other (specify) / Autre (préciser)
	SM (Streptomycin) / (Streptomycine)	mg / L	<input type="checkbox"/>	<input type="checkbox"/>	
	INH (Isoniazid) / (Isoniazide)	mg / L	<input type="checkbox"/>	<input type="checkbox"/>	
	RMP (Rifampin) / (Rifampicine)	mg / L	<input type="checkbox"/>	<input type="checkbox"/>	
	EMB (Ethambutol)	mg / L	<input type="checkbox"/>	<input type="checkbox"/>	
	PZA (Pyrazinamide)	mg / L	<input type="checkbox"/>	<input type="checkbox"/>	
	2nd line drugs (specify) Antibiotiques de 2° ligne (préciser)	Concentration	Sensitive / Sensible	Resistant / Résistant	Other (specify) / Autre (préciser)
	1.	mg / L	<input type="checkbox"/>	<input type="checkbox"/>	
	2.	mg / L	<input type="checkbox"/>	<input type="checkbox"/>	
	3.	mg / L	<input type="checkbox"/>	<input type="checkbox"/>	
	4.	mg / L	<input type="checkbox"/>	<input type="checkbox"/>	
	5.	mg / L	<input type="checkbox"/>	<input type="checkbox"/>	
	6.	mg / L	<input type="checkbox"/>	<input type="checkbox"/>	
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)

► Appendix 3

Proficiency panel results for antimicrobial susceptibility testing of *Mycobacterium tuberculosis* 2006

Antibiotic	Strain A	Strain B	Strain C	Strain D	Strain E	Strain F
Streptomycin	Sensitive 5/6 (83%)	Sensitive 6/6 (100%)	Sensitive 4/7 (57%)	Sensitive 5/7 (71%)	Sensitive 5/6 (83%)	Sensitive 6/6 (100%)
Isoniazid – low	Resistant 10/10 (100%)	Sensitive 10/10 (100%)	Resistant 10/10 (100%)	Resistant 10/10 (100%)	Sensitive 10/10 (100%)	Sensitive 10/10 (100%)
Isoniazid – high	Sensitive 4/5 (80%)	–	Resistant 5/5 (100%)	Resistant 6/6 (100%)	–	–
Rifampin	Sensitive 10/10 (100%)	Sensitive 10/10 (100%)	Sensitive 10/10 (100%)	Sensitive 10/10 (100%)	Sensitive 10/10 (100%)	Sensitive 10/10 (100%)
Ethambutol	Sensitive 10/10 (100%)	Sensitive 10/10 (100%)	Sensitive 10/10 (100%)	Sensitive 9/10 (90%)	Resistant 10/10 (100%)	Resistant 10/10 (100%)
Pyrazinamide	Sensitive 3/6 (50%)	Sensitive 6/7 (85.7%)	Resistant 5/7 (71%)	Resistant 5/7 (71%)	Sensitive 7/7 (100%)	Sensitive 7/7 (100%)

- A total of 10 laboratories participated in susceptibility testing of six *M. tuberculosis* complex isolates. Percentages indicate consensus values.
- Five laboratories are using the BACTEC 460 radiometric technology and five laboratories are using the MGIT 960 continuous monitoring technology in performing susceptibility testing.
- All laboratories are testing appropriate concentrations of antimicrobials in accordance with the parameters of the testing systems*.
- Not all laboratories choose to test the higher concentration of INH when the organism is resistant at the lower concentration of INH, as recommended by CLSI.
- **Streptomycin:** Current CLSI approved guidelines consider streptomycin as a second-line drug and suggest the laboratory director should consult with pulmonary/infectious disease specialist and TB control officer to decide if streptomycin should be routinely tested based on the following:
 1. Patient population,
 2. Prevalence of drug resistance,
 3. Use in community,
 4. Availability and timelines of testing if resistance or intolerance is encountered.

Antimicrobial concentrations tested to perform susceptibility testing

Antimicrobial	BACTEC 460 (µg/ml)	MGIT 960 (µg/ml)
Streptomycin	2.0, 6.0	1.0, 4.0
Isoniazid	0.1, 0.4	0.1, 0.4
Rifampin	2.0	1.0
Ethambutol	2.5, 7.5	5.0, 7.5
Pyrazinamide	100	100