Diabetes mellitus and non-traumatic lower extremity amputations in four public sector hospitals in Cape Town, South Africa, during 2009 and 2010

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Background. Diabetes mellitus (DM) is the most commonly reported cause of non-trauma-related lower extremity amputations (LEAs) worldwide, but there is a dearth of such information for South Africa (SA).

Objectives. To examine the proportion of LEAs due to diabetes and to describe the associated characteristics of these patients.

Methods. A retrospective analysis of all LEAs was performed in four public sector hospitals in Cape Town, SA, for 2009 and 2010. Operating theatre records were reviewed to identify all patients who had an LEA. Patient records were perused and information extracted using a structured questionnaire.

Results. Records for 941 of 1 134 patients identified as having an LEA were found (recovery rate 82.9%). Of the 867 patients with 1 280 LEAs included in the study, 925 LEAs were in 593 patients with DM and 355 LEAs in 274 non-DM patients. Therefore 72.3% (95% confidence interval CI 69.8 - 74.7) of LEAs were in people with DM, while 68.4% (95% CI 65.2 - 71.4) of the total patients had DM. The DM group underwent more multiple LEAs (42.0% v. 23%; p<0.001) and had more multiple admissions (14.3% v. 7.7%; p<0.005) than the non-DM group. Infection (85.7% v. 63.5%; p<0.001) and ulcer (25.3% v. 15.3%; p=0.001) were the leading causes for LEA in the DM group compared with the non-DM group. Ischaemia was the dominant cause in the non-DM patients (49.3% v. 23.3%; p<0.001), as was smoking (69.7% v. 43.5%; p<0.001), compared with the DM patients.

Conclusions. These data demonstrate an alarming burden of LEAs due to DM in the public sector in Cape Town. Given that the majority of LEAs are preventable with adequate education, screening, treatment and follow-up, effective interventions are needed.
details, diabetic status, type and treatment, associated comorbidities, risk factors, cause, amputation details and complications.

Trauma-related LEAs were excluded. Of the non-trauma-related LEAs, patients whose diabetic status was unknown were also excluded.

Descriptive analysis included percentages for categorical data, means, medians, standard deviations and ranges for numerical data where appropriate. Tests of significance included the χ2, Fisher’s exact and Wilcoxon tests. Statistical significance of \( p<0.05 \) was used.

The study was approved by the University of Cape Town Ethics Research Committee, HREC Ref: 365/2011. Permission to access patient records from the various hospitals was received.

Results

As seen in Fig. 1, records for 941 patients were found from the 1 134 patients identified as having an LEA from theatre records, a recovery rate of 82.9%. After exclusion of 39 patients who had a traumatic LEA and a further 35 with unknown DM status, a total of 867 patients with 1 280 LEAs remained, 593 DM patients with 925 LEAs and 274 non-DM patients with 355 LEAs; 72.3% (95% CI 69.8 - 74.7) and 27.7% (95% CI 25.4 - 30.3) of the LEAs were therefore in DM and non-DM patients, respectively. Of the total number of patients, 68.4% (95% CI 65.2 - 71.4) had DM.

The mean age (standard deviation (SD)) of all included patients was 62.2 (12.7) years. There was no significant difference in the mean age of men and women within and between the DM and non-DM groups. There were similar proportions of men and women in the DM group (50.1% and 49.9%, respectively), but twice as many men as women in the non-DM group (66.8% v. 33.2%, \( p<0.001 \)). (The patient records no longer include a population classification code, so this information is not reported.)

Type 2 DM accounted for the majority of the patients in the DM group (n=351, 92.9%); 7 patients (1.2%) had type 1 DM, while the type of diabetes was unknown in 35 (5.9%). Regarding therapy, 299 (50.4%) were on oral therapy, 104 (17.5%) were on insulin, 128 (21.6%) were on a combination of oral and insulin therapy, 3 (0.5%) were on no therapy, 7 (1.2%) were on diet alone and therapy in 52 (8.8%) was unknown.

Table 1 summarises the comorbidities, risk factors, causes and complications associated with an LEA in the DM and non-DM groups.

**Comorbidities.** Hypertension, ischaemic heart disease (IHD) and renal impairment were significantly more common in the DM group than in the non-DM group (\( p<0.001 \)). Conversely, associated alcohol use, asthma/chronic obstructive pulmonary disease (COPD) and HIV infection, were more common in the non-DM than the DM group (\( p<0.001 \)), but associated cerebral vascular accidents (CVAs)/transient ischaemic attacks (TIAs) and congestive cardiac failure frequencies did not differ in the DM and non-DM groups.

**Associated risk factors.** Smoking was the only associated risk factor that was significantly different between the two groups (43.5% in the DM group and in 69.7% in the non-DM group; \( p<0.001 \)).

**Causes of the LEAs.** Infection was the major cause of LEAs in both groups, albeit significantly higher in the DM group (\( p<0.001 \)). Ischaemia accounted for a significantly greater proportion of LEAs in the non-DM group (\( p<0.001 \)), whereas an ulcer was responsible for a significantly greater proportion of LEAs in the DM group (\( p=0.001 \)). Less common causes, including burns (\( p<0.05 \)), were more common in the DM group, while malignancy (\( p<0.01 \)), limb deformity (\( p<0.05 \)), neurological disorder (\( p<0.01 \)) and HIV vasculopathy (\( p<0.01 \)) were more common in the non-DM group.

**Complications associated with the LEAs.** There were significant differences for the main complications between the two groups, with a further LEA, sepsis and debridement being more common in the DM group than the non-DM group (\( p<0.05 \)). There was no significant difference for the other main complications of in-hospital death, blood transfusion, and intensive care unit (ICU) admission, or regarding other complications of deep-vein thrombosis (DVT), upper gastrointestinal tract (GIT) bleed and pneumonia between the DM and non-DM groups, although these numbers were very small.

The median duration of hospital admission was 9 days, with an interquartile range of 7 days for both groups, and a range of 1 - 45
days for the DM patients and 1 - 79 days for the non-DM patients. The 867 patients in the study were admitted 988 times; there were 688 admissions in the 593 DM patients and 300 admissions in the 274 non-DM patients. Multiple admissions were more common in the DM patients (14.3%) compared with the non-DM patients (7.7%) ($p<0.005$).

The DM group had a greater proportion of current multiple LEAs than the non-DM group (42% vs. 23%, $p<0.001$), while 20.4% in the DM group and 17.2% in the non-DM group had an LEA prior to the commencement of the study.

As seen in Fig. 2, the proportions of multiple toeectomies and TMAs did not differ significantly between the two groups. However, the proportions of single toeectomies ($p=0.002$), SMAs ($p<0.0001$), and BKAs ($p<0.0001$), were higher in the DM patients, while TKAs ($p<0.0001$) and AKAs ($p<0.0001$) were higher in the non-DM group.

### Discussion

DM accounted for the vast majority of non-traumatic LEAs performed in 2009 and 2010 in four public sector hospitals in Cape Town. On average six (number rounded up from 5.7) DM patients had nine (number rounded up from 8.9) LEAs per week over the 2-year period.

These data highlight the considerable burden that diabetes-related LEAs impose on local health services. This is in keeping with numerous studies conducted elsewhere that have stated that LEAs represent a considerable cost for such services, not only for the admission and amputation, but also for the additional components of rehabilitation, home care and social services.$^{[6,9,17,18]}$ The human cost is also considerable for the patients, their families and society. The best way to decrease these costs is to decrease the number of foot complications, including LEAs.

### Table 1. Comparison of comorbidities, risk factors, causes and complications between DM and non-DM patients having a lower extremity amputation

<table>
<thead>
<tr>
<th>Comorbidities</th>
<th>DM group n (%)</th>
<th>Non-DM group n (%)</th>
<th>$p$-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertension</td>
<td>493 (83.1)</td>
<td>148 (54.0)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>CVA/TIA</td>
<td>76 (12.8)</td>
<td>40 (14.6)</td>
<td>0.4735</td>
</tr>
<tr>
<td>Ischaemic heart disease</td>
<td>103 (17.4)</td>
<td>29 (10.6)</td>
<td>0.0097</td>
</tr>
<tr>
<td>Alcohol</td>
<td>28 (4.7)</td>
<td>41 (15.0)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Asthma/COPD</td>
<td>24 (4.1)</td>
<td>27 (9.9)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Congestive cardiac failure</td>
<td>33 (5.6)</td>
<td>8 (2.9)</td>
<td>0.088</td>
</tr>
<tr>
<td>Renal impairment</td>
<td>28 (4.7)</td>
<td>3 (1.1)</td>
<td>0.0074</td>
</tr>
<tr>
<td>HIV</td>
<td>2 (0.3)</td>
<td>23 (8.4)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Risk factors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypercholesterolaemia</td>
<td>75 (12.7)</td>
<td>27 (9.9)</td>
<td>0.2359</td>
</tr>
<tr>
<td>Smoking</td>
<td>258 (43.5)</td>
<td>191 (69.7)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Peripheral vascular disease</td>
<td>138 (23.3)</td>
<td>76 (27.7)</td>
<td>0.1563</td>
</tr>
<tr>
<td>Peripheral neuropathy</td>
<td>13 (2.2)</td>
<td>3 (1.1)</td>
<td>0.2653</td>
</tr>
<tr>
<td>Causes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ulcer</td>
<td>150 (25.3)</td>
<td>42 (15.3)</td>
<td>0.001</td>
</tr>
<tr>
<td>Infection</td>
<td>508 (85.7)</td>
<td>174 (63.5)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Ischaemia</td>
<td>138 (23.3)</td>
<td>135 (49.3)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Complications</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In-hospital death</td>
<td>34 (5.7)</td>
<td>17 (6.2)</td>
<td>0.7841</td>
</tr>
<tr>
<td>Further amputation</td>
<td>250 (42.2)</td>
<td>63 (23.0)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Blood transfusion</td>
<td>65 (11.0)</td>
<td>24 (8.8)</td>
<td>0.3206</td>
</tr>
<tr>
<td>Diabetic ketoacidosis</td>
<td>12 (2.0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICU admission</td>
<td>10 (1.7)</td>
<td>5 (1.8)</td>
<td>0.5399</td>
</tr>
<tr>
<td>Sepsis/debridement</td>
<td>52 (8.8)</td>
<td>13 (4.7)</td>
<td>0.0364</td>
</tr>
<tr>
<td>Other complications* total</td>
<td>9 (1.5)</td>
<td>4 (1.5)</td>
<td>0.9781</td>
</tr>
</tbody>
</table>

*Other complications included vascular event, DVT, upper GIT bleed and pneumonia.

![Fig. 2. Distribution (%) of current LEAs by site in the DM and non-DM patients. (*Indicates significant differences ($p<0.002$) between DM and non-DM groups.)*](image-url)
This study found that the associated comorbidities of hypertension, IHD and renal impairment were more common in the DM patients. This is similar to other studies and is thought to be due in part to the increasing westernisation of lifestyles. The associated renal impairment probably reflects complications of DM due to poor glycaemic control.

Smoking was the only associated risk factor found to be different, being more prevalent in non-DM patients. This was also reflected in the fact that associated asthma/COPD was more prevalent in the non-DM group. Yet a large proportion of DM patients (43%) smoked, which is of concern, as smoking is known to increase the risk of LEAs in people with DM. Associated peripheral vascular disease (PVD) was similar between the DM and non-DM groups, with about 25% of patients noted to have PVD as a risk factor, which is similar to a previous study. This study found only a small number of patients with associated peripheral neuropathy in the DM group, yet peripheral neuropathy is known to be a substantial cause of foot complications including LEAs. The number of patients with associated peripheral neuropathy is probably artificially low, reflecting under-reporting in the patient records.

A preceding ulcer and infection were the more common causes for LEAs in the DM patients, which is in keeping with what previous studies have shown. Echaemia was the most common cause for LEAs in the non-DM patients, perhaps reflecting the higher rate of smoking in this group. Burns causing LEAs were more common in the DM group and can probably be attributed to associated peripheral neuropathy. Under-reporting of peripheral neuropathy probably reflects failure on the part of healthcare workers to screen for this complication. They are therefore not educating patients on the danger of infections, burns, etc.

Post-LEA sepsis and debridements were found to be more common in the DM patients. This was expected, as sepsis was often the cause for the LEA in this group. Nearly 20% of LEAs in DM patients were SMAs. This indicates that sepsis was a major cause, as this operation is usually a sepsis control procedure, the definitive procedure being a BKA or AKA. It is also notable that the percentage of AKAs in the non-DM group was double that in the DM group. This may be because DM patients have more LEAs due to an ulcer or infection, requiring a more distal amputation, whereas non-DM patients have more LEAs due to ischaemia, requiring a more proximal amputation. The greater proportion of current, multiple LEAs in the DM group compared with the non-DM group reflects the fact that ‘creeping’ LEAs, i.e. multiple LEAs that start distally and progress proximally, are more prevalent in the DM group.

The strengths of this study are the large numbers of patients identified with a good recovery rate, as well as similar methodology employed as in other global studies. However, it has a number of limitations. Its retrospective nature allowed only for information recorded in the patient folders to be evaluated. Accurate data for comorbidities, risk factors, causes and complications associated with a LEA would require a prospective study. The records often revealed limited information on other factors such as the level of glycaemic control, duration of DM and obesity. The study was undertaken only in the public sector, thus underestimating the true burden of diabetes-related LEAs. Because of the lack of accurate data on DM incidence and population size in the study area, it is difficult to extrapolate the number of LEAs identified in this study to the prevalence of diabetes-related LEAs.

It is well known that the majority of foot complications, including LEAs, are preventable with adequate patient education, screening, treatment and follow-up. In this regard we have previously demonstrated that a third of patients attending primary care clinics in Cape Town had ‘at-risk feet’ although this had often been unre corded in the clinic notes. A number of reasons may account for suboptimal foot care: high patient numbers and decreased consultation times leading to infrequent foot examinations, limited opportunities for patient education and therefore non-adherence, as well as inadequate overall treatment at a primary healthcare level. While preventive diabetes foot care is not the sole preserve of the doctor or a podiatrist, it is important to note that there is a lack of podiatrists to adequately prevent and treat these complications. Nurses, health promoters and community health workers can all contribute to a diabetes foot programme, but would need to receive appropriate training to enable patients to be active participants in their own care, to screen for at-risk feet and to refer appropriately for further management.

Conclusions

This study highlights the enormous burden of LEAs in the public sector. There is clearly an urgent need to develop and implement foot care programmes to reduce the personal, societal and disease management costs associated with LEAs. This study provides a baseline against which the effectiveness of interventions can be measured in the future.

References