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Original Article

Prevalence of risk factors for diabetic foot complications in a Chinese tertiary hospital

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Abstract: Aims: To determine the prevalency of risk factors for diabetic foot complications in diabetic patients free of active ulceration in a hospital setting and to investigate the knowledge of foot care of the patients. Methods: A retrospective study was conducted on a cohort of 296 patients with diabetes hospitalized in a tertiary hospital. A convenience sampling was adopted to recruit subjects during 2012/2013. All completed an interviewer-administered questionnaire and underwent medical assessment including foot examination and assessment of presence of peripheral sensory neuropathy (PSN) and peripheral arterial disease (PVD). The patients were assigned to a foot risk category which was developed by the International Working Group on the Diabetic Foot (IWGDF). Results: 296 inpatients were evaluated. Foot deformity was noticed in 124 patients (42%), hallux valgus was the most prevalent abnormality, found in 65% of patients. Prevalency of neuropathy hypertension, nephropathy and retinopathy were 66.2%, 57.1%, 48.3% and 44.9% respectively. 37 (12.5%) patients had a history of ulceration (n = 33) and/or toe amputation (n = 4). According to the classification system of the IWGDF, 35.1% of patients were considered as having low-risk by the modified IWGDF classification (group 0), and 49% of the study population were at high risk for pedal ulceration (group 2 and 3). There was a clear trend between the increasing severity of the staging and HbA1c, duration of diabetes, prevalence of hypertension, nephropathy and retinopathy and absent of physical activity. The mean knowledge score of foot care was 21.21±3.84. Conclusion: The risk factors for foot ulceration and lack of fool care knowledge was rather common in a hospital-based diabetic population, emphasizing the importance of implementing simple and affordable screening tools and methods to identify high-risk patients and providing foot care education for them.

Keywords: Diabetic foot, risk factors, foot screening, foot care

Introduction

Diabetes has become a major public health issue in China. The age-standardized prevalences of total diabetes were 9.7% accounting for 92.4 million adults with diabetes [1]. The number of hospitalized diabetes increased correspondingly. Endocrine,Nutritional & Metabolic Diseases had been reported as one of 10 Main Diseases of Inpatients in City Hospitals in 2010 and 2011 [2].

Diabetic foot complications are a serious and disabling complication of diabetes. The prevalence of diabetic foot ulcer (DFU) ranges from 4% to 10% in the hospitalized patients and the risk of patients with diabetes developing a foot ulcer in their lifetime could be as high as 25% [3]. The most costly and feared consequence of a foot ulcer is lower-extremity amputation (LEA), it was reported that in a Chinese tertiary hospital, the overall amputation rate among DFU was 21.5% [4] and mortality associated with diabetic LEAs exceeded that of most cancers [5].

It is therefore vital to prevent foot complications. Preventing foot complications begins with identifying those at risk [6]. Risk identification is fundamental for effective preventive management of the foot in people with diabetes and all individuals with diabetes should receive an annual foot examination to identify high-risk foot conditions [7]. The Task Force of the Foot Care Interest Group of the American Diabetes Association (ADA) reported a protocol of comprehensive foot examinations and risk assess-

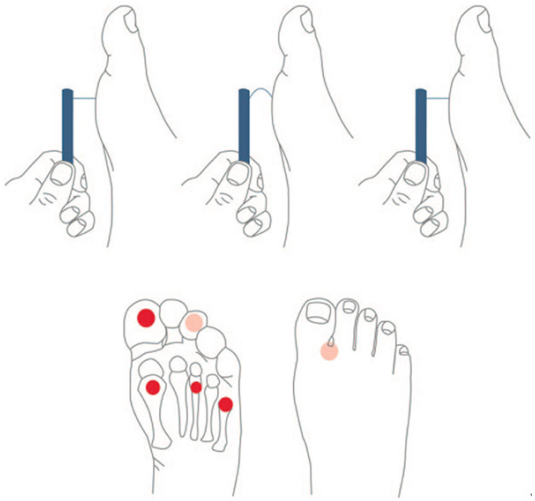

Figure 1. Monofilament Test for Pressure Sensation [8].

Figure 2. Biothesiometer.

ment and recommended that once the patient has been thoroughly assessed, he or she should be assigned to a foot risk category which was developed by the International Working Group on the Diabetic Foot (IWGDF) [8, 9]. High-risk patients should be educated regarding their risk factors and appropriate management, and a non-judgmental assessment of a person's current knowledge and care practices should be obtained first [7].

In Hunan, data on prevalence about diabetic patients at risk for foot ulceration and assessment of patients' knowledge and care practices are scarce. The purpose of this study was to determine the prevalence of risk factories for diabetic foot, to precise the distribution of the patients in the various risk categories as described by the IWGDF, and to investigate the knowledge and practice of foot care among diabetic patients in a hospital setting.

Figure 3. Dopplex Assist; Huntleigh Healthcare, Cardiff, U.K.

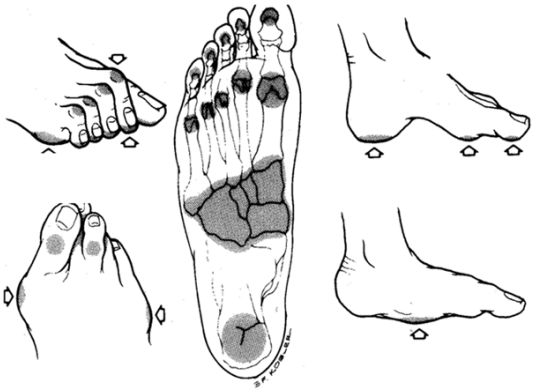

Figure 4. Foot deformities.

Methods

Subjects and setting

A retrospective study (between January 2012 and October 2013) was conducted in endocrinology department of Xiangya hospital. Diabetic patients who did not have current foot ulceration were recruited. All participants had provided consent to participate in the diabetic foot screening and assessment program. Patients that were unable to answer the questions because of altered mental state were excluded from the study.

Data collection

Foot risk factors screening: The clinical tool used during this screening program were based on valid methods of comprehensive foot examination and risk assessment recommended by ADA and American Association of Clinical Endocrinologists(AACE) [8]. The testing modalities and examination methods were carried out by one researcher to ensure uniformity. Each indi-

Table 1. Modified IWGDF risk classification

Risk category	Definition
Group 0	No PSN, no PAD
Group 1	PSN, no PAD, no deformity
Group 2	PAD, or PSN + deformity
Group 3	Ulcer or amputation history

vidual's sociodemographic characteristics and clinical history including duration of diabetes, type of diabetes and therapy, body mass index (BMI), Hemoglobin A1c (HbA1c) reading, lipids level and complications were recorded.

Peripheral sensory neuropathy: 10 g Semmes-Weinstein monofilaments (SWM) and Vibration perception threshold (VPT) testing were used to identify peripheral sensory neuropathy (PSN) [8]. The technique for testing pressure perception with the 10-g monofilament was illustrated in **Figure 1** [8]. The six-point test and single-use disposable monofilaments were used. Firstly, patients were demonstrated the sensation of pressure using the buckling 10 g monofilament on upper arm. With the eyes closed, the patient related to the investigator when and where he or she could feel the monofilament. Areas of callus were avoided when testing for pressure perception. Inability to recognize the perception of pressure as well as identify the correct site were considered as impaired sensation.

The VPT was measured with a Biothesiometer (**Figure 2**. Biomedical Instrument, Newbury, OH). With the patient lying supine, the stylus of the instrument was placed at the tip of the hallux and the amplitude is increased until the patient can detect the vibration. The resulting number is known as the VPT, the mean of three readings was taken over each hallux. A VPT > 25 V was regarded as abnormal and has been shown to be strongly predictive of subsequent foot ulceration [10].

Peripheral arterial disease: Peripheral arterial disease (PAD) was detected by the ankle brachial index (ABI) and qualitative waveform analysis. ABI was the ratio of systolic blood pressure in the ankle to that in the brachial artery. A portable hand held, 8-MHz Doppler probe and blood pressure cuffs (**Figure 3**, Dopplex Assist; Huntleigh Healthcare, Cardiff, U.K) were used to measure ABI and record waveform of dorsalis pedis and posterior tibial arteries. Qualitative waveform analysis was performed by visual interpretation of continuously displayed waveforms. An ABI of 0.90 or less [8] and the on-screen loss of reverse flow (loss of triphasic signal) suggested PAD [11].

Foot deformities and history of ulceration or amputation: Foot deformities were determined by the presence of hallux valgus, claw/hammer toes, prominent metatarsal heads, pes planus, pes cavus and so on (**Figure 4**). Patients were interviewed that whether they have previous ulceration or non traumatic amputation at any level of the lower limb.

Risk status classification: Based on the finding from screening patients were categorized into risk groups using the modified IWGDF risk classification (**Table 1**) [9].

Knowledge of foot care: The survey instrument used was a pre-tested, structured questionnaire developed by Yangqing et al and used in a similar previous study [12]. The questionnaire aimed to investigate 7 aspects of knowledge on foot care, including the susceptibility and the importance of prevention of diabetic foot (4 items), therapeutic footwear and inserts choices (6 items), foot examination (2 items), nails cutting (2 items), walking out (4 items), foot problems management (4 items) and foot care practices(13 items). It consisted of 35 items, and each correct answer was assigned one mark. The reliability and validity of the questionnaire were 0.89 and 0.92 respectively [12].

Statical analysis

Data obtained were analysed using SPSS statistical software version 16. Lacking or questionable data were labelled as inadequate and not taken into account for calculating percentage. Frequency and descriptive statistics were used to examine the general characteristics of the respondents. Comparison between risk groups was done using Pearson's Chi^2 test for qualitative data and Student's *t* test for quantitative variables. $P \leq 0.05$ was considered statistically significant.

Results

Sociodemographic characteristics of the study population

325 diabetic patients were initially examined and interviewed. 29 patients were excluded

Table 2. Sociodemographic characteristics of the study population (n = 296)

Variable name	N/mean ± SD	Percent (%)
Sex		
Male	156	52.7
Female	140	47.3
Age (years)	59.77±11.83 (19~85)	
Level of Education		
Illiterate	11	3.7
Elementary school	74	25.0
Junior high school	93	31.4
High school or technical secondary school	63	21.3
Junior col ledge or university	51	17.2
Graduate	4	1.4
Occupation		
Present	86	29.1
Absent	210	70.9
Smoking		
Current smoker	73	24.7
Ex smoker	122	41.2

due to impossibility to obtain reliable information. So, 296 diabetic patients were finally included whose sociodemographic characteristics are shown on **Table 2**.

Clinical characteristics of the study population

Of the total sample, the majority (96.6%) had Type 2 DM and managed the disease by insulin (85.8%), 58.8% had regular physical activity (at least 150 minutes a week). Foot deformity was noticed in 80 patients (27%), hallux valgus was the most prevalent abnormality, found in 65% of patients. Prevalency of neuropathy hypertension, nephropathy and retinopathy were 66.2%, 57.1%, 48.3% and 44.9% respectively. 37 (12.5%) patients had a history of ulceration (n = 33) and/or toe amputation (n = 4). 35.1% of patients were considered as having low-risk by the modified IWGDF classification (group 0), and 49% of the study population were at high risk for pedal ulceration (groups 2 and 3). **Table 3** displays the clinical characteristics of the study population.

The increase in the risk severity was significantly associated with increase in diabetes duration, presence of hypertension, neuropathy, nephropathy, and absent of regular physical activity (PA). Thus, compared to group 0, patients in group 2 and 3 had diabetes of longer duration; hypertension, retinopathy, nephropathy were significantly more frequent as neuropathy (**Tables 4**, **5**). On the contrary, Age and BMI were not significantly different.

Knowledge of foot care

The knowledge score was shown in **Table 6**. The range of the knowledge score obtained in this study was 0-35 out of maximum possible score of 35. Although 95% of patients were aware that diabetic patients were at risk for foot disorders, majority of the respondent (88.14%) were unware of the effect of therapeutic inserts. 78% did not know how to deal with corn/callus, redness or lesion on their feet. They chose to treat the foot problems by themselves at first, such as using special ointment or sharp instruments to treat corns, and using disinfectants or dressing for wound. 68% of the patients were unaware that planter callosity was related to high planter pressure, and 71% were unware that reducing planter pressure can prevent diabetic foot. In terms of foot hygiene and daily activities, 64% were unware of the importance of drying their feet after every foot wash and likewise (65%) the importance of applying emollients to keep their feet especially the heel from cracked.

Discussion

Diabetes foot ulcers are one of the most feared complication of diabetes and have important effects on the quality of life of affected individual, whereas at the same time they post important demands on the health care system in terms of manpower and costs. Limitation walking, special foot wear, frequent hospital visits or administrations, and the eventual consequences of an amputation all pose a heavy burden on the patient [13]. The implementation of an inpatient diabetic foot service should be the goal of all institutions that care for patients with diabetes. One of the objectives of diabetic foot

Table 3. Clinical characteristics of the study population (n = 296)

Item	N/mean ± SD	Percent
Type of DM		
Type 1	10	3.4
Type 2	286	96.6
Duration of the Disease	7.40±5.78 (0.5~26)	
Oral diabetic agents (OGA)	42	14.2
Insulin therapy	201	67.9
OGA + Insulin	53	17.9
Physical activity		
Present	174	58.8
Absent	122	41.2
Foot deformity	80	27.0
Risk category		
Group 0	104	35.1
Group 1	47	15.9
Group 2	108	36.5
Group 3	37	12.5
Retinopathy		
Present	133	44.9
Absent	163	55.1
Nephropathy		
Present	143	48.3
Absent	153	51.7
Neuropathy		
Present	196	66.2
Absent	100	33.8%
Cardiovascular disease		
Present	79	26.7
Absent	217	73.3
Hypertension		
Present	169	57.1
Absent	127	42.9
Hyperlipidemia		
Present	52	17.6
Absent	244	82.4

services is to prevent foot problems in patients while hospitalized [14]. Key to this preventive strategy is a structured clinical assessment that incorporates diagnostic tests alongside a thorough history and examination [15].

To our knowledge, the present survey was the first done in Hunan province aiming to precise the prevalence of risk factors for foot ulceration and knowledge of foot care in a hospital-based diabetic population. According to the modified IWGDF classification, 35.1% of patients were group 0, 15.9% were group 1, 36.5% were group 2 and 12.5% were group 3. It was a little different from other studies [16, 17]. The screening of foot risk factors in Al-Ain district, United Arab Emirates (UAE) reported that 39% of patients were group 1 and 12% were group 2 [16]. Compared to the prevalence of France, less patients were group 0 and more patients were higher group [17]. It might be explained by the different diagnostic criteria for PSN and PAD. As we know, peripheral neuropathy was the most common component cause in the pathway to diabetic foot ulceration [18]. As neuropathy was frequently asymptomatic, screening regularly this population was of utmost importance [17]. It was recommended that 10-g monofilament plus one of the four clinical tests: the Vibration using 128-Hz tuning fork, pinprick sensation, ankle reflexes and VPT should be regularly performed during the screening exam [8]. To increase the specificity and sensitivity, 10-g monofilament plus VPT were used to screen PSN in our study. While Diabetic Neuropathy Symptoms (DNS) along with the Diabetic Neuropathy Examination (DNE) scores were used together in UAE study, and the inability to feel the 10 g SWM was used in France study. As for PAD, it was determined by ABI, qualitative waveform analysis and symptoms of lower-limb claudication other than just ABI or palpitations of the foot pulses. The ankle brachial index (ABI), a primary non-invasive screening test for PAD, was an objective measure and a risk-assessment tool with a level of sensitivity [19]. However, because the ABI calculation uses the higher pressure in the lower extremity instead of the lower pressure, it may potentially miss distal disease, thus underestimating the severity and prevalence of PAD [20]. Qualitative waveform analysis was reported as the most effective screening tool among ABI and pulse palpation [21]. The high prevalence of PSN, PAD and foot deformity in our population explained that 52.4% of the patients were at risk and 12.5% were classified in the highest-risk category.

The most important point of the study was the high prevalence of risk factors for foot ulceration. 12.5% of the sample had a history of ulceration and/or amputation and therefore at very high-risk of (re)ulceration. It might be explained by the hospital recruitment bias.

Table 4. Comparison between patients in group 0 (no risk) and group 2-3 (high and very high risk)

Variables	Risk group		*T*	P
	Group 0 (n = 104)	Group 2+3 (n = 145)		
	$\bar{X}$±S	$\bar{X}$±S		
Age	59.45±11.08	60.32±12.68	-0.56	0.58
Diabetes duration	4.40±3.77	9.157±6.19	-6.96	0.00
BMI	24.11±4.16	23.89±3.37	0.44	0.66
HbA1c	8.94±2.73	10.14±2.67	-3.45	0.00
TC	4.71±1.57	4.58±1.18	0.78	0.44
HDL	1.26±0.64	1.29±0.33	-0.38	0.71
LDL	2.65±1.11	2.59±0.96	0.49	0.63

Table 5. Comparison between patients in group 0 (no risk) and group 2-3 (high and very high risk)

Variables		Risk group		X^2	P
		Group 0 (n = 104)	Group 2+3 (n = 145)		
		N (%)	N (%)		
Hypertension	Present	52 (50%)	93 (64%)	5.04	0.03
	Absent	52 (50%)	52 (36%)		
Retinopathy	present	27 (26%)	80 (55%)	15.19	0.00
	Absent	77 (74%)	65 (45%)		
Nephropathy	present	36 (35%)	83 (57%)	12.97	0.00
	Absent	68 (65%)	62 (43%)		
Neuropathy	Present	40 (38%)	118 (81%)	59.14	0.00
	Absent	64 (62%)	27 (19%)		
Physical activity	Present	65 (63%)	69 (48%)	22.98	0.00
	Absent	39 (37%)	76 (52%)		
Hyperlipidemia	Present	22 (21%)	19 (13%)	2.86	0.09
	Absent	82 (79%)	126 (87%)		

Xiangya hospital is a tertiary hospital and endocrinology department is highly specialized in treating diabetic foot problems. Diabetic complications or co-morbidities were highly prevalent in this population. A national study reported that 53.3% inpatients had at least one complication, such as peripheral neuropathy, retinopathy and nephropathy [22].

There was a clear trend between increasing severity category and diabetes duration, HbA1c, presence of hypertension, neuropathy, retinopathy and nephropathy, and absent of PA, confirming results of previous studies [9, 17]. It was generally acknowledged that the risk of ulcers and lower limb amputations was higher in patients with diabetes duration of 10 years or more, those who have poor glycemic control or have other cardiovascular, retinal or renal complications [23]. It was meaningful to note that compared to group 0, patients in group 2 and 3 were reluctantly to be active and did not participate in regular physical activity (PA). It was because that participation in regular PA improved blood glucose control, along with positively affecting lipids, blood pressure, cardiovascular events, mortality, and so as to prevent or delay diabetic complications [24].

The result of this study showed that a greater proportion of diabetic patients had a poor knowledge of diabetic foot care. These deficiencies arises from lack of awareness about the effect of therapeutic inserts; need for specialist consultation when warning signs like redness/bleeding occurs between toes; importance of drying foot after every foot wash or applying emollients to prevent cracks. The lack of knowledge foot care in our study was consistent with findings by other investigators worldwide [12, 25]. Lack of knowledge was reported as the greatest barrier to good foot care practice [25]. Proper foot care was significantly associated with literacy and socioeconomic status of patients and foot care teaching [25, 26]. Since foot care teaching was the only modified factor, the health workers should provide foot care education for patients to enhance and sustain the good knowledge and practice of foot care.

Conclusion

In conclusion, the risk factors for foot ulceration and lack of fool care knowledge was rather common in a hospital-based diabetic population, emphasizing the importance of implementing simple and affordable screening tools and methods to identify high-risk patients and providing foot care education for them.

Table 6. The knowledge score of foot care (n = 2 96)

Items	$\bar{X}$±S
Susceptibility and the importance of diabetic foot prevention (4)	2.17±0.68
Footwear and therapeutic inserts choices (6)	3.67±0.76
Foot examination (2)	1.79±0.41
Nails cutting (2)	1.64±0.50
Walking out (4)	1.36±1.46
Foot problems management (4)	1.47±1.61
Foot care practices (13)	9.11±1.31
Total score (35)	21.21±3.84

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Disclosure of conflict of interest

None.

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