ORIGINAL ARTICLE

Seasonal variations in non-traumatic major lower limb amputation in Hong Kong Chinese diabetic patients

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Objectives To study the relationship between hospitalisation for diabetic foot complications, non-traumatic major lower limb amputations, and seasonal variation in humidity and temperature.

Design Retrospective study.

Setting Regional hospital, Hong Kong.

Patients Diabetic patients hospitalised for lower limbs infection during the inclusive period 1995 to 2004.

Main outcome measures Monthly incidence of admissions for diabetic foot sepsis and non-traumatic non-neoplastic major lower limb amputations correlated with the monthly average humidity and temperature.

Results During the study period, a total of 770 patients contributed to 1285 episodes of hospitalisation and ensued 208 corresponding major lower limb amputations. Poisson regression study showed that the monthly incidences of hospitalisation as well as amputations were related to the monthly average temperature ($P<0.001$ and $=0.0012$, respectively) but not the monthly average humidity ($P=0.1560$ and 0.6332, respectively).

Conclusion The warm and humid weather of Hong Kong exerts a seasonal variation on the diabetic foot infection presentations. Warm temperature aggravates the severity of infection and precipitates amputation. More intensive patient education and clustering of medical services in late winter and spring might reduce the incidence of diabetic foot amputation, which is a preventable complication.

Introduction

Diabetes is a prevalent disease in Hong Kong. In a community-based Hong Kong Chinese population, the age-standardised prevalence for persons aged 35 to 64 years was 10.6% and it was markedly greater (29.3%) among women aged 65 to 74 years.[1] The disease is also accompanied by peripheral neuropathy, peripheral vascular disease, and impaired immunity. All these impairments, in concert, lead to diabetic foot ulceration, sepsis, and eventually amputation.[2,3] Through our 10 years of serving diabetic patients, we appreciated that their presentation may not be random; rather it was related to the weather. More sinister infection tends to present in spring and summer. If such seasonal variation is validated, out-patient appointments should be clustered in late winter and spring, so as to alert patients to meticulously check their feet daily and if needed seek medical advice earlier. By contrast, in the autumn and early winter, appointments could be more spread out, to improve cost-effectiveness.

Methods

A retrospective study was performed to review the records of all diabetic patients admitted to the in-patient service of the Department of Orthopaedics and Traumatology, Kwong Wah Hospital, for lower limb infections between the inclusive period January 1995 and December 2004. For each month, statistics on the number of admission, corresponding length of stay, major lower limb amputations (defined as non-traumatic, non-neoplastic amputations at or above the ankle) and the respective indications were collected. Clinical information about the patients (age, sex, type of diabetes, and the amputation level) was also retrieved. Monthly average temperature and humidity data were collected from the

Key words
Amputation; Diabetes mellitus; Humidity; Seasons; Temperature

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香港華裔糖尿病患者非創傷性下肢截肢的季節性變化

目的 探討糖尿病足併發症患者住院治療、非創傷性下肢截肢，以及濕度和溫度季節性變化之間的關係。

設計 回顧研究。

安排 香港一所分區醫院。

患者 1995至2004年間，因下肢感染而須住院治療的糖尿病患者。

主要結果測量 每月因糖尿病足敗血症入院的病例、非創傷性非瘤性下肢截肢，與濕度和溫度的季節性變化的相關程度。

結果 研究期內共入院1285次的770位患者接受治療，有208宗下肢截肢手術。Poisson迴歸分析研究顯示，每月住院治療和截肢與月平均溫度有關（P<0.001和=0.0012），但與月平均濕度無關（P=0.1560和0.6332）。

結論 香港溫暖潮濕的天氣使糖尿病足感染的情況出現季節性的變化。天氣溫暖使感染惡化，加快截肢的需要。糖尿病足是一種可以預防的併發症，加強對患者的教育，在晚冬和春季把病人集中治療，有可能減少患者須截肢的情況。

Hong Kong Observatory (www.hko.gov.hk).

Statistical tests were performed using the Statistical Package for the Social Sciences (Windows version 13.0; SPSS Inc, Chicago [IL], US). The log link function of Poisson regression analysis was utilised to determine the relationship between the weather (monthly average temperature and humidity) and major clinical outcomes (admission and amputation incidence), controlling for the year and month variables (seasonal). A probability of less than 0.05 was considered statistically significant.

Results

A total of 770 patients contributed to 1285 episodes of hospitalisation and 208 corresponding major lower limb amputations ensued in that period. Patient ages ranged from 31 to 98 (mean, 72) years. The male to female ratio was 384 to 386. In all, 101 (13%) were insulin-dependent diabetics. The length of hospitalisation ranged from 4 to 72 (mean, 15) days. Regarding the 208 amputations, 95 (46%) were above-knee, two (1%) were through-knee disarticulations, 104 (50%) were below-knee, and seven (3%) were Symes' procedures. Ninety-two (44%) of the patients underwent a single amputation, 46 (22%) underwent amputations twice, and eight (4%) underwent amputations thrice.

The log link Poisson regressions study showed that with other variables controlled, the incidence of hospitalisation was related to the temperature (estimated rate ratio for a rise of 1 degree Celsius=1.039, P<0.001) but not the humidity (estimated rate ratio for a rise of 1% of relative humidity=0.98, P=0.1560). Similarly, the amputation incidence was only related to the temperature (estimated rate ratio for a rise of 1 degree Celsius=1.09, P=0.0012) and not the humidity (estimated rate ratio for a rise of 1% of relative humidity=1.009, P=0.6332). A seasonal effect on the incidence of hospitalisation (estimated rate ratio=1.474, P<0.001) and the incidence of amputation (estimated rate ratio=1.977, P<0.001) was evident (Fig).

Discussion

Many diseases reveal seasonal variation. Flare-up of asthma in spring has been logically related to pollenation.[4] Occurrence of Legionella increases dramatically in the summer time; the downpour of summer hampering the efficiency of the chlorination systems being a plausible mechanism.[5] However, seasonal variations of diabetic control and even weekly variation of amputation rates of ischaemic legs appear to be less clear.[6,7] To the knowledge of the authors, diabetic foot complications have not been shown to be related to the weather. Our study clearly documents that warm and humid weather of Hong Kong appears to influence the presentation of diabetic foot infection. In particular, warm temperatures aggravate the severity of infections and precipitate amputations. Being the first study documenting the effect of weather on diabetic foot complications, we are conservative in projecting our result to other localities.

Hong Kong has habitats of modest climate; temperatures seldom drop below 10°C or rise above 33°C, and monthly averages range from 15 to 29°C. Moreover, since Hong Kong is largely surrounded by sea, the relative humidity stays above 70% throughout the year and can be up to 90% in spring and summer.[3] Without much variation in temperature and the absence of a dry season, the effect of temperature might be masked and the impact of humidity could be weakened. A similar warm and humid climate is shared by other South-East Asia nations, such as Thailand. Notably in South-East Asia, the incidence of major lower limb amputations has been quite high in comparison to that in Europe,[8] such that climate may partially explain the difference. However, such differences could also be related to inferior public education, poor hygiene, unsatisfactory footwear (South-East Asians prefer wearing sandals or walking barefoot), and/or merely different clinical decision-making processes.[9] A similar study to ours in a region with a more dynamic climate (such as Japan) might provide further insight.

The speculation that high temperatures and humidity favour micro-organism growth and encourage

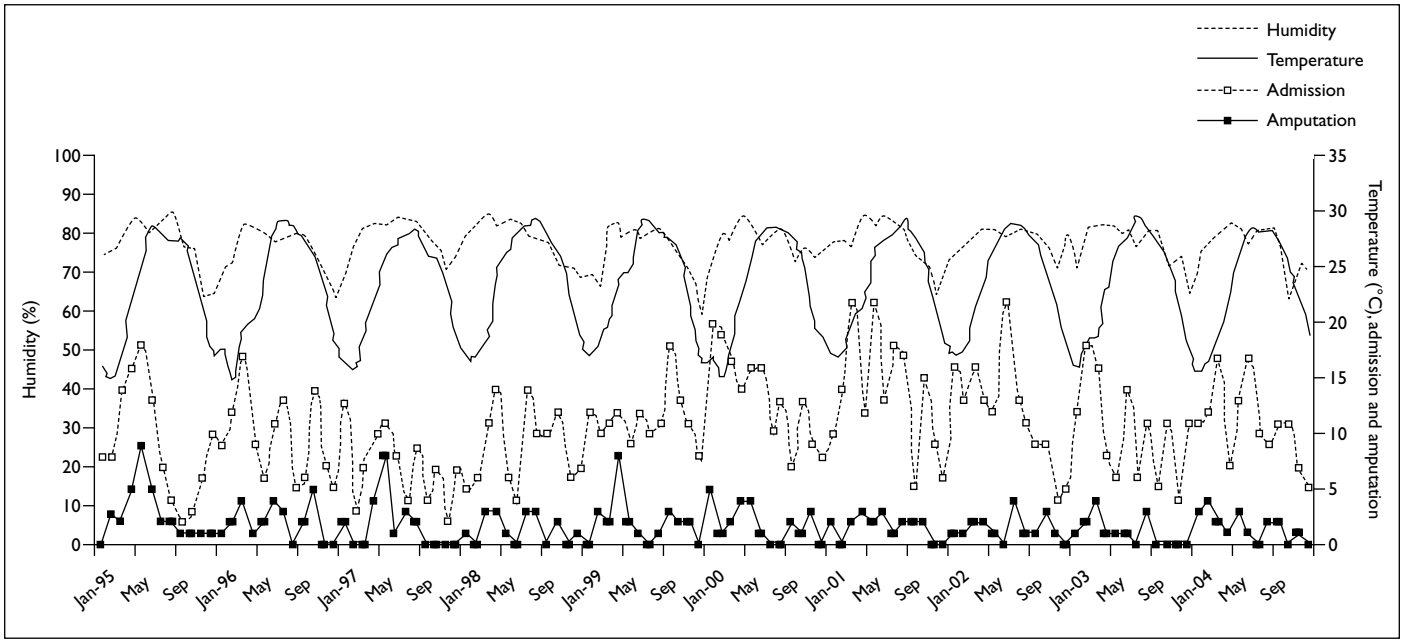

FIG. The relationship between average monthly humidity, temperature, admission rate for diabetic foot complication, and monthly incidence of corresponding amputations (January 1995 to December 2004 inclusive)

infections to flourish in previously uninfected diabetic foot ulcers, requires further scientific investigation. Analysing the daily, rather than monthly, average temperature and humidity might provide better insight on the acute effects of such parameters on the progression of diabetic foot ulcers. In contrast to the constant incubation period of legionellosis,[5] the time lag between the occurrence of infection, and the contemplation and execution of amputation varies widely. Such variation poses a methodological challenge to undertaking such a study. Regardless of possible conjectural explanations, the presence of seasonal variation remains factual. Therefore, we recommend that an extensive education programme on relevant foot care should be conveyed to all diabetic patients and their caregivers as early as winter, so as to minimise diabetic foot ulcerations in early spring. Clinic appointments should also be clustered in spring and summer, to facilitate the reinforcement of vigilant foot care and earlier intervention if necessary, during the most vulnerable periods. Efforts should be channelled to develop other effective tactics to combat non-traumatic amputations for diabetic foot ulcer, which is a highly preventable complication.[10]

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