

## Causes of Death In A Diabetic Population Of Costa Rica And The Quality Of Their Death Certificates

### Abstract

**Background and aim:** In Latin America, diabetes kills 45,000 people every year. It is likely that the actual figures are closer to 300,000 because of underreporting problems that exist in the cause of death. In Costa Rica, which has the lowest rate according to PAHO, this would increase by 56% if deaths from cardiovascular disease in people with diabetes were considered. This study aimed to recall the causes of death in a diabetic population of Costa Rica and the quality of their death certificates.

**Methods:** We analyzed the cause of death of 101 people that died of a cohort of 572 diabetics, using the diagnoses of death certificates issued by doctors and the final diagnoses recoded by the National Institute of Statistics and Census of Costa Rica (INEC). The quality of the death certificates were analyzed by comparing these two sources of basic death causes and the percentage of underdiagnosis of diabetes in pathologies associated with diabetes or cardiovascular disease.

**Results:** According to the INEC, causes of death were distributed: 24% for cardiovascular diseases, 23% for neoplasms and 24% for complications of diabetes. Diabetes was omitted in over 50% of the death certificates; it was not even mentioned as a secondary cause. The basic cause of death of the death certificates issued by doctors matched only in 66% with those of the INEC.

**Conclusion:** The omission of diabetes as a cause of death or as a secondary cause in the death certificates leads to an underestimation of its importance in the countries' vital statistics. Diabetes as a secondary cause is disregarded in vital statistics, contributing also to this underestimation. Analysis of secondary causes in vital statistics and better education of physicians to increase awareness of the importance of the inclusion of diabetes as a death cause in the death certificate would help to see better the impact of diabetes as a cause of death, especially associated with cardiovascular disease; this would visualize diabetes as a priority in public health in Costa Rica.

**Keywords:** Type 2 diabetes, death causes, death certificate

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**Abbreviations:**

BP, bronchopneumonia; ICD-10, international statistic classification of diseases and health-related conditions, 10<sup>th</sup> version; Dx, diagnosis; DM, type 2 diabetes mellitus; CVD, cardiovascular disease; CRI, chronic renal insufficiency; MI, myocardial infarction; INEC, Costa Rica's National Institute for Statistics and Censuses.

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Type 2 Diabetes Mellitus (DM) is nowadays considered a pandemic disease, affecting both developed and developing countries.<sup>1-4</sup> During recent years, DM has caused increasing distress because of its impact on the patient's and his or her family's quality of life, the costs it generates to the countries' health systems, and its indirect costs related to the loss of productivity as a result of disability and premature death.

DM mortality is 2 to 3 times higher than the general rate. It also represents one of the 5 most important causes of death in developed countries,<sup>5,6</sup> as well as in developing nations.<sup>7,8</sup> As a cause of death, DM holds

an important rate of underreporting within mortality statistics. This is because it is usually only registered as a secondary cause of death after cardiovascular disease (CVD), or one of its chronic complications such as chronic renal insufficiency (CRI). A recent analysis on mortality due to DM estimated that in the year 2000 7.5 million people died because of this disease throughout the world, but only for 2.9 million people DM was stated as the cause of death, and the remaining 4.6 million were assigned a different cause of death.<sup>9</sup> Also, the proportion of worldwide deaths attributed to DM that year was estimated to be 5.2%. These observations have allowed researchers to claim

that DM is probably the fifth most important cause of death worldwide.

In Latin America and the Caribbean, DM kills 45.000 people each year.<sup>10</sup> However, it is likely that the actual figures reach 300.000 deaths because of underreporting. Mortality rates in these countries vary between 7.8 and 89 deaths per 100.000 inhabitants. The reasons that explain the differences between countries are unclear. However, it has been shown that statistical records do not reflect the real situation with regard to DM-related mortality because of its exclusion from death certificates as the cause of death or its misclassification as a secondary cause. In Costa Rica, the country that has the lowest rate according to the PHO, DM-related mortality would be increased by 56% if the deaths by cardiovascular disease in DM patients were taken into account.<sup>10</sup> For this reason, similar to other countries in this region, the analysis of DM-related mortality would only identify about a third of the deaths that are actually associated with this disease.

According to data by Costa Rica's National Institute of Statistics and Censuses (INEC), DM-specific mortality rates in the country have increased constantly during the last decade (1995-2006), reaching a peak 19.3 deaths per 100.000 inhabitants in 2003. Patients over 60 years of age comprise 80.7% of the DM-related deaths, and most deceased patients are female (57.3%).<sup>10</sup> These numbers probably underestimate the real figures due to the aforementioned problems.

In view of the difficulties produced by the underreporting, we considered the fact of analyzing the mortality profile of the Costa Rican diabetic population by means of a cohort of DM patients which was characterized in Health Area 3, Desamparados, San José, in 2000,<sup>11,12</sup> to be a great opportunity. This project was approved by the Research Administration of the University of Costa Rica (project number 742-99-339) under the title "Prevalence, Incidence, and Natural History of type 2 DM in a Health Area of the Central Valley". The aim of this study was to analyze the 8 year-mortality (2000-2007) in this cohort in terms of its causes, underreporting on their death certificates, and to compare the causes of death on the death certificate to those of the vital statistics generated by the INEC.

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## Methods

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**Study population:** a cohort of all DM patients (n = 572) registered at 6 EBAS (Basic Teams for Integral Healthcare Services) within Health Area 3, Desamparados, province of San José, Costa Rica, was characterized during the year 2000. All subjects had been recruited for the project entitled "Prevalence, Incidence, and Natural History of type 2 DM in a Health Area of the Central Valley", which was approved by the Research Administration of the University of Costa Rica (project number 742-99-339). This cohort's characteristics have been described elsewhere.<sup>11,12</sup>

This was a prospective 8-year longitudinal study (2000-2007) and all subjects in the cohort were included for analysis.

**Data collection and coding:** all deaths recorded during the 8-year period on the National Deaths Registry –on line- at the Costa Rican Civil Registry (a dependency of the Supreme Electoral Tribunal) were included in the analysis. The main (a,b,c) and secondary causes of death as stated on the death certificate by the doctors and those of INEC were classified. For simplicity of comparison, some causes of death that share a common pathology were grouped within any of the 20 major groups defined by the International Classification of Diseases and Health-related Problems (ICD-10)<sup>13</sup>. Consequently, all kinds of cancer were grouped under the tumor category (C00-C97). Systemic septic syndromes (sepsis, septicemia, and septic shock) were grouped under chapter I of the ICD-10, infectious and parasitic diseases (A30-A49). Bronchopneumonia (BP) and pneumonia, which are prevalent and considered of great importance as causes of death, were codified under chapter X, respiratory disease (J10-J18).

**Definitions:** the following cause of death definitions were employed: direct or immediate cause (cause a): the disease, trauma or complications immediate to death and not the way of death as in heart failure, asphyxia, asthenia, etc. Basic or fundamental cause (causes b and c), background morbid conditions that, if present, would have produced the specific cause in a), being listed last.

Secondary cause, other significant pathologies that would have contributed to the death but are unrelated to the disease or morbid condition that directly caused it.

DM-associated secondary causes, pathologies derived from DM's chronic microvascular kidney complications (CRI),<sup>14</sup> and micro and macrovascular inferior limb complications with amputation or infections such as septic arthritis, cellulitis and/or osteomyelitis.<sup>15</sup> Urinary infections that derived in septicemia were also considered to be DM-related causes because of their high prevalence and their relationship with metabolic control in DM patients.<sup>16</sup>

**Analysis:** the following analyses of the data were included.

**Causes of death,** simple and percent frequencies for type a (direct or immediate), b and c (fundamental or basic), and secondary causes according to the original death certificate issued by INEC, and grouped in major categories or syndromes.

**Underreporting for DM,** percentage of deaths with a DM-associated cause for which DM is absent as a diagnosis from all the primary categories (a, b, c) on the certificate. Percentage of deaths with a DM-associated cause for which DM is absent as a diagnosis under categories a, b, c or as a secondary cause on the certificate. Percentage of deaths with a DM-associated cause, including cardiovascular events and for which DM is absent as a diagnosis under categories a, b, c or as a secondary cause on the certificate.

**Quality of the death certificates,** the percentage of DM underreporting on the death certificates issued by doctors was analyzed by the aforementioned criteria. A comparison between the causes of death stated on the doctor-issued death

**TABLE 1.** Relative frequency of the direct cause of death (cause (a) on the death certificate) and presence or absence of DM as a basic or secondary cause among 101 diabetic patients that died in Health Area 3, Desamparados, 2000-2007.

Direct cause (a)	No.(%)	Dx of DM as (b) or (c) cause	Dx of DM as a secondary cause
Sepsis /septic shock	16	4	6
Cancer	15	3	6
Cardiorespiratory arrest	12	4	1
Bronchopneumonía/pneumonia	8	3	1
Chronic Renal Insufficiency (CRI)	6	5	1
Acute myocardial infarction (MI)	5	2	
Diabetes	4		
Cardiogenic shock	4		3
Acute lung edema	3	1	
Multiorgan failure	3	1	
Cardiac arrhythmia	4		2
Ischemic cardiopathy	2	1	1
Cardiac insufficiency	1		
Stroke	1	1	
Sudden death	1	1	
Others	16	4	7
<b>Total</b>	<b>101</b>	<b>30</b>	<b>28</b>

certificates and those recorded by INEC was performed. INEC's adequately trained database curators re-codify the diagnoses on the original death certificates for the national vital statistics following parameters for mortality and morbidity coding and the selection of a basic cause of death and the re-identification of the main cause as stated by IDC.<sup>17</sup>

## Results:

**General analysis:** throughout the 8-year observation period of this cohort, a total of 101 patients died (60 female, 41 male), ages between 42 and 95 with a mean of  $71.5 \pm 12.4$  years. 32.7% died at home and 67.3% died in hospitals.

**Causes of death:** Table 1 shows the most frequent direct or immediate causes of death as well as the concomitant presence or absence of DM as a basic or secondary cause on the death certificate. Among the 101 deceased patients, 62% had a DM diagnosis in any of the categories (a, b, c, or secondary).

Table 2 shows the basic or fundamental causes of death according to the death certificate and those recorded on INEC's vital statistics.

Quality of the death certificate related to DM.

**Comparison of the basic causes of death between the death certificate and INEC's data:** there was a 66% and a 67.5% concordance between the basic causes of death stated on the certificate and those on INEC's database for deaths that occurred at home and deaths in hospitals, respectively. DM is stated as a basic cause of death in 24 cases, but only 14 cases bear this information on both the certificate and INEC's data.

Substantial changes between the diagnoses on the two data sources were prompted by the re-coding of diagnoses such as ischemic cardiopathy (n=4), arteriosclerotic disease (n=1), cardiac insufficiency (CI) (n=1), hypertension (HT) (n=1), DM (n=5), and other miscellaneous diagnoses such as upper digestive tract bleeding, to myocardial infarction (MI) because the latter was stated under categories a, b or as a secondary cause on the original certificate. Moreover, DM diagnosis as a basic cause on the original certificate of 12 cases was re-coded by INEC to diagnoses such as BP, chronic obstructive pulmonary disease (COPD), CI, MI, cancer, urinary infection and/or undefined. Chronic renal insufficiency (CRI) was re-coded on 3 occasions to DM by INEC when the latter was stated as a secondary cause on the medical certificate. As shown in Figure 1, various CI, HT, DM and MI diagnoses were

re-coded as cancer, which also appeared among the secondary causes.

33% of the certificates did not keep a logic sequence of events according to what is supposed to be the correct way of filling up the categories on these documents. Chronic diseases such as HT, DM and CI were found under any category without any logic, and associated to cancer, “prolonged bed-confinement”, pneumonia, multi-organ failure, many of which are not associated to DM (Table 1). A diagnosis of cardiorespiratory arrest was stated as a direct (a) or basic (c) cause in 12 and 1 cases, respectively.

**Underreporting of DM as a cause of death on the death certificates:** Among the 101 deaths, 43 patients (42.6%) died because of causes not directly related to DM. Among the remaining 58 patients, only 24 had DM as a basic cause, which meant an underreporting of 58.6%. If the cardiovascular diseases (MI, CI, stroke, etc.) are excluded as associated causes (n=23), the underreporting would be of 31.4%, corresponding to 11 patients: 5 CRI, 4 with compromised lower limbs (1 amputation, 2 septic arthritis, 1 cellulitis), and 2 urinary infections with septicemia.

**Underreporting of DM as a cause of death on INEC’s vital statistics:** among the 101 deaths, 44 (43.6%) patients died because of events not directly related to DM. Among the other 57 patients, DM was stated as a basic cause of death for 24 cases, generating an underreporting of 57.9%. Cardiovascular diseases were present in a total of 26 patients. If these are classified as DM-associated diseases, underreporting drops to 22.6%, and is now composed by 7 cases: 2 CRI, 3 with compromised lower limbs (1 amputation, 1 septic arthritis, 1 cellulitis), and 2 urinary tract infections with septicemia.

## Discussion

The Diabetes Initiative for the Americas Action Plan for Latin America and the Caribbean 2001-2006 showed that there are substantial differences on the mortality rates associate to this disease per country, spanning from very high rates such as that

of Trinidad and Tobago (89.0 per 100.000) to the lowest, found in Costa Rica (7.9 per 100.000).<sup>10</sup> One of the proposed reasons for this phenomenon is the extent of DM underreporting in national vital statistics. One of the causes of this underreporting, which has been identified by many studies,<sup>18-21</sup> is the quality of the information that is noted on the death certificates. DM is often ignored or included as a secondary cause of death on the certificates, and this is due to poor filling by the clinicians. This observation was confirmed by the present study, in which a great proportion of the certificates lacked a logic sequence of events from the immediate to the basic cause. For instance, 3 patients with cancer as an immediate cause of death on their original certificate had DM as a basic cause (category b or c), and were re-coded to cancer by INEC’s data curators. An even more illustrative case of poor filling of the certificates is one for which DM was stated as a basic cause while the secondary cause was reported to be metastatic ovarian cancer (Figure 1), which is obviously the cause of death as correctly recorded by INEC. Moreover, the use of unspecific terms for causes of death was also frequent; in 12% of the certificates “*cardio respiratory arrest*” was recorded as the direct (i.e. immediate) cause (Table 1) even in certificates that were issued in a Hospital. This “diagnosis” is considered to be a “poorly defined” cause of death in vital statistics. Even though DM was included as a diagnosis on the certificate under any category for 62% of the patients in this cohort, the poor filling of these documents because of the lack of a logic sequence of events leading to the death, or it being included as a secondary cause of death (28%), the number of cases for which this disease was stated as the fundamental cause of death, either on the death certificate or INEC’s data, was reduced to 24, meaning an underreporting of more than 50%. If cardiovascular diseases are not considered to be related to DM and are excluded, the underreporting is still high (approximately 25%). In 5 cases, the fact that DM was included as a secondary cause of death allowed INEC to re-encode the entries, demonstrating the importance of the inclusion of this category on the death certificates.

Another problem related to the recording of the basic cause of death that prompts the loss of DM mortality data is the re-coding of DM to MI by the statistics institutes of each country, a problem that affected 5 cases of the present study’s cohort that were re-coded by INEC to CVD-related mortality (MI or CI).

Figure 1

The image shows a handwritten death certificate form. The form is divided into several sections:

- I PARTE CAUSA DIRECTA O INMEDIATA:** (a) I DM SEOT. Devido a, o como consecuencia de (b)
- CAUSAS ANTECEDENTES:** (b) Cardiopatía miocárdica fase de infarto. Devido a, o como consecuencia de (c)
- II PARTE:** (c) DM tipo 2, HTA-C, TAC. Cáncer de ovario metastásico.
- III PARTE:** SI LA MUERTE SE DEBIO A FACTORES EXTERNOS SE DEBE ESTABLECER SI FUE SUICIDIO  HOMICIDIO  ACCIDENTE
- Other fields:** Date: 13/56, Hospital: 220, and a circled number 56.



**TABLE 2.** Relative frequency of the basic or fundamental cause of death as stated under cause (c) on the death certificate and INEC's data among 101 deceased diabetic patients of Health Area 3, Desamparados, 2000-2007.

Basic or fundamental cause	Cause (c) on death certificate %	INEC's data %
Cancer	19	23
Diabetes	24*	24
Ischemic cardiopathy	10	6
Chronic Renal Insufficiency	5**	2
Broncopneumonia/Pneumonia	5	5
Acute myocardial infarction	3	12
COPD	3	3
Cardiac insufficiency	4	2
Chronic hepatopathy / Cirrhosis	3	4
Prolonged bed confinement	2	
Stroke	3	3
Sepsis / SepticShock	5	5
HT	4*	1
Cardiorespiratory arrest	1	
Car accident	1	1
Atherosclerotic disease	3	
Lower limb amputation	1	1
Others	9	9
<b>Totals</b>	101	101

\* Agreement on DM Dx between the original death certificate and INEC's data was found only in 14 cases.

\*\* Three CRI were re-codified to DM by INEC, as it was stated among secondary causes.

This bias of MI over DM as a cause of death has been a common feature of database curators worldwide, and it is unlikely that this is going to change in the short term. Many official data curators also commonly promote pneumonia and BP over DM as causes of death. So long as the secondary causes of death continue to be excluded from vital statistics, DM's role is likely to remain underestimated and CVD will remain the most important cause of death for the majority of the countries worldwide.

In our country, DM is associated with 5% of the deaths every year. Even though the causes of death among diabetic and non-diabetic population are the same, their relative frequency varies significantly. In our study, according to INEC's data, 3/4 of the causes of death were evenly distributed among CVD (24%), neoplasm (23%) and DM complications (24%). Respiratory diseases (8%) and sepsis (5%) came fourth and fifth among the most common causes. When these results are compared with data from other countries,<sup>22-27</sup> a similar pattern is seen, although CVD predominate, frequently accounting for more than 30% of the deaths, followed by DM complications, respiratory diseases and neoplasm (the frequency of the latter being 5 to 17% and

much lower than that found in the present study). All these data could be analyzed in a future study with a larger group of DM patients taking age and sex into account.

We conclude that when the data from death certificates which only include a basic cause of death is analyzed, DM mortality is being underestimated by 2 or 3 times, both in our study and in the literature.<sup>21,22,28,29</sup> This problem could be addressed by analyzing DM mortality including entries under all categories on the death certificate as has been proposed in various studies<sup>23-24</sup> and is being currently applied in Mexico.<sup>30</sup> This practice would allow the development of multiple-cause mortality studies in order to better understand the associations between DM and CVD and to fully characterize the morbidity profile of this disease at the time of death. Also, in view of the importance of DM for public health, it would be useful to develop better estimations of the mortality load excess that can be attributed to this disease and to develop better healthcare planning.

Finally, there is no doubt that the quality of the death certificate is still poor; there is a lack of proficiency in correctly

completing this important official document among medics, mainly because of this practice not being given enough time and attention in the curricula of medical courses. However, no one doubts the importance of the correct completion of the certificate, as this study's results showed. In view of these problems, it would be advisable that INEC, the universities that teach Medicine, and other entities such as the College of Medics promote a continuous education program on the correct completion of the death certificate, as is currently being done in Mexico.<sup>31</sup> A better education of medics in order to raise awareness about the importance of the inclusion of DM on the death certificate would contribute to promote interest in it and to make this disease a priority for public health action.

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