



Classifying Whiplash Recovery Status Using the Neck Disability Index: Optimized Cutoff Points Derived From Receiver Operating Characteristic



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Abstract

Objective: Researchers often use Neck Disability Index (NDI) scores to classify recovery status in whiplash patients. The purpose of this study was to investigate the optimal cutoff point score for the NDI as a mechanism for differentiating recovery from nonrecovery after whiplash.

Methods: Subjects (N = 123) who had previously sustained whiplash injuries were recruited from 12 clinics. Subjects rated themselves as being recovered (36%) or nonrecovered (64%). This state variable was compared with their NDI score as test variable using the receiver operating characteristic statistic. The area under the receiver operating characteristic curve and optimized cutoff points were computed for the whole group and also dichotomized for sex and age.

Results: The mean NDI score for the recovered group was 7.8. It was 27.1 for the nonrecovered group. The cutoff point that optimized sensitivity and specificity for the whole group was an NDI score of 15. For women, it was 19; for older persons, it was 21.

Conclusion: The optimal NDI score cutoff point for differentiating the recovery state after whiplash is 15. Misclassification errors are likely when using lower values.

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Introduction

In the 1960s and 1970s, patient self-reports of pain and dysfunction were generally regarded by researchers and clinicians as being too subjective to serve as

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reliable measures of disability. Accordingly, they sought more objective forms of disability assessment such as measures of the ranges of motion of joints, physical strength as assessed by manual muscle testing, and the results of orthodox orthopedic and neurological tests. However, the boundary between hard (ie, objective or measurable) and soft (ie, subjective self-report) data is often blurred.¹ Range of motion measurement is associated with a degree of uncertainty arising from the limited precision in recording the ranges, as well as the temporal variability in voluntary range of motion associated with the subject's day-to-day experience of pain. Manual muscle testing has been shown to be lacking in sensitivity. Trained examiners have been unable to detect changes in muscular strength until the loss in strength approaches 50%.²

Disability rating assessment methodologies of the past have been grounded on assumptions that do not always coincide with real-life conditions. For example, although a loss of range of motion is usually considered an indicator of impairment, in some cases, reduced spinal mobility may be associated with reductions in pain and disability scores.³ Conversely, joint instability is often associated with pain and impairment but can also coincide with greater than normal joint motion. Accordingly, Feinstein⁴ argued that the crucial attribute of hardness is simply the reliability and reproducibility of a finding.

Fairbank et al⁵ developed a questionnaire for the assessment of disability related to low back pain. Known today as the Revised Oswestry Disability Index, it is widely used both in the clinical setting and in research.⁶ It is a self-assessment questionnaire patients can quickly complete in a few minutes, and it can be easily scored by therapists or physicians. The format is categorical, but each category is ordinal. As such, the scale is not arithmetically isomorphic, and the scores cannot be considered linearly correlated with disablement.

In 1991, Vernon and Mior⁷ modified the Revised Oswestry Disability Questionnaire so that it would be responsive to disability related to neck pain and named it the Neck Disability Index (NDI). The NDI was subsequently validated in a whiplash patient population and achieved a high degree of internal consistency, reliability, and responsiveness.⁷ In subsequent years, a number of other questionnaires have been developed for evaluating neck pain. These include the Whiplash Disability Questionnaire,^{8–10} the Functional Rating Index,¹¹ the Northwick Park Neck Pain Questionnaire,^{9,10} the Neck Pain and Disability Scale,⁹ the Copenhagen

Neck Functional Disability Index,^{9,12,13} and the EQ-5D.¹⁴ To date, the NDI has been the most extensively used questionnaire in clinical trials and prognosis studies.^{9,13,15–43}

The general format follows that of the Oswestry questionnaire, with a 10-item design. These items or subscales include Pain Intensity, Personal Care, Lifting, Reading, Headaches, Concentration, Work, Driving, Sleeping, and Recreation. Each has 6 possible choices, with the first representing the normal state and carrying a score of 0, and the last representing the greatest degree of suffering or disability and carrying a score of 5. The 10 subscales are summed and multiplied by 2, thereby providing a range of 0%-100% disability.

Although the theoretical perfect NDI score would be 0, it is likely that many adults will endorse 1 or more of the NDI subscales in the lower or moderate ranges. Several authors have used the NDI to classify subjects' recovery status in clinical trials or outcome studies. Whereas some authors, using the NDI within a whiplash population to establish recovery, have set the threshold for recovery at 2% or less for headaches and at 1% or less for all other symptoms,³⁹ in 3 other published studies, recovery from whiplash injury based on the NDI score was set at a score of less than 8%.^{44–47}

Notwithstanding published cutoff points for NDI scores, limited normative data have been available until recently. The mean background score obtained from a large adult Japanese study was 6.98.⁴⁸ Another group has recently published normative data for Indian adolescent boys (3.59) and girls (4.92).⁴⁹ The purpose of this study was to investigate the optimal cutoff point for NDI score for a group of American adults who had suffered whiplash injury, using their self-assessment of recovery as the state variable or criterion standard.

Methods

Clinic patients from 12 clinics throughout the United States were recruited to participate in this study. Inclusion criteria included a whiplash injury resulting from a motor vehicle collision at least 24 weeks prior to recruitment, at least 3 treatment sessions with a licensed health care practitioner for the injury, fluency in English, and the requirement that they were at least 18 years of age when the injury occurred. Exclusionary criteria included prior cervical spine surgery or serious

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