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A retrospective study from southern Turkey



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Hospitalization costs associated with diabetic foot ulcers treated by a multidisciplinary team in clinical practice: a retrospective study from southern Turkey

PURPOSE: *Diabetic foot ulceration (DFU) is a common problem throughout the world and results in major economic consequences for the patients and country. We aim to describe the estimated cost of illness in patients with DFU in southern Turkey.*

METHODS: *A total of 148 (F=55, M=93) patients with DFU were included in this retrospective study. Patients characteristics, duration time of hospitalisations, biochemical parameters and the presence of diabetic retinopathy, nephropathy, neuropathy, coronary artery disease and peripheral artery disease were recorded from our database. The cost of each patient was recorded from financial affairs and the billing department unit of our hospital.*

RESULTS: *The average unit cost of each patient was £ 730.90±664.9. The major component in the total cost were medication (£ 258.8±360.9) and hospitalisation fees (£ 76.58±56.3). One hundred and fifteen (77.7%) of the patients had peripheral arterial diseases. While we could not determine significant correlations between the patients' demographical features (age, gender, $p>0.05$), biochemical parameters (plasma glucose, hemoglobin A1c % (HbA1c %)) and year of diagnoses with diabetes mellitus, the length of hospitalisation, presence of peripheral artery diseases and whether amputation (minor or major) was performed were significantly correlated with the total expenses.*

CONCLUSION: *The study revealed that the cost of DFU could show variability in relation to countries' level of development. We highlighted similar studies in other countries; the major factors of total expenses were length of hospitalisation, medication prescription and use of surgery.*

KEY WORDS: Costs, Diabetic foot, Multidisciplinary team

Introduction

Diabetes mellitus is a chronic disease with a high prevalence worldwide, and it is related to serious complications. Moreover, diabetes mellitus and its complications cause a significant portion of health expenditures¹. Diabetic foot diseases typically present as ulcer, acute infection and Charcot foot related with diabetic

neuropathy or peripheral arterial disease². It has been reported that the risk of developing diabetic foot ulceration during diagnosis can be up to 12-25%. The global prevalence (6.3%) of diabetic foot ulceration (DFU) can vary between countries. While North America has the highest prevalence of the disease (13%), Asia, Europe and Africa have prevalence rates of 5.1%, 5% and 7.1%, respectively³. The cost of amputation due to DFU is in the range of £ 25 000-36 000 depends on the country's different healthcare management.

We know that the cost of DFU could show variability related to the amputation type⁴. The average cost of single minor amputations is reported as £ 10 578, while that of multiple minor amputations is £ 25 214 and that of major amputations £ 59 376⁵.

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In Turkey, it was reported that there were 1,000,000 total diabetic foot infections ⁶. According to data from 2012, the global health expense for diabetes mellitus and complications was £ 1.280 billion; the expenses incurred specifically by diabetic foot infection amounted to £ 60.7 million ⁷.

DFU has always been one of the most disabling conditions, representing a high economic burden on the healthcare system. Thus, we aim to identify the annual cost of DFU in our clinic; moreover, we hope to prevent these costly complications of diabetes mellitus by highlighting the significant expenditure for diabetic foot diseases.

Methods

In this study, data from 148 DFUs patients treated in 2017–2018 were included retrospectively at the Endocrinology Clinic of Cukurova Medical Faculty Balcali Training and Research Hospital. Patient characteristics, duration time of hospitalisations, biochemical parameters and the presence of diabetic retinopathy, nephropathy, neuropathy, coronary artery disease and peripheral artery disease were recorded from our database. Foot ulcer admissions were classified based on the Wagner classification. This classification is one of the most accepted grading systems for DFU, consisting of six simplistic wound grades used to assess ulcer depth (grades 0-5) ⁸.

We also grouped DFUs as minor and major amputations based on the amputation type. A minor amputation was described as an amputation at the level of the metatarsal phalanx or below. Major amputations were described as an amputation above the level of the metatarsal phalanx (above-knee amputations, below-knee amputations and Chopart amputations). Data on the costs of DFU were obtained from financial affairs and the billing department unit of our hospital. The average cost of treatment was calculated based on the cost of services, drugs and technical equipment. The sum of the cost included the cost of medical examination, consultations, biochemical and radiological examination, wound debridement, surgical operations and hospitalisation fees. The cost for each patient was calculated in Turkish liras (TL) and converted to British pounds (£) at a rate of 1 £ = 6.95 TL (2019).

STATISTICAL ANALYSIS

Categorical variables were expressed as numbers and percentages, whereas continuous variables were summarised as the mean and standard deviation or the median and minimum-maximum where appropriate. The normality of distribution for continuous variables was confirmed with the Shapiro-Wilk test. For comparison of conti-

nuous variables between two groups, the Student's *t*-test was used. For comparison of more than two groups, one-way analysis of variance (ANOVA) or the Kruskal–Wallis test was employed, depending on whether the statistical hypotheses were fulfilled. To evaluate the correlations between measurements, the Pearson correlation coefficient was used. All the analyses were performed using the IBM SPSS Statistics Version 20.0 statistical software package (SPSS reference: IBM Corp. Released 2011. IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp). The statistical level of significance for all tests was considered to be 0.05.

Results

A total of 148 patients were enrolled in our study, the mean age was 63.1 ± 10.5 years (range 22–87), the mean diabetes mellitus duration was 15.75 ± 8.2 years (range 1–40), the mean duration of hospitalisation was 16 ± 11

Table I - Summary of the patients' demographic and biochemical data

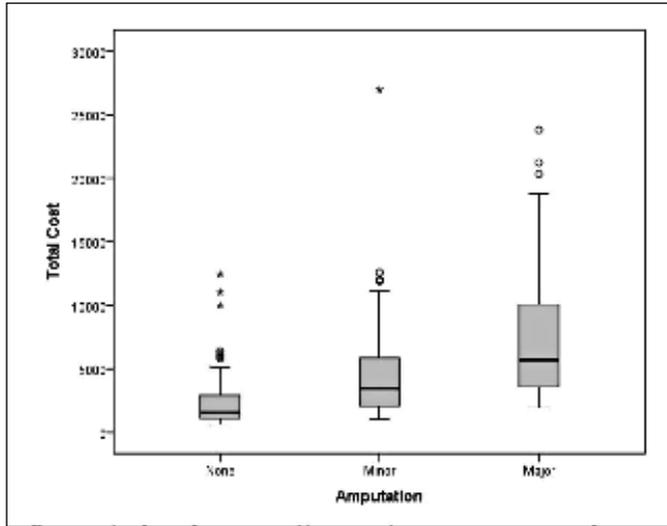
Patients (n = 148)	Correlation with average unit cost of DFU* (£)(<i>p</i> -value)
Sex: F/M	55/93
Age(mean,years)	63.18±10.5 0.801
Duration of diabetes mellitus (mean, years)	15.75±8.22 0.610
Length of hospitalisation (mean, days)	16.76±11.14 0.00
Serum level of HbA1c (mean, mg/dl)	9.01±2.13 0.425
Ulcer with periphericartery disease	115/148 0.00
Ulcer with nephropathy	89/148 0.378
Ulcer with retinopathy	121/148 0.279
Wagner classification	Grade 2: 21/148 0.017
	Grade 3: 37/148
	Grade 4: 63/148
	Grade 5: 27/148

*Diabetic foot ulceration

Table II - Analysis of the average cost components.

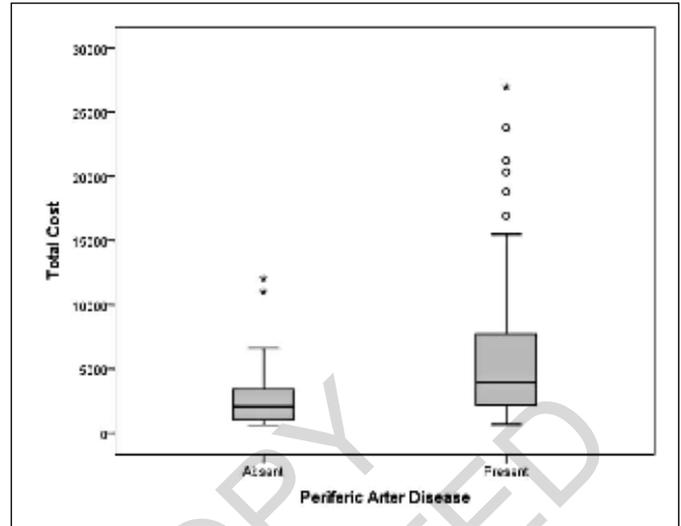
Treatment components	Mean cost per-patient £ (n: 148)
Outpatient visit	2.15±0,47
Cost of consultation	4.64±3,44
Cost of hospitalization	76.58±56,3
Cost of operation	46.22±51,8
Cost of imaging test	48.27±32,3
Cost of laboratory test	68.09±45,5
Drug cost	258.80±360,9
Other costs *	122.36±101,6
Cost of medical supplies	103.71±250,7
Total cost	730.90±664,9

*Vacuum-assisted closure (VAC) therapy and deep tissue debridement.



Open circles shows outliers and stars extreme values

Fig. 1: Correlation of the average total cost and amputation level.



Open circles shows outliers and stars extreme values

Fig. 2: Correlation of the average total cost and preferic arter disease.

days (range 3-57) and the mean HbA1c % level was $9.01 \pm 2.13\%$ (range 6-16). In addition, 115 patients (77.7%) had peripheral arterial diseases, 121 patients (60.1%) had diabetic retinopathy and 89 patients (60.1%) had diabetic nephropathy. The majority ($n = 63$; 42.6%) were classified as having Wagner class 4 (Table I).

Of the 148 patients who were hospitalised, the mean per-patient unit cost, including all medical, biochemical and radiological examinations, consultations, wound debridement, surgical operations and hospitalisations, was $\pounds 730.90 \pm 664.90$, while the mean drug cost per patient was $\pounds 258.80 \pm 360.90$. Patient expenses are shown in Table II.

As shown in Table I, there were no significant correlations between DFU patients' mean unit costs and their demographic characteristics (age, gender; $p = 0.8$), HbA1c percentage levels ($p = 0.42$) or diabetes mellitus duration ($p = 0.6$). However, both minor ($n = 81$) and major ($n = 57$) amputations were significantly correlated with higher per-patient total costs ($p = 0.00$; Fig. 1), as was the length of hospitalisation ($p = 0.00$) and peripheral arterial disease ($p = 0.00$; Fig. 2). However, there was no significant correlation between per-patient costs and retinopathy or nephropathy.

Discussion

In the present study, 148 patients with DFUs were admitted over a period of 2 years (2017–2018). We found that patients' age, gender, HbA1c levels and diabetes mellitus duration were not significantly correlated with total costs; however, peripheral arterial disease, the

need for either a major or minor amputation and hospitalisation length were all significantly correlated with higher costs.

Several studies of DFU patient costs have been conducted in Turkey, although they have included limited numbers of patients⁹⁻¹¹. Oksuz et al.¹⁰ reported mean per-patient annual DFU costs of $\pounds 14,287.70$, with hospitalisation costs accounting for roughly half of that ($\pounds 7,357$). As our data also demonstrated, higher Wagner scores were also significantly associated with higher costs. Globally, the costs associated with DFU patients vary widely between countries and are partly related to national sociocultural and economic development factors¹². For instance, one study in Niger found a median per-patient cost of $\pounds 1,381.50$, with hospitalisation duration, duration of diabetic ulcers, frequency of hospital admission and presence of comorbidities all significantly correlated with higher costs¹³, while two studies in India put the mean per-patient cost at just $\pounds 343$, with hospitalisation being the biggest contributing factor to increased costs^{14,15}. However, more developed countries typically have much higher per-patient costs associated with DFUs¹⁶⁻¹⁸, particularly in the United States and the United Kingdom^{19,20}. For instance, one large study in the United States found that patients with DFUs cost $\$9,397$ per admission²¹, while a study in the United Kingdom reported mean per-DFU-patient costs of $\pounds 7,800$, rising to $\pounds 16,900$ per amputated limb²². Similarly, a European study found that the mean per-DFU-patient cost was $\pounds 7,147-18,790$ depending on whether the ulcer healed within 12 months²³.

Our study also demonstrate having amputation (minor or major), presence of diabetic arterial diseases and length of the hospitalization were major component for high

cost of the DFU. The period of hospitalization is prolonged due to hyperglycemia long term infections, debridement, newly developed complications, increased using of medical drug, technical equipment etc. so the cost of treatment increase²⁴⁻²⁶.

In conclusion the cost of treatment for patients with DFU was £ 730.90±664.9 per patients. This average cost was below however cost that reported by previous studies in developed countries (USA, UK) but this cost was higher than the cost of patients in developing countries. This cost from our study could be attributed to inflation otherwise all these variations in the total cost depends on the center where was performed and type of used equipments.

There is need to reduce human and economic burden of diabetic foot ulcer disease to individuals affected and their families by primary prevention of diabetes mellitus and secondary prevention of foot ulcers. Management of diabetic foot ulcers by multidisciplinary team improves survival and is cost effective.

Riassunto

L'ulcerazione del piede diabetico (DFU) è un problema comune in tutto il mondo e si traduce in importanti conseguenze economiche per i pazienti e il paese. Con questo studio retrospettivo vogliamo descrivere il costo stimato per il trattamento di questa patologia nei pazienti con DFU nel sud della Turchia.

Sono stati inclusi nello studio un totale di 148 pazienti (F = 55, M = 93) affetti da DFU. Le caratteristiche dei pazienti, e sono stati registrati dal nostro database la durata dei ricoveri, i parametri biochimici e la presenza di retinopatia diabetica, nefropatia, neuropatia, malattia coronarica e malattia delle arterie periferiche. Il costo di ciascun paziente è stato registrato dagli uffici finanziari e dall'unità del reparto fatturazione del nostro ospedale. **RISULTATI:** Il costo unitario medio di ciascun paziente è stato di £ 730,90 ± 664,9. La componente principale del costo totale erano le medicine (£ 258,8 ± 360,9) e le spese di ricovero (£ 76,58 ± 56,3). Centoquindici (77,7%) dei pazienti presentavano malattie delle arterie periferiche. Sebbene non sia stato possibile determinare correlazioni significative tra le caratteristiche demografiche dei pazienti (età, sesso, p > 0,05), parametri biochimici (glucosio plasmatico, emoglobina A1c% (HbA1c%)) e anno di diagnosi con diabete mellito, la durata del ricovero, la presenza di malattie delle arterie periferiche e l'eventuale amputazione (minore o maggiore) sono risultate correlate significativamente alle spese totali.

CONCLUSIONI: Lo studio ha rivelato che il costo di DFU potrebbe mostrare variabilità in relazione al livello di sviluppo dei paesi. Abbiamo messo in evidenza studi simili in altri paesi; i principali fattori delle spese totali erano la durata del ricovero, la prescrizione di farmaci e il ricorso alla chirurgia.

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