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REVIEW

Tuberculosis treatment outcomes in Europe: a systematic review

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ABSTRACT: In order to facilitate the control of tuberculosis (TB), the World Health Organization (WHO) has defined a standardised short-course chemotherapy and a strategy, directly observed therapy. In 2000, WHO surveillance of TB treatments in Europe recorded a successful outcome rate of 77%. The aim of this report is to estimate treatment outcomes in European countries based on published studies and to identify their determinants.

A systematic review was conducted of published reports of TB treatment outcomes in Europe. Meta-analysis, meta-regression and subgrouping were used to pool treatment outcomes and analyse associations with mean age, sex, immigration status and multidrug resistance.

Of the 197 articles identified in the search, 26 were eligible for the review; 74.4% of outcomes were successful, 12.3% were unsuccessful and 6.8% of patients died. Heterogeneity was high for all outcomes. National estimates were possible for six countries. Multidrug resistance was inversely associated with successful outcome, which were fewer in populations with >9% multidrug-resistant TB, and in patients aged <44 yrs.

Successful tuberculosis treatment outcomes were below the 85% threshold suggested by the World Health Organization. There was an inverse association with levels of multidrug-resistant tuberculosis. The unexplained heterogeneity between the studies for unsuccessful outcomes seems to be due to differing interpretations given to World Health Organization definitions.

KEYWORDS: Meta-analysis, surveillance, surveys, systematic review, tuberculosis treatment outcomes

The therapeutic regimen defined by the World Health Organization (WHO) as efficacious in curing tuberculosis (TB) and preventing the development of acquired drug resistance is standardised short-course chemotherapy (SSCC). Essential to its efficacy are the use of appropriate drugs, and the dose and timing of therapy, as well as correctly identifying the characteristics of TB cases. Candidates for SSCC are new cases of pulmonary TB, both smear-positive and smear-negative. SSCC is also recommended in cases of HIV infection and less severe forms of extrapulmonary TB. Only chronic and multidrug-resistant (MDR) TB require individual therapeutic regimens since SSCC is less effective in these cases [1]. Treatment success rates as low as 56–58% have been reported in countries with good control programmes [2].

An efficacious regimen is essential for treating TB, but a more complex strategy is needed to control the disease, one which cures as many cases as possible, prevents acquired drug resistance and decreases the transmission of infection. The WHO recommends the directly observed therapy strategy (DOTS), and has set diagnostic thresholds of $\geqslant$70% of infectious cases, and curative thresholds of 85% [1].

In 1993, the WHO introduced surveillance of treatment outcomes in order to evaluate the impact of TB control programmes [1]. In 2000, the worldwide rate of treatment success was 82% in DOTS areas, but only 67% in non-DOTS areas. In Europe, the successful outcome rates were 77 and 72%, respectively. The proportion of patients in Europe who interrupted their treatment or failed to be cured was as high as 13% [3], and as many as 6% died during treatment, most of them older patients. Immigration from high prevalence countries and MDR-TB have been proposed as factors contributing to unsuccessful treatments, but few European countries have implemented surveillance of TB treatment outcomes.

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The results of a systematic review undertaken to estimate the pooled percentages of TB treatment outcomes in European countries and analyse the factors associated with these outcomes are reported.

METHODS

Identification and selection of articles

Published reports dealing with TB treatment outcomes in Europe were reviewed. Studies were identified through a computerised search of the following databases: PubMed (1993–2003), EMBASE (1993–2003), TOXLINE (1993–2003), Serfile (1998–2003), and CAB Abstracts (1993–2003). MEDLINE was searched through PubMed. The term tuberculosis was searched with all of the following as a combination of free text and thesaurus terms in different variations: treatment outcome, treatment failure, successful therapy, unsuccessful therapy, mortality due to, surveillance, surveys, and therapy follow-up. WHO documents were systematically searched on their website. *The International Journal of Tuberculosis and Lung Disease* was selected as the key journal for hand-searching.

Any original study from a European country was included in this review, whereas comments, editorials and reviews were excluded. The articles were included if they estimated both successful and unsuccessful treatment outcomes in the total population of TB cases who started treatment, including patients lost to follow-up, those transferring out and/or those for whom outcomes were not reported.

Articles were excluded if they dealt with extrapulmonary TB alone, chronic TB or MDR-TB, a mycobacterium other than tuberculosis, high-risk groups such as HIV-positive or neoplastic patients, or previously treated cases alone. Case studies reporting results regarding diagnostic/laboratory methods, drug efficacy tested *in vitro* or through clinical trials, TB surgical procedures, side-effects of drugs, TB vaccination, and indications for management or treatment of TB cases were also excluded.

Outcome measures and definitions

The outcome measures of TB treatment were assessed as percentages of successful and unsuccessful outcomes, and of deaths during treatment, among all patients who started therapy.

Cases reported in the articles presented each WHO outcome definition for surveillance concerning TB patients before and after therapy [1, 4, 5]. Successful outcomes in the review included cured patients and those who completed treatment. Two definitions were used for unsuccessful outcomes, one included failures and defaulters [1, 4, 5] and the other patients lost to follow-up or transferred-out.

European countries were selected according to the WHO regional classification, which includes Israel and Turkey.

Statistical analysis

Where appropriate, the pooled percentages for each TB treatment outcome were used in a random effects meta-analysis. The SE and 95% confidence interval (CI) of outcomes were calculated from data reported in each article. Heterogeneity between studies was assessed using the Chi-squared test, and the variation due to heterogeneity across the studies estimated by calculating I^2. Meta-regression was performed in order to analyse the association between treatment outcome and: mean age; percentages of males, immigrants and MDR-TB among patients; year of TB occurrence; and study design. It was not used to analyse the association with percentages of patients treated with WHO standard chemotherapy because only nine studies reported this information. For variables associated with treatment outcome, pooled stratified estimates were calculated and sensitivity analysis of potential bias performed.

RESULTS

Of 197 articles selected from the initial PubMed search for TB treatment outcomes in European countries, 46 were considered for full-text review on the basis of the inclusion criteria. One additional article was identified by manual search of *The International Journal of Tuberculosis and Lung Disease*. Of the 47 papers reviewed in full, 26 fulfilled the stated criteria. Three papers [6–8] were excluded because they did not report outcomes for all patients, and are detailed in table 1.

Thirteen European countries were represented in the review: the former USSR [9–12], Czech Republic [13], Poland [14, 15] and Romania [16] from former Eastern Europe; and Denmark [17], France [18], Germany [19–22], Italy [23–27], the Netherlands [28], Northern Ireland [29], Spain [30, 31], Sweden [32] and Switzerland [33, 34] from former Western Europe.

The articles are from 1996–2004, the number of cases studied ranged 104–8,038 and the studied periods from 1988–2001.

Eight were prospective studies, four of which used the WHO method of quarterly cohort reports. Eighteen were retrospective studies or surveys, using heath services data.

Most of the surveys were population-based; they identified cases on the basis of all TB notifications, although the population varied from national to city level. The five Italian studies [23–27] and the Parisian study [18] were conducted on a nonrandom sample of TB therapeutic units. The proportion of the population covered in these reports was 15–26%. Three other studies were hospital-based [22, 29, 31].

Patients were reported as having pulmonary TB in 24 articles, and as TB, without specification, in a further two [21, 31]. Fifteen studies presented results for microbiologically confirmed TB. Five papers included only new cases [10, 13, 21, 30, 31] and a further three stratified the outcomes for new and previously treated cases [9, 12, 19]. Ten studies only reported, as the proportion cured, those patients whose successful treatment was documented by a conversion of sputum smear test [9, 10, 12, 13, 17, 19, 20, 22, 33, 34]

The successful outcomes reported in each study are shown in figure 1 and table 2; their pooled estimate was 74.4% (95% CI 71.0–77.9%), but heterogeneity was very high. Success rates were 73.5% (95% CI 71.0–76.1%) among new cases (11 studies) and 42.3% (95% CI 26.2–68.4%) among previously treated cases (three studies). The percentage cured was 52.0% (95% CI 43.2–62.5%) (10 studies).

The pooled estimate for unsuccessful outcomes was 7.4% (95% CI 5.3–10.4%), or 12.3% (95% CI 8.5–17.9%) if those lost to

TABLE 1 Tuberculosis (TB) treatment outcomes for articles not included in the review

First author [Ref.] (period)	Location	Design	Cases			Treatment outcome %							
			Type	Category#	Subjects¶ n	Successful			Died	Unsuccessful			Lost to follow-up+	Complete information
						Total	Cured	Treatment completed		Total	Failure	Default		
Ormerod [6] (1988–2000)	UK district	Retro survey§	P	New‡	301	90.2	4.7	85.5	10.3	0			0	100
Chemtob [7] (1990–1992)	Israel	Retro cohort§	P/EP	Combined##	877	27.6			5.0	66.8				99.4
				New	820	26.5			4.9	68.6				99.8
				Retreated	57	43.9			7.0	43.9				94.7
Coninx [8] (1995–1997)	Azerbaijani prison	Follow-up§	P¶¶	Combined##	467	54.0	42.0	12.0	11.0	35.0	22.0	13.0		100

Retro: retrospective; P: pulmonary; EP: extrapulmonary. #: on diagnosis; ¶: who underwent therapy and were observed for the whole prescribed treatment period (those still in therapy at the end of follow-up or who died before treatment are not included); +: includes transfer-out cases; §: all cases; ‡: excludes treated cases at diagnosis because this would include EP cases; ##: new and retreated; ¶¶: confirmed by positive direct smear examination for acid-fast bacilli or culture.

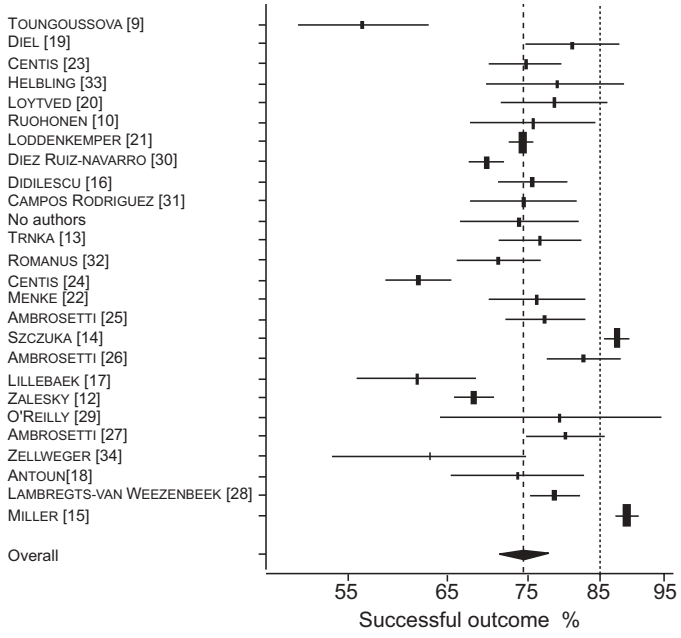

FIGURE 1. Forest plot showing percentage of successful tuberculosis (TB) treatment outcomes (■ (size proportional to number of cases)) and 95% confidence interval (CI) (horizontal bars) in European countries (random-effect meta-analysis). The centre of the diamond represents the combined success rate (-----) and its extremities the 95% CI (·····: 85% curative threshold, suggested by the World Health Organization for gaining effective TB control). The scale on the x-axis is logarithmic. The combined success rate was 74.4% (95% CI 71.0–77.9%; n=26). In testing for heterogeneity, X^2=505.6 (25 degrees of freedom; p=0.001) and I^2=95.1%. In testing for overall effect, z=181.4 (p=0.001).

follow-up and transferred-out were included; 6.8% (95% CI 5.9–7.8%) of patients died during treatment. Heterogeneity was very high for all estimates.

National pooled estimates could be calculated for six countries. Treatment success rates were 68.1% (95% CI 61.5–75.4%) in the former USSR, 76.2% (95% CI 73.1–79.4%) in Germany, 70.9% (95% CI 67.2–75.0%) in Spain, 88.4% (95% CI 86.9–90.0%) in Poland, 71.2% (95% CI 57.3–88.4%) in Switzerland and 74.8% (95% CI 67.2–83.4%) in Italy (fig. 2; table 2).

The proportion of MDR-TB cases was inversely associated with successful outcome (p=0.006), the pooled estimates of success being 76.9% (95% CI 74.8–79.0%) if MDR-TB levels were <10 (analysing together the groups of 2–9% and <2% MDR-TB) and 59.7% (95% CI 54.4–65.5%) when MDR-TB levels were >9% (fig. 3; table 2). The inverse association between MDR-TB level and successful outcome was confirmed when all 14 articles with unknown proportions of MDR-TB were included in the groups with <2% and 2–9% MDR-TB (p=0.03). No relationship was found when all 14 articles were included in the group with >9% MDR-TB (p=0.3), except when the two Polish papers were excluded (p=0.03).

Although mean age was not associated with successful outcome, stratified analysis showed that the lowest proportion of successful treatments occurred in people aged <44 yrs (72.2%; 95% CI 68.1–76.5%). It was difficult to compare the outcome in the 44–49-yr-old age group with the other age groups due to the high heterogeneity (fig. 4; table 2).

No relation was found between successful outcome and the proportion of immigrant or male patients nor the year of occurrence or study design.

No relation was found between death or unsuccessful outcome, whatever definition was used, and any of the factors analysed.

DISCUSSION

Successful tuberculosis treatment outcomes

Successful TB treatment outcomes were below the 85% threshold suggested by the WHO. The estimate of 74.4% found is coherent with those from WHO surveillance [3]. The lower percentage of successes observed in previously treated than in new TB cases, although estimated only for three studies, was also consistent with previous knowledge, since

TABLE 2 Successful tuberculosis (TB) treatment outcomes in Europe weighted by study, country, multidrug-resistant (MDR) TB level and age group

First author [Ref.]	Year	Cases n	Successful outcome n (%; 95% CI)	Weight#	Country	Weight	MDR-TB %	Weight	Age group yrs	Weight
Toungoussova [9]	2004	296	166 (56.1; 50.0–62.9)	3.49	Former USSR	22.63	>9	36.74		
Diel [19]	2003	518	419 (80.9; 74.2–88.2)	3.84	Germany	16.61			44–49	10.79
Centis [23]	2002	906	677 (74.7; 70.0–79.8)	4.08	Italy	20.08	2–9	23.67	44–49	11.24
Helbling [33]	2002	265	209 (78.9; 69.9–89.0)	3.41	Switzerland¶	53.87			38–43	15.41
Loytved [20]	2002	425	334 (78.6; 71.4–86.5)	3.74	Germany	14.30	<2	8.72	50–53	80.34
Ruohonen [10]	2002	312	236 (75.6; 67.7–84.6)	3.53	Former USSR	23.00			38–43	17.11
Loddenkemper [21]	2002	8038	5964 (74.2; 72.6–75.9)	4.39	Germany	53.00	<2	49.10		
Diez Ruiz-Navarro [30]	2001	3572	2493 (69.8; 67.5–72.1)	4.34	Spain	74.53			38–43	39.89
Didilescu [16]	2001	1032	779 (75.5; 71.0–80.3)	4.12						
Campos Rodriguez [31]	2001	438	326 (74.4; 67.7–81.8)	3.75	Spain	25.47				
No authors [11]	2001	349	258 (74.0; 66.5–82.2)	3.61	Former USSR	23.69	2–9	11.93	38–43	18.32
Trnka [13]	2001	682	522 (76.5; 71.0–82.6)	3.97						
Romanus [32]	2000	676	481 (71.2; 66.0–76.8)	3.97					44–49	11.03
Centis [24]	2000	1162	719 (61.9; 58.4–65.6)	4.15	Italy	20.41	>9	63.26	44–49	11.38
Menke [22]	2000	497	378 (76.1; 69.6–83.1)	3.82	Germany	16.10	<2	9.97		
Ambrosetti [25]	1999	715	552 (77.2; 71.7–83.1)	3.99	Italy	19.70	2–9	20.33	44–49	11.08
Szczuka [14]	1999	7548	6612 (87.6; 85.6–89.6)	4.39	Poland	47.95			44–49	11.83
Ambrosetti [26]	1999	838	692 (82.6; 77.1–88.4)	4.05	Italy	19.97	2–9	22.56	44–49	11.19
Lillebaek [17]	1999	350	216 (61.7; 55.5–68.6)	3.61					44–49	10.32
Zalesky [12]	1999	3318	2263 (68.2; 65.9–70.6)	4.33	Former USSR	30.67				
O'Reilly [29]	1999	104	81 (77.9; 64.2–94.5)	2.51					50–53	19.66
Ambrosetti [27]	1999	787	623 (80.1; 74.6–85.9)	4.02	Italy	19.84	2–9	21.50	44–49	11.14
Zellweger [34]	1998	133	84 (63.2; 53.2–75.0)	2.77	Switzerland¶	46.13			38–43	9.27
Antoun [18]	1998	280	206 (73.6; 65.4–82.8)	3.45			<2	6.01		
Lambregts-van Weezenbeek [28]	1998	1836	1441 (78.5; 75.0–82.2)	4.25			<2	26.21		
Miller [15]	1996	8393	7487 (89.2; 87.3–91.2)	4.39	Poland	52.05				

The total weight across each subgroup and across all studies was 100%; individual weights were determined by random-effect meta-analysis. CI: confidence interval. #: all studies; ¶: combined cases.

previously treated patients are more likely to have had or acquired multidrug resistance to *Mycobacterium tuberculosis* [35].

The estimate of cured patients could not be used even though it is the best indicator of the impact of a TB control programme. It measures transmission interruption, as well as cured patients, but requires microbiological tests to be carried out before and after therapy in each pulmonary TB case. From the low percentage of cured patients, it was hypothesised that this practise is not common in European countries, and, therefore, that this percentage underestimates the conversion rate and impact of TB control programmes.

Although lower than in Western countries, the pooled estimate of treatment success in the former USSR was not significantly different. This was not as expected because of the high prevalence of MDR reported in the former USSR by the WHO [36]. The present authors are unable to explain these results, but suggest that most studies from Western countries in the present review, although population-based, do not give valid estimates of MDR-TB prevalence since the drug sensitivity data referred to TB patients selected on the basis of clinical criteria. It is possible that those who did not respond to standardised therapy have been more frequently studied for sensitivity than others; therefore, the prevalence of MDR-TB could be overestimated by the studies from Western Europe. This could also explain, in part, the low observed percentages of successful therapy.

The heterogeneity between the studies could not be explained by subgrouping by national data in Switzerland and Italy. Differences in MDR-TB levels explained the heterogeneity observed among Italian studies.

Finally, the results obtained in Poland could be due to the epidemiological characteristics of infection in that country; however, the methods used for TB surveillance could also have influenced the observed results.

Determinants of outcome

MDR-TB levels were inversely associated with successful treatment. It was found that a proportion of >9% MDR-TB resulted in an important significant reduction in successful outcomes. Although this result needs to be confirmed by other observations, it represents the first quantitative estimate of the MDR-TB threshold in the population that influences TB

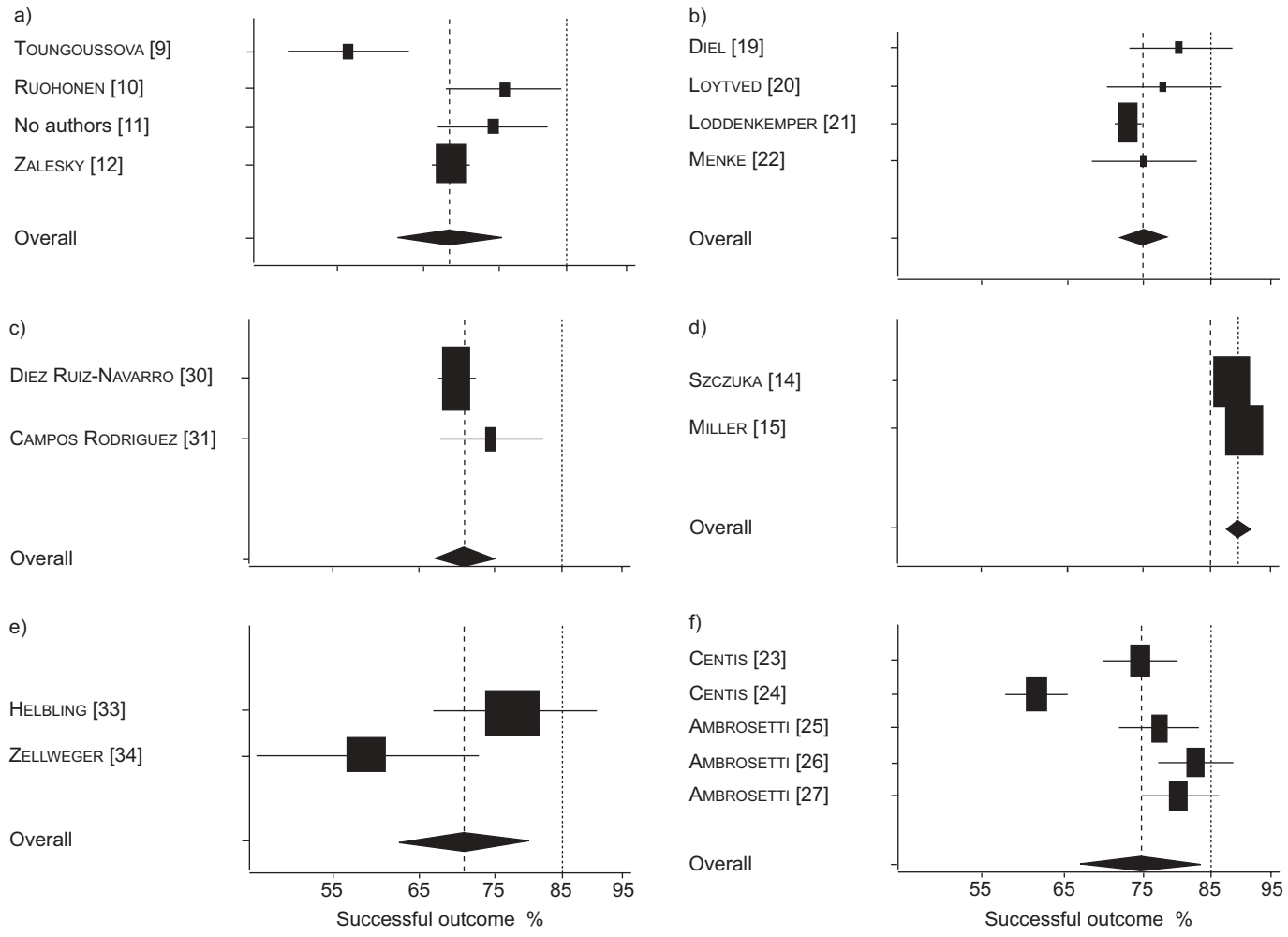

FIGURE 2. Forest plot showing percentage of successful tuberculosis (TB) treatment outcomes (■ (size proportional to number of cases)) and 95% confidence interval (CI) (horizontal bars) in Europe by country (random-effect meta-analysis): a) former USSR, b) Germany, c) Spain, d) Poland, e) Switzerland (combined cases), and f) Italy. The centre of the diamond represents the combined success rate (-----) and its extremities the 95% CI (·····: 85% curative threshold, suggested by the World Health Organization for gaining effective TB control). The scale on the x-axis is logarithmic. The combined success rate (95% CI; n) was: a) 68.1% (61.5–75.4%; n=4), b) 76.2% (73.1–79.4%; n=4), c) 70.9% (67.2–75.0%; n=2), d) 88.4% (86.9–90.0%; n=2), e) 71.2% (57.3–88.4%; n=2), and f) 74.8% (67.2–83.4%; n=5). In testing for heterogeneity, X^2 and I^2 were: a) 16.67 (3 degrees of freedom (df); p=0.001) and 82.0%; b) 4.81 (3 df; p=0.186) and 37.6%; c) 1.59 (1 df; p=0.207) and 37.1%; d) 1.30 (1 df; p=0.255) and 23.1%; e) 4.31 (1 df; p=0.038) and 76.8%; and f) 52.66 (4 df; p=0.001) and 21.5%. In testing for overall effect, z was: a) 81.13, b) 206.1, c) 152.1, d) 493.9, e) 38.52, and f) 78.00 (p=0.001 for all).

treatment outcomes. The selection of patients studied for MDR prevents estimation of the true MDR-TB prevalence in the population, as discussed above, but is unlikely to distort the results of the regression.

People aged <45 yrs have already been reported as at higher risk of MDR-TB in many European countries [37–40], the rationale for this being that rifampicin was introduced as part of therapy in 1969, more recently than other drugs [41]. The lower percentage of successful outcomes found in people aged <44 yrs could be due to a higher prevalence of MDR in younger patients.

The lack of association between successful outcome and foreign-born status is surprising. Since immigrants were treated as a single group in the articles, regardless of their countries of origin (and whether the countries were at low or high risk of MDR-TB), this result might have been influenced by a dilution of the effect. Studies of immigration as a risk factor for MDR-TB have clearly shown this point [40]. Notably, foreign-born status was only studied in Western European countries, whereas no study from the former USSR or Eastern Europe reported data on immigrants.

Unfortunately, factors related to the characteristics of treatment, such as drugs, dose and timing of therapy, could not be analysed because they were not reported in the articles.

Unsuccessful tuberculosis treatment outcomes

Unsuccessful outcomes, defined as failure and treatment interruption, are strong predictors of MDR [36, 42], but other outcomes, such as death, loss to follow-up, transfer-out, or those for whom the outcome is unknown, contribute to the low threshold level of success. A valid estimate of these outcomes is essential in evaluating TB control programmes as well as in suggesting adequate corrections.

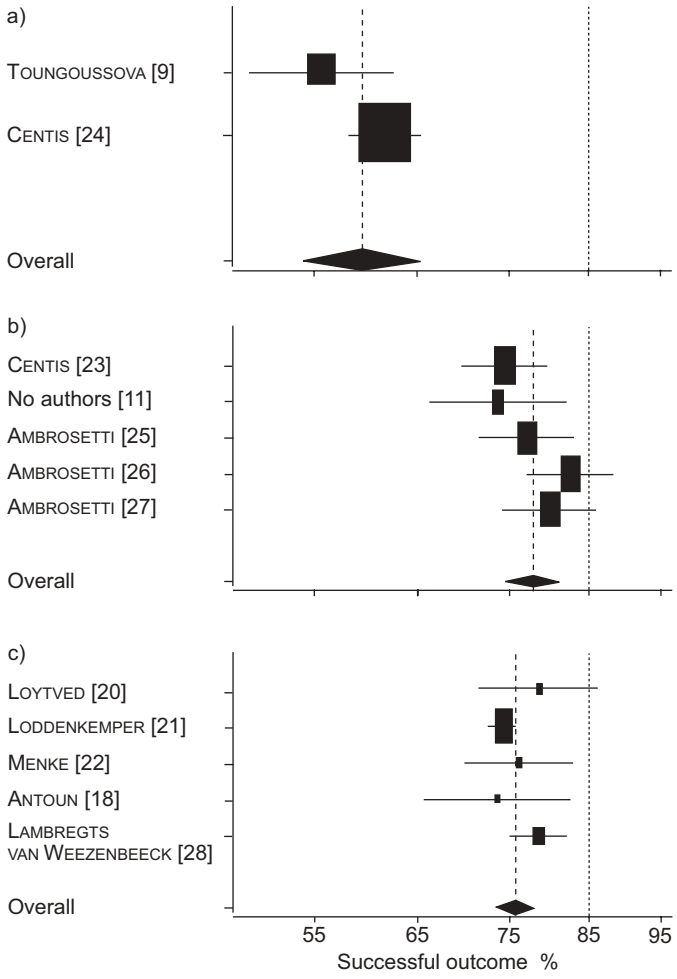

FIGURE 3. Forest plot showing percentage of successful tuberculosis (TB) treatment outcomes (■ (size proportional to number of cases)) and 95% confidence interval (CI) (horizontal bars) in Europe by multidrug-resistant (MDR) TB level (random-effect meta-analysis): a) >9%, b) 2–9%, and c) <2%. The centre of the diamond represents the combined success rate (-----) and its extremities the 95% CI (·····: 85% curative threshold, suggested by the World Health Organization for gaining effective TB control). The scale on the x-axis is logarithmic. The combined success rate (95% CI; n) was: a) 59.7% (54.4–65.5%; n=2), b) 78.0% (74.9–81.2%; n=5), and c) 75.8% (73.6–78.2%; n=5). In testing for heterogeneity, χ^2 and I^2 were: a) 2.24 (1 degree of freedom (df); p=0.134) and 55.4%; b) 5.93 (4 df; p=0.204) and 83.1%; and c) 5.74 (4 df; p=0.219) and 30.3%. In testing for overall effect, z was: a) 86.25, b) 210.0, and c) 279.9 (p=0.001 for all).

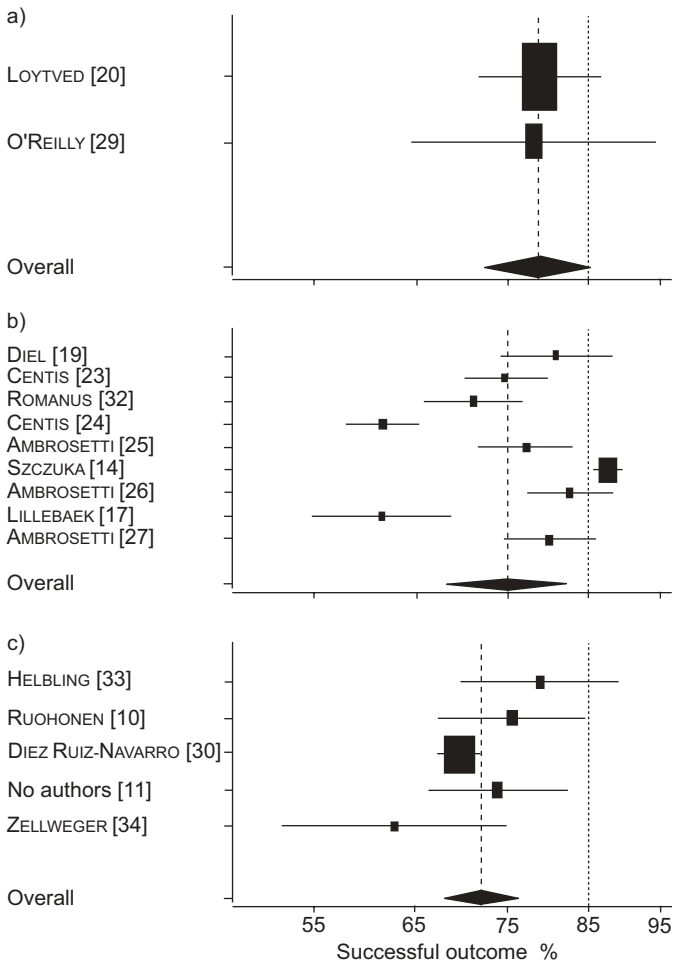

FIGURE 4. Forest plot showing percentage of successful tuberculosis (TB) treatment outcomes (■ (size proportional to number of cases)) and 95% confidence interval (CI) (horizontal bars) in Europe by age group (random-effect meta-analysis): a) 50–53 yrs, b) 44–49 yrs, and c) 38–43 yrs. The centre of the diamond represents the combined success rate (-----) and its extremities the 95% CI (·····: 85% curative threshold, suggested by the World Health Organization for gaining effective TB control). The scale on the x-axis is logarithmic. The combined success rate (95% CI; n) was: a) 78.4% (72.0–85.5%; n=2), b) 75.0% (68.3–82.3%; n=9), and c) 72.2% (68.1–76.5%; n=5). In testing for heterogeneity, χ^2 and I^2 were: a) 0.01 (1 degree of freedom (df); p=0.935) and 0%; b) 173.24 (8 df; p=0.001) and 95.4%; and c) 7.47 (4 df; p=0.113) and 46.4%. In testing for overall effect, z was: a) 99.70, b) 91.24, and c) 143.6 (p=0.001 for all).

In the present review, no single factor explained the heterogeneity of unsuccessful outcomes between studies. The first hypothesis investigated was that misclassification of unsuccessful outcomes could have occurred in the articles, due to the different interpretations given to WHO definitions of these outcomes. Indeed, four studies in the present review did not explicitly report numbers for loss to follow-up or transfer-out [11, 14, 15, 34], but the high percentages (up to 20.0%) of patients with unknown outcomes suggest that these are included in this group. Ten other studies specified those lost and transfer-out but did not report cases with unknown outcomes [9, 12, 19–22, 28, 29, 31, 33]. Two studies included transfers-out among the unsuccessful outcomes [16, 19], giving them the same meaning as failure or interruption of treatment.

For these reasons, a definition of unsuccessful outcome was also used that included patients lost to follow-up and transferred-out. This definition gave an estimate nearer to that reported by WHO surveillance, but the heterogeneity remained unexplained. No association was found between unsuccessful outcome and any factor, regardless of the definition used.

A few studies have reported an association between unsuccessful outcome and factors related to the social characteristics of patients. Treatment interruption has been associated with

immigrants in Italy [23–27] and Switzerland, where asylum seekers and refugees showed the highest risk [33]. Interruption was also associated with homelessness, injecting drugs and alcohol dependence in Hamburg, Germany [19]. In Spain, homelessness was a risk factor for transfer-out and HIV-positivity, and injecting drugs for unsuccessful treatment. Finally, one study analysed factors related to treatment and found that no standard therapy in the initial or secondary phase of treatment was associated with unsuccessful outcome or death [22].

Limitations of the present study

The most important limitation of the present study is the large number of articles with missing data on factors analysed; seven gave no information on sex, and 11 none on foreign status. Sensitivity analysis of bias for MDR-TB, the factor influencing outcome, showed no important influence on regression results, although only 12 studies, of the 26 included, reported this information.

Chronic TB cases should have been excluded from the treatment outcomes analysis, as treatment success is known to be less than in those treated with SSCC [1, 43]. Unfortunately, few authors reported this explicitly, and only one Russian author clearly defined the patients treated, by including chronic cases [12]. This hypothesis seems to be confirmed for studies conducted in the former USSR, where only new TB revealed no heterogeneity. The possible inclusion of chronic cases in other articles could contribute to the low proportion of successes.

Finally, the possible misclassification of new and previously treated cases [44] could explain the present somewhat surprising results, such as the higher percentage of successful outcomes observed in studies which included both new and previously treated cases than in those studying new TB alone.

Conclusions

Since successful TB treatment outcomes fell below the 85% threshold, in most European countries, enhancement of national TB control programmes is desirable.

A threshold of >9% MDR-TB was found to have the greatest negative impact on successful outcome. Further studies, possibly including representative estimates of MDR-TB prevalence, are needed to confirm this result.

Treatment characteristics, such as the drugs used, therapeutic regimens, duration of therapy and outcome of previous treatment, need to be more consistently reported in order to identify the factors related to inadequate treatment and permit improvement of TB control programmes [36, 45].

The different meanings attributed to definitions of unsuccessful outcomes possibly prevented calculation of their pooled estimates and made it difficult to analyse the associated factors. Discussion regarding the difficulties in using World Health Organization definitions of treatment outcomes could help in the comparison of survey results.

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