

Original article

# Identifying at-risk foot among hospitalized patients with type 2 diabetes: A cross-sectional study in one Chinese tertiary hospital

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Received 13 May 2015

Available online 8 January 2016

## Abstract

**Objective:** To investigate the prevalence of diabetic at-risk foot and its associated factors.

**Methods:** A total of 838 hospitalized patients with type 2 diabetes were screened for at-risk foot. Neural and vascular disorders were evaluated by assessing vibration perception thresholds and ankle brachial indexes (ABIs). After excluding 12 patients with abnormally high ABIs, remaining individuals with neural and/or vascular disorder were identified as at-risk patients and further classified into three subtypes: isolated neural disorder, isolated vascular disorder and mixed disorder. Potential associated factors were examined using Logistic regression models.

**Results:** In the final sample of 826 individuals, the prevalence of diabetic at-risk foot was 30.6%. Among all at-risk patients, isolated neural disorders (69.6%) were more common than mixed (16.2%) or isolated vascular disorders (14.2%). Isolated neural and vascular disorders shared specific risk factors, including age per 20-year increment (odds ratio [95% CI], 3.73 [2.59–5.37] and 4.01 [1.98–8.11]), diabetic duration  $\geq 10$  years (1.69 [1.13–2.54] and 3.29 [1.49–7.24]) and systolic blood pressure  $\geq 140$  mmHg (1.96 [1.31–2.93] and 2.90 [1.38–6.10]) respectively. In addition, isolated neural disorders were associated with a heavy smoking history (95% CI 2.69 [1.15–6.31]), increased high-sensitivity C-reactive protein levels (95% CI 1.30 [1.04–1.62]) and mild obesity (95% CI 0.49 [0.20–1.24]). Isolated vascular disorders were linked with decreased high density lipoprotein (HDL) cholesterol levels (95% CI 3.42 [1.31–8.96]) and increased triglycerides levels (95% CI 2.74 [1.26–5.97]).

**Conclusions:** Diabetic at-risk foot is epidemic among hospitalized patients with type 2 diabetes. Aging, long-term diabetes, hypertension, smoking, inflammatory response and dyslipidemia may be associated with the prevalence of diabetic at-risk foot.

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Peer review under responsibility of Chinese Medical Association.



<http://dx.doi.org/10.1016/j.cdtm.2015.11.002>

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**Keywords:** Ankle brachial index; Diabetic at-risk foot; Vibration perception threshold

## Introduction

Diabetic foot disease is one of the most common and severe chronic complications of diabetes mellitus. About 15–25% of patients with diabetes will develop a foot ulcer during their lifetime.<sup>1</sup> The most feared consequence of a foot ulcer is lower-extremity amputation, which occurs about 23 times more often in patients with diabetes than in the population without diabetes.<sup>2</sup> Diabetic foot lesions are difficult to be cured but easily be prevented, which suggests the importance of early identification of patients at risk.

Diabetic foot disease develops as a result of a mixture of intrinsic conditions, such as neuropathy, vascular disease and foot deformity, along with extrinsic risks, such as unexpected trauma and infection, among which diabetic peripheral neuropathy (DPN) and peripheral artery disease (PAD) are believed to be the major initiating factors.<sup>2–4</sup> PAD is reported to be presented in 49% of foot ulcers in Europe<sup>5</sup> and up to 90% of diabetic foot lesions are related to neuropathy, alone or with ischemia, and the incidence of neuro-ischemic problems has increased in recent years.<sup>6</sup> Therefore, screening tests focused on the presence of DPN and PAD can predict the risk of diabetic foot disease. Patients with diabetes and evidence of peripheral neuropathy and/or ischemia should be identified as individuals with at-risk foot. It is estimated that early recognition and appropriate protection of at-risk foot can prevent 50% of diabetic ulcerations and amputations.<sup>3</sup>

In order to investigate the prevalence and clinical characteristics of diabetic at-risk foot as well as to explore potential associated factors, we conducted this cross-sectional study on a population of hospitalized adult patients diagnosed with type 2 diabetes in a Chinese tertiary hospital from March 2013 to February 2014.

## Materials and Methods

### *Study participants*

The sample consisted of 899 consecutive hospitalized patients who underwent a diabetic foot screening from March 1, 2013 to February 28, 2014 and were diagnosed with diabetes at the Department of Endocrinology and Metabolic Disease of the First Affiliated Hospital of Soochow University in China. Informed

consents were received from all participants. We excluded patients who were; 1. not diagnosed with type 2 diabetes, 2. pregnant at the time of diabetic foot screening, 3. aged <20 years at the time of diabetic foot screening.

### *Screening criteria for diabetic at-risk foot*

Every participant underwent a screening for diabetic at-risk foot on the first or second day after admission. The screening process, as recommended by the American Diabetes Association,<sup>7</sup> was mainly comprised of taking a history focused on neuropathic and ischemic symptoms and a previous history of foot ulcerations and amputations, a careful inspection to detect foot deformities and inappropriate footwear, and tests targeting the presence of DPN and PAD. The vibration perception threshold (VPT) values of both feet were measured using a sensimeter as a semi-quantitative neurological assessment. A VPT over 25 volts has been associated with a high cumulative risk of neuropathic ulcerations.<sup>8</sup> Therefore, we defined patients with a VPT >25 volts in at least one foot as individuals with neural disorder. Plus, we tested ankle brachial index (ABI) values of both sides using a standard Doppler ultrasonic probe to evaluate the peripheral artery condition. The ABI value was obtained by dividing the ankle systolic pressure by the higher of the two brachial systolic pressures. An ABI  $\leq 0.9$  is strongly linked with a 7-year risk of amputation in people with diabetes.<sup>9</sup> In this study, we considered patients with an ABI  $\leq 0.9$  in either foot as individuals with vascular disorder. Additionally, we excluded patients with an abnormally high ABI  $>1.3$ <sup>10</sup> on either side: no patient presented with an ABI  $\leq 0.9$  in one limb and an ABI  $>1.3$  in the other. Patients with neural and/or vascular disorders were identified as individuals with at-risk foot. Otherwise, they were considered risk-free subjects.

### *Data collection*

Each patient's gender, age, duration of diabetes and smoking history were collected on admission. Duration of diabetes was categorized as either short (<10 years) or long ( $\geq 10$  years). The smoking history of each patient was evaluated by the level of pack-years of cigarette smoking (the total number of years smoked times the average number of packs of cigarettes

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