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The cost of managing diabetic foot ulceration in an Irish hospital

D Smith, MJ Cullen, JJ Nolan
Department of Endocrinology, St James's Hospital, Dublin, Ireland

Abstract

Background Little is known about the economic impact of diabetic foot ulceration in the Irish healthcare setting.

Aim Audit of diabetic foot ulcer admissions in St James's Hospital between April 2001 and March 2002.

Methods Hospital charts were reviewed and costs were calculated on the length of patients' hospital stay and the cost of individual investigations performed.

Results Thirty patients were admitted with diabetic foot ulceration as the primary complaint. Amputation was performed in eight patients, two patients with a non-healing ulcer died. The average duration of each hospital admission was 20.3±30.7 days. Net in-hospital expenditure was €704,689, an average of €23,489.63 per hospital admission.

Conclusions The management of diabetic foot ulceration has a significant economic impact on the Irish healthcare budget. Treatment should therefore be focused on primary prevention through specialised foot clinics and a multidisciplinary team approach to reduce this economic burden.

Introduction

Diabetic foot ulceration, past or present, affects 7.4% (type 1 and type 2 combined) of people with diabetes.[1] The lifetime risk of developing a foot ulcer for any diabetic patient is up to 15%.[2] The morbidity associated with diabetic foot ulcers is considerable. People with diabetes are 15–40 times more likely to undergo a lower extremity amputation than patients with non-diabetic foot ulceration.[3] A prospective study of 314 consecutive patients admitted with diabetic foot ulceration to a university hospital reported an amputation rate of 25% and over 40 patients died with unhealed ulcers.[4]

The economic impact of diabetic foot disease is enormous. Diabetic foot problems are responsible for 47% of all diabetes-related hospital admissions.[5] Reiber published a comprehensive summary of the direct costs of diabetic foot disorders in the USA.[6] She reported that the treatment of foot ulceration in patients with type 2 diabetes accounted in 1986 for $150 million. A Swedish study estimated that the treatment of diabetic gangrene accounted for 25% of the institutional costs of diabetes care in 1978 (87.9 million out of a total of 351.6 million Swedish kronor).[7] Little is known about the economic impact of managing diabetic foot ulceration in the Irish healthcare setting. We therefore performed an audit of diabetic foot ulcer admissions in St James's hospital between the 1 April 2001 and the 31 March 2002 to look at morbidity and mortality associated with foot ulceration, length of hospital stay and hospital expenditure during the admission.

Methods

Patients were identified from the Hospital In-patient Enquiry (HIPE) database, diabetes day centre and podiatry records. The ulcers were classified as either neuropathic (defined as absent vibration sensation measured by the technique of a tuning fork applied at the malleoli in association with an ankle-brachial pressure index >0.8) or ischaemic (vibration sensation intact with an ankle brachial pressure index of <0.8) or neuro-ischaemic (absent vibration sensation with an ankle brachial pressure index of <0.8) or other causes.

Details of glycaemic control, the treatment for diabetes, co-existent history of hypertension (defined as three consecutive readings >140/90mmHg), dyslipidaemia (defined as a fasting total cholesterol >5.0mmol/l), microalbuminuria (defined as an albumin concentration >30mg in a 24-hour urine collection) and current smoking history were recorded.

Individual patient charts were reviewed in detail recording the manner of presentation of the foot ulcer, presence of active infection and the organism involved, the investigations and therapies directly applied to the management of the diabetic foot ulcer. Patients were followed to determine the outcome measures of healing or non-healing of the ulcer, length of hospital stay and the estimated cost in euro per patient. Costs for the length of hospital stay were calculated from the 2002 end of year hospital budget for St James's Hospital. Radiological and operating theatre costs were obtained from the financial manager of the relevant department. Costs did not include laboratory tests performed during the hospital admission or the cost of antibiotic therapy or outpatient care and follow-up of the diabetic foot ulcer.

Results

There were 30 diabetic foot ulcer admissions over the one-year period to St James's Hospital. Within these 30 admissions, three patients had more than one hospital admission with recurrent infection of a non-healing foot ulcer. Four patients had type 1 diabetes, the remainder had type 2 diabetes. Three patients were diagnosed with type 2 diabetes at time of presentation with their foot ulcer. Mean age of patients was 68.6±12.8 (mean±SD) years with a male to female ratio of 5:1 and a mean duration of diabetes of 10.1±12.5 years. Fourteen of the admissions to hospital were from the diabetes day centre, seven via the vascular service, six from the diabetes and podiatry outpatient department and three directly through the hospital's accident and emergency department. The characteristics of the group according to glucose control and diabetes complications are outlined in Table 1.

Table 1. Patients' characteristics according to their diabetes treatment

Treatment	HbA1C (mean±SD)	PVD (%)	Neuropathy (%)	Smoker (%)	BP (%)	ALB (%)	Lipid (%)
Diet only (n=3)	8.3±0.4	100	67	67	67	33	33
Sulphonlyurea only (n=8)	8.2±1.4	100	12	25	88	50	75
Metformin only (n= 7)	8.4±2.8	86	57	0	86	0	29
Metformin+sulphonlyurea (n=3)	9.3±1.9	67	67	67	100	67	67
Insulin+oral hypoglycaemics (n=3)	8.3±1.4	100	33	67	67	33	100
Insulin only (n=6)	8.8±1.4	67	83	50	67	17	33

HbA1C=glycosylated haemoglobin; PVD=peripheral vascular disease with an ankle brachial index pressure <0.8; BP=blood pressure >140/90mmHg on three consecutive readings; ALB = >30mg of albumin on a 24 hour urine collection; Lipid=total cholesterol >5.0mmol/l.

Table 2. Characteristics of the foot ulcer

Type of ulcer	Organism identified	Choice of antibiotic	Length of antibiotic Rx (days:mean±SD)
Ischaemic (n=15)	Staphylococcal in 3 (MRSA, MSSA x 2) Streptococcal in 2 GM- Bacilli in 2	Benzylpenicillin/flucloxacillin (7). Ciprofloxacin/clindamycin (5). Co-amoxiclavulinic acid (1).	23.0±14.2
Neuropathic (n=2)	Staphylococcal in (1), Streptococcal (2), GM– Bacillus (1).	Benzylpenicillin/flucloxacillin (1). Ciprofloxacin/clindamycin in (1).	23.5±6.4
Mixed (n=11)	Staphylococcal in (6), (MRSAx1), Streptococcal (3), GM– Bacilli (3), anaerobe (1).	Benzylpenicillin/flucloxacillin (5). Ciprofloxacin/clindamycin in (2). Clindamycin/Levofloxacin in (1). Vancomycin/rifampicin in (1).	35.6±15.5
Others (n=2)	Staphylococcal in (2), Streptococcal (2), GM– Bacilli (2), anaerobe (1).	Benzylpenicillin/flucloxacillin (1). Co-amoxiclavulinic acid and metronidazole (1).	15.5±7.8

MRSA=methicillin-resistant *Staphylococcus aureus*; MSSA=methicillin-sensitive *Staphylococcus aureus*.

Of the 30 hospital admissions, 15 had an ischaemic ulcer, two admissions were due to an infected neuropathic ulcer whilst 11 were due to mixed neuro-ischaemic ulcers, one was a venous ulcer and one was an ulcerated infected ingrown toenail (see Table 2). A swab of the ulcer was performed in only 50% of cases. The ulcer swabs were cultured on three different media, blood agar in carbon dioxide, MacConkey agar and neomycin blood agar. The majority of swabs (73%) revealed polymicrobial infection, the most commonly identified organisms were Staphylococcus, Streptococcus and Gram-negative bacilli. Twenty-six of the patients received antibiotic treatment. The most commonly prescribed antibiotic combination was flucloxacillin and benzylpenicillin or ciprofloxacin and clindamycin. Antibiotic treatment was changed in 11 patients on the basis of repeat swabs taken from the ulcer.

One patient with a neuropathic foot ulcer was referred to the orthopaedic service for contact casting to relieve pressure on the affected foot. However in this patient previous skin grafting for a burn injury on the affected foot prohibited the use of a contact cast.

The results of laboratory and radiological investigations are outlined in Table 3. An elevated white cell count was present in only 20% of patients. Osteomyelitis complicated foot ulceration in 7% of cases and no patient presented with an acute Charcot's foot.

Nearly all of the foot ulcer patients had a formal vascular assessment on admission to hospital (see Table 4). The majority of patients (97%) had an ankle brachial pressure index performed. Patients were referred to the vascular surgical service for an opinion if they had an ankle brachial index of <0.8 and/or clinical evidence of arterial insufficiency. At the recommendations of the vascular service, 17 patients had a femoral angiogram with a femoral angioplasty attempted in 10 patients. One patient had a stent inserted into the femoral artery. Angioplasty with or without stent insertion was successful in only 45% of cases. The remaining cases underwent femoral-popliteal bypass surgery or amputation. Amputation was performed in eight patients (bilateral amputation performed in one patient); five of the eight had an above knee amputation, the remaining three had an amputation restricted to the affected foot. Amputation was performed after the patients had been in hospital for an average of 19.0±8.7 days. Full ulcer healing occurred in 43% of foot ulcers, the length of time for this to occur was 76.5±74.2 days. Unfortunately at time of completion of the audit two patients with a non healing ulcer had died. One

Table 3. Investigations

Type of ulcer	WCC (3.5–11.0x10^9/l)	ESR (0–10mm/hr)	C-RP (0-4mg/l)	Foot X-ray (%)	Bone scan (%)	MRI foot (%)
Ischaemic (n=15)	9.1±1.8	71.9±36.3	37.3±30.5	53	20	27
Neuropathic (n=2)	8.3±2.3	70.0±14.1	48.2±61.9	100	100	50
Mixed (n=11)	8.4±3.9	97.9±18.9	99.8±61.2	64	27	18
Others (n=2)	5.9±0.5	52.5±33.2	18.9±0	100	50	0

WCC=white cell count; ESR=erythrocyte sedimentation rate; C-RP=C-reactive protein. Normal reference ranges are given in brackets. Data is presented as mean±SD or percentage (%).

Table 4. Vascular investigations and treatment

Type of ulcer	ABI* (mean±SD)	Angiogram (%)	Angioplasty (%)	Stent (%)	Bypass (%)	Amputation (%)
Ischaemic (n=15)	0.34±0.29	73	33	7	13	47
Neuropathic (n=2)	0.92±0.21	0	0	0	0	0
Mixed (n=11)	0.34±0.25	55	37	0	18	27
Others (n=2)	0.81±0.38	0	0	0	0	0

*ABI=ankle brachial pressure index of the affected leg.

Table 5. Outcome

Type of ulcer	Healed (%)	Non-healed (%)	Died (%)	Length of hospital stay (days: mean±SD)	Estimated cost* (euro)
Ischaemic (n=15)	27	67	7	24.8±18.6	296,902
Neuropathic (n=2)	50	50	0	24.5±5.0	34,990
Mixed (n=11)	27	64	9	42.2±21.6	347,413
Others (n=2)	100	0	0	18.0±8.5	25,384

*Estimated cost does not include laboratory tests or antibiotic treatment.

patient died in hospital from a myocardial infarction, the cause of death in the second patient is not known. The average duration of each hospital admission was 20.3±30.7 days (see Table 5); one patient spent 220 days in hospital over three separate admissions with problems directly related to his diabetic foot ulceration. Net in hospital expenditure was €704,689, an average of €23,489.63 per hospital admission.

Discussion

This audit estimates the economic impact of diabetic foot ulceration in the Irish hospital setting. Over a one-year period between April 2001 and March 2002 there were 30 admissions to St James's Hospital with diabetic foot ulceration as the primary problem. This year was not exceptional with a similar number of foot-related admissions the previous year. We calculated the net cost of managing diabetic foot disease in one year in these patients to be over €700,000.

This calculation is an underestimate of the impact of diabetic foot disease on the hospital budget. We did not include the cost of routine blood testing or of antibiotic treatment during the hospital stay. Since diabetic foot ulcer patients are often very sick, are either pre or post surgery and have numerous coexisting medical conditions then it is reasonable to assume that blood tests were taken on a daily or alternate day basis. Other studies have shown the cost of antibiotic treatment to be between 5% and 11% of total direct hospital costs in the management of diabetic foot disease.[8,9] Therefore at least an extra €100,000 could be added to the net hospital cost when blood testing and antibiotic therapy are included. While this audit focused on the economic burden of diabetic foot ulceration in the hospital setting, it is important to remember the community healthcare costs and the psychological impact of foot ulceration on our patients with diabetes, in particular those patients who unfortunately underwent an amputation. Patients with non healing ulcers were reviewed regularly by public health nurses, community and hospital podiatry services and attended the hospital outpatient department up to six times a year following discharge. Unfortunately there are no published data on the overall cost of managing a foot ulcer on an outpatient basis in Ireland but in Europe outpatient dressings and nursing time contribute most to the cost of care for foot ulcer patients.[9,10]

The audit also emphasises the significant morbidity and mortality associated with diabetic foot ulceration. In general diabetic patients with foot ulceration have poor glycaemic control and a high incidence of coexistent vascular risk factors.[11,12] They are unable to mount a systemic white cell response despite the presence of active infection,[13] the ulcers are infected with polymicrobes and require prolonged courses of combination antibiotic therapy but unfortunately despite extensive use of resources the amputation rate remains high, close to 27% in our audit.[14]

Therefore the treatment of diabetic foot ulceration should focus on primary and secondary prevention. The presence of one foot ulcer is strongly predictive of new ulceration.[15] Similarly primary prevention is crucial, education, regular surveillance, a specialised diabetes foot clinic, identification of the high risk foot with appropriate targeted care should in theory reduce the incidence of diabetic foot ulceration, amputation rates and be cost effective.[16] An intensive diabetes foot programme involving patient foot education, regular podiatry and appropriate footwear, has recently been shown to significantly reduce the hospital admission rate for diabetes foot ulcers, the number of

investigations performed, the length of hospital stay, and overall saved an American hospital approximately US$5,000 per person when compared to a standard foot programme.[17]

In conclusion, foot ulceration and amputation are known and feared by almost every person with diabetes and have a huge economic impact on our healthcare services. Yet these are potentially the most preventable of all diabetic complications by the simplest techniques of education and care. Successful management of diabetic foot ulceration requires a multidisciplinary approach within the hospital with specialised foot care teams and close collaboration between primary care and the hospital service.

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Correspondence to: Professor John Nolan, Department of Endocrinology, St James's Hospital, James's Street, Dublin 8. Email:jnolan@stjames.ie