Original Article

Deaths attributed to multiple causes and involving tuberculosis in the state of Rio de Janeiro Brazil between 1999 and 2001*

AUGUSTO HASIAK SANTO[1]

ABSTRACT

Objective: To evaluate deaths attributed to multiple causes in which tuberculosis was one of the causes listed. **Methods:** All deaths among residents of the state of Rio de Janeiro, Brazil, occurring between 1999 and 2001 and for which the death certificate mentioned tuberculosis, were investigated. The World Health Organization guidelines were used in characterizing the underlying and associated (non-underlying) causes of death. **Results:** In deaths from tuberculosis, conditions related to its natural history were the principal associated causes, together with alcoholism and diabetes. In approximately three-fifths of all deaths for which tuberculosis was listed as an associated cause, the underlying cause of death was acquired immunodeficiency syndrome. High proportion of ill-defined causes of death, low values found for the number of causes informed per death certificate and for TB as an associated cause point towards a certain degree of underestimation of the actual number of TB-related deaths in Rio de Janeiro State. **Conclusion:** The study shows that the rates of tuberculosis-related mortality in the state of Rio de Janeiro, calculated based on the number of times tuberculosis was listed as a cause of death (underlying or associated), are the highest in the country. Epidemiological studies of mortality are recommended as a means of guiding the activities of the tuberculosis control program.

Keywords: Tuberculosis/mortality; Acquired immunodeficiency syndrome; Multipe cause of death; Brazil

*Study carried out in the Department of Epidemiology of the Universidade de São Paulo (USP, University of São Paulo) School of Public Health - São Paulo, Brazil.

Associate Professor in the Department of Epidemiology of the Universidade de São Paulo (USP, University of São Paulo) School of Public Health - São Paulo, Brazil
Correspondence to: Augusto Hasiak Santo. Av. Dr. Arnaldo, 715 - CEP: 01246-904, São Paulo, SP, Brasil. Tel: 55 11 3066-7764. Email: auhsanto@usp.br

Submitted: 4 March 2005. Accepted, after review: 8 March 2006.

INTRODUCTION

The World Health Organization recommends that mortality statistics be presented by underlying cause of death, defined as "the disease or injury which initiated the train of morbid events leading directly to death" or "the circumstances of the accident or violence which produced the fatal injury". From a public health point of view, prevention of the underlying cause of death should lead to achieving the objective of avoiding death.[1] However, the demand for more comprehensive information regarding the constellation of lethal events has resulted in the study of mortality attributed to all causes of death registered on the death certificates. In addition to the underlying cause of death, associated causes can include its complications and other contributing causes unrelated to the process that led directly to death. All of these causes are collectively referred to as multiple causes of death.[2-3]

Among the merits of studying multiple causes of death, the retrieval of a certain cause of death as an associated cause is one of the most important. This observation is true for tuberculosis in the past years. In the USA, when mentioned on death certificates, tuberculosis was identified as an associated cause of death in 56% of the cases in 1980, and in 57% in 1990.[4] In the Autonomous Community of Madrid, Spain, the same occurred in 53.1% (640) of the 1206 deaths reported between 1991 and 1998.[5] In the state of São Paulo, in 1983, of the cases in which tuberculosis was mentioned on the death certificate, it was identified as an associated cause of death in 21.9% (294/1337),[2] rising to 45.8% (1388/3032) in 1998.[3] Tuberculosis is not presented as an associated cause of death in the primary statistics used to calculate mortality. This higher rate at which tuberculosis is currently listed as an associated cause of death is due in part to the provisions introduced in the International Statistical Classification of Diseases and Related Health Problems, more commonly known as the International Classification of Diseases, tenth revision (ICD-10). These provisions incorporate the updated knowledge of the etiopathogenesis of tuberculosis caused by the human immunodeficiency virus, bestowing upon the latter the honor of being considered an underlying cause. Infectious diseases, opportunistic infections in particular, are interpreted as a consequence of the acquired immunodeficiency syndrome (AIDS), which has led to tuberculosis being characterized as an associated cause.[1,3,6-8] In the state of São Paulo, in 1998, AIDS was listed as the underlying disease on 98.2% (4619) of the 4703 death certificates on which it was mentioned.[7] In addition, taking into consideration all of the deaths in which tuberculosis was mentioned, not only those in which it was listed as the underlying cause of death, the tuberculosis-related mortality rate practically doubled.[3] Statistics of mortality attributed to multiple causes have been available in the state of São Paulo since 1983 and in the rest of Brazil since 1999.[2,9]

Brazil is included among the 22 countries presenting the highest tuberculosis burdens,[10-11] and the state of Rio de Janeiro presents higher rates of tuberculosis incidence and mortality than does any other state/district of the federation.[12-15] Factors responsible for the deficiencies in the prevention and treatment of tuberculosis in the state of Rio de Janeiro, as well as for the failure of the control program to interrupt the progression of the disease, include the following: a low index of case detection; a long interval between the onset of symptoms and the confirmation of the diagnosis; failure to perform complementary diagnostic procedures; insufficient investigation of co-infection with the human immunodeficiency virus; high rates of noncompliance with treatment; inappropriate treatment regimens; unnecessary hospitalizations; high mortality and high rates of underreporting of cases with a subsequent lack of monitoring of the individuals with whom they have been in contact, in areas of high populational density and poor socioeconomic conditions.[12-18]

The study of tuberculosis-related mortality has proven useful in increasing knowledge of its epidemiological characteristics.[3-5,13,19-21] In the state of Rio de Janeiro, the high rate of underreporting of cases makes it practically unviable to use compulsory reporting data and makes mortality an indispensable instrument to guide the planning of the tuberculosis control program.[13-15]

The objective of this study was to analyze tuberculosis-related mortality due to multiple causes, describing its importance as an underlying cause and as an associated cause of death, as well as to look for correlations between tuberculosis and other causes of death, particularly AIDS.

METHODS

The mortality data were provided by the National Health Foundation, and the populational data were provided by the Information Technology Department of the Unified Health Care System. Both institutions are organs of the Brazilian Ministry of Health.[9] Each record in the mortality database presents fields corresponding to those appearing on the death certificate currently used in Brazil. Auxiliary fields have been added. For example, the fields corresponding to the underlying cause and to lines (a), (b), (c) and (d) of Part II of the International Form of Medical Certificate of Cause of Death have been combined into a single string. This transformation was necessary in order to process the causes of death using the Multiple Causes of Death Tabulator.[22]

Some conventions have been adopted for the study of multiple causes of death. The World Health Organization concept was used to identify the underlying cause of death, assigned according to the ICD-10 guidelines.[1,23-24] The causes derived from the underlying cause, also known as consequential causes, including terminal and intervening causes, as well as contributing causes that are not related to the morbid process leading directly to death, were designated associated causes of death, also characterized as non-underlying causes of death.[2-3] The underlying cause of death was automatically processed using the Underlying Cause of Death Selection System.[24] All of the causes reported on the death certificate were considered, even ill-defined causes and those characterized by the World Health Organization as modes of death,[1,23] among which 'respiratory failure', due to the importance of these causes in the natural history of tuberculosis. Tuberculosis as a cause of death corresponded to the clinical forms included in the A15-A19 group of the ICD-10.[23] The deaths related to late effects or sequelae of tuberculosis and resulting from complications of the effects of cured tuberculosis, included in the category 'B90 - sequelae of tuberculosis', were not considered.[1,23] The expression 'deaths from' or 'due to' a specific disease refers to the underlying cause of death, and the expression 'deaths with mention of' corresponds to the presence of this disease reported either as the underlying or associated cause on the death certificate.[3]

The variables studied were age, gender, underlying cause of death, associated causes of death, clinical forms of tuberculosis, number of causes reported (by death certificate) and year of death. The medical and demographic variables were processed using the following programs: dBASE III Plus (version 1.1; Ashton-Tate, 1985, 1986), Epi Info (version 6.04b/c, 1997; Centers for Disease Control and Prevention) and Excel 2000 (Microsoft Corporation). The program Multiple Causes of Death Tabulator (version 2.2, 2/22/2001) was used to process the associated causes and mean number of diagnoses per death certificate.[22] Special lists for the presentation of associated causes were prepared to identify the causes of death integral to the natural history of tuberculosis and of AIDS, as well as those most frequently mentioned through the identification and counting of these causes in the Brazilian Mortality Database. Duplications and multiple listings of causes of death found on abbreviated lists were eliminated. The number of associated causes depends on the amplitude of the class in which these causes are presented. If two or more causes within a given class (category, grouping or chapter of the ICD-10) were reported on the same death certificate, only one cause was counted.[22] The Mortality Record Separator program was used in the recovery of records that might be relevant to the study of the correlation between a certain associated cause and tuberculosis.

The mortality rate per 100,000 inhabitants and the mortality ratio were calculated for the underlying causes and for the total number of deaths in which tuberculosis was reported, whether as an underlying cause or as an associated cause. The mortality rates for the state of Rio de Janeiro were compared with the respective mortality rates for Brazil and for the state of São Paulo.

The following tests were carried out using the Epi Info program: the Wilcoxon test (for differences between mean ages at the time of death); the Student's t-test (for the difference between the mean number of causes reported per death certificate); and the chi-square test (for the difference among the rates of tuberculosis-related mortality, as well as the difference among the proportions of associated causes in the deaths in which tuberculosis, AIDS or other causes were identified as underlying causes). The deaths of individuals of unknown gender or age were excluded from the

calculation of the median age at the time of death, as well as from the calculation of specific mortality rates by age and gender. The mean number of causes per death certificate is presented with the respective standard deviation.

RESULTS

In the state of Rio de Janeiro, tuberculosis was identified as the underlying cause of death in 1114, 966 and 1030 deaths, respectively, in 1999, 2000 and 2001, translating to mortality rates of 8.1, 6.7 and 7.1 per 100,000 inhabitants, as well as to proportional mortality ratios of 1%, 0.9% and 0.9%. In those same years, tuberculosis was mentioned as an associated cause in another 369, 453 and 430 deaths, bringing the total number of deaths in which it was mentioned to 1483, 1419 and 1460, respectively, with mortality rates of 10.7, 9.9 and 10 per 100,000 inhabitants, as well as mortality ratios of 1.3% for all three years (Table 1). During this period, the tuberculosis-related mortality rates were higher among males (13, 10.3 and 11.2 per 100,000) than among females (3.5, 3.4 and 3.3 per 100,000), as was the total number of times it was mentioned, respectively, among males (16.9, 14.9 and 15.7 per 100,000) and females (5, 5.2, and 4.8 per 100,000). The deaths related to the late effects of tuberculosis (42, 32 and 60 as an underlying cause and 11, 15 and 14 as an associated cause) were not included in the study.

The principal associated causes in the deaths from tuberculosis are presented in Table 2. Respiratory failure, which was listed on nearly 50% of the death certificates in 2001, is worthy of mention. Malnutrition and wasting, as well as symptoms and signs related to the circulatory and respiratory systems, together with pneumonias and septicemia, are characteristic of terminal diseases. In addition to these causes, alcoholism and diabetes mellitus were also mentioned as contributing causes of death (Table 2). During the three years of the period, out of a total of 140 deaths in which mental disorder due to the use of a psychoactive substance was mentioned, 134 were caused by alcohol (95.7%), 20 by smoking (14.3%) and one by cocaine use (0.7%). It should be noted, as well, that some deaths were caused by the use of multiple substances. In

TABLE 1

Specification of data on the study of tuberculosis-related mortality attributed to multiple causes, State of Rio de Janeiro - 1999, 2000 and 2001

Specifications	1999	2000	2001
Population of Brazil	163.947.436	169.799.170	172.385.776
TB listed as the underlying cause of death	5.940	5.532	5.421
TB listed as an associated cause of death	2.468	2.803	2.697
Population of Rio de Janeiro	13.807.368	14.391.282	14.558.561
Total number of deaths in Rio de Janeiro	113.497	111.196	113.816
Deaths from undetermined causes in Rio de Janeiro (%)	10,9	11,5	11.2
Number of causes per death certificate in Rio de Janeiro*	2.6 (±1,3)	2.9 (±1.4)	2.9 (±1.4)
TB listed as the underlying cause of death	1.114	966	1.030
TB listed as an associated cause of death	369	453	430
Total number of death certificates mentioning TB	1.483	1.419	1.460
Ratio between total mentions/underlying cause	1.33	1.47	1.42
Number of causes per death certificate*	2.6 (±1,1)	2.7 (±1.2)	2.7 (±1.2)
Mortality rate by underlying cause**	8.1	6.7	7.1
Mortality rate by total mentions**	10.7	9.9	10.0
Mortality ratio by underlying cause (%)	1.0	0.9	0.9
Mortality ratio by total mentions (%)	1.3	1.3	1.3
AIDS listed as the underlying cause of death	1.572	1.644	1.652
TB mentioned on the death certificate	204	283	261
Mortality rate by underlying cause**	11.4	11.4	11.4
Mortality rate for AIDS as the underlying cause and TB as an associated cause**	1.5	2.0	1.8

Source: National Health Foundation, Ministry of Health, Brazil. Department of Information Technology of the Unified Health Care System of the Ministry of Health, Brazil; TB: tuberculosis; *mean ± standard deviation; **per 100,000 inhabitants

TABLE 2

Number and percentage of tuberculosis-related deaths according to associated causes of death, State of Rio de Janeiro - 1999, 2000 and 2001

Associated (non-underlying) causes of death*	1999 (deaths = 1114)		2000 (deaths = 966)		2001 (deaths = 1030)	
	n	%	n	%	n	%
Respiratory failure (J96)	489	43.9	448	46.4	508	49.3
Malnutrition/wasting (E40-E46, R64)	189	17.0	173	17.9	190	18.4
Other symptoms and signs Circulatory and respiratory systems (R09)	114	10.2	121	12.5	138	13.4
Pneumonias (J12-J18, J69)	70	6.3	75	7.8	91	8.8
Septicemia (A40-A41)	57	5.1	67	6.9	71	6.9
Other diseases of the respiratory system (J00-J11, J20-J39, J60-J68, J70, J85-J86, J95, J98)	58	5.2	66	6.8	53	5.1
Chronic diseases of the lower airways (J40-J47)	54	4.8	45	4.7	51	5.0
Mental disorders due to psychoactive substance use (F10-F19)	54	4.8	51	5.3	37	3.6
Diabetes mellitus (E10-E14)	40	3.6	41	4.2	46	4.5
Liver diseases (K70-K77)	35	3.1	44	4.6	44	4.3
Hemorrhage of the airways (R04)	43	3.9	41	4.2	31	3.0
Nonspecific anemia (D64.9)	27	2.4	34	3.5	34	3.3
Electrolyte, metabolic and acid-base disorders (E86-E88)	30	2.7	29	3.0	27	2.6
Other heart diseases (I00-I09, I30-I49, I51)	15	1.3	29	3.0	26	2.5
Other diseases of the digestive system (K00-K66, K80-K92)	20	1.8	22	2.3	25	2.4
Renal disease (N17-N19)	17	1.5	16	1.7	29	2.8
Heart failure (I50)	15	1.3	23	2.4	21	2.0
Multiple organ failure (R68.8)	13	1.2	23	2.4	20	1.9
Shock not elsewhere classified (R57)	16	1.4	22	2.3	17	1.7
Other pleural diseases (J90-J94)	12	1.1	23	2.4	18	1.7
Other diseases of the circulatory system (I60-I99)	15	1.3	19	2.0	16	1.6
Hypertensive diseases (I10-I13)	14	1.3	14	1.4	22	2.1
Other interstitial lung diseases (J80-J84) (J80-J84)	10	0.9	22	2.3	17	1.7
Cardiac and pulmonary disease (I26-I28)	17	1.5	15	1.6	16	1.6
Ischemic heart disease (I20-I25)	6	0.5	6	0.6	9	0.9
Other associated causes of death	202	18.1	192	19.9	105	10.2
Total	1.632	NC	1.661	NC	2.692	NC

Source: National Health Foundation, Ministry of Health, Brazil. *Notes and codes from the International Statistical Classification of Diseases and Related Health Problems, tenth revision. Percentages calculated in relation to number of deaths. NC: not calculated.

the deaths in which tuberculosis was the underlying cause, in the period studied, the predominant clinical form was pulmonary tuberculosis (93.5%, 94.8% and 93.2%), followed by miliary tuberculosis (4.2%, 2.6% and 4.5%).

Of the deaths in which tuberculosis was mentioned as an associated cause during those same three years, the principal underlying causes of death were AIDS (55.3%, 62.5% and 60.7%, respectively), followed by diseases of the circulatory system (10.8%, 12.4% and 9.1%), neoplasms (7.9%, 7.7% and 10.9%), diseases of the digestive system (6.5%, 5.1% and 5.8%) and diabetes mellitus (5.7%, 3.5% and 3.3%) (Table 3). Considering all the deaths occurring during the period, we found that miliary tuberculosis was more frequent among those in which the underlying cause was AIDS, and that pulmonary tuberculosis was predominant among the remaining underlying causes of death ($p < 0.001$) (Table 4). Among all the deaths from AIDS in the

TABLE 3

Number and percentage of deaths in which active tuberculosis was listed as an associated cause, according to AIDS and other underlying causes of death, State of Rio de Janeiro - 1999, 2000 and 2001

Underlying causes of death*	1999		2000		2001	
	n	%	n	%	n	%
Diseases caused by human immunodeficiency virus (B20-B24)	204	55.3	283	62.5	261	60.7
Neoplasms (C00-D48)	29	7.9	35	7.7	47	10.9
Diabetes mellitus (E10-E14)	21	5.7	16	3.5	14	3.3
Diseases of the circulatory system (I00-I99)	40	10.8	56	12.4	39	9.1
Diseases of the respiratory system (J00-J99)	17	4.6	10	2.2	16	3.7
Diseases of the digestive system (K00-K93)	24	6.5	23	5.1	25	5.8
Other underlying causes of death	34	9.2	30	6.6	28	6.5
Total	369	100.0	453	100.0	430	100.0

Source: National Health Foundation, Ministry of Health, Brazil. *Notes and codes from the International Statistical Classification of Diseases and Related Health Problems, tenth revision

state of Rio de Janeiro in this period, the deaths in which tuberculosis was mentioned as an associated cause corresponded to 13% (204/1572), 17.2% (283/1644) and 15.8% (261/1652) (Table 1).

The importance of AIDS is revealed by the fact that the mortality rates for tuberculosis as an associated cause were higher than those for tuberculosis as the underlying cause, in the 20-29 age bracket in 2000, among males (3.6 vs. 3.2 per 100,000) and females (2.0 vs. 1.9 per 100,000), as well as, in 2001, among males (4.0 vs. 2.8 per 100,000). In 1999, 2000 and 2001, for the same age bracket, AIDS was the underlying cause in 88.4% (38/43), 91.3% (63/69) and 90.9% (60/66), respectively, of the deaths in which tuberculosis was listed as an associated cause.

The means and medians of ages at the time of death, regardless of gender and for the years of the period, were quite comparable and virtually constant. Therefore, summing up all the deaths between 1999 and 2001, we found that the mean ages at the time of death were as follows: age at time of death from tuberculosis, for males and females, respectively: 49.5 and 48.5 years of age; age at time of death from AIDS with mention of tuberculosis, for males and females, respectively: 37.5 and 35.5 years of age; and age at time of death from other underlying causes with mention of tuberculosis: 55.5 years of age (for both genders). The differences among these modes of death were significant for both genders ($p < 0.001$). Median age was lower in the deaths from tuberculosis in which alcoholism was listed as an associated cause than in those in which it was not (45.5 vs. 50.5 years of age, $p < 0.001$) and was more frequent in males (93%, $p < 0.001$). Regarding

TABLE 4

Number and percentage of deaths due to AIDS and other causes, according to clinical forms of tuberculosis as associated causes of death, State of Rio de Janeiro - 1999, 2000 and 2001

Associated causes of death (not immediate)*	AIDS (deaths = 748)		Outras causas (deaths = 504)		p
	n	%	n	%	
Pulmonary tuberculosis (A15-A16)	603	80.61	457	90.67	0.000001
Tuberculosis of the nervous system (A17)	18	2.41	6	1.19	0.123859
Tuberculosis of other organs (A18)	56	7.49	30	5.95	0.292522
Miliary tuberculosis (A19)	83	11.10	14	2.78	0.000000
Total	760	NC	507	NC	

Source: National Health Foundation, Ministry of Health, Brazil. *Notes and codes from the International Statistical Classification of Diseases and Related Health Problems, tenth revision. Percentages calculated in relation to number of deaths. NC: not calculated.

the deaths in which diabetes was listed as an associated cause, the median age was higher (58.5 vs. 50.5 years of age, $p < 0.001$), and diabetes was more common among males (62.2% vs. 37.8%, $p < 0.001$).The mean number of causes mentioned per death certificate, for each of the three years studied, varied significantly ($p < 0.001$) among the deaths from tuberculosis (2.6, 2.7 and 2.7), from AIDS with mention of tuberculosis (3.6, 3.8 and 3.6), and from other causes with mention of tuberculosis (4, 4 and 3.8). When tuberculosis was reported as an underlying cause, the standard was only two causes per death certificate, as was seen in nearly half of the deaths.

DISCUSSION

The tuberculosis-related mortality rates observed in the state of Rio de Janeiro from 1999 to 2001 are the highest in the country. These mortality rates are more than twice as high as those found for Brazil as a whole, as well as being one and a half times higher than those seen in the state of São Paulo, for the same period.[19-20,25] The use of multiple causes of death was found to be a more comprehensive means of studying tuberculosis-related mortality. The recovery of the deaths in which tuberculosis was identified as an associated cause increased the value of the mortality rate by the total number of times it was mentioned, 33%, 47% and 42%, in relation to the classical rate, in the three years of the period. Nevertheless, despite the dimension of these numbers, they are lower than those observed in the country and in the state of São Paulo. In Brazil, this increase in the mortality rates, resulting from the consideration of all the times tuberculosis was mentioned, was 42%, 51% and 50% (Table 1). In the state of São Paulo, for the same (1999-2001) period, this increase was approximately 70%.[3,19]

The associated causes of deaths from tuberculosis in Rio de Janeiro present the same pattern observed in other Brazilian states/districts.[19-20,25] Among these causes, we find those that are characterized as complications of tuberculosis (such as respiratory failure, malnutrition and wasting, pneumonias and septicemia), together with signs and symptoms related to the circulatory and respiratory systems. When respiratory failure constitutes the principal reason for admission into specialized hospitals, it relates to higher mortality rates.[26] Diabetes and alcoholism should be mentioned due to the frequency with which they occur concomitantly with tuberculosis. Concomitance with alcoholism, principally among males, is an important factor related to noncompliance with treatment and expulsion from the hospital for disciplinary reasons.[26-27] Similarly to the present study, we found that the mean age at the time of death from tuberculosis, when accompanied by alcoholism, was lower than when this association was not present, in approximately 5.7 years in the state of São Paulo in 1998.[3] The finding that the median age at the time of death was higher in the deaths from tuberculosis with mention of diabetes than in those without such mention suggests that complementary investigations should be carried out in an attempt to find evidence of a hypothetical protective effect of diabetes. The study of multiple causes seems advantageous when it identifies these associated causes, which should be taken into consideration in order to guide tuberculosis control measures and prevent the occurrence of tuberculosis-related deaths.[3,13-14,17]

The mortality rates increased when the deaths in which tuberculosis occurred as an associated cause were taken into consideration, of which approximately three-fifths (around 60%) were due to AIDS. The low frequency of the test for human immunodeficiency virus leads to the hypothesis that the AIDS-related deaths have been underestimated.[15] A study in the five hospitals that concentrated the most tuberculosis-related deaths of residents in the state of Rio de Janeiro revealed that the test for the human immunodeficiency virus was carried out in only 25.8% of the deceased, and more commonly among the confirmed cases of tuberculosis.[13-14]

The quality and the advantage of the use of multiple causes of death depend on the number of entities reported on the death certificate. The block provided for listing the causes of death in Part I of the death certificate includes four lines intended for, respectively, the terminal causes (on line a), two intervening causes (on lines b and c) and the underlying cause (on line d). In Part II, there are lines intended for contributing causes present at the time of death. The reporting physician will find space for four or more causes of death.[1] In the present study, the mean number of causes per death certificate in cases of tuberculosis-related death was

lower than that found for the state of São Paulo during the same years (2.9 ± 1.2, 3.1 ± 1.2 and 3.1 ± 1.3, respectively),[19] as well as being lower than that observed for the state of Rio de Janeiro as a whole in 2000 and 2001 (2.9 and 2.9). In addition, it was observed that this value was lower than that found in cases of AIDS-related deaths, a fact also observed in São Paulo and attributed to the greater importance that doctors give to this syndrome when providing the death certificate.[7]

As a corollary, the issue of physician responsibility for the correct completion of the death certificate should be taken into consideration.[28-30] The accuracy in the reporting of the causes of death resulting from the use of the International Form of Medical Certificate of Cause of Death leads to the identification of the true causes of death. A review of medical charts in the city of New York, USA revealed that 36.2% (230) of the 635 cases in which tuberculosis was listed as an underlying or associated cause of death on death certificates issued in 1992 were cases in which tuberculosis was never confirmed as a cause of death.[28] In addition, the authors found that the death certificates issued for 310 patients who had died from active tuberculosis made no mention of tuberculosis.

In the state of Rio de Janeiro, the proportion of causes characterized as undetermined is above 10%, which compromises the quality of the mortality statistics.[9] This limitation related to the mortality data in Rio de Janeiro, which results in part from the inadequate completion of the death certificate, leads to the supposition that the number of tuberculosis-related deaths is, to some degree, underestimated.[12]

Deaths related to the late effects or to the sequelae of tuberculosis have been included in some studies.[3,11,31] This inclusion is important since it allows us to infer, in a more comprehensive and appropriate way, the magnitude of the role that tuberculosis plays in mortality. Many deaths occur due to residual complications of tuberculosis when the infectious process is resolved and is no longer active. In addition, it has been observed that, due to problems related to the inadequate reporting of causes of death or erroneous interpretation of diagnoses listed on the death certificates, some deaths are attributed to late effects of tuberculosis when the process is still active. In the present study, such interpretations were not included, thereby allowing us to compare our results with those of previous studies that only considered deaths due to active tuberculosis.

The study of mortality created the opportunity to again suggest that epidemiological studies to assess tuberculosis-related mortality be carried out,[15,28-29] a measure that has also been recommended in the current[11] Brazilian Consensus on Tuberculosis.[32] Mortality surveillance is important and useful for monitoring the deaths of infants and mothers, as well as for improving health care facilities provided for pregnant women (during gestation, delivery and puerperium), children and their families. Nevertheless, the efficacy of such surveillance depends on the quantity and quality of the data registered on the death certificates, which are not totally satisfactory in the state of Rio de Janeiro. Teaching doctors about the epidemiological and legal importance of the death certificate is a prerequisite to improving the appropriate use of data on tuberculosis-related mortality.

The study of mortality attributed to multiple causes has made an invaluable contribution to the study of the epidemiology of tuberculosis. The results of the present study show that the mortality rate increased significantly when the count included deaths in which tuberculosis was mentioned as an associated cause, as it was in approximately three-fifths of the cases in which AIDS was listed as the underlying cause. In addition, our findings suggest that collecting information on all of the causes of death listed on death certificates will allow us to partially reconstruct the natural history of tuberculosis. The advantage of evaluating multiple causes depends on the appropriate completion of the death certificate, which can be compromised when there is inaccuracy in the listing of causes of death and when the number of causes per death certificate is low.

REFERENCES

1. World Health Organization. International statistical classification of diseases and health related problems. 10th rev. Geneva: WHO; 1993. v.2.
2. Santo, AH. Causas múltiplas de morte: formas de apresentação e métodos de análise [tese]. São Paulo: Faculdade de Saúde Pública da Universidade de São Paulo; 1988.
3. Santo AH, Pinheiro CE, Jordani MS. Causas múltiplas de morte relacionadas à tuberculose no Estado de São Paulo, Brasil, 1998. Rev Saude Publica. 2003;37(6):714-21.

4. White MC, Portillo CJ. Tuberculosis mortality associated with AIDS and drug or alcohol abuse: analysis of multiple cause-of-death data. Public Health. 1996;110(3):185-9.
5. Ordobas M, Gandarillas A, Fernandez de la Hoz K, Fernandez Rodriguez S. [Mortality and tuberculosis: analysis of multiple causes in the Community of Madrid (1991-1998)]. Rev Esp Salud Publica. 2003;77(2):189-200. Spanish.
6. Santo AH. Equivalência entre revisões da classificação internacional de doenças: causas de morte. Rev Saude Publica. 2000;34(1):21-8.
7. Santo AH, Pinheiro CE, Jordani MS, Silva M. Causas básicas e associadas de morte por Aids, Estado de São Paulo, Brasil, 1998. Rev Saude Publica. 2000;34(6):581-8.
8. Selik RM, Anderson RN, McKenna MT, Rosenberg HM. Increase in deaths caused by HIV infection due to changes in rules for selecting underlying cause of death. J Acquir Immune Defic Syndr. 2003;32(1):62-9.
9. Brasil. Ministério da Saúde. Fundação Nacional de Saúde. Banco de dados dos Sistemas de Informação sobre Mortalidade (SIM) e Nascidos vivos (SINASC)- 1996 a 2000 [CD-ROM]. Brasília (DF).
10. Raviglione MC. The TB epidemic from 1992 to 2002. Tuberculosis (Edinb). 2003;83(1-3):4-14.
11. Corbett EL, Watt CJ, Walker N, Maher D, Williams BG, Raviglione MC, et al. The growing burden of tuberculosis: global trends and interactions with the HIV epidemic. Arch Intern Med. 2003;163(9):1009-21.
12. Rio de Janeiro. Secretaria de Estado da Saúde do Rio de Janeiro. Programa de controle da tuberculose do Estado. Plano estratégico para o controle da tuberculose no Estado do Rio de Janeiro, 2003 a 2005 [texto na Internet]. Rio de Janeiro; 2003. [citado 2004 Nov 17]. Disponível em: http://www.saude.rj.gov.br/Tuberculose/planos.shtml
13. Selig L, Belo MT, Teixeira EG, Cunha AJ, Brito R, Sanches K, et al. The study of tuberculosis-attributed deaths as a tool for disease control planning in Rio de Janeiro, Brazil. Int J Tuberc Lung Dis. 2003;7(9):855-9.
14. Selig L, Belo M, Cunha AJLA, Teixeira EG, Brito R, Luna AL, et al. Óbitos atribuídos à tuberculose no Estado do Rio de Janeiro. J Bras Pneumol. 2004;30(4):327-34.
15. Selig L, Belo MT, Teixeira EG, Cunha AJLA, Branco MMC, Trajman A. Tuberculosis-attibuted deaths in Rio de Janeiro, Brazil: a descriptive study. Int J Tuberc Lung Dis 2001; 5 (Suppl 1): S93.
16. Selig L, Cunha AJLA, Teixeira EG, Belo MT, Branco MMC, Trajaman A. Testagem anti HIV nos pacientes com tuberculose no Estado do Rio de Janeiro. Pulmão RJ. 2001;10(1):8-13.
17. Selig L, Belo MT, Teixeira E, Brito R, Cunha A, Greaves W, et al. Deaths from tuberculosis in a reference hospital in Rio de Janeiro, Brazil. Int J Tuberc Lung Dis. 2001;5(Suppl 1):S70.
18. Vicentin G, Santo AH, Carvalho MS. Mortalidade por tuberculose e indicadores sociais no município do Rio de Janeiro. Ciênc Saúde Coletiva. 2002;7(2):253-63.
19. Santo AH, Jordani MS, Pinheiro CE. Trend of multiple causes of death related to tuberculosis, State of São Paulo, Brazil, 1997 to 2001. In: 4th World Congress on Tuberculosis, 2002. Washington, DC, June 3-5, 2002.
20. Santo AH, Pinheiro CE. Tendência das causas múltiplas de morte relacionadas á tuberculose, Estado de São Paulo, 1997 a 2002. Bol Pneumol Paul. 2003;17:42.
21. Braun MM, Coté TR, Rabkin CS. Trends in death with tuberculosis during the AIDS era. JAMA 1993;269(22):2865-8.
22. Santo AH, Pinheiro CE. Tabulador de causas múltiplas de morte. Rev Bras Epidemiol. 1999;2(1/2):90-7.
23. World Health Organization. International statistical classification of diseases and health related problems. 10th rev. Geneva: WHO; 1993. v.1.
24. Santo AH, Pinheiro CE. Uso do microcomputador na seleção da causa básica de morte. Bol Oficina Sanit Panam. 1995:119(4):319-27.
25. Santo AH, Pinheiro CE. Causas múltiplas de morte relacionadas à tuberculose, Brasil, 2000. Ciênc Saúde Coletiva. 2003;8(Supl 1):198.
26. Nogueira PA. Motivos e tempo de internação e o tipo de saída em hospitais de tuberculose no Estado de São Paulo, Brasil - 1981 a 1995. J Pneumol. 2001;27(3):123-9.
27. Albuqueruque MFM, Leitão CCS, Campelo ARL, Souza WV, Salustiano A. Fatores prognósticos para o desfecho de tratamento da tuberculose pulmonar em Recife, Pernambuco, Brasil. Rev Panam Salud Publica. 2001;9(6):368-74.
28. Washko RM, Frieden TR. Tuberculosis surveillance using death certificate data, New York City, 1992. Public Health Rep. 1996;111(3):251-5.
29. Heldal E, Naalsund A, Kongerud J, Tverdal A, Boe J. Deaths from active tuberculosis: can we rely on notification and mortality figures? Tuber Lung Dis. 1996;77(3):215-9.
30. Hooi LN, Goh KY. A hospital based audit of tuberculosis deaths. Med J Malaysia. 1995;50(4):306-13.
31. McKeown PJ. Tuberculosis mortality - deaths with, rather than from tuberculosis. Ir Med J. 1997;90(1):17.
32. Sociedade Brasileira de Pneumologia e Tisiologia. II Consenso Brasileiro de Tuberculose: diretrizes brasileiras para tuberculose 2004. J Bras Pneumol. 2004;30(Supl 1):S57-86.