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Taking the next step in 2005, the year of the diabetic foot

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ABSTRACT

Objectives: To determine the age-standardized rate of lower limb amputations among Type 2 diabetics admitted to the Port of Spain General Hospital (POSGH), San Fernando General Hospital (SFGH) and Sangre Grande County Hospital (SGCH) for the period 2000–2004. To determine in-hospital mortality following amputation, for the same period. To determine the risk factors that contributed to diabetic foot complications.

Design and methods: All patients who had a lower limb amputation at the three major public health institutions in Trinidad during the study period were enrolled. In addition patients attending the surgical out-patient clinic and currently admitted to the ward with a diabetic septic foot was selected for the administration of a questionnaire to determine the major contributing factors. Data on the type of amputation, age, sex, ethnicity, from which an age-standardized mortality rate, was determined for the age group 30–60.

Results: Of 822 patient files examined, 515 (80%) of these major amputations were performed on Type 2 diabetics, of which 352 (68%) were AKA and 163 (32%) were BKA. The AKA:BKA ratio for the period 2000–2004 was 2.2:1. There was a significant difference between the mean ages at which females had a major amputation to males ($p = 0.001$). The overall ratio of Africans to South East Asians was 1.5:1 amongst the Type 2 diabetic amputees. For major amputations the average length of stay was found to be 22.5 (0–192) days.

The age-standardized rate for the age group 30–60 was 13.85 per 100,000 for 2004. Of 66 deaths, 31 (47%) were septicemia cases and 14 (21%) cardio-respiratory failure cases. Finally, of 97 persons interviewed, the major causative agent for diabetic foot complications and amputations was foot trauma (51%).

Conclusion: Type 2 diabetic amputation status of Trinidad would seem to have improved as shown by this study. However, steps must be taken to improve patient awareness about prevention and care of the diabetic foot. Doctors must also seek to increase their vigilance when screening diabetic patient in the primary care setting in order to prevent the late detection and treatment of the septic lower limb.

1. Introduction

Of the many complications associated with Diabetes Mellitus (DM) [1] a lower-extremity amputation continues to present a major challenge to primary care physicians. The prevalence of DM in Trinidad is approximately 20% and therefore most patients are managed in a primary care setting. If a lower-extremity amputation is indicated the patient is referred for

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tertiary care. The only previously published data by Gulliford et al. showed an age-standardized rate of diabetic amputations in the general Trinidadian population aged 30–60 years of 54 per 100,000 [2]. In contrast, in 2000 a population-based study of diabetic amputations conducted in Australia reported a prevalence of 14 per 100,000 [4]. Although there is a 5-year difference in these studies it underscores the large disparity in the occurrence of diabetic amputations in a developed country compared to a developing country. Amputations arise from sepsis (57%), ischemia (13%) or a combination of both sepsis and ischemia (25%) [2]. In addition, as much as 37% (36/97) of diabetic amputees die within 6 months of surgery [5]. The population consists of two major diaspora Africans and South East Asians equally distributed [6]. The St. James Cardiovascular Study by Beckles and Miller showed that the prevalence of Type 2 DM was higher among South East Asians while hypertension was higher in Africans [7]. Therefore, ethnicity may impact on the occurrence of lower-extremity amputation.

The focus of this study is to determine the current age-standardized rate of lower limb amputations among Type 2 diabetics admitted to the three major tertiary care centers on the island, i.e. the Port of Spain General Hospital (POSGH), the San Fernando General Hospital (SFGH) and the Sangre Grande County Hospital (SGCH), for the period 2000–2004, in order to compare rates previously reported. In addition, the current in-hospital mortality rate was measured for the first time. The study also explored risk factors associated with the development of diabetic lower limb complications.

2. Methodology

The study design was a descriptive retrospective observational analysis conducted at the three major public health institutions, which perform lower limb amputations in Trinidad. The study population consisted of patients who met the following entry criteria: (1) Type 2 diabetics [8], (2) major amputation and (3) diabetic amputees who died within 28 days of their postoperative in-hospital stay [9]. All eligible participants were selected by convenience. The patients were sub-divided according to level of amputation [ICD-9 procedure codes for transmetatarsal/toe, below knee (BKA), and above knee (AKA)]. A BKA is preferable to an AKA as the patient retains range of movement as well as expends less effort to walk with a prosthesis. With extensive sepsis or a poor distal blood supply an AKA may be necessary. Therefore, the AKA:BKA ratio is useful as a marker of severity of the diabetic foot.

If on admission, more than one amputation was performed on one leg, the highest level of amputation was recorded. If amputations of both legs were performed, each leg was dealt with separately. Multiple admissions for a single patient were considered separately. A review of the surgical register was conducted to obtain the initial data set. Then, each eligible patient's medical record was found in order to establish reliability and validity of the data.

Relevant demographic data, dates of admission, operation and discharge, and type of operation were recorded. To determine in-hospital mortality rate and the major causes of death, data was collected on mortality within 28 days of a lower limb amputation, the date of death and the cause of death. The direct method was used to calculate the age-standardized rate of major amputations among Type 2 diabetics. Age standardization of the population of Trinidad, stratified by age group [10], was performed with reference to the standard world population [11].

The risk factors that contributed to diabetic foot complications were explored by administering a pre-tested questionnaire to a convenient sample of 100 subjects. Three incompletely answered questionnaires were discarded. The sample consisted of Type 2 diabetics with foot complications in surgical wards and Surgical Out Patient Clinics (SOPCs). Foot complications included ischemia, sepsis, neuropathy and amputation. Foot inspection was adequate if the soles and inter-digital spaces of feet were examined on a daily basis. The point of care, either primary health care facility or hospital's 24-h accident and emergency (A&E) service was noted. Immediate medical care meant that the above facilities were accessed within 24 h of noting a foot lesion. The patient's knowledge on the diabetic foot and their source of knowledge was also noted. Avoidable injuries included improper footwear, improper foot care and direct trauma. All analyses were conducted using the Statistical Package for the Social Sciences, Version 13.0 and Microsoft Excel®2003. *T*-tests and chi-squared tests were used to determine significant differences between both continuous and categorical variables. The level of significance was set at $p \leq 0.05$. A univariate logistic regression model determined the risk factors that were predictors of amputation for Type 2 diabetics with foot complications.

1143 major and minor lower limb amputations were obtained from surgical registers for 2000–2004, but only 822 (72%) patient records were available for analysis. The surgical register for the period January 2000 to May 2002 at the SFGH was reported lost. This underestimated the reported rates for 2000–2002. 444 (69%) amputations were confirmed at POSGH; 146 (73%) amputations at SGCH and 232 (77%) amputations at SFGH for the period 2003–2004.

3. Results

Of the 822 patient records analyzed, there were 643 (78%) major amputations. 515 (80%) of the major amputations occurred in Type 2 diabetics. Of these 515, 352 (68%) were AKA and 163 (32%) were BKA (AKA:BKA ratio 2.2:1). 15 of the 352 AKA were previously BKA. There were 179 minor amputations, of which 157 (88%) patients had Type 2 diabetics (Table 1).

Due to the absence of data from SFGH for 2000–2002, only data from 2003 to 2004 could be analyzed. For this period, POSGH had an AKA:BKA ratio of 3.1:1, SFGHs AKA:BKA ratio was 2.7:1 and SGCHs AKA:BKA ratio was 0.4:1.

Among patients with major amputations there were 259 males and 256 females (Table 2). The male:female ratio was therefore 1. The average age for male Type 2 diabetic amputees at POSGH, SFGH and SGCH was 65.1, 64 and 67.3 years, respectively. The average age for their female counterparts were 69.2, 65.7 and 68.1 years, respectively. Among males the highest incidence of amputations occurred in the age group 60–64 versus 70–74 in females ($p = 0.001$).

Table 1 – Types of Type 2 DM lower limb amputations in the three (3) major hospitals from 2000 to 2004

Year	Port of Spain				San Fernando					Sangre Grande				
	Major amp.[a]			Minor amp.[a]	TA[a]	Major amp.[a]			Minor amp.[a]	TA[a]	Major amp.[a]			Minor amp.[a]	TA[a]
	AKA	BKA	TMA[a]			AKA	BKA	TMA[a]			AKA	BKA	TMA[a]		
2000	30	14	**44**	17	**61**	N/A	N/A	N/A	N/A	N/A	2	6	**8**	5	**13**
2001	41	12	**53**	13	**66**	N/A	N/A	N/A	N/A	N/A	7	5	**12**	10	**22**
2002	47	28	**75**	11	**86**	24	6	**30**	3	**33**	7	1	**8**	13	**21**
2003	44	15	**59**	10	**69**	41	17	**58**	15	**73**	8	15	**23**	24	**47**
2004	47	14	**61**	10	**71**	51	17	**68**	12	**80**	3	13	**16**	14	**30**
Total	**209**	**83**	**292**	**61**	**353**	**116**	**40**	**156**	**30**	**186**	**27**	**40**	**67**	**66**	**133**

Bold values are significant at $p < 0.05$.

[a] TMA, total major amputation; TA, total amputation; Amp, amputation.

Table 2 – Demographic composition of the study population

	Age ranges						
	31–40	41–50	51–60	61–70	71–80	81–90	91–100
Male	2	23	73	79	57	23	2
Female	3	17	52	60	71	47	6
African	1	14	50	77	86	46	7
South East Asian	4	23	62	54	31	9	0
Mixed	0	3	13	8	11	15	1

The ratio of Africans to South East Asians was 1.5:1 amongst the 515 Type 2 Diabetic amputees ($p < 0.001$). Further analysis of ethnicity for 2003–2004 at SFGH, POSGH and SGCH, showed that Africans accounted for 44 (34%), 71 (59%) and 23 (59%) cases, respectively whereas South East Asians accounted for 71 (55%), 33 (28%) and 14 (36%) cases, respectively. Therefore, the African:South East Asian ratios were 0.53:1, 2.1:1 and 1.64:1, respectively.

The average length of hospital stay was 22.5 days with AKA being 21.3 days and BKA being 23.7 days, showing no difference when stratified by hospital (Table 3).

The age-standardized amputation rate in 2004 for the age group 30–60 was calculated as 13.85 per 100,000 (Table 4).

The total number of in-hospital deaths of the 515 Type 2 diabetic amputees was 66 (12.8%). The average ages for female mortality for the years 2000, 2001, 2002, 2003, 2004 were 75.2, 74.5, 68.8, 72.9 and 70.3, respectively while the average ages for males were 65.0, 76.8, 62.6, 77.2 and 66, respectively.

Most common causes of mortality postoperatively in all three hospitals	
Septicemia (47%)	Peripheral vascular disease (11%)
Cardio-respiratory failure (21%)	Myocardial infarction (14%)
Ischemic heart disease (15%)	COPD
Cerebro-vascular accident (9%)	Chronic renal failure

These causes of mortality are not mutually exclusive.

97 of the 100 questionnaires met the criteria for use in the study. 53% of patients had avoidable injuries necessitating hospital admission. 64% received information on diabetes from doctors, 40% from family, 27% from clinic, 8% from newspapers and 5% from television and friends. Three main causes of diabetic foot complications included trauma (51%), improper foot wear (25%) and nail maintenance problems (7%). 59% of patients reported that they administered self-treatment after injuring their feet (Table 5).

Table 3 – Average length of stay and stay range by hospital for the period 2000–2004

Hospital	Duration of stay for operation (days)		*p* values
	Major amputation	Minor amputation	
POSGH	23.1 (0–192)	24.6 (1–97)	0.513
SFGH	20.3 (1–160)	46.9 (5–188)	0.016
SGCH	23.3 (5–63)	21.2 (0–62)	0.21

Table 4 – In-hospital mortality data stratified by hospital for period 2000–2004

	Port of Spain	San Fernando	Sangre Grande	Total
Gender				
Male	15	4	10	29
Female	19	11	7	37
Ethnicity				
South East Asian	9	12	7	28
Mixed	3	1	3	7
African	22	2	7	31
Type of amputation				
AKA	30	14	11	55
BKA	4	1	6	11
Average age of death	72	66	75	71

Table 5 – Diabetic amputation status by risk factor categories

Independent variables	Number of cases	# major of amputation	B	Adjusted OR	95.0% C.I. for adjusted OR		p value
					Lower	Upper	
Daily foot inspection							
No	51	9 (18%)	−0.5	0.61	0.23	1.61	0.32
Yes	46	12 (26%)		1			0
Point of care							
Clinic/G.P.	68	15 (22%)	0.08	1.08	0.37	3.15	0.88
A&E/hospital	29	6 (21%)		1			0
Immediate medical care							
No	58	13 (22%)	0.11	1.11	0.41	3.02	0.82
Yes	39	8 (20%)		1			0

Self-administered interventions included

Aloe Perfoliata leaves	Oral antibiotics
Bacitracin Neomycin Tyrothricin (BNT) powder	Hibitane
Magnesium sulphate	Edinborough University solution antiseptic
Paraffin wax (soft candle)	Hydrogen peroxide
Iodex	Sterile needle to puncture fluid-filled blisters

Univariate analyses using logistic regression determined which risk factors were adequate predictors of an amputation for a Type 2 diabetic. However all p values were greater than 0.05.

4. Discussion

An important finding is that most major amputations, i.e. 515 (80%) are done for complications of Type 2 DM. Broome in Barbados reported 61% of amputations occurred in Type 2 diabetes [12] and Aulivola et al. reported 80.6% in the USA [13].

The total AKA:BKA ratio was 2.2:1. This is higher than the AKA:BKA of 1.7:1 reported by Naraynsingh et al. in 2002 [4]. An AKA may be more preferable in our setting because of advanced pathology. This concurs with this study's high in-hospital mortality. Parvin in the UK reported that diabetic patients attained AKA:BKA close to 1 [14]. This is in keeping with the aim to improve mobility at the knee joint.

The average age at which females have a major amputation is higher than males ($p = 0.001$). This may be attributed to better female compliance as highlighted in the International Central European study [15]. Additionally, in Trinidad and Tobago, life expectancy in females is 73.2 years and males 68.4 years [16] indicating that females live longer [17].

On investigation of the two major ethnic groups in Trinidad, Africans represented the majority (55%) of Type 2 diabetic amputees. Naraynsingh et al. reported similar findings in Type 2 diabetics with 75.5% Africans having major amputations compared to 21.4% South East Asians [18]. This may appear divergent from the St. James cardiovascular study which showed a higher rate of diabetes among South East Asians versus Africans [7]. Furthermore, Gulliford et al. reported annual admission rates of diabetics to the POSGH was 33% higher in the South East Asians [3]. Therefore though more South East Asians are admitted to the POSGH, more Africans than South East Asians have major amputations in Type 2 diabetics.

According to the Ministry of Health (2001), the average hospitalization stay is 3.7 days and for diabetic patients, 5.8 days. Therefore diabetics stay 36.2% longer in the hospital than the average patient. Our study showed that average length of stay of the Type 2 diabetic amputee was 22.5 days versus 22.2 days reported by Narayansingh et al. [18] indicating an unchanged length for the period 1993–2005. This increases the burden on health care facilities.

Our age-standardized amputation rate for age group 30–60 was 13.85 per 100,000 in 2004 compared to 54 per 100,000 reported by Gulliford [2]. Notwithstanding the 72% retrieval rate, the diabetic amputation rate for 2004 still represents a decrease from Gulliford et al. [2]. This may be attributed to better management practices, increased knowledge about the diabetic foot and changes in patients' foot care practices.

The in-hospital mortality rate of Type 2 diabetic amputees of 12.8% was high in comparison to 5.8% in USA (1989–1992) [19] and 10% in Newcastle, U.K. [20].

Mortality among amputees was attributed mainly to septicemia (47%) and cardio-respiratory failure (21%). This is consistent with findings reported by Rahaman et al., which reported overwhelming sepsis and "multiorgan failure" as the major causes (54%) of death among Type 2 diabetic amputees [21]. It is however important to note that these causes of death are not mutually exclusive.

Our study showed that the ratio of deaths following AKA and BKA was 5:1, however Rahaman et al. reported that the AKA mortality rate was 26% while the BKA mortality rate was 10% [21].Of the 97 questionnaires, 51 patients (52.5%) had avoidable foot injury and subsequent infection. Jackman and Walrond stated that 75% of diabetics had avoidable injuries precipitating hospital admission. Only two patients were aware of the serious nature of the injury [22].The primary sources of information on diabetes came from doctors (62%), family members (39%) and clinics/nurses (26%). These patients attended public health clinics and hospitals but received no information from the Health Education Unit of the Ministry of Health. These primary sources should be used to promote preventative strategies in diabetic foot care.

Past studies showed that risk factors for diabetic foot amputations are neuropathy, peripheral vasculopathy and lack of patient education [23]. Pecoraro et al. reported that though component causes are insufficient individually they are required components for an outcome [24]. This, in addition to the small sample size, may have affected the success of our model. Future studies should use a larger sample size in order to re-evaluate the significance of our risk factors.

The Type 2 diabetic amputation rate has declined in Trinidad. Primary care practices positively influencing the amputation rate are the institution of measurement of HbA_{1C} levels and the availability of free medication on the government's Chronic Disease Assistance Plan. However, diabetic amputation is a significant public health problem and continues to challenge surgical care. Since 20% of the Trinidadian population is diabetic, this indicates that emphasis remains on improved diabetic foot care at the level of the primary practitioner since these large numbers of diabetics cannot be managed in tertiary or specialized clinics.

Conflict of interest

All the authors declare that there are no conflicts of interest.

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