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Identifying and monitoring cognitive deficits in clinical populations using Automated Neuropsychological Assessment Metrics (ANAM) tests

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Abstract

In this article we review studies in which Automated Neuropsychological Assessment Metrics (ANAM) measures were used to screen for impairment in various clinical populations. These clinical groups include patients with multiple sclerosis, systemic lupus erythematosus, Parkinson's disease, Alzheimer's dementia, acquired brain injury, and migraine headache. Data are also presented from a group of outpatient referrals unselected with respect to clinical condition. Findings support the use of ANAM as a screening procedure for identifying the impaired patient.
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Although the Automated Neuropsychological Assessment Metrics (ANAM) system (Reeves et al., 1992) was developed from efforts within the DoD to monitor human performance changes in healthy individuals undergoing environmental challenges, it has increasingly been employed in the clinical arena. These clinical applications were motivated by the need to develop an instrument to screen patients at risk for neurocognitive impairment. It is neither practical nor cost-efficient to examine every patient at risk for neurocognitive deficits with a comprehensive neuropsychological battery. Hence, identifying patients in need of more detailed assessment is an important health care objective for patients and for the efficient use of health care resources. The objective for studies using ANAM in clinical settings has been to validate brief automated assessment techniques for screening and triage.

An additional motivation for developing ANAM for clinical use was that it was designed for repeated evaluations. Hence, it seemed well suited for the important task of monitoring changes in a patient's status and for assessing a patient's response to medications or other medical interventions.

In this article we review findings from investigations using ANAM with clinical populations. These studies all shared the common objective of validating ANAM as a clinical screening instrument and assessed the ability of relatively

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short ANAM batteries to identify impairment in at risk populations. In most cases, longer traditional batteries were used to separate impaired from non-impaired individuals. Patients were classified as impaired or not impaired based on their performance of these traditional measures; ANAM's sensitivity for detecting impairment was then judged against classifications based on traditional test performance. In other studies patients were compared against controls. In the case of migraine, patients were assessed pre, post, and during headache attacks. In these migraine studies ANAM was used to assess acute change and recovery. Specifically, in this paper we review findings from studies using ANAM to detect deficits in multiple sclerosis (MS), systemic lupus erythematosus (SLE), Parkinson's disease (PD), a mixed clinical sample, Alzheimer's disease (AD), acquired brain injury, and in patients suffering from migraine headaches.

1. Multiple sclerosis (MS)

MS is a demyelinating disorder affecting the central nervous system (CNS). Lesions can appear in various areas of the brain and brain atrophy is noted in some patients (Comi et al., 1993; Fulton et al., 1999; Gonzalez et al., 1994). Cognitive impairment can occur early in MS, and there is little relationship between the degree of physical and cognitive disability (Beatty, Goodkin, Hertsgaard, & Monson, 1990; Rao, Leo, Bernardin, & Unverzagt, 1991; van den Burg, van Zomeren, Minderhoud, Prange, & Meijer, 1987; Wishart & Sharpe, 1997). While the relationship between physical and cognitive disability is weak, the relationship is significant between cognitive deficits and quality of life.

Approximately 50% of patients with MS evidence cognitive changes. Early changes may be subtle and manifest as changes in processing efficiency rather than more substantial cognitive impairment. In some patients the extent of cognitive deficits may increase over time. Hence, there is a need in MS for methods of detecting the presence and progression of cognitive deficits that are both time efficient and cost effective.

Wilken et al. (2003) published initial findings from a multi-center study designed to assess ANAM as a tool for identifying neurocognitive deficits in patients with relapsing-remitting (RR) MS. All patients were given a battery of neurocognitive tests that included traditional neuropsychological measures frequently used with MS patients and selected ANAM measures. Participants diagnosed with MS were assessed prior to starting treatment with interferon-β1a and then at 6-month intervals for an additional 24 months. Published data reviewed here is for the initial assessment. Follow-up data will be published at the completion of the study.

The principal objective of this study was to assess the sensitivity of select ANAM measures for detecting neurocognitive deficits in MS. The design used traditional neuropsychological measures as the standard for assessing impairment. Patients' performance on ANAM was evaluated against their performance on these traditional measures. Statistical comparisons included correlation and regression analyses.

All patients were assigned an impairment index based on their performance of the standard neuropsychological measures including the California Verbal Learning Test (CVLT; Delis, Kramer, Kaplan, & Ober, 1987); omission errors from the Kay Continuous Performance Test (unpublished); Digit Symbol and Block Design from the Wechlser Adult Intelligence Test-III (WAIS-III; Wechsler, 1997); Parts A and B of the Trail Making Tests (Reitan, 1992); total score from the Paced Auditory Serial Addition Test (PASAT; Gronwall, 1977); Wisconsin Card Sorting Test (WCST) perseverative responses (Heaton, Chelune, Talley, Kay, & Curtiss, 1993); lexical (CFL; Benton, Hamsher, Varney, & Spreen, 1983) and semantic (Animal Naming; Goodglass & Kaplan, 1996) fluency scores; and dominant hand finger tapping speed (Reitan, 1979). The impairment index was computed in the traditional fashion as a ratio of the number of tests performed in an impaired range divided by the total number of included tests. A score was defined as impaired if it was greater than one standard deviation below the mean (Heaton, Grant, & Matthews, 1991). Based on prior neuropsychological research using impairment indices (Reitan, 1979), patients having an impairment index of 0.4 or higher were classified as impaired.

The ANAM measures used in this study included: Simple Reaction Time, Procedural Reaction Time, Code Substitution and Code Substitution Delayed Memory, Running Memory, Sternberg Memory Search, Logical Relations, Finger Tapping, and Mathematical Processing. In this study, the 4-item version of Mathematical Processing was used (see paper in this issue by Reeves et al.). ANAM tests were selected to assess cognitive deficits frequently reported in MS (Fischer, 2001).

The authors published tables of the correlation coefficients between traditional and select ANAM measures to assess similarities among the tests (Wilken et al., 2003). However, the focus of the study was to assess the ability of ANAM to identify individuals presenting as impaired on traditional measures and to discriminate these individuals from those performing normally. This was done statistically through two types of regression analysis.

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