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Health Risk Adjustment: Urinary Tract Infection Rates in Diabetic Women In-Hospital

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1. Abstract

1.1 Aims: Urinary tract infection is one of the most frequent nosocomial events in diabetic women during hospitalization in Portugal. This study aimed to estimate the rates of urinary tract infections in diabetic women in-hospital and to identify the potential risk factors for these infections.

1.2. Materials and Methods: A case-control study in 331 female patients with type 2 diabetes mellitus who were discharged with confirmed urinary tract infection and 1070 controls without urinary tract infection was carried out between August 1st to December 31st ,2018 to study the risk for nosocomial infections. We used medical data from the National Hospital Morbidity Database provided by the Central Administration of the Health System.

1.3. Results: Of the 1401 women, there were 331 (23.6%) cases of nosocomial urinary tract infection events. After risk adjustment model, the stage (3) of the severity of type 2 diabetes mellitus (OR=1.296; 95% IC =0.582-2.886), the medical treatment (OR=7.215; 95% IC=4.505-11.554) and the stage (3) of the co-morbidity cerebrovascular disease (OR=2.018; 95% IC=1.192-3.417) were found to be the risk factors for urinary tract infection events in the five hospitals considered.

1.4. Conclusion: The co-morbidity cerebrovascular disease and stage 3 of severity of type 2 diabetes mellitus were risk factors for nosocomial urinary tract infection event. Doctors and nurses should pay more attention and set practical and effective guidelines for the prevention of UTI in-hospital, particularly in medical treatment.

2. Introduction

In this study we show that nosocomial UTI events was significantly higher in those who received medical treatment than those who received surgical treatment. Furthermore, cerebrovascular disease and stage 3 of severity of T2DM were risk factor for nosocomial UTI events in diabetic women [1].

In Portugal, one of the most frequent adverse events in women during hospitalization is urinary tract infections (UTI)1, and occur more frequently in diabetic patients 1,2. Several authors3 have shown that patients with type 2 Diabetes mellitus (T2DM) are more likely to have UTI and repeat UTI than patients without diabetes. Among the infections frequently in patients with diabetes4,5,6 such as asymptomatic bacteriuria (ASB)5, acute cystitis6, complicated lower UTI (including catheter-associated UTI)7, uncomplicated pyelonephritis and complicated pyelonephritis/urosepsis6, the ASB is three times higher than in normal people4 because of urine glucose excretion and chronic neurologic bladder dysfunction8,9. High glucose concentration with [2] glycated hemoglobin (HbA1c) level > 7% in the urine can allow urinary colonization by microorganisms8. T2DM is a chronic, metabolic disease characterized by elevated levels of blood glucose due to defect in insulin secretion, insulin action, or both10 and is expected to increase to 642 million by 20401. In worldwide, from 1980 to 2014, trends in age-standardized adult diabetes prevalence increased from 5.0% to 7.9% in women1. By 2015, in Portugal, the prevalence in women was 7.7%1.

In previous studies11,12,13 it was reported that, [3-6] advanced age and the presence of co-morbidities such as stroke, heart fail-

ure, myocardial infarction, obesity, arterial hypertension, lipid abnormalities, chronic kidney disease and kidney transplant increase the occurrence of UTI in diabetics.

The objective of this study is to find the potential risk factors responsible for UTIs in-hospital in women with T2DM.

3. Materials and Methods

A total of 1401 women with T2DM with 18 years old, who were hospitalized in 32 Portuguese public hospitals between August 1 to December 31, 2018, were included in this case-control study using the administrative data of National Hospital Morbidity Database (NHMD) provided by the Central Administration of the Health System. All of the patients were diagnosed with T2DM as principal diagnosis and classified according to Diagnosis Related Group (codes DX 250.00) during hospitalization. The co-morbidities and its stages, and the UTI events were identified through the methodology of Disease Staging1. The exclusion criteria for patient selection were hospitals with a minimum number of 100 cases (i.e. hospitals providing oncology services and mental health), type 1 diabetes and gestational diabetes [7].

Variables included were:

- Age; Days of hospitalization;
- The severity of principal disease1,13:
- stage 1 - corresponds to the initial phase of the disease without evidence of organ injury;
- stage 2 and stage 3 - corresponds to more advanced sever ity levels of the disease with evidence of organ injury, micro and macrovascular, respectively;
- The comorbidities and stage levels:
- Neoplasm, Malignant: Stomach (GIS30), Essential Hypertension (CVS13), Obesity (NUT02), Coronary Artery Disease without Prior Coronary Revascularization (CVS11), [8-10] Cerebrovascular Disease (NEU04), Congestive Heart Failure (CVS09), Pneumonia: Bacterial (RES15), Renal Failure (GUS08), Other Disorders of Respiratory System (RES83), Rhino, Adeno, and Corona Virus Infections (RES24), Neoplasm, Malignant: Colon and Rectum (GIS27), Neoplasm, Malignant: Lungs, Bronchi, or Mediastinum (RES13) and Lipid Abnormalities (NUT82). For all comorbidities we consider 3 stages1,13:
- Stage 1 - Known diagnosis, without local or systemic complications;
- Stage 2 - Disease limited to an organ or system; Increased risk of adverse outcomes;
- Stage 3 - Generalized involvement of the system, with systemic complications, with even higher risk of adverse outcomes.
- Treatment type: Surgical and Medical;
- Hospitals.

The parameters of UTIs were:

- Code 59010 - Acute Pyelonephritis Not specified; code 5950 – Acute cystitis; code 5953 – Trinities; code 5959 – Cystitis Not specified; Code 5990 – Urinary tract infection Not specified [11, 14].

4. Statistical Analysis

Analyses were performed using Statistical Package for Social Sciences (SPSS©) for Windows® version 22. All variables were tested for normal distribution of the data. Data are presented as means ± standard error or percentages. Bivariate analysis was performed to answer to the 1st objective using the following formula:

- UTI Infection Rate = Total number of patients with UTI/ Sum of controls patient and with UTI* 100.

The OR values are presented with the respective confidence intervals at 95% (95% CI) or P-Values.

Multivariate logistic regression and the risk adjustment model was performed to respond to the 2nd objective to estimate the strength of the association [12, 13] between each independent variable (potential risk factors) and the dependent variable (nosocomial UTIs) based on the forward conditional method and was used the Hosmer and Lemeshow (H-L) test. An adjusted odds ratio with 95% CI that did not include 1.0 was considered significant. The significance level of the P value was set at 0.05. For the validation of the model, its discriminatory, sensitivity and specificity were analyzed using the ROC curve graph, in particular the value of the area below the curve (c).

5. Results

A) Characteristics of the UTIs patients

The (Table 1) describes the characteristics of the patients:

The study population had a total of 1401 women with T2DM. The age group more frequent was over 75 years old, with 716 (51.1%). The median of the number of days of hospitalization [15] was 10 days, with an average of 15 ± 19 days and a maximum of 581 days.

The nosocomial UTI events had a total of 23.6%.

B) UTIs Rate

The (Table 2) describes the values of UTIs rate by gender, age (stratified), severity of principal disease, co-morbidities, treatment type, and also the ORs and P-values [16].

The UTIs rate ranged from 16.1% in the age of 18-64 years, and 31.7% in the level over 85 years (OR=2.42; p<0.0001). The stage 2 of the severity of T2DM rate was 8.7% (OR=0.25; p=0.0004) compared to 30.0% at stage 1. And, the UTIs rate in the medical treatment was 32.2% (OR=7.13; p<0.0001) compared to 6.3% in the surgical treatment.

C) Risk Factors for UTIs

The (Table 3) describes the result of the logistic regression analysis considering the dependent variable UTIs.

Table 1: Baseline characteristics of participants in the case–control study of risk factors for nosocomial urinary tract infection

Baseline characteristics	**Cases N (%)**	**Controls N (%)**	**Total N (%)**
Sex			
Female	331 (23.6)	1070 (76.4)	1401 (100.0)
Age (years)			
18-64	55 (16.1)	287 (83.9)	342 (24.2)
65-74	62 (18.1)	281 (81.9)	343 (24.3)
75-84	136 (28.9)	334 (71.1)	470 (33.5)
Above 85	78 (31.7)	168 (68.3)	246 (17.6)
Mean (SD)		72.7 (12.7)	
Median		75.0	

SD = standard deviation

Table 2: Nosocomial UTI event rates by sex, age, severity of T2DM, comorbidities, and treatment type

Variables		Number of cases/ controls	Rate (%)	OR	P-value
Age (years)	18-64 (ref.)	55/287	16.1		
	65-74	62/281	18.1	1.15	0.48
	75-84	136/334	28.9	2.12	<0.0001
	Above 85	78/168	31.7	2.42	<0.0001
Severity of T2DM	Stage 1 (ref.)	29-Nov	30		
	Stage 2	45/470	8.7	0.25	0.0004
	Stage 3	275/571	32.5	1.27	0.51
Comorbidities	GIS30 (ref.)	4-Jan	20		
	CVS13	90/207	30.3	1.74	0.62
	NUT02	74/239	23.6	1.24	0.85
	CVS11	38/151	20.1	1.01	0.96
	NEU04	56/100	35.9	2.24	0.48
	CVS09	29/76	27.6	1.53	0.71
	RES15	26/56	31.7	1.86	0.59
	GUS08	30/67	30.9	1.79	0.61
	RES83	28/56	33.3	2	0.54
	RES24	24-Sep	27.3	1.5	0.73
	GIS27	9-Apr	30.8	1.78	0.65
	RES13	3-Jan	25	1.33	0.86
	NUT82	84/311	21.3	1.08	0.95
Treatment type	Surgical (ref.)	29/435	6.3	7.13	<0.0001
	Medical	302/635	32.2		

Table 3: Risk factors for nosocomial UTI from the multivariate analysis

Risk factors	Adjusted OR	95% CI
Age	1.022	1.009-1.035
Duration of hospitalization (days)	1.02	1.011-1.028
Severity of T2DM		
Stage 1 (Ref.)	1	
Stage 3	1.296	0.582-2.886
Treatment type		
Surgical (Ref.)	1	
Medical	7.215	4.505-11.554
Hospital		
1 (Ref.)	1	
2	2.161	1.089-4.286
5	2.351	1.162-4.758
8	2.643	1.217-5.738
28	11.214	3.700-33.990
32	8.972	2.844-28.301
Stages NEU04		
Without (Ref.)	1	
Stage 3	2.018	1.192-3.417
Constant	0.006	

Multivariate regression analysis showed that the following variables [17] were significant predictors for the UTIs: age from 18 years old (OR=1.022; 95% CI =1.009-1.035); the number of days of hospitalization (OR=1.020; 95% IC =1.011-1.028); the stage (3) of the severity of T2DM (OR=1.296; 95% IC =0.582-2.886); the medical treatment (OR=7.215; 95% IC=4.505-11.554); the hospitals [2, 5, 8], 28 and 32 of which, the hospital that presented the lowest OR value of 2.161 was the hospital 2 and the highest value was the hospital 28 with OR of 11.214; and, the stage (3) of the co-morbidity cerebrovascular disease (OR=2.018; 95% IC=1.192-3.417) [18].

The P-value found for the model was $p < 0.001$. The H-L test revealed a P-value of 0.228, and the area under curve was 0.802 (Figure 1).

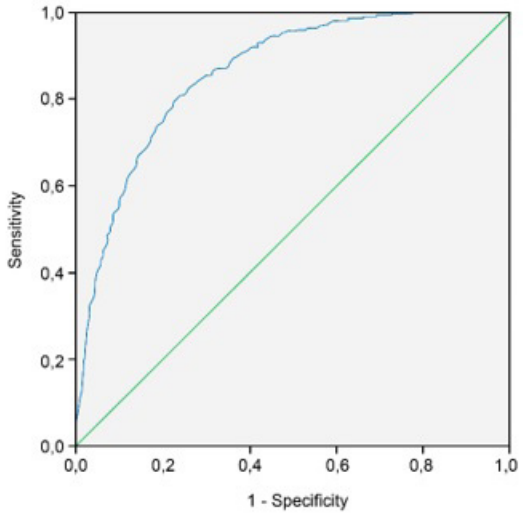

Figure 1: ROC curve for predicting the nosocomial urinary tract infection in diabetic women

6. Discussion

In this study, the prevalence of nosocomial UTI events in diabetic women in-hospital was 23.6%, which was similar to that reported in other studies (range 11.6%–63.9%)14,15,16. The discrepancy in UTIs rate values might be because we only included female diabetic patients in our study, while the previous studies included both male and female diabetic patients [19]. In our study, nosocomial UTI events in diabetic women was 28.9% (OR=2.12) from 75 years old, which was related to the medical procedures (OR=7.13). Beside the old age, the duration of hospitalization, the stage 3 of severity T2DM, the medical treatment and the stage 3 of the co-morbidity cerebrovascular disease were also risk factors of UTIs in women diabetic. These results were in accordance with previous studies [5, 7, 17, 18, 19].

The reason why diabetic women tend to get UTIs after medical treatment seems to be associated with the (i) contamination and inappropriate use of devices such as urinary catheters [20], intravenous infusion devices and hemodialysis and (ii) procedures in patients with poor control of blood glucose [18, 20, 21]. In our understanding this discrepancy in UTIs rate values might be due to different therapeutic attitudes, such as the preventative antibiotics administered to patients when undergoing surgical procedures, and because there is no maximal asepsis when handling catheters.

Although the relationship between severity of T2DM stage 3 (OR=1.296) and risk of UTIs seems to be associated with longer duration of diabetes [9, 22], so the results found in our study may be justified by a non-effective blood glucose control. On the other hand, we found a higher UTI rate in patients with stage 2 diabetes than that of those with stage 1 diabetes (8.7% vs 30.0% respectively; OR = 0.25), which was no similar to that reported in other studies [22,23]. We think that results might be justified by previously undiagnosed diabetes.

The logistic regression analysis shows the influence of some hospitals on the risk of nosocomial UTI events, it might be due to implementation of unsafe treatments [24], the non-adoption of good practices [24], which allows each geographic area to develop different clinical practices. In our opinion, this justifies a reflection in the search for the best recommended practice and how to implement it in the treatment of patients, day-to-day.

This study confirms that the stage (3) of co-morbidity cerebrovascular is associated with a higher risk of nosocomial UTI events. Similar results were obtained by Smith et al.25 who justify with: (i) urinary dysfunction and (ii) the increased post void residual. Thus, the results found in our study may be justified by the adoption of ineffective prophylactic procedures, particularly in medical treatment. It is justified the use of more effective clinical safety protocols directed to nursing staff [24, 25].

Our study has some limitations, the first is related to the lack of information of the blood glucose levels during hospitalization and which may be responsible for a less favorable outcome. The main limitation attributed to the analysis of UTIs through the administrative data (ICD9-CM) is that it is not possible, per se, to understand where is the error process and if what originated the COC would be preventable or not.

7. Conclusions

The results found in our study allowed us to identify the profile of women diabetic for the most frequent nosocomial event in Portuguese hospitalization, the UTI. In hospital, health professionals should adopt preventive therapies to reduce rate infections, especially in medical treatment and control blood glucose levels. Local and individual protocols (per patient) should be adopted to improve the effectiveness of treatments. Other studies should be done particularly on UTI microorganisms in diabetic women patients.

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