Costs of Patients Admitted for Diabetic Foot Problems

Dear Editor,

Singapore has a high prevalence of diabetes, with 12.4% of the adult population living with diabetes in 2013. Up to 1 in 6 diabetic patients develop diabetic foot problems[1] and these are estimated to account for 15% to 25% of healthcare costs for treating diabetes.[2] At present the costs of treating diabetic foot problems in Singapore are not known. Our study aims to evaluate the costs of inpatient treatment of diabetic foot problems.

Materials and Methods

This is a retrospective study of 214 patients admitted to the Department of Orthopaedic Surgery, National University Hospital (NUH) for a diabetic foot problem, from January 2011 to December 2011. We defined a diabetic foot problem as a foot wound, infection, arthropathy or deformity due to underlying diabetes mellitus. Patient data based on clinical records was documented based on a predesigned study protocol. Financial records were obtained from hospital financial records. Data was recorded by the co-authors of this paper.

Patient data documented included demographic data, clinical data, and treatment received. Clinical data included presence of complications of diabetes including retinopathy, nephropathy, and peripheral vascular disease (PVD); and comorbidities such as ischaemic heart disease (IHD), hypertension, hyperlipidaemia, critical limb ischaemia and end-stage renal failure. We defined critical limb ischaemia as an arterial brachial index (ABI) less than 0.4 and peripheral vascular disease as an ABI less than 0.9.

Treatment received included conservative treatment, minor surgery, minor amputation and major amputation. Conservative treatment consisted of antibiotics, podiatric interventions and dressings. Minor surgery included incision and drainage, debridement and skin grafting. Minor amputations included all amputations at and below the level of the ankle joint. Major amputations referred to amputations above the ankle joint. Other factors studied included stay in high dependency/intensive care units (ICUs), dialysis treatment and readmissions. Total duration of hospital stay was also recorded.

Cost components studied included the total cost of inpatient treatment (total cost), ward and high dependency/ICU charges (cost of hospital stay), costs of surgery, costs of antibiotics, costs of dressings, cost of investigations and cost of allied healthcare (podiatry, physiotherapy and occupational therapy). These costs in Singapore dollars SGD ($) were calculated based on the total hospital bill from January to December 2011.

Statistical Analysis

All statistical analyses were performed using SPSS 18.0 with statistical significance set at $P < 0.05$. Predictive factors for high cost were determined using univariate and stepwise logistic regression analysis. Mann-Whitney U test was used for numerical prognostic factors, and chi-square test was used for categorical factors.

Results

Patient Profile

In our cohort of patients, the mean age was 60.5 years with an age range between 20 to 92 years. There was an equal gender distribution of patients and the racial distribution in our study was 41.1% Chinese, 44.9% Malay and 14% Indian. There was a high rate of critical limb ischaemia, 50.5% (108) patients and other associated comorbidities.

Hospital Stay

The mean length of hospital stay was 24 days, with non-operatively treated and operatively treated patients having a mean stay of 8 and 30 days respectively. Patients undergoing major amputations had a mean length of hospital stay of 53 days, 6.5 times that of non-operatively treated patients, which was statistically significant $P < 0.05$.

Type of Treatment

In this study, 25.5% (54) of patients were conservatively managed, 28% (60) had minor surgery, 22.9% (49) had minor amputations and 51 (23.8%) had major amputations. There was a high rate of multiple admissions and high dependency/ICU stay in this cohort of patients, 32.7% (70) and 34.1% (73) respectively.

Analysis of Predictive Factors

Table 1 shows the various factors studied as potential predictive factors for high cost (cost >SGD ($) 5000)

Table 1. Results of Evaluation of Predictive Factors

Predictive Factors	Value (%)	Univariate Analysis	Multivariate Analysis
Demographics			
Age			
>60	116 (54.21%)	*P* = 0.03	*P* = 0.723
<60	98 (45.79%)		
Gender			
Male	113 (52.8%)	*P* = 0.721	-
Female	101 (47.2%)		
Race			
Chinese	88 (41.12%)	*P* = 0.242	-
Malay	96 (44.86%)		
Indian	30 (14.02%)		
Comorbidities			
Hypertension			
Yes	183 (85.51%)	*P* = 0.001	*P* = 0.615
No	31 (14.49%)		
Hyperlipidaemia			
Yes	159 (74.3%)	*P* = 0.004	*P* = 0.305
No	55 (25.7%)		
Ischaemic heart disease			
Yes	83 (38.76%)	*P* <0.001	*P* = 0.482
No	131 (61.24%)		
Cerebrovascular disease			
Yes	38 (17.76%)	*P* = 0.01	*P* = 0.412
No	174 (81.24%)		
Peripheral vascular disease			
Yes	128 (59.81%)	*P* <0.001	*P* = 0.687
No	86 (40.19%)		
Critical limb ischaemia			
Yes	108 (50.47%)	*P* <0.01	*P* = 0.033
No	106 (49.53%)		
Nephropathy			
Yes	114 (53.27%)	*P* = 0.092	*P* = 0.728
No	100 (46.73%)		
End stage renal failure			
Yes	57 (26.64%)	*P* = 0.044	*P* = 0.198
No	154 (73.36%)		
Treatment			
Non-major amputation • Conservative 54 (25.23%) • Minor surgery 60 (28.04%) • Minor amputation 49 (22.9%)	163 (76.17%)	*P* <0.001	*P* = 0.01
Major amputation	51 (23.83%)		
Treatment factors			
Multiple admissions	70 (32.71%)	*P* <0.01	*P* = 0.01
High dependency/intensive care unit stay	73(34.11%)	*P* <0.001	*P* <0.001
Dialysis	40 (18.69%)	*P* <0.03	*P* = 0.528
Non-compliance/refusal of surgery	38 (17.76%)	*P* = 0.01	*P* = 0.028

Note: Predictive factors for high cost were determined using univariate and stepwise logistic regression analysis. Mann-Whitney U test was used for numerical prognostic factors, and chi-square test was used for categorical factors.

Table 2. Total Cost of Each Cost Component for Each Type of Treatment Per Year

Type of Treatment	Cost of Hospital stay SGD ($)	Cost of Dressings SGD ($)	Cost of Antibiotics SGD ($)	Cost of Investigations SGD ($)	Cost of Surgery SGD ($)	Cost of Dialysis SGD ($)	Cost of Allied Healthcare SGD ($)	Total Cost SGD ($)
Conservative	$30,634.96	$7,423.74	$10,562.36	$20,145.61	NA	$1244.83	$1707.98	$71,719.48
Minor surgery	$75,372.62	$39,685.92	$32,315.83	$42,494.38	$28,677.84	$2389.00	$5220.79	$226,156.38
Minor amputation	$79,629.67	$68,836.65	$43,413.46	$29,842.82	$19,662.75	$5090.97	$7580.17	$254,056.49
Major amputation	$196,128.03	$48,316.28	$72,447.25	$63,704.51	$60,829.93	$31,522.57	$21,506.85	$494,455.43
All patients	$381,765.28	$164,262.59	$158,738.90	$156,187.32	$109,170.52	$40,247.37	$36,015.80	$1,046,387.78

NA: Not applicable

and the result of our analysis. On multivariate analysis, only critical limb ischaemia, major amputation, multiple admissions and high dependency/ICU stay were found to be significant predictive factors (P <0.05).

Cost

Table 2 shows the total cost in SGD ($) of each cost component for each type of treatment. The total cost of treatment was SGD ($) 1,046,387.80. In this cohort, patients undergoing major amputation accounted for nearly half of the total cost, SGD ($) 494,455.40. The cost of hospital stay was the largest cost component with 35.9% (SGD ($) 381,765.30) of the total cost spent on hospital stay costs.

Table 3 shows the mean cost of each cost component for each type of treatment. The mean cost of treatment was SGD ($) 4907.30 per patient. Patients undergoing major amputations had the highest mean hospital stay cost of SGD ($) 3845.70 per patient, which was 6.8 times that of non-operative patients. Patients undergoing major amputation also had the highest mean cost of antibiotics, investigations and surgical costs.

Discussion

The care for patients with diabetic foot problems is an increasingly heavy economic burden. Diabetic foot patients are estimated to have a healthcare expenditure 3 times that of the general population, with hospitalisations costs accounting for 73% of increased cost.[3] Our study attempts to evaluate the cost of inpatient treatment of patients with diabetic foot problems in our institution and the contributing factors to higher cost of treatment.

The largest cost component was that of hospital stay, SGD ($) 381,765.30, which was 36.5% of total cost of treatment. These findings are similar to other studies which show that the major cost in treating diabetic foot ulcers is inpatient care, accounting for 74 to 84 percent of total costs.[4,5]

In our study, the following factors were found to be associated with higher cost of treatment: critical limb ischaemia, major amputation, multiple admissions and high dependency/ICU stay. Critical limb ischaemia is a risk factor for higher costs due to higher rates of amputation, postoperative complications, revisions, and length of hospitalisation.[6-8] Patients undergoing major amputation had

Table 3. Mean Cost of Each Cost Component for Each Type of Treatment Per Year

Type of Treatment	Mean Cost of Hospital Stay SGD ($)	Mean Cost of Dressings SGD ($)	Mean Cost of Antibiotics SGD ($)	Mean Cost of Investigations SGD ($)	Mean Cost of Surgery SGD ($)	Mean Cost of Dialysis SGD ($)	Mean Cost of Allied Healthcare SGD ($)	Mean Total Cost SGD ($)
Conservative	$567.31	$140.07	$195.60	$373.07	NA	$23.05	$31.63	$1328.14
Minor surgery	$1277.50	$672.64	$547.73	$720.24	$486.07	$40.49	$88.49	$3833.16
Minor amputation	$1615.26	$1404.83	$883.93	$601.59	$397.57	$103.90	$154.41	$5161.49
Major amputation	$3845.65	$947.38	$1448.95	$1249.11	$1192.74	$618.09	$421.71	$9695.20
All patients	$1790.06	$771.19	$1265.82	$731.56	$511.68	$188.96	$169.02	$4907.25

NA: Not applicable

a total cost of treatment 7.3 times that of non-operatively treated patients. This could be accounted for by major amputation patients having longer hospital stays, increased requirement for high dependency/ICU care and multiple readmissions.

Prior to the formation of the NUH multidisciplinary team for diabetic foot problems, the mean total cost of treatment per patient in 2002 was SGD ($) 8847.20.[9] This has decreased to SGD ($) 4907.30 per patient, a decrease of nearly 50%. A coordinated outpatient and inpatient multidisciplinary approach is needed to manage these patients and prevent hospital admissions and major amputation. When such an approach is used, an estimated 45% to 85% of all amputations can be prevented.[10-13]

Limitations

This was a retrospective study with possible selection bias as patients not treated by the multidisciplinary team were not studied. This study also only used total hospital bills and did not take into account the effect of government subsidies.

Conclusion

This study demonstrates the high cost of treating diabetic foot problems in the inpatient setting, with costs of hospital stay being the largest cost component. Critical limb ischaemia, major amputation, multiple admissions and high dependency/ICU stay were found to be risk factors for high cost of treatment. A multidisciplinary approach to treatment of diabetic foot problems is needed to reduce costs and major amputation rates.

REFERENCES

1. Putting feet first in diabetes. Lancet 2005;366:1674.
2. 2005, World Diabetes Day on Diabetic Foot Care, International Working Group on Diabetic Foot (2005).
3. Ramsey SD, Newtn K, Blough D, McCulloch DK, Sandhu N, Reiber GE, et al. Incidence, outcomes, and cost of foot ulcers in patients with diabetes. Diabetes Care 1999;22:382-7.
4. Harrington C, Zagari MJ, Corea J, Klitenic J. A cost analysis of diabetic lower-extremity ulcers. Diabetes Care 2000;23:1333-8.
5. Stockl K, Vanderplas A, Tafesse E, Chang E. Costs of lower extremity ulcers among patients with diabetes. Diabetes Care 2004;27:2129-34.
6. Raviola CA, Nichter LS, Baker JD, Busuttil RW, Machleder HI, Moore WS. Cost of treating advanced leg ischemia: bypass graft vs primary amputation. Arch Surg 1988;123:495-6.
7. Perler BA. Cost-efficacy issues in the treatment of peripheral vascular disease: primary amputation or revascularization for limb-threatening ischemia. J VascIntervRadiol 1995;6:111S-5S.
8. Ashry HR, Lavery LA, Armstrong DG, Lavery DC, van Houtum WH. Cost of diabetes-related amputations in minorities. J Foot Ankle Surg 1998;37:186-90.
9. Nather A, Siok Bee C, Keng Lin W, Xin-Bei Valerie C, Liang S, Tambyah PA, et al. Value of team approach combined with clinical pathway for diabetic foot problems: a clinical evaluation. Diabet Foot Ankle 2010;1.
10. Fusilli D, Alviggi L, Seghieri G, deBellis A. Improvement of diabetic foot care after the implementation of the International Consensus on the Diabetic Foot (ICDF): results of a 5-year prospective study. Diabetes Res Clin Pract 2007;75:153-8.
11. Krishnan S, Nash F, Baker N, Fowler D, Rayman G. Reduction in diabetic amputations over 11 years in a defined UK population: benefits of multidisciplinary team work and continuous prospective audit. Diabetes Care 2008;31:99-101.
12. Canavan RJ, Unwin NC, Kelly WF, Connolly VM. Diabetes and non diabetes related lower extremity amputation incidence before and after the introduction of better organized diabetes foot care: continuous longitudinal monitoring using a standard method. Diabetes Care 2008;31:459-63.
13. Wukich DK, Armstrong DG, Attinger CE, Boulton AJ, Burns PR, Frykberg RG. Inpatient management of diabetic foot disorders: a clinical guide. Diabetes Care 2013;36:2862-71.

Jiong Hao Tan, [1]*MRCS(Ed)*, Choon Chiet Hong, [1]*MRCS(Ed)*, Liang Shen, [2]*Phd(Stats)*, Elaine YL Tay, [2], Jamie KX Lee, [2], Aziz Nather, [1]*FRCS(Ed)*

[1]Department of Orthopaedic Surgery, University Orthopaedic, Hand and Reconstructive Microsurgery Cluster, National University Health System, Singapore

[2]Biostatistics Unit, Yong Loo Lin School of Medicine, National University of Singapore, Singapore

Address for Correspondence: A/Prof Aziz Nather, Department of Orthopaedic Surgery, National University of Singapore and National University Hospital, 5 Lower Kent Ridge Road, Singapore 119074.
Email: aziz_nather@nuhs.edu.sg