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Inpatient Mortality in People With Type 2 Diabetes: A Cross-sectional Study

ABSTRACT

Objective: This study aimed to estimate inpatient mortality rate for diabetes and identify its associated factors.

Materials and methods: This is a cross-sectional study. The population was comprised between January 1 and December 31, 2019 in 32 public hospitals in Portugal, using summary hospital discharge data. We used both the Disease-Related Diagnosis Groups and the Disease Staging. Patients were grouped into survivors and non-survivors, and inpatient mortality was compared using competing event regression.

Results: A total of 7980 patients were admitted with type 2 diabetes mellitus, there were 747 (10.3%) non-survivors. The advanced age (OR = 1.772; 95% CI 1.625–1.932), the stage (3) severity of type 2 diabetes mellitus (OR = 4.301; 95% CI 2.564–7.215), comorbid lung, bronchial or mediastinal malignant neoplasm (OR = 5.118; 95% CI 2.222–11.788), comorbid bacterial pneumonia (OR = 3.214; 95% CI 2.539–4.070), other respiratory system disorders (OR = 2.187; 95% CI 1.645–2.909), comorbid rhino-, adeno- and coronavirus infections (OR = 1.680; 95% CI 1.135–2.488) were determinants for inpatient mortality.

Conclusions: Elderly patients with diabetes with micro- and macrovascular complications of the disease, who have bacterial pneumonia and who enter the emergency department are those who have a lower survival rate. (Clin Diabetol 2022; 11; 5: 340–345)

Keywords: type 2 diabetes, mortality, inpatient, comorbidities

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Introduction

Worldwide, in 2021, diabetes was responsible for 6.7 million of deaths, 1 every 5 seconds [1]. In Europe, 1 in 11 adults (about 61 million) live with diabetes and it is expected to reach 67 million in 2030 and 69 million in 2045 [1].

In 2018, in-hospital mortality in Portuguese public hospitals of the National Health Service (NHS) represented 37.3% of all deaths that occurred in mainland Portugal [2]. The population with diabetes represented, in 2018, 26.6% of in-hospital mortality in the NHS (corresponding to 10.701 people; in 2016 and 2017 this figure was, respectively, 12.478 and 12.718) [2]. However, there was a decrease in the absolute number of deaths registered in hospitalizations in which diabetes mellitus was the main diagnosis (about 39% in the last decade) and, on the other hand, the increase in the number of deaths in hospitalizations with diabetes mellitus as an associated diagnosis (about 46% in the last 10 years) [3]. The main causes of admission of patients with diabetes to NHS hospitals are diseases of the circulatory system, diseases of the endocrine glands (which includes diabetes), respiratory tract diseases, digestive tract diseases and neoplasms [3, 4]. Similarly, in Spain, the main cause of hospitalization is cardiovascular disease [4, 5].

In previous studies [6–13] it has been reported that patients with diabetes having a history of hyper-

glycemic hyperosmolar state, hypoglycemia events, comorbidities such as hypertension, lipid abnormalities, cardiovascular disease, cardio-renal complications, and cancer, active smoking and diabetes not diagnosed in a timely manner have increased rates of diabetes-related complications, length stay and mortality.

Given the high number of hospitalizations for diabetes, the use of hospital care to treat the disease, and the high costs associated with such care, it is important to identify the associated factors that may lead to an increased risk of a diabetes-related hospital death. This study will be of interest to healthcare organizations and providers including physicians, nurses and other healthcare professionals, public health personnel, policy makers who may be interested in decreasing the burden of diabetes mortality in hospitals.

The aim of this study was to estimate the inpatient mortality rate in patients with diabetes and its associated factors during hospitalization.

Materials and methods

For this analysis, we included a total of 7980 patients with type 2 diabetes (T2D) aged 18 years and older, admitted to 32 Portuguese public hospitals between January 1 and December 31, 2019, using administrative data from the National Hospital Morbidity Database provided by the Central Administration of the Health System. All patients had T2D as a principal diagnosis and were classified according to the Related Diagnosis Group (DX codes 250.00) and ICD9-CM codes during hospitalization. Comorbidities were identified using the Disease Stage [5]. The comorbidities included in the study were defined according to the number of in- and out-of-hospital deaths as representing a significant burden on people with diabetes. Exclusion criteria for patient selection were type 1 diabetes mellitus and gestational diabetes. Independent variables included were: sex, age, days of hospitalization, the severity of principal disease T2D (stage 1 — disease onset without evidence of organ damage; stage 2 and 3 — more advanced severity levels with evidence of organ damage and micro- and macrovascular complications, respectively) [5], the comorbidities [5] (stomach cancer, essential hypertension, obesity, coronary artery disease without prior coronary revascularization, cerebrovascular disease, congestive heart failure, bacterial pneumonia, renal failure, other respiratory system disorders, rhino-, adeno-, and coronavirus infections, colorectal cancer, lung, bronchial or mediastinal cancer, and lipid abnormalities), type of admission (elective — admission to perform medical and/or invasive procedures; emergency — admission for decompensation of micro- or macrovascular diabetic lesions) and treatment type (surgical — surgical and some invasive procedures; medical — other diagnostic and therapeutic medical procedures).

Statistical analysis

Continuous data are displayed as mean ± standard deviation (SD) or median, and characteristics of population were compared between survivors and non-survivors using the Student *t* test. Categorical data are shown as percent and were compared by the chi-squared test. All variables were tested for normal distribution of the data by the Kolmogorov-Smirnov test. Regression Cox was used to calculate the association between each independent variable (associated factors) and the dependent variable (mortality) based on the forward conditional method. An adjusted odds ratio with 95% confidence interval (CI) that did not include 1.0 was considered significant. The significance level of the P value was set at 0.05. Analyses were performed using *Statistical Package for Social Sciences* (SPSS©) for Windows® version 23.

Results

a) Characteristics of the population

Table 1 shows the characteristics of the patients.

The study population included a total of 7980 patients with T2D aged 18 years or older. The most frequent age group was under 75 years (n = 4264; 53.4%). The median of the number of days of hospitalization was 8 days, with an average of 12.1 ± 17.7 days and a maximum of 548 days.

The mortality rate was 9.4%.

Patients with the highest mortality rate were those with stage 3 of T2D severity (13.9%, $p < 0.001$), who underwent medical-type treatment (10.4%, $p < 0.001$), who had the comorbidities such as bacterial pneumonia (30.2%, $p < 0.001$) and the lung, bronchial or mediastinal cancer (27.3%, $p < 0.001$) and were admitted urgently (10.9%, $p < 0.001$).

b) Associated factors for inpatient mortality

Table 2 shows the result of the Cox regression considering mortality as the dependent variable. Figure 1 shows the ROC curve for the determinants of inpatient mortality.

The Cox regression showed that the following variables were significant determinants of mortality: age (OR = 1.772; 95% CI 1.625–1.932); the emergent admission type (OR = 3.316; 95% CI 2.242–4.904); the stage (3) of the T2D severity (OR = 4.301; 95% CI = 2.564–7.215); comorbid bacterial pneumonia (OR = 3.214; 95% CI 2.539–4.070); comorbid lung, bronchial or mediastinal cancer (OR = 5.118; 95% CI 2.222–11.788); comorbid coronary artery disease without prior coronary revascularization (OR = 1.261;

Table 1. Baseline Characteristics of Participants Admitted to Hospital with Type 2 Diabetes

Characteristic	All patients (n = 7980)	Survivors (n = 7233)	Non-survivors (n = 747)	Mortality rate (%)	P value*
Male, n (%)	4076 (51.1)	3718 (51.4)	358 (47.9)	8.8	0.70
Female, n (%)	3904 (48.9)	3515 (48.6)	389 (52.1)	10.0	
Age [years]	71.09 ± 13.40	70.22 ± 13.42	79.49 ± 9.77		< 0.001
Past medical diagnosis, n (%)					
Stomach cancer	33 (0.4)	27 (81.8)	6 (18.2)	18.2	0.081
Essential hypertension	1516 (19.0)	1335 (88.1)	181 (11.9)	11.9	< 0.001
Obesity	1263 (15.8)	1189 (94.1)	74 (5.9)	5.9	< 0.001
Coronary artery disease without prior coronary revascularization	921 (11.5)	807 (87.6)	114 (12.4)	12.4	0.001
Cerebrovascular disease	821 (10.3)	713 (86.8)	108 (13.2)	13.2	< 0.001
Congestive heart failure	455 (5.7)	387 (85.1)	68 (14.9)	14.9	< 0.001
Bacterial pneumonia	444 (5.6)	310 (69.8)	134 (30.2)	30.2	< 0.001
Renal failure	409 (5.1)	358 (87.5)	51 (12.5)	12.5	0.027
Other respiratory system disorders	375 (4.7)	301 (80.3)	74 (19.7)	19.7	< 0.001
Rhino-, adeno-, and coronavirus infections	202 (2.5)	167 (82.7)	35 (17.3)	17.3	< 0.001
Colorectal cancer	176 (2.2)	149 (84.7)	27 (15.3)	15.3	0.006
Lung, bronchial or mediastinal cancer	33 (0.4)	24 (72.7)	9 (27.3)	27.3	< 0.001
Lipid abnormalities	2210 (27.7)	2048 (92.7)	162 (7.3)	7.3	< 0.001
Type of treatment, n (%)					
Surgical	1916 (24.0)	1800 (93.9)	116 (6.1)	6.1	< 0.001
Medical	6064 (76.0)	5433 (89.6)	631 (10.4)	10.4	< 0.001
Admission type, n (%)					
Elective	1318 (17.2)	1288 (97.7)	30 (2.3)	2.3	< 0.001
Emergency department	6605 (82.8)	5888 (89.1)	717 (10.9)	10.9	< 0.001
T2D severity, n (%)					
Stage 1	476 (6.0)	460 (96.6)	16 (3.4)	3.4	< 0.001
Stage 2	3047 (38.2)	2937 (96.4)	110 (3.6)	3.6	< 0.001
Stage 3	4457 (55.9)	3836 (86.1)	621 (13.9)	13.9	< 0.001

Mortality rate (%) = Total number of non-survivors/ sum of survivors and non-survivors *100
*Survivors vs. non-survivors

95% CI 1.003–1.584); other comorbid respiratory system disorders (OR = 2.187; 95% CI 1.645–2.909); and comorbid rhino-, adeno-, and coronavirus infections (OR = 1.680; 95% CI 1.135–2.488).

The p-value found for the model was $p < 0.001$.

Discussion

In this study, the inpatient mortality rate in hospitalized patients with diabetes was 9.4%, in contrast to that reported in other studies (range 4.4–7.4%) [13–16]. Some studies [12, 13] explain these results by elevated hemoglobin A1c on admission (elective or emergency department) and severe hypoglycemic episodes. We think that our results may be caused by a high number of severely ill patients admitted to the emergency room.

In our study, the mortality rate was higher in patients with stage 3 T2D, which can be explained by (i) hyperglycemia increasing mortality in severely ill individuals regardless of disease severity [13, 17–19] and (ii) hypoglycemia in patients receiving insulin therapy [13, 18, 20]. In our opinion, special attention should be paid to glycemic control to help avoid complications of uncontrolled hyperglycemia and hypoglycemia in these patients.

Our study also shows that the mortality rate in patients with diabetes was higher in those who received medical-type treatment than in those who underwent surgery (10.4% vs. 6.1%). These results were in agreement with previous studies [13, 21, 22]. The reason why the mortality rate is lower in surgery

Table 2. Determinants of Inpatient Mortality from Cox Regression

Independent variables	OR	95% CI
Age [years]	1.772	1.625–1.932
Admission type		
Elective (Ref.)	1	
Emergency department	3.316	2.242–4.904
T2D severity		
Stage 1 (Ref.)	1	
Stage 3	4.301	2.564–7.215
Bacterial pneumonia		
Without (Ref.)	1	
With	3.214	2.539–4.070
Lung, bronchial or mediastinal cancer		
Without (Ref.)	1	
With	5.118	2.222–11.788
Coronary artery disease without prior coronary revascularization		
Without (Ref.)	1	
With	1.261	1.003–1.584
Other respiratory system disorders		
Without (Ref.)	1	
With	2.187	1.645–2.909
Rhino-, adeno-, and coronavirus infections		
Without (Ref.)	1	
With	1.680	1.135–2.488
Constant	0.003	

Variables used in the adjustment model: sex, age, days of hospitalization, severity of principal disease T2D, comorbidities (stomach cancer, essential hypertension, obesity, coronary artery disease without prior coronary revascularization, cerebrovascular disease, congestive heart failure, bacterial pneumonia, renal failure, other respiratory system disorders, rhino-, adeno- and coronavirus infections, colorectal cancer, lung, bronchial or mediastinal cancer, and lipid abnormalities), type of admission (elective and emergency department) and treatment type (surgical and medical)
CI — confidence interval; OR — odds ratio; Ref. — reference group

than in medical treatment seems to be associated with (i) specific preoperative diets that lead to improved blood glucose immediately before surgery, (iii) control of hypoglycemic events and (ii) glycemic optimization in the preoperative, intraoperative and postoperative periods [21–23]. In our understanding, our study warns that we should adopt safe protocols in managing glycemic control before, during and after procedures.

Several authors [24] have shown that patients with diabetes aged < 64 years, and especially those aged ≤ 40 years or without other comorbidities, had a higher risk of bacterial pneumonia (community-acquired pneumonia and invasive pneumococcal disease). As for diabetes-associated pneumonia, the risk of hospitalization was also higher in those without other comorbidities, and in those with longer duration of diabetes and/ /or poor glycemic control (based on A1C levels) [25, 26]. In our study, logistic regression analysis shows that bacterial pneumonia was a determinant of our patients' deaths that occurred in the emergency room, which may be justified by the effects of hyperglycemia on immune and/or lung function [26]. In our opinion, patients with diabetes who go to the emergency room have poor control of their glycemic levels, which leads to unfavorable outcomes, in this particular case death.

In most cases, the physician initiates empirical antibiotic therapy based on epidemiological data until the etiologic pathogen is identified, so after identification the spectrum of antibiotics may be narrowed, leading to non-resolution or slow resolution of pulmonary infiltrates, and ending in death of the patient. Therefore, before starting therapy, the physician must rule out other causes of lung infiltrates, fever, and microbiological tests (for example, primary or metastatic lung carcinomas, other respiratory system disorders affecting the lungs, or congestive heart failure) [27, 28]. Our study shows that the presents of comorbidities such as lung, bronchial or mediastinal cancer, coronary artery disease without prior coronary revascularization, other respiratory system disorders, and rhino-, adeno- and coronavirus infections contributed to the death of our patients. In our opinion, this warrants deep reflec-

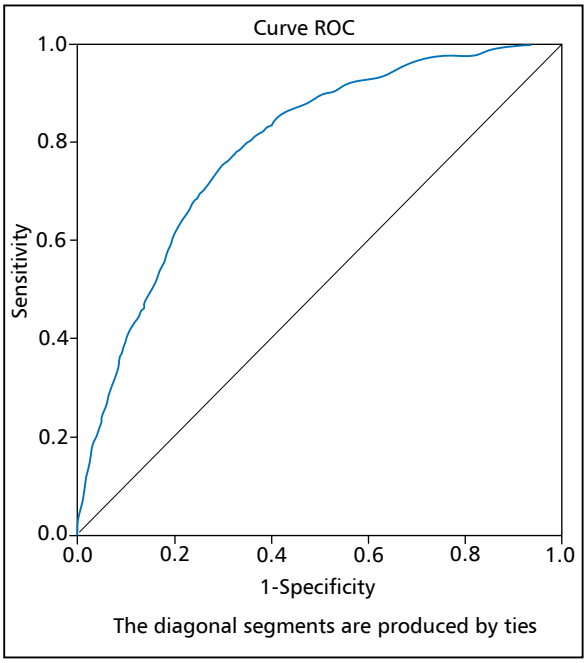

Figure 1. ROC Curve for the Determinants of Inpatient Mortality

tion by the physicians treating these patients in the emergency room in search of the best recommended practice.

Our study has some limitations. First, we used the ICD-9-CM codes as a study tool, we did not know the main reason why the patient sought emergency care or had scheduled admission: whether it was diabetes decompensation (micro- or macrovascular), or a hypoglycemic episode. Also, it did not allow us to have the patients' laboratory data, namely glycated hemoglobin, duration of diabetes, and anthropometric data. However, in the emergency department it is not usual to collect anthropometric data, and sometimes not even during hospitalization. This information can only be included in the patient's clinical record. Second, it was not possible to determine when death occurred, whether during the first 30 days of hospitalization or after a readmission episode. However, our study revealed no association with days of hospitalization. In addition, we do not know how many of the patients suffering from malignant tumors received chemotherapy based on administrative data. For future work it is suggested to restrict this study to only one large hospital and to collect all biological and analytical parameters for a better characterization of patients with diabetes.

Conclusions

The data found in our study allowed us to identify the profile of T2D inpatients admitted to Portuguese public hospitals via emergency and scheduled admission. Our study concluded that elderly patients with diabetes who had micro- and macrovascular lesions, bacterial pneumonia, and who entered the hospital emergency department had a lower survival rate. The use of the Disease Staging and ICD9-CM codes allowed us to identify and understand which comorbidities increase the risk of inpatient mortality and the type of admission of these patients. Patient safety and surveillance programs should be implemented in emergency hospital visits.

Conflict of interest

None declared.

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