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Non-tuberculous mycobacteria: patterns of isolation. A multi-country retrospective survey

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SUMMARY

OBJECTIVE: To collect data on non-tuberculous mycobacteria (NTM) isolated from clinical laboratories in different countries to establish: 1) whether the isolation of NTM was increasing, 2) which species were increasing, and 3) whether there was any pattern of geographical distribution.

DESIGN: In 1996, the Working Group of the Bacteriology and Immunology Section of the International Union Against Tuberculosis and Lung Disease contacted 50 laboratories in different countries for the necessary information.

RESULTS: The number of patients reported with NTM was 36 099 from 14 countries. *Mycobacterium avium* complex, *M. gordonae, M. xenopi, M. kansasii* and *M. fortuitum* were the five species most frequently isolated. There was a significant upward trend for *M. avium* complex and *M. xenopi*. Pigmented mycobacteria predominated in Belgium, the Czech Republic and the Mediterranean coast of Spain. Non-chromogenic mycobacteria were found to be predominant in the area of the Atlantic coast of Brazil and in Turkey, the United Kingdom, Finland and Denmark.

CONCLUSIONS: There was an increase in the number of NTM isolated from clinical samples of patients. Isolation of the most frequent species is constantly changing in most of the geographical areas, and newer species are emerging due to better diagnostic techniques to detect and identify NTM.

KEY WORDS: non-tuberculous mycobacteria (NTM); isolation; geographical distribution; epidemiology

IN THE PAST TWO decades, many clinical laboratories have noticed changes in the number and species of non-tuberculous mycobacteria (NTM) isolated from clinical specimens. However, it is difficult to establish whether these changes were restricted to a specific area only or whether they concerned a larger number of laboratories in different geographic areas.

Literature about NTM corresponds mainly to three kinds of articles: 1) isolation of NTM from clinical specimens producing diseases; 2) data on isolation and identification of NTM from a single laboratory only; and 3) isolation of NTM from different sources such as water, food, animals or plants. Comparison of such data is difficult because the data may correspond to different sources (animals, plants, etc.), periods of time and isolation methods.

In 1996, the members of the Bacteriology and Immunology Section of the International Union Against Tuberculosis and Lung Disease formed a Working Group aiming at collecting data on NTM isolated in clinical laboratories in different countries, to establish whether: 1) the total number of patients from whom

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NTM were isolated was increasing; 2) any increase in isolation was specific for a particular species of mycobacteria; and 3) there was any pattern of geographical distribution among certain species, especially among those that cause infections or diseases in patients.

MATERIALS AND METHODS

Data collection

Information about the purpose of the Working Group and a questionnaire for entering NTM species and the number of strains isolated each year were sent to 50 laboratories from 21 countries.

The criteria for recovering data were: 1) inclusion of only those mycobacteria isolated from clinical specimens; 2) one NTM isolation per patient, in case more than one positive specimen was obtained from the same patient; 3) isolation of two or more species from the same patient was considered as coming from different patients; 4) laboratories that received specimens or cultures from other countries had to submit the information on separate forms for each country. If positive cultures were reported without this information, the data were analysed separately. It was not the aim of the study to know the clinical significance of the NTM isolates.

Data were included from the time a laboratory started collecting data up to 31 December 1996. Part of the data from Spain included in this report originated from 26 laboratories of all the autonomous communities of the country and has been published separately.[1]

Countries included in the study

Countries were grouped in five geographical areas: Northern Europe, including the United Kingdom, Denmark, Finland and Belgium; Central Europe, including Germany, Switzerland and the Czech Republic; Southern Europe, including France, Portugal, Spain and Italy; Eastern countries, including Turkey and Iran; and South America, including only Brazil. Data were provided by 41 laboratories from 14 countries: Iran (n = 1), Denmark (n = 1), Brazil (n = 1), Belgium (n = 2), Germany (n = 2), Czech Republic (n = 1), Finland (n = 1), Turkey (n = 1), Portugal (n = 1), Switzerland (n = 1), Spain (n = 26), Italy (n = 1), France (n = 1) and the UK (n = 1). Overall data were reported from 1976 to 1996. The number of laboratories increased each year. Spain included 26 laboratories from a previous study,[1] and contributed 30.8% of the total patients included in the data.

Statistical analysis

Data provided by different laboratories from the same country were pooled. To study the number of NTM isolates, the data collected were divided into 3 periods: period 1 = the first year data started to be collected to 31 December 1984; period 2 = from 1 January 1985 to 31 December 1990; and period 3 = from 1 January 1991 to 31 December 1996. For countries that had collected data for more than 12 years, we compared the percentage of the last 6 years with the percentage of all previous years. To compare results between countries only the results of the last 6 years, from 1991 to 1996, were used (the period with all participating laboratories). Only NTM identified to the species level were included. To analyse the trend of any specific species of NTM isolated in the different periods of time the Mantel-Haenszel test was used. To compare data between countries and geographical areas the χ^2 test was used. $P < 0.05$ was considered as statistically significant.

RESULTS

Total number of patients from whom NTM were isolated

The total number of patients from whom NTM were isolated was 36 099. The National Reference Center for Mycobacteria (NRCM) in Borstel, Germany, reported 10 651 positive cultures rather than patients with NTM. These data were not included in the total data and were considered separately. The Figure illustrates the overall isolation of NTM from 1976 to 1996.

Pattern of isolation over time

A total of 3049 patients (8.4%) were reported in period 1, 6676 (18.5%) in period 2, and 26 374 (73.0%) in period 3. Respectively 6, 8 and 14 countries reported data in each time period.

The number of patients from whom NTM were isolated gradually increased over the years in all participating laboratories. When the results of the laboratories that collected data for more than 12 years were divided into two time periods (<1991 and 1991–1996, Table 1), the number of NTM was higher in the latter, e.g., 20.3% vs. 79.6% in Germany.

Data were provided from Turkey only for the last 2 years of the study. This laboratory reported isolation

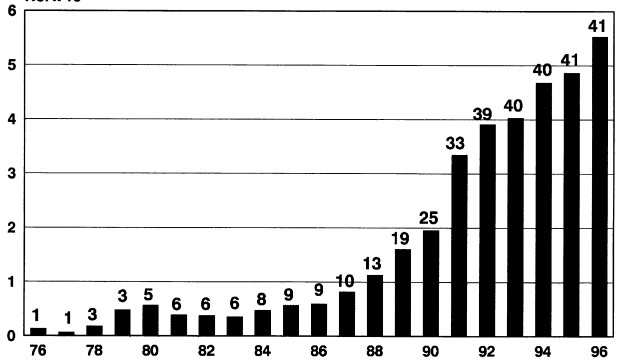

Figure Overall isolation of NTM compared to the year of isolation, all countries combined. Patients (n = 36 099). Numbers on the bars indicate the number of laboratories included each year. NTM = non-tuberculous mycobacteria.

Table 1 Number of NTM isolated in two time periods in countries that reported data over more than 12 years

Country (years of reported data)	NTM n	<1991 %	1991–1996 %*
Czech Republic (1978–1996)	8 713	44.5†	55.5
Germany (1985–1996)	1 999	20.3‡	79.6
Portugal (1984–1996)	1 212	41.9§	58.0
Spain (1976–1996)	11 128	26.3¶	73.6
Switzerland (1982–1996)	3 774	37.9#	62.0

* Percentage of total NTM isolates in the 6-year period.
† Includes 13 years of data.
‡ Includes 6 years of data.
§ Includes 7 years of data.
¶ Includes 15 years of data.
# Includes 9 years of data.
NTM = non-tuberculous mycobacteria.

of NTM from 18 patients in 1995 and from 37 patients in 1996. Iran provided data from 34 patients between 1980 and 1984, from 34 patients in 1993 and from 29 patients in 1996.

Species

Identification to the species level was done for 30 969 (85.8%) isolates (Table 2); 5130 (14.2%) were reported as NTM only. The five most frequently isolated species were, in decreasing order, *M. avium* complex, *M. gordonae, M. xenopi, M. kansasii* and *M. fortuitum.* These five species accounted for 87.6% of total NTM isolated.

The total number of isolates increased, along with the species, over time, but some of the species, such as *M. avium* complex and *M. xenopi*, increased more significantly. Overall, there was a significant upward trend for *M. avium* complex and *M. xenopi*, but a significant downward trend for *M. gordonae* and *M. kansasii.* No definite trend was observed for *M. fortuitum* or *M. chelonae*.

In period 3 (1991–1996), the 10 most frequent species isolated were the same species as in period 1 (1976–1984), with the exception of *M. malmoense* and *M. marinum*, which were included only after 1984 (Table 2B). Conceivably new species such as *M. genavense, M. celatum* and *M. lentiflavum* were reported only after 1990 (Table 2C).

From 1992 to 1996, the NRCM in Borstel, Germany, reported 10 651 positive cultures (and not patients) of NTM; the most common species identified in this laboratory were the same as in all the other laboratories together: *M. avium* (31.26%), *M. xenopi* (16.71%), *M. gordonae* (15.25%), *M. fortuitum* (12.56%) and *M. kansasii* (6.44%). This laboratory was the only centre to report isolation of *M. paraffinicum* (18 cultures), *M. parafortuitum* (9), *M. intermedium* (5), *M. schimoidei* (2), *M. agri* (1), *M. ulcerans* (1) and *M. obuense* (1).

Geographical distribution of the five most common species reported

To compare the results from different countries, only data for the last 6 years (1991–1996) were used. During that time 22 884 NTM were isolated from patients' specimens. The percentage of each of the five most frequent species in reference to the total number of NTM patients in each country is shown in Table 3.

Except for Iran, Turkey, Belgium and the Czech Republic, the isolation rate of *M. avium* complex was above 20%. *M. gordonae* had an irregular distribution, with the highest percentage reported in Germany and Portugal. *M. kansasii* isolation was predominant in Iran and the Czech Republic, accounting for 25% of all NTM identified in the latter. Isolation of *M. fortuitum* was most frequent in Turkey and Iran. *M. xenopi* isolation comprised more than 25% of all NTM isolates in Belgium, Italy and Spain. Two species, *M. malmoense* and *M. xenopi*, showed an interesting distribution: *M. malmoense* was seventh among the most frequent species and showed a limited area of distribution (Table 4). The percentages of this species from 1991 to 1996 were: UK, 27.7%; Finland, 9.4%; Denmark, 3.6%; Switzerland, 2.2%; Germany, 1.7%; France, 1.2%; Spain 0.1% and Italy 2.7%. The organism was not reported in Belgium, Portugal, Czech Republic, Brazil, Iran or Turkey. These data indicate that *M. malmoense* species is predominant in northern European countries. In contrast, *M. xenopi* appears to be almost unknown in the north of Europe, Portugal, Brazil and the Middle East, while western and southern European countries showed high percentages. With respect to the three time periods (Table 5), *M. xenopi* initially showed low percentages in all countries from which data were available. In period 2, a steep increase was detected in the Czech Republic, Switzerland and Spain. Finally, in the most recent period, *M. xenopi* was also more frequently seen in other countries: the increase started in both the Czech Republic and Spain in 1987, a second wave was observed from 1990 to 1992, when it concomitantly occurred in the Czech Republic, Germany, Switzerland and Spain, and in 1996 it was again on the increase in the Czech Republic, Belgium and Spain. Interestingly, the increase of *M. xenopi* was not restricted to a few regionalised laboratories, but was observed simultaneously in central and southern Europe.

Grouping all identified species by their ability to produce carotene, as judged by country (Table 6), the number of chromogenic mycobacteria decreased from the east to the west and from the south to the north in Europe, with the exception of Turkey. Pigmented mycobacteria predominated in some areas, such as the Czech Republic and the Mediterranean coast of Spain. Non-chromogenic mycobacteria prevailed in an area of the Atlantic coast of Brazil.

DISCUSSION

NTM are everywhere in nature,[2] such as in water,[3] food,[4,5] soil,[6] plants,[7] animals[8] and other sites.[9] Isolation rates depend on the different isolation methods

Table 2 Non-tuberculous mycobacteria species

A Species identified from 1976 to 1996, all countries combined

Species	1976–1996 *n* (%)*	1976–1984 *n* (%)*	1985–1990 *n* (%)*	1991–1996 *n* (%)*
Total	30 969 (100)	2249 (7.2)	5836 (18.8)	22 884 (73.8)
M. avium	7 873 (25.42)	203 (9.0)	1007 (17.2)	6 663 (29.1)†
M. gordonae	6 106 (19.71)	557 (24.7)	1247 (21.3)	4 302 (18.8)‡
M. xenopi	5 271 (17.02)	50 (2.2)	872 (14.9)	4 349 (19.0)†
M. kansasii	4 472 (14.44)	1035 (46.0)	1061 (18.1)	2 376 (10.3)‡
M. fortuitum	3 118 (10.06)	147 (6.5)	724 (12.4)	2 247 (9.8)§
M. chelonae	1 457 (4.70)	88 (3.9)	290 (4.9)	1 079 (4.7)§
M. scrofulaceum	536 (1.73)	93 (4.1)	143 (2.5)	300 (1.3)
M. terrae	500 (1.61)	33 (1.4)	164 (2.8)	303 (1.3)
M. flavescens	204 (0.65)	13 (0.5)	79 (1.3)	112 (0.5)
M. nonchromogenicum	77 (0.24)	1 (0.04)	30 (0.5)	46 (0.2)
M. szulgai	45 (0.14)	1 (0.04)	7 (0.19)	37 (0.1)
M. aurum	41 (0.13)	4 (0.1)	21 (0.3)	16 (0.06)
M. triviale	41 (0.13)	7 (0.3)	12 (0.2)	22 (0.09)
M. gastri	29 (0.09)	4 (0.1)	9 (0.1)	16 (0.06)
M. vaccae	23 (0.07)	8 (0.3)	6 (0.1)	9 (0.03)
M. diernhoferi	5 (0.01)	5 (0.2)	—	—
Subtotal	29 798 (96.2)	2249 (100)	5672 (97.18)	21 877 (95.59)

B Species identified from 1985 to 1996, all countries combined

Species	1985–1996 *n* (%)*	1985–1990 *n* (%)*	1991–1996 *n* (%)*
M. malmoense	565 (1.82)	102 (1.7)	463 (2.0)
M. marinum	258 (0.83)	27 (0.4)	231 (1.0)
M. abscessus	85 (0.27)	10 (0.2)	75 (0.3)
M. simiae	80 (0.25)	7 (0.1)	73 (0.3)
M. phlei	23 (0.07)	9 (0.1)	14 (0.06)
M. smegmatis	11 (0.03)	2 (0.03)	9 (0.03)
M. gadium	7 (0.02)	3 (0.05)	4 (0.01)
M. thermorresistibile	4 (0.01)	4 (0.06)	—
Subtotal	1033 (3.33)	164 (2.8)	869 (3.8)

C Species identified only from 1991 to 1996, all countries combined

Species	*n*
M. genavense	41
M. celatum	25
M. peregrinum	13
M. aurum-neoaurum	12
M. lentiflavum	12
M. mucogenicum	12
M. interjectum	8
M. haemophilum	5
M. pulveris	4
M. triplex	3
M. fallax	1
M. gilvum	1
M. novum	1
Subtotal 1991–1996	138 (0.6%)*

* Percentage of total NTM reported from all countries combined. Statistical significance $P < 0.05$.
† Increasing linear tendency $P < 0.001$.
‡ Decreasing linear tendency $P < 0.001$.
§ No linear tendency $P = 0.48$ for *M. fortuitum* and $P = 0.37$ for *M. chelonae*.
NTM = non-tuberculous mycobacteria.

used in the different types of specimens studied.[10–12] Correlation of NTM isolated from the environment and those isolated from clinical samples of patients was not satisfactory.[13,14] Portaels has suggested that by regular human contact with NTM, inhaling or ingesting them, these mycobacteria colonise the respiratory or digestive tract temporarily or permanently.[15] Thus, if any species of mycobacteria has colonised or causes infection in a patient, it should show up when clinical specimens are cultured. Thus, we could analyse the isolation data from several years and estimate if there was any variation in the incidence or changes in the frequency of a specific species. Our collected data evidence an increase in the number of NTM

Table 3 The five most frequently isolated species in each country from 1991 to 1996

	MA %*	MG %*	MX %*	MK %*	MF %*	Total NTM
Brazil	68.5	9.3	0.7	12.0	4.4	1 142
Belgium	11.9	23.8	35.4	2.9	2.1	1 180
Czech Republic	8.6	29.0	17.1	25.2	17.5	2 955
Denmark	71.9	3.7	3.9	1.8	5.3	713
Finland	64.9	14.7	0	0	6.7	251
France	40.5	9.1	21.3	11.4	6.5	3 200
Germany	25.8	35.4	13.0	3.6	12.2	1 390
Iran	0	0	0	19.0	53.9	63
Italy	28.1	6.7	30.0	4.3	2.5	550
Portugal	43.0	35.3	0.1	0	16.5	639
Spain	42.4	17.4	26.5	10.6	10.8	7 527
Switzerland	25.5	22.8	13.8	5.9	7.5	2 341
Turkey	9.4	22.6	0	0	33.9	53
United Kingdom	42.4	9.2	4.6	5.6	6.0	875
Total	29.1	18.8	19.0	10.3	9.8	22 884

* Percentage of the total number of NTM isolated in the same country.
MA = *Mycobacterium avium* complex; MG = *M. gordonae*; MX = *M. xenopi*; MK = *M. kansasii*; MF = *M. fortuitum;* NTM = non-tuberculous mycobacteria.

Table 4 Isolation of *M. malmoense* from 1985 to 1996

Countries	1985–1990 %*	1991–1996 %*
United Kingdom	39.0	27.7
Finland	NR	9.4
Denmark	NR	3.6
Switzerland	0.9	2.3
Germany	12.1	13.0
France	NR	1.2
Spain	0.3	0.1
Italy	NR	2.7
Total	1.7	2.2

* Per cent of total mycobacteria isolated in each period of time.
NR = not reported.

isolated from clinical specimens by the participating laboratories. The number of laboratories included in the last period was higher than in the previous time periods, which may be one reason. However, although between 1980 and 1985 there was also an increase in the number of laboratories, this did not influence the number of NTM isolated.

Table 5 Trends of isolation of *M. xenopi* in the three time periods of the study

Countries	1976–1984 %*	1985–1990 %*	1991–1996 %*
Belgium	NR	50.4	35.4
Czech Republic	2.9	28.4	17.1
France	NR	NR	21.0
Germany	NR	12.1	13.0
Spain	1.3	8.1	26.5
Switzerland	2.8	6.4	13.8
Total†	2.3	16.4	22.0

* Per cent of total mycobacteria isolated in each period of time.
† $P < 0.001$, comparing periods.
NR = not reported.

In 1964, Tacquet et al.[16] compiled published references on the isolation of atypcal mycobacteria from clinical specimens in Europe; they reported 119 NTM isolates in Lille (France) in 1961; 25 NTM in Lyon (France) from 1956 to 1960; 59 NTM in Wales (UK) during a 10-year period (1950–1960); NTM isolated from 91 patients in 5 years in Germany (1956–1961); 90 NTM in Finland over 2 years (1958–1959); in Chicago, in 1958, 32% of 929 mycobacteria obtained from clinical samples were NTM; and in Japan (1956–1959), of 675 mycobacteria isolated, 43 (6.8%) were NTM. Thirty years later, in only 1 year (1994), 638 NTM were reported from Paris, 145 from Wales and 230 from Germany. It is evident from this report that the total number of NTM increased sharply in these regions. There was an increase not only from the first data from our study in 1976 but also in the previous years. These increases seem to continue until 1989, independently of the number of laboratories included each year. From 1991, there was a higher increase that continued until the end of the study.

Our understanding is that the rise in the incidence

Table 6 Distribution according to pigment production by country

Country	Years	NTM *n*	Chromogenic %	Non-chromogenic %
Denmark	1991–1996	862	13.4	86.5
Finland	1991–1996	265	15.5	84.4
United Kingdom	1988–1996	1 121	20.5	79.5
Brazil	1991–1996	1 177	22.5	77.4
Turkey	1995–1996	55	32.0	67.9
Portugal	1984–1996	1 212	40.7	59.2
France	1991–1996	3 592	45.7	54.2
Italy	1993–1996	550	47.6	52.3
Iran	1980–1983 1993–1996	98	51.0	48.9
Switzerland	1982–1996	3 774	52.1	47.8
Germany	1985–1996	1 999	55.2	44.7
Spain	1976–1996	11 128	58.8	41.1
Belgium	1989–1996	1 553	70.8	29.1
Czech Republic	1978–1996	8 713	76.3	23.6
Total		36 099	55.2	44.7

NTM = non-tuberculous mycobacteria.

of NTM disease[17] has accelerated rapidly since the first reports of NTM in AIDS patients in 1982 in the United States and a few years later in Europe, and that it has expanded to other countries.[18,19] Another reason for this increase is certainly the introduction of new technologies in laboratories that allow better recovery and more accurate identification of new species of NTM. Moreover, in recent years there has been more awareness and interest in the isolation of all species of the *Mycobacterium* genus.[20] Finally, in some countries, improvement of public health services for tuberculosis has increased both the number and the quality of mycobacteriology laboratories.

As regards the second objective of this work, our analysis indicates that the isolation of NTM species is constantly changing in most of the geographical areas studied, and that newer species are emerging. The most evident change in the years studied concerns the isolation of *M. xenopi*. Previous studies have also described different periods of time in which there were increases in *M. xenopi* isolation from clinical specimens, such as in the UK,[21] France[22] and different areas of the Czech Republic.[23] Data collected in Spain[1] indicate that *M. xenopi* was isolated for the first time in 1980. In 1984, 10 strains were isolated, while from 1991 to 1996, it was isolated from the clinical specimens of 2000 patients. Thus, the rate of isolation of this species increased from 1.3% (1976–1984) to 26.0% (1991–1996). Data from the US indicate that this species is not as frequent there as in Europe.[24] Nevertheless, some authors have suggested that disease due to *M. xenopi* could be more frequent than reported.[25] The area of the English Channel seems to be a specific location for *M. xenopi*. Not only do our data from Belgium agree with previous reports,[22] but published data from South-East England[26] also confirm that *M. xenopi* is predominant in this area. However, the results included in the present study from the UK do not reflect this due to the fact that only results from Scotland were available.

The increase in *M. avium* complex during period 3 of the study (1991–1996) is most likely due to the increase in the incidence of HIV infection. This organism had a uniform distribution in all countries included, but was predominant in Brazil and Northern European countries Denmark and Finland, where our data agree with other reports.[27–29]

In our study, *M. gordonae* was the second most frequently reported species, predominating in the Czech Republic and Germany. This species is considered a non-pathogenic contaminant which is widespread in the environment. The few cases of infection due to *M. gordonae* were reported in immunosuppressed patients.[30]

In 1979, silicosis was considered a propitious factor for pulmonary disease due to *M. kansasii* in patients working in the salt industry in Lorraine, France.[31] In 1983, a rapid increase in the incidence of lung disease due to *M. kansasii* was reported in Japan,[32] especially along the south coast of the Pacific Ocean, which is the principal industrial area of Japan. Pulmonary disease due to *M. kansasii* has been associated with industry and mines.[33] In our study, *M. kansasii* accounted for about 46% of all isolates between 1976 and 1984. This high percentage was due to the fact that during these years data were available from eight laboratories only. One was the Institute of Public Health in Prague, which reported 996 isolates of *M. kansasii* from this endemic area.[34]

New technologies such as high-performance liquid chromatography, polymerase chain reaction-restriction enzyme pattern analysis, 16S *rRNA* gene sequencing and DNA homology studies have helped to identify new species in the last few years.[35] However, this will require costly molecular techniques that are not available in most clinical laboratories.

In this study, some countries were not well represented because we were able to collect records from only one or two main laboratories. Moreover, in some countries many laboratories do not identify isolated mycobacteria, and even if they do, records are kept only in the event of suspicion that the isolated mycobacteria could be the cause of the disease (as in Denmark until 1994). Thus, the data reflect neither the true incidence of NTM in the total population nor the relationship between the isolation of NTM and disease.

Today, due to the availability of new rapid communication systems, it is easier to collect this kind of data from different countries. We hope that the task initiated by the Working Group will be expanded in the future to collect more comprehensive data to help us to better understand the prevalence, pattern of increase and disease due to NTM.

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References

1 Martín Casabona N, Rosselló Urgell J, Grupo Español de Estudio sobre Micobacterias Ambientales. Micobacterias ambientales en España: aislamientos en el periodo 1976–1996. Med Clin (Barc) 2000; 115: 663–670.
2 Viallier J, Viallier G. Inventaire des mycobactéries de la nature. Ann Soc Belge Med Trop 1973; 4: 361–371.
3 Collins C H, Grange J M, Yates M D. A review: mycobacteria in water. J Appl Bacteriol 1984; 57: 193–211.
4 Dunn B L, Hodgson D J. Atypical mycobacteria in milk. J Appl Bacteriol 1982; 52: 373–376.
5 Mediel M J, Rodriguez V, Codina G, Martin-Casabona N. Isolation of mycobacteria from frozen fish destined for human consumption. Appl Environ Microbiol 2000; 66: 3637–3638.
6 Domingo A, Martín Casabona N, González Fuente T, Pérez F. Ecologia dels micobacteris atípics a la ciutat de Barcelona. Gaseta Sanitaria de Barcelona 1983; 9: 103–106.
7 Taber R A, Thielen M A, Falkinham J O III. *Mycobacterium scrofulaceum*: a bacterial contaminant in plant tissue culture. Plant Sci 1991; 78: 231–236.

8 Hoop R K, Böttger E C, Ossent P. Mycobacteriosis due to *Mycobacterium genavense* in six pet birds. J Clin Microbiol 1993; 31: 990–993.
9 Eaton T, Falkinham J O III, Von Reyn F. 1995. Recovery of *Mycobacterium avium* from cigarettes. J Clin Microbiol 33: 2757–2758.
10 Tacquet A, Tison F, Devulder B, Roos P. Techniques de recherche des mycobactéries dans le lait et les produits laitiers. Ann Inst Pasteur de Lille 1966; 17: 161–171.
11 Songer J G. Methods for selective isolation of mycobacteria from the environment. Can J Microbiol 1981; 27: 1–7.
12 Kirschner R A Jr, Parker B C, Falkinham J O III. Epidemiology of infection by nontuberculous mycobacteria. *Mycobacterium avium*, *Mycobacterium intracellulare* and *Mycobacterium scrofulaceum* in acid brown water swamps of the south-eastern United States and their association with environmental variables. Am Rev Respir Dis 1992; 145: 271.
13 Collins C H, Yates M D. Infection and colonisation by *Mycobacterium kansasii* and *Mycobacterium xenopi*: aerosols as a possible source? J Infect 1984; 8: 178–179.
14 Yajko D M, Chin D P, Gonzalez P C, et al. *Mycobacterium avium* complex in water, food, and soil samples from the environment of HIV-infected individuals. J Acq Imm Defic Synd Hum Retrov 1995; 9: 176–182.
15 Portaels F. Epidemiology of mycobacterial diseases. Clin Dermatol 1995; 13: 207–222.
16 Tacquet A, Tison F, Devulder B. Quelques aspects actuels des infections broncho-pulmonaires provoquées par les mycobactéries dites 'atypiques'. Rev Tuberc Pneumol 1964; 28: 89–116.
17 Falkinham J O III. Epidemiology of infection by nontuberculous mycobacteria. Clin Microbiol Rev 1996; 9: 177–215.
18 Collins F M. Mycobacterial disease, immunosuppression and acquired immunodeficiency syndrome. Clin Microbiol Dis 1989; 2: 360–377.
19 Young L S. Mycobacterial diseases and the compromised host. Clin Microbiol Dis 1999; 17 (Suppl 2): S436–S441.
20 Shinnick T M, Good R C. Diagnostic mycobacteriology laboratory practices. Clin Infect Dis 1995; 291–299.
21 Bullin C H, Tanner E L, Collins C H. Isolation of *Mycobacterium xenopei* from tap water. J Hyg Camb 1970; 68: 97–100.
22 Lemercier J P, Morel A, Savigny G, Thierry C, Lambert J. Etude de 960 souches de *Mycobacterium xenopi* isolées en Seine-Maritime pendant 12 années. Répartition géographique et evolution. Rev Fr Mal Resp 1979; 7: 510–512.
23 Slosarek M, Kubin M, Jaresova M. Water-borne household infections due to *Mycobacterium xenopi*. Cent Eur J Public Health 1993; 1: 78–80.
24 O'Brien R, Geiter L J, Snider D E Jr. The epidemiology of nontuberculous mycobacterial diseases in the United States. Results from a national survey. Am Rev Respir Dis 1987; 135: 1007–1014.
25 Tajuddin M J, Jacoby H M, Weymouth L A, Kaminski D A, Portmore A C. *Mycobacterium xenopi*: bystander or emerging pathogen? Clin Infect Dis 1997; 24: 226–232.
26 Yates M D, Pozniak A, Uttley A H C, Clarke R, Grange J M. Isolation of environmental mycobacteria from clinical specimens in south-east England: 1973–1993. Int J Tuberc Lung Dis 1997; 1: 75–80.
27 Tala E, Viljanen M. Mycobacterial infections in Finland. Scand J Infect Dis 1995; 98 (Suppl): 7–8.
28 Romanus V. Mycobacterial infections in Sweden. Scand J Infect Dis 1995; 98 (Suppl): 15–16.
29 Myrvang B. Mycobacterial infections in Norway. Scand J Infect Dis 1995; 98 (Suppl): 12–14.
30 Lessnau K-D, Milanese S, Talavera W. *Mycobacterium gordonae*: a treatable disease in HIV-positive patients. Chest 1993; 104: 1779–1785.
31 Lamy P, Dailloux M, Lamaze R, Martinet Y, Canet B. Role pathogène de *Mycobacterium avium* et *Mycobacterium kansasii*. A propos de 15 observations. Rev Fr Mal Respir 1979; 7: 513–515.
32 Tsukamura M and Mycobacteriosis Research Group of the Japanese National Chest Hospitals. Rapid increase of the incidence of lung disease due to *Mycobacterium kansasii* in Japan. Chest 1983; 83: 890–892.
33 Corbett E L, Hay M, Churchyard G J, et al. *Mycobacterium kansasii* and *M. scrofulaceum* isolates from HIV-negative South African gold miners: incidence, clinical significance and radiology. Int J Tuberc Lung Dis 1999; 3: 501–507.
34 Chobot S, Malis J, Sebakova H, et al. Endemic incidence of infections caused by *Mycobacterium kansasii* in the Karvina district in 1968–1995 (analysis of epidemiological data-review). Cent Eur J Public Health 1997; 5: 164–173.
35 Wayne L G, Sramek H A. Agents of newly recognized or infrequently encountered mycobacterial diseases. Clin Microbiol Rev 1992; 5: 1–25.

RÉSUMÉ

OBJECTIF : Recueillir les données sur les mycobactéries non-tuberculeuses (NTM) isolées dans des laboratoires cliniques de différents pays, afin d'établir : 1) dans quelle mesure l'isolement de NTM va en augmentant ; 2) dans quelles espèces l'augmentation apparaît ; et 3) s'il existe un type quelconque de distribution géographique.

SCHÉMA : En 1996, le Groupe de Travail de la Section Bactériologie et Immunologie de l'Union Internationale Contre la Tuberculose et les Maladies Respiratoires a pris contact avec 50 laboratoires dans différents pays pour obtenir les informations nécessaires.

RÉSULTATS : Le nombre de patients signalés comme porteurs de NTM a été de 36.099, provenant de 14 pays. Le complexe *M. avium, M. gordonae, M. xenopi, M. kansasii* et *M. fortuitum* sont les cinq espèces le plus fréquemment isolées. On a noté une tendance significative d'augmentation pour le complexe *M. avium* et pour *M. xenopi*. Les mycobactéries pigmentées prédominent en Belgique, en République Tchèque et sur la côte méditerranéenne d'Espagne. Les mycobactéries non-chromogènes s'avèrent prédominantes dans la zone de la côte atlantique du Brésil, en Turquie, au Royaume Uni, en Finlande et au Danemark.

CONCLUSIONS : On a noté une augmentation du nombre d'isolements de NTM à partir d'échantillons cliniques de patients. L'isolement des espèces les plus fréquentes se modifie constamment dans la plupart des zones géographiques et on voit apparaître de nouvelles espèces à la suite d'une amélioration des techniques de diagnostic pour la détection et l'identification des NTM.

RESUMEN

OBJETIVO : Recopilar los datos de micobacterias no tuberculosas (NTM) aisladas en laboratorios clínicos para conocer : 1) si el número de aislamientos de NTM había aumentado, 2) que especies habían aumentado y 3) si las variaciones tenían una distribución geográfica.

DISEÑO : En 1996, se formó un Grupo de Trabajo en la Sección de Bacteriología e Inmunología de la Unión Internacional contra la Tuberculosis y Enfermedades Respiratorias que solicitó los datos de aislamiento de NTM a 50 laboratorios de diferentes países.

RESULTADOS : Se recibió información sobre el aislamiento de NTM en 36 099 pacientes de 14 países. Las especies más frecuentemente aisladas fueron *M. avium* complex, *M. gordonae, M. xenopi, M. kansasii* y *M. fortuitum.* Se observó un aumento significativo en el número de aislamientos de *M. avium* complex y *M. xenopi.* Las especies pigmentadas predominaron en Bélgica, Republica Checa y la costa mediterránea de España. Las micobacterias no pigmentadas fueron más frecuentes en la costa atlántica de Brasil, Turquía, Reino Unido, Finlandia y Dinamarca.

CONCLUSIONES : Se observó un incremento significativo en el número de aislamientos de NTM en muestras clínicas de pacientes. El aislamiento de las especies más frecuentes cambió en la mayoría de las áreas geográficas ; la aparición de nuevas especies se debe probablemente a la mejora de las técnicas de detección e identificación en micobacterias.