Hospitalisation Cost of Diabetic Patients with Foot Ulcers: A Retrospective Descriptive Analysis from Turkey

Diyabetik Ayak Ülserli Hastaların Hastane Maliyeti: Türkiye'den Retrospektif Bir Analiz

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Abstract

Objective: With the increase in the prevalence of diabetes and associated complications, most of the healthcare expenditure is due to treatments of diabetes complications. This study evaluated the determinants affecting the total treatment cost in hospitalized patients with diabetic foot ulcers (DFU), an important complication of diabetes. **Material and Methods:** Factors affecting cost in 300 cases of hospitalization due to DFU were analyzed retrospectively. Hospital invoices were examined, and incurred cost of each patient was calculated in Turkish lira and then converted into US dollars at the exchange rate on the date of hospitalization, considering the number of days of hospitalization. **Results:** Among the 300 included patients, the ratio of male/female participants was 1.94. The mean age of the patients was 62.6±11 years. Hemoglobin A1c mean was determined as 9.5±2.4%. The average hospitalization time was 17.8±12.9 days. When the average cost was analyzed according to Wagner phases, the average cost increased as the stage of the disease. The factor that most affected the cost was hospitalization cost (p=0.001, r=3.24). Diagnostic imaging tests affected the total cost the most (p=0.001, r=2.52) after hospitalization. **Conclusion:** The cost of hospitalization was the most important factor affecting the total cost in the analysis of DFU. Therefore, taking precautions before the advancement of ulcer stage and treatment at an early stage is expected to reduce the treatment cost. In addition, reducing the duration of hospital stay will be effective in reducing the cost of DFU treatment.

Keywords: Diabetes mellitus;
diabetic foot ulcers; cost of treatment

Özet

Amaç: Diyabet ile birlikte diyabete bağlı komplikasyonların da artmasıyla sağlık harcamalarının çoğu diyabet komplikasyonlarının tedavi harcamalarından kaynaklanmaktadır. Bu çalışmada, diyabetin önemli bir komplikasyonu olan diyabetik ayak ülseri ile hastanede yatan hastalarda, toplam tedavi maliyetini etkileyen faktörler değerlendirildi. **Gereç ve Yöntemler:** Diyabetik ayak ülseri nedeniyle hastaneye yatırılan 300 olguda, maliyeti etkileyen faktörler geriye dönük olarak incelendi. Hastane faturaları incelendi ve her hastanın tahakkuk eden maliyeti Türk lirası olarak hesaplandı ve hastanede yattığı gün sayısı dikkate alınarak yatış tarihindeki döviz kuru üzerinden ABD dolarına çevrildi. **Bulgular:** Üç yüz hasta arasında erkek/kadın katılımcı oranı 1,94 idi. Hastaların ortalama yaşı 62,6±11 yıl idi. Hemoglobin A1c ortalaması %9,5±2,4 olarak belirlendi. Ortalama hastanede kalış süresi 17,8±12,9 gündü. Wagner evrelerine göre ortalama maliyet incelendiğinde, hastalığın evresi arttıkça ortalama maliyet yükselmişti. Maliyeti en çok etkileyen faktör hastanede kalmak için ödenen maliyet olarak saptandı (p=0,001, r=3,24). Toplam maliyeti hastaneye yatış maliyetinden sonra en fazla etkileyen değişken ise tanısal görüntüleme testleriydi (p=0,001, r=2,52). **Sonuç:** Hastanede yatış maliyeti, toplam maliyeti etkileyen en önemli faktördü. Bu nedenle ülser evresi ilerlemeden önlem alınması ve erken dönemde tedavi edilmesinin tedavi maliyetini düşürecektir. Ayrıca mümkün olan en kısa sürede hastanın, hastaneden taburcu edilmesi ve hastanede kalış süresinin azaltılması da diyabetik ayak ülseri tedavisin maliyetinin düşürülmesinde etkili olacaktır.

Anahtar kelimeler: Diabetes mellitus;
diyabetik ayak ülseri; tedavi maliyeti

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Introduction

Diabetic foot ulcer (DFU) is one of the common complications of both Type 1 and Type 2 diabetes mellitus (DM). Patients with DFU generally need long and intensive treatments. DFU is the primary cause of the necessity of hospitalization in diabetes and the reason for hospitalization of one in every five diabetic patients (1). DM is the cause of 50-70% of non-traumatic amputations. Treatment of diabetic patients suffering from DFU is more costly than the non-DFU diabetic population (2). Healthcare costs for people diagnosed with diabetes represent a significant proportion of the estimated national cost of $ 327 billion in the United States (3). In Turkey, 16.4% of total health expenditures was due to the treatment of diabetes in 2008. However, this rate increased to 23% in 2012 (4).

In 2025, the number of people with diabetes is expected to increase from 51 million to 72 million (41% increase) in developed countries and from 84 million to 228 million (170%) in developing countries (5, 6). Unfortunately, the number of DFU patients is expected to increase with the increase in the number of patients with diabetes (7). The cost of DFU treatment is quite high because of amputation, long duration of wound care, the need for hospitalization, and loss of workforce. Although patients with DFU require substantial resource utilization, little is known about the burden of DFUs on the healthcare system around the world. Moreover, studies on the evaluation of costs for the treatment and diagnostic intervention are limited. In this study, we aimed to retrospectively evaluate treatment cost in patients followed up for DFU and determine the effect of each factor on the total cost.

Material and Methods

A total of 300 male and female patients with Type 2 DM over the age of eighteen who were hospitalized in Endocrinology and Metabolism department for the treatment of DFU were included in our study. Among them, there were 198 (66%) males and 102 (34%) females. The number 300 was determined by a calculation of the sample's power analysis. Patients whose diagnosis and treatment were first made at our center were included in the study. Patients with DFU diagnosis who applied to outpatient clinics or were hospitalized in other clinics were not included in the study.

Age, gender, hemoglobin A1c, Wagner grade, and length of hospital stay were examined with a diagnosis of DFU in these 300 patients (ages of 18-90), with grades 1 to 5 according to the Wagner Classification.

There are various methods of classification of DFU; nevertheless, Wagner classification is used more frequently than others. This classification was made according to the ulcer area, depth, and tissue damage. Wagner classification is a potential guide for the treatment approach in clinical practice (8,9).

Cost of negative-pressure wound treatment, diagnostic imaging examinations, daily dressing and wound care, antibiotic therapy, insulin treatment, amputation treatment, and hospitalization were calculated. Total cost was analyzed (Republic of Turkey Social Security Institution bills of our hospital were retrospectively examined) (10). All this information was recorded in case report forms. The impact of each factor on the total cost was determined.

The mean length of stay and the mean cost analysis of 300 patients with DFU complications were estimated. To calculating the cost of hospitalization of each patient, the data obtained from the day of hospitalization to the day of discharge were analyzed. In this study, costs were calculated in Turkish lira (₺) and converted to USD ($) at the exchange rate at the time of the hospitalization.

This study was approved by the Ethics committee of the Gaziantep University Clinical Research Ethics Committee and conducted in accordance with the Helsinki Declaration Principles. Decision number of 145 dated 12.09.2018.

The criteria of research participation for patients were: diagnosed with Type 2 diabetes, having DFU, more than eighteen years of age.

Statistical Analysis

The compatibility of numerical data to normal distribution was tested with the Shapiro-Wilk test. Student's t-test was used to compare variables with normal distribution in two groups. One-way analysis of variance was used to compare variables that fit

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normal distribution in three or more groups. The relationships between quantitative variables thought to have an effect on the total cost were examined by Pearson's correlation analysis, and then regression analysis was applied to determine their effects on the total cost. SPSS 22. 0 (SPSS Inc. Chicago. IL. USA) package program was used for the analysis of data. $p<0.05$ was considered significant. Treatment cost was the dependent variable, while the cost of negative pressure wound therapy, diagnostic imaging examinations, daily wound care, and dressing, antibiotic treatment, insulin medication, and hospitalization were independent factors.

Results

A total of 300 participants included 198 (66%) males and 102 (34%) females, with the male: female ratio of 1.94. The mean age of the patients was 62.6 years, the hemoglobin A1c average was 9.5%, and the average hospitalization time was 17.8 days. When cases are analyzed according to average cost, antibiotic treatment had the highest average, amounting to $ 603.9 (Table 1).

According to the Wagner Classification, 37 patients were diagnosed as grade 1 (12.33%), 61 patients were diagnosed as grade 2 (20.33%), 110 patients were diagnosed as grade 3 (36.67%), 52 patients were diagnosed as grade 4 (17.33%), and 40 patients were diagnosed as grade 5 (13.33%) DFU. Only 45 of the patients had an amputation.

Analysis of the average cost of the cases according to the Wagner grades revealed that the average cost increased as the grade increased (Table 2).

A statistically significant, moderately positive correlation was observed between the Wagner Grade and the cost of amputation treatment ($p<0.005$, $r=0.684$). Patients with Wagner 1 DFU did not need hospitalization.

On examining the relationship of the total cost to other variables, a statistically significant relationship was observed between the total cost and the cost of negative-pressure wound therapy, daily wound care and dressing, antibiotic treatment, insulin medication, amputation treatment, and hospitalization. A statistically significant relationship was observed through Pearson's correlation analysis on the relationship between quantitative variables that could have an impact on cost. According to the regression analysis, the most significant variable was the hospitalization cost, followed by the cost of diagnostic imaging examinations (Table 3).

Discussion

In this study, we investigated the determinants of treatment costs of patients with DFU. The costs of treatment of patients with DFU were estimated to be higher than those of hyperglycemic patients without DFU (11). In our study, the cost of hospitalization was found to be the most important factor affecting the total cost in the cost analysis of DFU.

Table 1. Demographic data, laboratory findings, and cost analysis of 300 diabetes patients with foot ulcers.	
Variables	**Mean standard deviation**
Age (years)	62.6±11
Hemoglobin A1c (%)	9.5±2.4
Hospitalization time (days)	17.8±12.9
Cost of negative-pressure wound therapy (USD $)	104.9±305.4
Cost of diagnostic imaging examinations (include angiography) (USD $)	88.9±64.1
Cost of daily wound care and dressing (USD $)	80.6±94.1
Cost of antibiotic treatment (USD $)	603.9±603.4
Cost of insulin medication (USD $)	146.7±114.8
Cost of hospitalization (USD $)	267.3±194.5
Total cost (USD $)	1973.5±1611.2

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Table 2. The relationship between Wagner grades and cost of hospitalization.

Wagner grade	Number of cases	Cost (USD $) mean standard deviation
2	81	772.07±655.25
3	117	1863.26±1292.23
4	62	1927.48±1332.45
5	40	3556.05±2077.80

Thus, reducing the duration and number of hospitalizations will be effective in reducing the cost of treatment of DFU. Patients with DFU may need to stay in the hospital for a longer duration due to uncontrolled hyperglycemia, long-term wound care, late-healing wound infections, debridement, amputations, and emerging complications; (12) these factors contributed to increasing the cost. The average cost was also found to increase as the Wagner grade increased. The highest average cost of treatment was of Wagner grade five patients. As the Wagner grade progressed, prolonging the length of hospitalization and increasing the frequency of amputation led to increasing costs. In our study, the relationship between the Wagner grade and the cost of amputation treatment was statistically significant. It is expected that taking precautions before the disease reaches the advanced grade and starting treatment from the early grade will reduce the treatment cost.

A meta-analysis investigating the cost-effectiveness of diagnostic imaging methods revealed that some non-invasive diagnostic procedures performed on patients did not contribute to the treatment; in fact, they increased the total cost (13). Similarly, in our study, we observed that after the hospitalization cost, the variable affecting the total cost the most was diagnostic imaging tests. Most cases in our study had the use of direct radiography, magnetic resonance (MR), bone scintigraphy, and lower extremity arterial doppler ultrasonography. Further assessment of the available bills showed that bone scintigraphy was the most costly per shot among the imaging methods, considering the available bills. The patient with DFU must undergo X-ray radiography imaging to detect bone deformities in the wound area, foreign objects, or gas formations in soft tissue. Therefore, the use of low-cost examinations is recommended first in the case of DFU suspicion (14). Direct X-ray radiography may not be sufficient for patients who do not recover with antibiotherapy and are observed to have osteomyelitis or deep soft tissue abscess. In these cases, the sensitivity and specificity of MR imaging are higher (15). Bone scintigraphy and other radionuclide bone scans can be performed in patients where MR imaging is contraindicated or cannot be performed (16). We think that avoiding unnecessary use of imaging methods such as MR and bone scintigraphy would be cost-effective and hope that developing radiological examination eligibility criteria will be helpful in reducing unnecessary demands and building consensus among departments.

The male/female ratio of participants in this study was found to be 1.94. The reason for the higher rates of DFU in male patients compared to female patients may be be-

Table 3. Results of regression analysis between total cost and various variables.

Regression model	Regression coefficient	p value
Cost of negative-pressure wound therapy	0.827	0.001
Cost of diagnostic imaging examinations	2.522	0.001
Cost of daily wound care and dressing	1.027	0.110
Cost of antibiotic treatment	0.847	0.001
Cost of insulin medication	1.397	0.001
Cost of hospitalization	3.242	0.001

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cause men work under physically severe conditions, do not care enough about foot hygiene, and due to neuropathy.

Prolonged hospitalization is an important factor that leads to high costs. In our study, patients with DFU had longer hospitalization times.

This study, however, had some limitations. Wagner classification, despite very useful, is quite outdated and overcome by many other methods, more recently introduced. We should have chosen one of these more updated classification methods. Second, our study did not include patients with reperfusion procedures or bypass surgery. Besides, off-loading footwear cost was also not taken into account. However, we thought that the study addresses a very important issue, which is often undervalued. Evaluation of the costs of DF, different components of health system expenditure, and differences between costs in patients with different complexities will be very useful for the economy of the countries. Thus we hope that the aim of this study is not only inspirational but will provide guidance for future studies.

Conclusion

The most important factor affecting the total cost in the cost analysis of DFU was found to be the cost of hospitalization. Reducing the rate of hospitalizations will be effective in reducing the treatment cost of DFU. Therefore, taking precautions before the disease reaches an advanced stage and starting treatment at an early stage will shorten the length of hospital stay and reduce the total cost of treatment.

Source of Finance

Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

Idea/Concept: Ersin Akarsu; Design: Ersin Akarsu, İbrahim Halil Açar; Control/Supervision: Ersin Akarsu, Zeynel Abidin Sayiner, Mustafa Araz; Data Collection and/or Processing: Nuray Gül Açar, İbrahim Halil Açar, Zeynel Abidin Sayiner; Analysis and/or Interpretation: Ersin Akarsu; Literature Review: Zeynel Abidin Sayiner, Nuray Gül Açar, İbrahim Halil Açar; Writing the Article: İbrahim Halil Açar, Zeynel Abidin Sayiner, Ersin Akarsu; Critical Review: Zeynel Abidin Sayiner, Ersin Akarsu, Mustafa Araz; References and Fundings: İbrahim Halil Açar, Nuray Gül Açar; Materials: İbrahim Halil Açar, Ersin Akarsu.

References

1. Apelqvist J. Diagnostics and treatment of the diabetic foot. Endocrine. 2012;41:384-397. [Crossref] [Pubmed]
2. Gershater MA, Löndahl M, Nyberg P, Larsson J, Thörne J, Eneroth M, Apelqvist J. Complexity of factors related to outcome of neuropathic and neuro-ischaemic/ischaemic diabetic foot ulcers: a cohort study. Diabetologia. 2009;52:398-407. [Crossref] [Pubmed]
3. Johnson EP, Dunn M, Cooper M, Bhakta N. Diabetes Prevention Program Sites Compared With Diabetes Prevalence and Ratio of Primary Care Physicians in Texas. Prev Chronic Dis. 2019;16:E165. [Crossref] [Pubmed] [PMC]
4. Turkey Diabetes Program 2015-2020. T. C. Ministry of Health Public Health Agency of Turkey: Ankara. 2014;23-38. [Link]
5. Satman İ, İmamoğlu Ş, Yılmaz C, Akalın S, Salman S. Glisemik bozukluklarda tanı, sınıflama ve tedavi. Diabetes Mellitus ve Komplikasyonlarının Tanı, Tedavi ve İzleme Kılavuzu. 6. Baskı. Ankara: Türkiye Endokrinoloji ve Metabolizma Derneği Yayınları; 2013:15-30. [Link]
6. Apelqvist J, Larsson J. What is the most effective way to reduce incidence of amputation in the diabetic foot? Diabetes Metab Res Rev. 2000;16 Suppl 1:S75-83. [Crossref] [Pubmed]
7. Tang UH, Zügner R, Lisovskaja V, Karlsson J, Hagberg K, Tranberg R. Foot deformities, function in the lower extremities, and plantar pressure in patients with diabetes at high risk to develop foot ulcers. Diabet Foot Ankle. 2015;6:27593. [Crossref] [Pubmed] [PMC]

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8. Schaper NC, van Netten JJ, Apelqvist J, Bus SA, Hinchliffe RJ, Lipsky BA; IWGDF Editorial Board. Practical Guidelines on the prevention and management of diabetic foot disease (IWGDF 2019 update). Diabetes Metab Res Rev. 2020;36 Suppl 1:e3266. [Crossref] [Pubmed]

9. Satman I, Imamoglu S, Yilmaz C; ADMIRE Study Group. A patient-based study on the adherence of physicians to guidelines for the management of type 2 diabetes in Turkey. Diabetes Res Clin Pract. 2012;98:75-82. [Crossref] [Pubmed]

10. Sosyal Güvenlik Kurumu [Internet]. Turkey Medula Data SCI. 05.05.2018. Erişim linki: [Link]

11. Keskek SO, Kirim S, Yanmaz N. Estimated costs of the treatment of diabetic foot ulcers in a tertiary hospital in Turkey. Pak J Med Sci. 2014;30:968-971. [Pubmed] [PMC]

12. Shulman R, Slater M, Khan S, Jones C, Walker JD, Jacklin K, Green ME, Frymire E, Shah BR. Prevalence, incidence and outcomes of diabetes in Ontario First Nations children: a longitudinal popu lation-based cohort study. CMAJ Open. 2020;8:E48-E55. [Crossref] [Pubmed] [PMC]

13. Krishnan S, Nash F, Baker N, Fowler D, Rayman G. Reduction in diabetic amputations over 11 years in a defined U.K. population: benefits of multidisciplinary team work and continuous prospective audit. Diabetes Care. 2008;31:99-101. [Crossref] [Pubmed]

14. Nelson EA, O'Meara S, Craig D, Iglesias C, Golder S, Dalton J, Claxton K, Bell-Syer SE, Jude E, Dowson C, Gadsby R, O'Hare P, Powell J. A series of systematic reviews to inform a decision analysis for sampling and treating infected diabetic foot ulcers. Health Technol Assess. 2006;10:iii-iv, ix-x, 1-221. [Crossref] [Pubmed]

15. Russell JM, Peterson JJ, Bancroft LW. MR imaging of the diabetic foot. Magn Reson Imaging Clin N Am. 2008;16:59-70, vi. [Crossref] [Pubmed]

16. Dinh T, Snyder G, Veves A. Current techniques to detect foot infection in the diabetic patient. Int J Low Extrem Wounds. 2010;9:24-30. [Crossref] [Pubmed]