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Symptom scoring systems to diagnose distal polyneuropathy in diabetes: the Diabetic Neuropathy Symptom score

J. W. G. Meijer†, A. J. Smit‡, E. V. Sonderen†, J. W. Groothoff†, W. H. Eisma§ and T. P. Links¶

Abstract

Aims To provide one of the diagnostic categories for proximal diabetic neuropathy, several symptom scoring systems are available, which are often extensive and lack in validation. We validated a new four-item Diabetic Neuropathy Symptom (DNS) score for diagnosing distal diabetic polyneuropathy.

Methods We compared score characteristics of the generally accepted Neuropathy Symptom Score (NSS) with the DNS score, and tested construct validity, predictive value and reproducibility with the Diabetic Neuropathy Examination score, Semmes–Weinstein monofilaments and Vibration Perception Threshold (clinical standards) in 73 patients with diabetes (24 Type 1, 49 Type 2; 43 male/30 female; mean age 57 years (19–90); mean diabetes duration 15 years (1–43)).

Results Correlation between NSS and DNS score was high (Spearman $r = 0.88$). Patient scores were more differentiated on the DNS score. The relation of the NSS and DNS scores, respectively, with clinical standards was good (Spearman $r = 0.21–0.60$). Reproducibility of the DNS score was high (Cohen weighted $k = 0.78–0.95$). The DNS score was easier to perform in clinical practice.

Conclusions The DNS is validated, fast and easy to perform, with a high predictive value when screening for diabetic polyneuropathy.


Keywords diabetic neuropathy, symptom score, polyneuropathy, DNS score, DNE score
Mean age (years) (SD) 56.9 (16.1
73
Clinical standards
Present or former ulcer, % 20
Peripheral vascular disease, % 38
Nephropathy, % 42
Retinopathy, % 40
Min.–max. 6.6–13.5
Appendix.
4 points. Guidelines to use with the score are shown in the
legs or feet. Presence is scored 1, absence 0, maximum score
(ii) pain, burning or aching at legs or feet, (iii) numbness in
weakness, five on sensory disturbances and four on autonomic symp-
toms [5,6]. Items that are answered negative/absent are scored
Supported by the Department of Clinical Epidemiology. The
consent was obtained. Exclusion criteria were factors which may have
with the neurological condition other than neuro-
pathy. Fifty patients were randomly selected from the diabetes
tout-patient clinic of the University Hospital Groningen. The
other 23 all had obvious diabetic foot complications or clinical
neuropathy, and attended the Rehabilitation Centre Beatrix-
oord. Patient characteristics are shown in Table 1.

Methods
The same researcher (J.W.G.M.) examined all 73 individuals.
The symptom scores were obtained first, followed by clinical
standards: a physical examination score (the Diabetic Neuro-
pathy Examination (DNE) score) and quantitative sensory tests
(Semmes–Weinstein Monofilaments (SW-MF) and Vibration
Perception Threshold (VPT)), respectively.

Symptom scores
NSS The NSS consists of 17 items, eight focusing on muscle
weakness, five on sensory disturbances and four on autonomc symp-
toms [5,6]. Items that are answered negative/absent are scored
0, presence scored as 1 point. The maximum score is 17 [5–8].
DNE score An expert panel developed a four-item symptom
score for diabetic neuropathy, consisting of a diabetologist, a
vascular internist, a neurologist and a physician for rehabili-
tation medicine. The DNE score has the following items: (i) un-
steadiness in walking, (ii) pain, burning or aching at legs or feet, (iii)
prickling sensations in legs or feet, and (iv) numbness in
legs or feet. Presence is scored 1, absence 0, maximum score
4 points. Guidelines to use with the score are shown in the
Appendix.

Clinical standards
The DNE score, SW-MF and VPT were chosen as clinical
standards to study the construct validity of the symptom scores
for neuropathy.

<table>
<thead>
<tr>
<th>#</th>
<th>Patient characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>73</td>
<td>Mean age (years) (SD) 56.9 (16.1)</td>
</tr>
<tr>
<td>19–90</td>
<td>Min.–max. (years)</td>
</tr>
<tr>
<td>14.9 (9.9)</td>
<td>Mean duration DM (years) (SD)</td>
</tr>
<tr>
<td>1–43</td>
<td>Min.–max. (years)</td>
</tr>
<tr>
<td>43–10</td>
<td>Sex, male–female</td>
</tr>
<tr>
<td>24–49</td>
<td>Type DM 1–2</td>
</tr>
<tr>
<td>8.7 (1.4)</td>
<td>Mean HbA1c (%) (SD)</td>
</tr>
<tr>
<td>6.6–13.5</td>
<td>Min.–max.</td>
</tr>
<tr>
<td>40</td>
<td>Nephropathy, %</td>
</tr>
<tr>
<td>42</td>
<td>Peripheral vascular disease, %</td>
</tr>
<tr>
<td>38</td>
<td>Present or former ulcer, %</td>
</tr>
</tbody>
</table>

Patients and methods

Patients
We studied 73 patients with diabetes, covering the entire
spectrum of secondary complications. Informed consent was
obtained. Exclusion criteria were factors which may have interfered
with the neurological condition other than neuropathy. Fifty patients were randomly selected from the diabetes
tout-patient clinic of the University Hospital Groningen. The
other 23 all had obvious diabetic foot complications or clinical
neuropathy, and attended the Rehabilitation Centre Beatrix-
oord. Patient characteristics are shown in Table 1.

Reproducibility
To test reproducibility of the DNS score, inter- and intra-rater
agreement was assessed in a separate study on 10 patients. The
six women and four men, with a mean age of 50.0 years (SD 15.9)
had a wide range of neuropathy severity. The mean duration of
diabetes mellitus (DM) was 11.5 years (SD 10.5); three participants had Type 1, and seven Type 2 DM. Two doctors
rated these on two occasions at 1-week intervals.

Statistical analysis
Internal consistency of the symptom scores was assessed by
calculating Cronbach’s $\alpha$, and reliability coefficient $r$, which
is comparable to $\alpha$. The statistical package SPSS-PC was used
to compute the descriptive statistics, reliability coefficient
Cronbach’s $\alpha$, Spearman’s correlation coefficient $r$, Student’s
t-test and ROC curves [21].

Inter- and intra-rater agreement was assessed using Cohen’s
weighted $k$ [22,23].

Results
The NSS and DNS scores, scored a mean (SD) of 1.9 (2.0), and
1.1 (1.3), respectively. The reliability of the DNS score (0.64) was
somewhat lower than of the NSS (0.74). Correlation (Spearman’s
$r$) between these two symptom scores was 0.88 ($P < 0.001$).

Relationship of NSS and DNS with the clinical standards
Spearman’s correlation coefficient $r$ for the DNE score with
NSS and DNS score was slightly at 0.56 and 0.60 (both
$P < 0.001$), respectively. Scores between the monofilament, NSS
and DNS scores were 0.21 (NS) and 0.25 ($P < 0.05$), respect-
ively; and for VPT, 0.46 and 0.56 (both $P < 0.001$), respectively.
The DNS and NSS scores predicted the clinical standards adequately (Table 2).

Sensitivity/specificity and reproducibility

Figure 1 shows the ROC curves of the NSS and DNS, respectively, compared with the DNE. The areas under the curve are 0.75 and 0.78 for NSS and DNS, respectively. Using the monofilament at the hallux these values were 0.62 and 0.65, respectively; and using VPT 0.68 and 0.73.

The intra-rater agreement showed a Cohen’s weighted $k$ for both raters of 0.89 and 0.78, the inter-rater agreement on two occasions was 0.95 and 0.83, respectively, indicating a good to very good level of agreement [22,23].

Discussion

The DNS and NSS scored similarly and both fulfil the Jaeschke criteria for diagnostic tests. Although the NSS has been validated previously and is widely accepted, it is probably too extensive to be used in every day clinical practice to diagnose neuropathy. Other, shorter scoring systems and modifications do not appear to fulfil the criteria for diagnostic tests. Thus, we propose the four-item DNS score as a fast and easy to perform symptom score with high reproducibility. The DNS has been validated using standard clinical methods, but might be too short to provide reliable follow-up when used alone.

Sensitivity and specificity of the DNS score were high when defined using other standard methods for evaluating neuropathy. Because the DNS score will be used for screening purposes, a high sensitivity is to be preferred. A score of 1 or more points on the DNS score is sensitive when identifying neuropathy. In combination with the results of the other diagnostic categories, classified by the San Antonio Consensus, the type and severity of neuropathy can be estimated. Unfortunately, the relative importance of different categories of the San Antonio Consensus in diagnosing diabetic neuropathy and predicting diabetic foot complications is unknown.

Controversy exists about the use of symptom scoring in diagnosing diabetic neuropathy [7,24–27]. In our report, significant and clinically relevant correlations were shown between the symptom scores and other methods which can predict diabetic foot complications. We believe that symptom scoring should complement other diagnostic categories for diabetic neuropathy [3].

However, symptom scores may be less reliable [3,4,8], due to their subjectivity. Using dichotomous scores may improve reproducibility [3], a feature of the DNS.

In conclusion, the DNS has been validated for cases of diabetic polyneuropathy, and is fast and easy to perform in clinical practice. However, it should be used in combination with other methods.

References

Maximum score: 4 points; 0 points, PNP absent; 1–4 points, PNP present.
distal>proximal, stocking glove distribution occurring at rest or at night, distal>proximal, stocking glove distribution

3 Do you have prickling sensations at your legs and feet? occurring at rest or at night, not related to exercise, exclude claudicatio intermittens

1 Are you suffering of unsteadiness in walking? need for visual control, increase in the dark, walk like a drunk man, lack of contact with floor

Appendix 1 DNS score
The questions should be answered ‘yes’ (positive: 1 point) if a symptom occurred more times a week during the last 2 weeks or ‘no’ (negative: no point) if it did not

DNS-score and guidelines
1 Are you suffering of unsteadiness in walking? need for visual control, increase in the dark, walk like a drunk man, lack of contact with floor
2 Do you have a burning, aching pain or tenderness at your legs or feet? occurring at rest or at night, not related to exercise, exclude claudicatio intermittens
3 Do you have prickling sensations at your legs and feet? occurring at rest or at night, distal->proximal, stocking glove distribution
4 Do you have places of numbness on your legs or feet? distal->proximal, stocking glove distribution

Maximum score: 4 points; 0 points, PNP absent; 1–4 points, PNP present.