

## PROGNOSTIC FACTORS IN THE CAUSATION OF RECURRENT PLANTAR ULCERATION IN PATIENTS WITH DIABETES.

Roelof Waaijman (1), Mirjam de Haart (1), Mark L.J. Arts (1), Daan Wever (2), Anke Verlouw (3), Frans Nolleet (1), and Sicco A. Bus (1,4)

1. Department of Rehabilitation, Academic Medical Center, University of Amsterdam, Amsterdam, the Netherlands
2. Department of Rehabilitation, Medisch Spectrum Twente, Enschede, the Netherlands
3. Department of Rehabilitation, Maxima Medical Centre, Veldhoven, the Netherlands
4. Department of Surgery, Ziekenhuisgroep Twente, Almelo, the Netherlands

### BACKGROUND

Elevated plantar pressure is a risk factor for ulceration in diabetes (Frykberg, 1998). Custom-made footwear is aimed to reduce pressures and is often prescribed to patients at high risk for re-ulceration. Despite this, ulcer recurrence rates are still high, up to 40% annually. Many factors may contribute to this outcome, including biomechanical factors such as barefoot and in-shoe plantar pressure, disease related factors, and behavioral factors, such as adherence to prescribed footwear use and activity level of the patient. Prospective studies that determine the role of all these factors in plantar foot ulceration is non-existent, but important for screening and treatment purposes to reduce risk for ulceration. Therefore, the aim of this study was to assess the predictive value of disease-related, biomechanical, and behavioral factors on plantar foot ulceration in diabetic patients at high risk for foot ulceration.

### METHOD

In a multicenter prospective study design, 171 diabetic patients (141 men, mean age 63.3) with neuropathy, a recently healed plantar foot ulcer, and custom footwear were followed for 18 months or until plantar ulceration. At entry, patient and disease-related factors were assessed. Barefoot peak pressures distal to the heel were measured using the EMED-x system, and in-shoe pressures were measured using Pedar-X. At each 3-month follow-up, visits to the footcare provider, minor lesions, and ulceration as assessed from photographs by a panel of 3 blinded observers was assessed. Adherence to footwear was measured over a 7-day period using shoe worn sensors (@monitor), together with daily step count using an ankle-worn step activity monitor (StepWatch).

Univariate logistic regression ( $P < 0.10$ ) was used to assess independently determinants of ulceration in two separate models: one including parameters at the patient level ( $N=171$ ), and another including parameters at the foot level ( $N=342$ ). Using ANOVA ( $P < 0.05$ ), we compared in-shoe and barefoot pressures between patients who re-ulcerated at the same location and those who did not.

### RESULTS

Significant predictors of ulcer recurrence were: type of footwear (semi-customized,  $OR=0.49$ ), variance in number of daily steps ( $OR$  per 100 steps= $0.98$ ), cumulative months of prior ulceration ( $OR=1.03$ ), minor lesions (presence of major callus, hemorrhage, or blister,  $OR=8.19$ ), barefoot peak pressure ( $OR$  per 50 kPa= $1.11$ ), level of deformity (moderate or severe,  $OR=1.78$ ), and foot amputation ( $OR=2.26$ ). Non-significant predictors were gender, age, ethnicity, social status, education level, diabetes type, diabetes duration, HbA1c, BMI, daily step count, footwear adherence, in-shoe peak pressure, and peripheral arterial disease.

Mean ( $\pm$ SD) barefoot and in-shoe peak pressure at the previous ulcer location was significantly higher in those patients who re-ulcerated at that location compared to those who did not (in-shoe:  $172 \pm 96$  vs.  $211 \pm 98$  kPa, barefoot:  $671 \pm 392$  vs  $865 \pm 375$  kPa).

### DISCUSSION

Several significant disease-related predictive factors found were also identified in previous studies (Boyko et al, 1999). Some predictive factors are unalterable, such as elevated barefoot pressures, severity of deformity and cumulative months of previous ulcers, whereas others are alterable, such as type of footwear, variance in number of daily steps and minor lesions. In-shoe plantar pressure did not prove predictive of ulceration, although those who re-ulcerated had significantly higher in-shoe pressures.

This study shows which risk factors should be screened for in this high-risk group of patients. For the prevention of ulcer recurrence in diabetic neuropathy, the focus should be on managing alterable factors such as behavior of the patient and certainly minimizing minor lesions and on reducing in-shoe peak pressure at the previous ulcer location.

### REFERENCES

- Frykberg *et al*, Diabetes care 21: 1714-1719, 1998.  
Boyko *et al*, Diabetes Care 22: 1036-1042, 1999.