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The Assessment of Direct Cost incurred to Type 2 Diabetes *mellitus* Management in the Portuguese Hospital

Cristina Carrondo

Pulmonology Service, Hospital Central of Saint John of Oporto (RT pulmonology); Center for Research and Studies in Public Health, National School of Public Health (PhD student), Lisbon, Portugal

Abstract Type 2 Diabetes *mellitus* is the most common type of diabetes and a serious global health problem with economic impact in Portuguese National Health Service system. The aim of this study was to characterize diabetic patient profile and assess the direct costs management during hospitalization. The study involved 1321 type 2 diabetic patients coded as principal diagnosis, of three Central Hospitals, of National Health System, admitted of January 1st to December 31st of 2011. Coded discharge summaries from each hospital were consulted including procedures, clinical analyses and medication. The age of the patients was between 51 and 80 years of age. There was no significant difference regarding sex. In total EUR spent in the three institutions, the Hospital Center of Saint John of Oporto contributed more with 2214302.15, seconded by the Hospital Center of North of Lisbon 373831.45 and, the University of Coimbra Hospital Center with 346979.59. The medical specialties have shown more costs were the Ophthalmology, the Endocrinology and Medicine. There was association of costs with each institutes and specialties. The concentration of care in some of the medical specialties may reduce costs.

Keywords Type 2 Diabetes *mellitus*, Costs, Direct costs, Inpatient

1. Introduction

Type 2 Diabetes *mellitus* (T2DM) is the most common type of diabetes and a serious global health problem with economic impact in National System of Health because of their complications [1, 2].

In United States of America, diabetes caused at least USD 548 billion dollars in health expenditure in 2013, 11% of total health spending to treat and manage complications, was estimated average of USD 1,437 per person. The countries of Europe spent USD 147 billion, in 2013 [3]. Following the same line of calculation in the year 2035/2036, indirect costs of diabetes in the United Kingdom, will be above 22 billion dollars, representing an increase of 17% of total NHS expenditure [4]. In Portugal, according to the annual report of the National Diabetes Observatory (NDO), the direct costs of diabetes accounted for in 2010, between 1150 and 1350 million euros, an increase of 100 million compared to the previous year. Considering the average cost of people with diabetes, and according to the data presented by the International Diabetes Federation in 2010, the disease in Portugal represented a cost of 1850 million euros. This corresponds to 1% of the National Gross Domestic Product (GDP) and 11% of health expenditure in the year 2010 [5]. This value may be underestimated due to the number of people with diabetes have not yet diagnosed (60), it is estimated that in Portugal are about 5.6% undiagnosed people [6].

Additionally, 58% of total costs are attributed to diabetes which derives from the extra increase in hospital admissions for acute and chronic complications [2, 7], especially, when in the presence of hypoglycemia [8], advanced age, duration of diabetes, medication [9], by increasing the number of days of hospitalization [10], at plus cost in treating diabetes in subsequent years [11, 12], suggesting that resources should concentrate on restriction of complications of diabetes. The chronic complications of diabetes may increase the hospital costs up to 450% [7, 12]. The cost of treating diabetes is influenced by characteristics of the diabetic and the way health care is organized [13].The vast majority of direct costs have been linked to complications of diabetes, more than treatment of the disease itself [13, 14]. At the level of hospital admissions for complications of diabetes, the NDO highlights an increase of 35% in recent years, hospitalized diabetic patients, as principal diagnostic, with ophthalmic manifestations, lower-limb amputations, stroke, and acute myocardial infarction (AMI) [15].

In the United Kingdom, in 2010/2011, 1 160 000 of diabetics over the age of 70 years spent about $ 336 million hours in healthcare [4].

The clearance of hospitalization costs is essential to managing healthcare organizations [16]. Allows to quantify a long-term profile of costs of the disease and its

* Corresponding author:
cristina.carrondo@gmail.com (Cristina Carrondo)
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complications [17] enabling the creation of financing systems. The most common sources of cost data are those based on diagnostic related groups (DRG) [17]. This study set out to describe the profile of the diabetic patient, analyze the direct costs per patient and their determinants in hospitalization.

2. Methods

The study was observational, descriptive and transversal type, involving 1321 diabetic patients type 2 admitted as principal diagnosis, of January 1st to December 31st of 2011. The collection of information was made in 3 central hospitals in different regions of the country, Hospital Center of Saint John of Oporto EPE, University of Coimbra Hospital Center EPE and Hospital Center of North of Lisbon EPE, of the Portuguese National Health System (NHS). Having been consulted and released by Auditors/encoders the descriptive base imported from the base DRG hospital information systems, called DREAM and SAM. The principal diagnostic code registry of Diabetes *mellitus* (DM) type II non-specified type/ DM (ICD-9-CM:250.x0 or 250.x2) and the procedures were based on classification of diagnoses and procedures of International Classification of Diseases 9th Revision, ICD 9 of the WHO. Therefore, the variables selected were discharges summaries of each episode of encoded admission: age, gender, principal diagnosis, inpatient service, procedures and clinical analysis of each episode; the last two were converted according to the Ordinance 110-A/2007, 132/2009 and 839-A/2009 (price list published in the *Diárioda República Portuguesa*) that covered the period of the data. The prescribed medication during the episode of hospitalization was also requested, in particular, the quantity and the price, provided by the hospital pharmacy. To better investigate the distribution of costs in each sector was decided to divide into three categories: procedures costs (included therapeutic, diagnostic or prophylactic acts); laboratory/clinical analysis costs; and pharmacological costs (medication prescribed during hospitalization). To obtain the cost per unit was multiplied the amount consumed by unit price. Data was entered and analyzed using the statistical program *Statistical Package for Social Sciences* (SPSS©) for Windows® version 18 and univariate and bivariate analysis were applied to establish relationships between two distinct variables. The analysis of qualitative variables was conducted mainly through counts and frequencies. Correlation test using Pearson's R with CI of 95% was carried out to measure relationship between variables. Also Chi-Square Tests with CI of 95% was carried out to verify the existence of dependency relationships between variables.

3. Ethical Considerations

The study was approved by the ethics committee of three hospitals; namely Hospital Center of Saint John of Oporto EPE, Hospital Center of North of Lisbon EPE, and University of Coimbra Hospital Center EPE. The confidentiality and privacy of data collected were guaranteed in accordance with the Helsinki Declaration, in the recently revised version of the World Medical Association.

4. Results

Of 1321 attendants 6.31% were encoded as principal diagnosis of type II DM/DM-type specified, where the Hospital Center of Saint John of Oporto was more diabetics men 51.9% than women 48.1%, at Hospital Center of North of Lisbon it was more diabetics women55.2% than men44.8%, while it was 50,9% and 49,1% for men and women, respectively, at the University of Coimbra Hospital Center **Figure-1.**

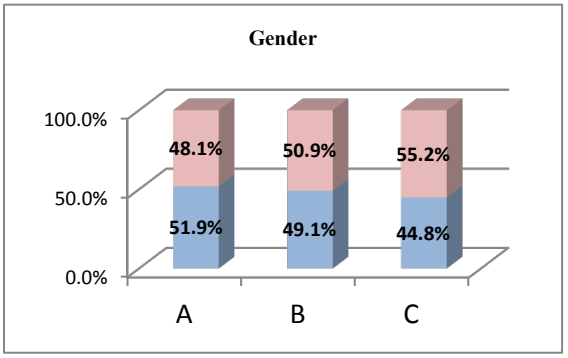


Figure 1. Distribution by sex

Analyzing the age stratification by ranges was observed that the age of diabetic patients, in the 3 institutions, varied more expressive between 51 and 80 years or more, with a higher frequency between 61 and 80 years of age **Table -1**.

Table 1. Distribution by age

Age (years)	A	B	C
Until 40	3,2%	3,4%	3,7%
41 - 50	6,3%	6,6%	6,7%
51 - 60	19,2%	18,5%	14,3%
61 - 70	30,2%	24,0%	21,9%
71 - 80	29,1%	29,0%	31,3%
81 or more	11,9%	18,5%	22,2%
Total	100%	100%	100%

The sample by types of encoding of DM and its incidence was observed that most frequent encoding at the University of Coimbra Hospital Center and Hospital Center of North of Lisbon was Diabetes *mellitus* without complication, type II or unspecified, uncontrolled (47.0% and represents 38.9%, respectively), with higher incidence in women. However, at Hospital Center of Saint John of Oporto, the encoding type more frequent was DM with ophthalmic manifestations, type II or unspecified, unspecified as uncontrolled which represents 31.5% of diabetic patients, with higher incidence in men.

Examining the average length of inpatient days by institution, diabetic patients were more admitted at Hospital

Center of Saint John of Oporto which represents an average of inpatient days equal to 11.45, seconded by University of Coimbra Hospital Center with 8.77 and, finally, the Hospital Center of North of Lisbon with a mean equal to 7.12. However, when we look at the number of days of admission of patients according to the encoding type of DM, at Hospital Center of North of Lisbon diabetic patients with neurological manifestations, type II or unspecified, unspecified as uncontrolled (about 31 days), at the University of Coimbra Hospital Center diabetic patients with hyperosmolarity, type II or unspecified, not specified as uncontrolled (about 38 days of hospitalization), and at Hospital Center of North of Lisbon, diabetic patients with peripheral circulatory changes type II or unspecified, (about 20 days of hospitalization).

When we analyze the distribution of diabetic by different inpatient services (top3 of each institution), it turns out that, the service that concentrates the highest number of diabetic patients was Endocrinology service at the University of Coimbra Hospital Center (66.5% of diabetics). At Hospital Center of Saint John of Oporto the service with the largest number of diabetic patients was Ophthalmology with 32.8%. At Hospital Center of North of Lisbon, the services present percentages of diabetic patients very close; however, the service that stands out was the Medicine with 9.4%. Viewing the distribution of diabetic patients by the respective services and number of days of admission, were created 6 groups of diabetic patients: the first group concerns the admission lasting between 1 to 3 days, the second group between 4 to 7 days, the third group between 8 to 15 days, the fourth between 16 and 21 days, the fifth group between 22 and 31 days and the sixth group of more than 31 days. At Hospital Center of Saint John of Oporto, the percentage of diabetic patients admitted between 8 to 15 days focuses on Medicine A and B services. At the University of Coimbra Hospital Center the percentage of diabetic patients admitted between 8 to 15 days also was high (20.6%), but the percentage of diabetic patients admitted between 4 to 7 days is superior (33.8%). The number of diabetic patients admitted between 4 to 7 days was superior to the other, in the services; Hospital Center of Saint John of Oporto, Ophthalmology specialty; University of Coimbra Hospital Center, Endocrinology and Medicine specialty; and at Hospital Center of North of Lisbon, Medicine E (Rheumatology, Endocrinology, Medicine) specialty.

4.1. Procedures, Clinical Analyses and Pharmacy Prices

In total EUR spent for procedures in the three institutions and for this the Hospital Center of Saint John of Oporto contributed more 2,214,302.15, seconded by Hospital Center of North of Lisbon373,831.45 and then by University of Coimbra Hospital Center 346,979 .59. For the medical specialties the total EUR spent for this at Hospital Center of Saint John of Oporto, Ophthalmology service contributed more 859,249.58, seconded by General Surgery 49 309,205 and Vascular Surgery with 241,960.15; at the University of Coimbra Hospital Center the service which contributed more was General Surgery 145,862.63, seconded by Ophthalmology 66,194.98 and Endocrinology 44,555.60; at Hospital Center of North of Lisbon the medical specialty which contributed more was Surgery II65,438.00, seconded by Medicine service (Rheumatology, Endocrinology and Medicine) 12 57,806, and Surgery 5047,048. Though, not always the medical specialty with more spending is the one that most consumes, regardless of the costs that are associated with. In each institution, the specialties that consumed more procedures were: Hospital Center of Saint John of Oporto, Ophthalmology specialty with 38.9%; seconded by Medicine A specialty with 13.2%, and Medicine B specialty with 12.2%; at the University of Coimbra Hospital Center was the specialty of Endocrinology with 53.8%;seconded by Medicine A specialty; and General Surgery specialty with 11.6%; and, at Hospital Center of North of Lisbon was the Medicine E specialty (Rheumatology, Endocrinology, Medicine) with 13.4%; seconded by Medicine I specialty with 7.1%; Endocrinology specialty with 6.3% and Medicine I specialty with 6.3%, too.

The total EUR spent for specialties at Hospital Center of Saint John of Oporto was Ophthalmic, with higher incidence of diabetic patients (13.4%) with 2,001 to 4,000. At the University of Coimbra Hospital Center, was Endocrinology which spent between 1 to 200. At Hospital Center of North of Lisbon was Medicine I between 1 and 200 (7.9%) **Table-2.**

Table 2. Distribution of consumption per patient according to the admission service (for the Top3)

		0 eur	1 - 200 eur	201 - 2000 eur	2001 - 4000 eur	4001 - 6500 eur	6501 - 9000 eur
	24400		0,8%		13,4%	6,9%	9,3%
A	**21010**		6,5%		0,9%	0,9%	1,1%
	21020		8,2%		1,3%	1,9%	0,2%
	21500	21,1%	42,0%		1,6%		
B	**21010**	3,2%	11,9%		0,0%		
	24400	0,0%	0,0%		5,0%		
	2030		4,9%	0,2%	3,9%		0,2%
C	**2012**		7,9%	0,5%	0,2%		
	2014	0,2%	7,4%		0,2%		

Table 3. Distribution of total expenditure per patient in three institutions

EXPENDITURE IN EUROS				
Category				
	A	**B**	**C**	**Total**
Adm. Cost	2.214.302.15	346.979.59	373.831.45	2.935.113.19
Adm. Days				
1 - 3	392.374.34	57.598.61	149.158.74	599.131.69
4 - 7	884.170.84	151.977.06	117.756.90	1.153.904.80
8 - 15	607.383.08	97.848.24	62.429.85	767.661.17
>16	330.373.88	37.473.79	33.270.99	401.118.66
Clinical Analyses	195.329.80	39.639.05	-	234.968.85
Medication	452.251.74	-	10.463.274.26	10.915.526.0
Total	**5.076.185.83**	**731.516.34**	**11.199.722.19**	17.007.424.36

Legend: Adm. Cost (Administration Costs); Adm. Days (Administration Days).

Table 4. Correlation cost per patient and specialty service

Chi-Square Tests

A	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	647,683[a]	144	,000
Likelihood Ratio	601,952	144	,000
Linear-by-Linear Association	97,884	1	,000
N of Valid Cases	536		
B	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	643,402[a]	66	,000
Likelihood Ratio	337,990	66	,000
Linear-by-Linear Association	80,751	1	,000
N of Valid Cases	379		
C	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	647,155[a]	162	,000
Likelihood Ratio	397,680	162	,000
Linear-by-Linear Association	,022	1	,881
N of Valid Cases	406		

At Hospital Center of Saint John of Oporto and University of Coimbra Hospital Center, the total EUR spent for procedures per patient had concentrated in 4 to 7 days; meanwhile, at Hospital Center of North of Lisbon, the cost had concentrated between 1 to 3 days. When we look at to consumption of clinical analyses, the Hospital Center of Saint John of Oporto spent more 195.329,80 than University of Coimbra Hospital Center 39.639,05. There are no reference values for Hospital Center of North of Lisbon. The total consumption of pharmacy, the Hospital Center of North of Lisbon contributed more with 10.463.274,26 than Hospital Center of Saint John of Oporto 452.251,74. There are no reference values for University of Coimbra Hospital Center **Table-3**.

When we look at if there is correlation between the variables "total number of length stays" and the "price per patient procedure", we note that Hospital Center of Saint John of Oporto and Hospital Center of North of Lisbon, correlation exist. When increases the average number of days of admission increases the cost of the patient. At Hospital Center of Saint John of Oporto, the value of significance was equal to 0.000 (sig. (2-tailed = 0.000)), presents a correlation value equal to 0.307. At Hospital Center of North of Lisbon, the relationship between the variables takes a value of significance equal to 0.000 (sig. (2-tailed = 0.176), with the value of the positive correlation (0.274). In contrast, at the University of Coimbra Hospital Center, the value found was equal to 0.625 (sig. (2-tailed) = 0.625) greater than 0.05, the correlation value (0.25), and there was no correlation between the variables.

When we look at if there is correlation between the variables "cost per patient" and the "specialty where the patient was treated", for each institution, correlation exist. The value of sig was equal to 0.00 (less than 0.05) **Table-4.**

5. Discussion

The results of this study clearly indicated that *Diabetesmellitus* represents a significant cost increment in hospital institutions, whose research is of great importance because of the increasing prevalence [18]. Some studies observed that diabetic patients represent 4-6% of total hospital admissions [10, 19, 20]. This feature corresponds to the number of admissions found in the present study, with 6.31% of total admissions (as principal diagnosis).Another, the study conducted by Sampson et al. [21] in a period of 4 years noted 10.8% of total admissions due to diabetes with complications.

In line with some authors, age, unlike the gender, proved to be an indicator of high cost, with incidence in individuals of age group more advanced [8, 10, 11, 12, 22], which is consistent with the present study, but it is not to Bo et al. [9], refer to higher incidence in younger diabetic patients under the age of 65 years.

It also noted differences in the three institutions in the coding of diabetes mellitus, with higher incidence of DM without complication, type II or unspecified, uncontrolled in two institutions, and the other to highlight a significant number of DM for ophthalmological manifestations, these

findings go in the opposite direction to other works, where the main causes of admission for diabetes complications, are the ketoacidosis, hyperosmolality and diabetes coma [23], suggesting more research. In the same line of orientation, this study verified yet, significant differences regarding the incidence of complications of diabetes, at the three hospitals, determining an increase on the average number of days of admission, not corroborating with the research available for some complications of diabetes [14, 22, 24], as is the case of peripheral circulatory changes (10.5 days), neurological manifestations (7.7 days), and renal manifestations (7.6%), that represent inpatient averages lower than was observed in this study.

Different costs of DRG [24, 25] are responsible for different admissions. Another explanation could be the difference of the treatments and diabetic patient characteristics [23]. Ray et al. [26] have shown that in the presence of co morbidities and chronic complications of diabetes health care costs are enormous, with repercussions on hospital admissions [12]. Diabetic patients are admitted into various specialty services, this is defined according to the clinical manifestations that the diabetic patient presents at the time of admission. There are clearly differences in the three institutions on this matter, with one of the institutions accommodate the largest proportion of diabetic patients in the ophthalmic service, and the other two, in the service of Endocrinology and Medicine (the latter encompasses the Rheumatology, Endocrinology and Medicine). This finding is not consistent with most hospitals, in the United Kingdom, where the specialty more prone to admission of diabetic patients is General Medicine about 76.2% of patients [13]. This fact emphasizes the number of specialty services that exists in each institution, and how each diabetic patient is treated, particularly in the absence of a standardization of care. On the other hand, demonstrates repercussions at the level of the average annual hospital cost, with abysmal differences in one of the three institutions, however, in this study didn't try to investigate this issue. There is no evidence that the diabetic patient management in institutions with less annual spending is worse than the institution with greater expense and vice versa. The hospital financing is carried out through the DRG, which determines the allocation and the care of the treatment of diabetic patients in the different services (with varying degrees of severity). Ballesta, et al. [27] conducted a study involving 517 diabetic patients with T2DM from Endocrinology service, where he presented an annual cost per patient of EUR 4278 (a total of EUR 2,211.726). Another study mentioned in the literature showed that, the cost per patient for the treatment of complications of DM, including complications macrovascular complications, microvascular complications and complications of the foot was EUR 2380 [28]. Similar to these results, Ringborg et al. [29] observed an average annual cost of care in the public hospital of EUR 2053.14 in Sweden. Henriksson and Jonsson [30] estimated the direct cost of diabetic patient T2DM admitted, as principal diagnosis, about 245.1 million euros.

The present study suggested that hospitals manage their diabetic patients in different ways. The difference is not in the number of diabetic patients treated and admitted but in medical specialties with invasive interventions. It seems clear that, the proportion of each specialty service activity results in an incremental positive effect of costs, noting an increase in the early days of admission, with a decrease in the remaining days. Finally, as regards the costs of pharmaceuticals, an article published by Liatis et al. [31] after examining the medical prescription of 938 diabetic patients admitted, estimated the average annual cost of antidiabetic per patient of EUR 398.8, excluding other ministrations, disallowing the comparison with the present study, which encompassed the entire prescription administered during hospitalization; the works refer exclusively to oral antidiabetics, insulin, blood glucose strips.

The present study presents some limitations. The study was based on administrative and clinical records of each inpatient episode from each institution's information system. It has not been possible to include the characteristics of the diabetic patients, or some activities provided to the patient, as the measurement of blood pressure, internal consultation requests. But these limitations do not have damaged the objective of the study. It is assumed that health professionals have filled correctly diagnoses and reported all the procedures.

6. Conclusions

In conclusion, the analysis of the variation in costs between the hospitals revealed that the DRG where the diabetic patient is allocated is the most powerful indicator of costs. The cost may be lower if the care of diabetes focus on some of the medical specialties [32]. Because of the volume of procedures of some specialties, would be plausible the existence of a single shopping center at national level in order to reduce prices.

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