NEUROPSYCHOLOGICAL TESTING UNDER THE MEDICAL BENEFIT

Policy Number: BEHAVIORAL 026.4 T2

Effective Date: October 1, 2016

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INSTRUCTIONS FOR USE

This Clinical Policy provides assistance in interpreting Oxford benefit plans. Unless otherwise stated, Oxford policies do not apply to Medicare Advantage members. Oxford reserves the right, in its sole discretion, to modify its policies as necessary. This Clinical Policy is provided for informational purposes. It does not constitute medical advice. The term Oxford includes Oxford Health Plans, LLC and all of its subsidiaries as appropriate for these policies.

When deciding coverage, the member specific benefit plan document must be referenced. The terms of the member specific benefit plan document [e.g., Certificate of Coverage (COC), Schedule of Benefits (SOB), and/or Summary Plan Description (SPD)] may differ greatly from the standard benefit plan upon which this Clinical Policy is based. In the event of a conflict, the member specific benefit plan document supersedes this Clinical Policy. All reviewers must first identify member eligibility, any federal or state regulatory requirements, and the member specific benefit plan coverage prior to use of this Clinical Policy. Other Policies may apply.

UnitedHealthcare may also use tools developed by third parties, such as the MCG™ Care Guidelines, to assist us in administering health benefits. The MCG™ Care Guidelines are intended to be used in connection with the independent professional medical judgment of a qualified health care provider and do not constitute the practice of medicine or medical advice.

CONDITIONS OF COVERAGE

<table>
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<tr>
<th>Applicable Lines of Business/ Products</th>
<th>This policy applies to Oxford Commercial plan membership.</th>
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<tbody>
<tr>
<td>Benefit Type</td>
<td>General benefits package</td>
</tr>
<tr>
<td>Referral Required</td>
<td>No</td>
</tr>
<tr>
<td>(Does not apply to non-gatekeeper products)</td>
<td></td>
</tr>
<tr>
<td>Authorization Required</td>
<td>No - Office, Outpatient</td>
</tr>
<tr>
<td>(Precertification always required for inpatient admission)</td>
<td></td>
</tr>
<tr>
<td>Precertification with Medical Director Review Required</td>
<td>Yes&lt;sup&gt;1,2,3&lt;/sup&gt; - Home</td>
</tr>
<tr>
<td>Applicable Site(s) of Service</td>
<td>Yes - Home</td>
</tr>
<tr>
<td>(If site of service is not listed, Medical Director review is required)</td>
<td></td>
</tr>
</tbody>
</table>
Special Considerations

1. Precertification requests require review by the Medical Director or Designee.
2. Precertification is required for services covered under the Member's General benefits package when performed in the office of a participating provider. For Commercial plans, precertification is not required, but is encouraged for out-of-network services performed in the office that are covered under the Member's General benefits package. If precertification is not obtained, Oxford may review for medical necessity after the service is rendered.
3. For Connecticut Commercial plans, precertification is not required for neuropsychological testing (CPT codes 96118-96120) for children diagnosed with cancer (ICD-9 codes 140-239.9) when ordered by a licensed physician regardless of setting.

BENEFIT CONSIDERATIONS

Before using this policy, please check the member specific benefit plan document and any federal or state mandates, if applicable.

Some benefit documents within Oxford exclude neuropsychological testing for some or all indications. The exclusions section of the member-specific benefit plan document must be consulted in order to determine benefit coverage for neuropsychological testing.

Neuropsychological testing for attention-deficit/hyperactivity disorder (ADHD) is a medical benefit service when medically referred and related or secondary to a known/suspected organic-medical condition resulting from brain injury or disease process (e.g., concussion, intractable seizure disorder, cancer treatment effects). Neuropsychological testing for ADHD is a mental health benefit service when representing a developmental condition not due to specific brain injury or disease process, where there are suspected organic functional impairments.

The scope of the criteria for attention-deficit/hyperactivity disorders and developmental disorders or significant developmental delays is applicable only to neuropsychological testing that is covered by the medical benefit.

Essential Health Benefits for Individual and Small Group

For plan years beginning on or after January 1, 2014, the Affordable Care Act of 2010 (ACA) requires fully insured non-grandfathered individual and small group plans (inside and outside of Exchanges) to provide coverage for ten categories of Essential Health Benefits (“EHBs”). Large group plans (both self-funded and fully insured), and small group ASO plans, are not subject to the requirement to offer coverage for EHBs. However, if such plans choose to provide coverage for benefits which are deemed EHBs, the ACA requires all dollar limits on those benefits to be removed on all Grandfathered and Non-Grandfathered plans. The determination of which benefits constitute EHBs is made on a state by state basis. As such, when using this policy, it is important to refer to the member specific benefit plan document to determine benefit coverage.

COVERAGE RATIONALE

Neuropsychological testing is proven and medically necessary evaluating patients with the following conditions when the result of testing will influence clinical decision making:

- Attention-deficit/hyperactivity disorder (ADHD) when all of the following are present:
  - Specific neurocognitive behavioral deficits related to ADHD need to be evaluated and
  - Testing has been recommended by a physician and is related or secondary to a known or suspected organic-medical condition resulting from brain injury or disease process (e.g., concussion, intractable seizure disorder, cancer treatment effects, genetic disorders, inborn errors of metabolism)
  The scope of these criteria is applicable only to neuropsychological testing that is covered by the medical benefit.
  These criteria do not apply to evaluate or determine educational interventions.
- Confirmed space-occupying brain lesion including but not limited to the following:
  - Brain abscess
  - Brain tumors
  - Arteriovenous malformations within the brain
- Dementia or symptoms of dementia such as memory impairment or memory loss (including extrapyramidal disorders such as Parkinson’s disease) that is associated with a new onset or progressive memory loss and a decline in at least one of the following cognitive domains (DSM-5):
• Complex attention
• Executive function
• Learning and memory
• Language
• Perceptual-motor
• Social cognition
• Demyelinating disorders including multiple sclerosis
• Intellectual disability or intellectual developmental disorder when all of the following are present:
  o The intellectual disability or intellectual developmental is associated with a known or suspected medical cause (e.g., traumatic brain injury, in utero toxin exposure, early seizure disorder, sickle cell disease, genetic disorders) and
  o The intellectual disability or intellectual developmental disorder meets all of the following criteria (DSM-5):
    ▪ Deficits in intellectual function, such as reasoning, problem solving, planning, abstract thinking, judgment, academic learning, and learning from experience, confirmed by both clinical assessment and individualized, standardized intelligence testing
    ▪ Deficits in adaptive functioning that result in failure to meet developmental and sociocultural standards for personal independence and social responsibility. Without ongoing support, the adaptive deficits limit functioning in one or more activities of daily life, such as communication, social participation, and independent living across multiple environments, such as home, school, work and community. and
    ▪ Onset of intellectual and adaptive deficits during the developmental period
  The scope of these criteria is applicable only to neuropsychological testing that is covered by the medical benefit. These criteria do not apply to evaluate or determine educational interventions.
• Encephalopathy including acquired immunodeficiency syndrome (AIDS) encephalopathy, human immunodeficiency virus (HIV) encephalopathy, hepatic encephalopathy, Lyme disease encephalopathy including neuroborreliosis, Wernicke's encephalopathy and systemic lupus erythematosus (SLE) encephalopathy
• Neurotoxin exposure with at least one of the following:
  o Demonstrated serum levels of neurotoxins
  o Individual with documented significant prenatal alcohol, drug, or toxin exposure
• Seizure disorder including patients with epilepsy and patients being considered for epilepsy surgery
• Stroke
• Traumatic brain injury (TBI): TBI is defined as a bump, blow, or jolt to the head or a penetrating head injury that disrupts the normal function of the brain (Centers for Disease Control and Prevention). See the following website for more information: http://www.cdc.gov/TraumaticBrainInjury/index.html. (Accessed April 2016)

Baseline neuropyschological testing is unproven and not medically necessary in asymptomatic persons at risk for sport-related concussions.
There is insufficient evidence to indicate that the use of baseline neuropsychological testing in athletes or other individuals alters risk from concussion. There is insufficient evidence that baseline tests influence physician decision-making or outcomes of treatment of concussion.

Computerized neuropsychological testing is unproven and not medically necessary when used alone for evaluating concussions.
Computerized neuropsychological testing should be used in conjunction with a standard non-computerized neuropsychological evaluation to evaluate concussions. The evidence is insufficient to establish the validity and reliability of computerized tests to evaluate concussions when used in isolation. Prospective controlled trials are needed to demonstrate the clinical utility of these tests to detect impairment following concussion when used alone.

Neuropsychological testing is unproven and not medically necessary for the following diagnoses alone without other proven conditions as noted above:
• Headaches including migraine headache
• History of myocardial infarction
• Intermittent explosive disorder

There is insufficient clinical evidence to demonstrate that the use of neuropsychological testing for patients with myocardial infarction, migraine or other headaches or intermittent explosive disorder without associated cognitive disorders can be used effectively for clinical decision making to improve patient management of those conditions.

Computerized cognitive testing such as Mindstreams® Cognitive Health Assessment and BrainCare™ is investigational, unproven and not medically necessary for diagnosing dementia or mild cognitive impairment.
Available clinical trials have failed to document a beneficial effect of computerized cognitive testing on long-term clinical outcomes. The evidence is insufficient to establish the validity of computerized cognitive testing compared with
Neuropsychological testing is a set of formal procedures utilizing diagnostic tests specifically focused on identifying the presence of brain damage, injury or dysfunction and any associated functional deficits. Measurement of deficits cannot be based on single test results and should always be assessed in the context of the medical and neurological examination. Neuropsychological testing is customarily associated with neurological diagnoses rather than behavioral health diagnoses.

Neuropsychological tests are administered in a variety of contexts including paper-and-pencil, computers, and visual aids. Following an initial clinical interview with a neuropsychologist, tests are strategically selected to identify specific deficits and preserved abilities. Standardized tests are then administered by a trained technician or neuropsychologist. Some tests offer multiple forms making them useful for repeated administration to the same patient, thereby minimizing practice effects. In light of the numerous procedures available for assessment of different neurocognitive functions, test selection is based on familiarity of the examiner with certain tests, availability of appropriate normative data, ability of the patient to participate in testing (e.g., quadriplegic or hemiplegic patients may not be able to participate in psychomotor testing), and validity of particular procedures for the specific function being measured. For developmental disorders, neuropsychological tests are useful as part of a complete clinical decision making process and do not unilaterally make the diagnosis of autism spectrum disorder (Zwaigenbaum, 2009).

Neuropsychological tests include but are not limited to the following: Boston Diagnostic Aphasia Examination (BDAE), Conners' Continuous Performance Test (CCPT), Controlled Oral Word Association Test (COWAT), Delis-Kaplan Test Battery, Freedom from Distractibility Index (FFDI) from the Wechsler Intelligence Scales, Gordon Diagnostic System (GDS), Halstead-Reitan Neuropsychological Battery, Rey Auditory Verbal Learning Test (RAVLT), Rey-Osterreith Complex Figure Test, Stroop Color and Word Test, Test of Variables of Attention (TOVA), Trail Making Tests, Wechsler Adult Intelligence Scale-Revised (WAIS-III/IV), Wide Range Assessment of Memory and Learning (WRAML), and Wisconsin Card Sorting Test (WCST). At times, neurocognitive measures are supplemented by emotional functioning and personality testing and include but are not limited to the following: Minnesota Multiphasic Personality Inventory-2 (MMPI-2)/Minnesota Multiphasic Personality Inventory-A (MMPI-A), Personality Assessment Inventory (PAI), Geriatric Rating Scale, Beck Depression Inventory (BDI), Beck Anxiety Inventory (BAI), and Rorschach Inkblot Method. Computerized testing for dementia and cognitive impairment including the Mindstreams® Cognitive Health Assessment (NeuroTrax® Corp.) uses computer-based assessments in an attempt to identify cognitive impairment in the elderly. The software programs give patients various stimuli or puzzles to solve using a mouse or a keypad. The Mindstreams® system automatically generates a report that details the patient's performance in the standard cognitive domains, or

The following list(s) of procedure and/or diagnosis codes is provided for reference purposes only and may not be all inclusive. Listing of a code in this policy does not imply that the service described by the code is a covered or non-covered health service. Benefit coverage for health services is determined by the member specific benefit plan document and applicable laws that may require coverage for a specific service. The inclusion of a code does not imply any right to reimbursement or guarantee claim payment. Other Policies may apply.

### APPLICABLE CODES

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<th>CPT Code</th>
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<tr>
<td>96116</td>
<td>Neurobehavioral status exam (clinical assessment of thinking, reasoning and judgment, e.g., acquired knowledge, attention, language, memory, planning and problem solving, and visual spatial abilities), per hour of the psychologist's or physician's time, both face-to-face time with the patient and time interpreting test results and preparing the report</td>
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<tr>
<td>96118</td>
<td>Neuropsychological testing (e.g., Halstead-Reitan Neuropsychological Battery, Wechsler Memory Scales and Wisconsin Card Sorting Test), per hour of the psychologist's or physician's time, both face-to-face time administering tests to the patient and time interpreting these test results and preparing the report</td>
</tr>
<tr>
<td>96119</td>
<td>Neuropsychological testing (e.g., Halstead-Reitan Neuropsychological Battery, Wechsler Memory Scales and Wisconsin Card Sorting Test), with qualified health care professional interpretation and report, administered by technician, per hour of technician time, face-to-face</td>
</tr>
<tr>
<td>96120</td>
<td>Neuropsychological testing (e.g., Wisconsin Card Sorting Test), administered by a computer, with qualified health care professional interpretation and report</td>
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CPT® is a registered trademark of the American Medical Association

**DESCRIPTION OF SERVICES**

Neuropsychological testing is a set of formal procedures for the assessment of dementia and cognitive impairment. No U.S. Food and Drug Administration (FDA) clearance was located in the FDA database for MindStreams® Cognitive Health Assessment or for BrainCare™.

Neuropsychological tests are administered in a variety of contexts including paper-and-pencil, computers, and visual aids. Following an initial clinical interview with a neuropsychologist, tests are strategically selected to identify specific deficits and preserved abilities. Standardized tests are then administered by a trained technician or neuropsychologist. Some tests offer multiple forms making them useful for repeated administration to the same patient, thereby minimizing practice effects. In light of the numerous procedures available for assessment of different neurocognitive functions, test selection is based on familiarity of the examiner with certain tests, availability of appropriate normative data, ability of the patient to participate in testing (e.g., quadriplegic or hemiplegic patients may not be able to participate in psychomotor testing), and validity of particular procedures for the specific function being measured. For developmental disorders, neuropsychological tests are useful as part of a complete clinical decision making process and do not unilaterally make the diagnosis of autism spectrum disorder (Zwaigenbaum, 2009).

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Neuropsychological testing is within the scope of the provider's professional training and licensure when the provider is any of the following:

- A doctoral-level psychologist who is licensed to practice independently, and demonstrates sufficient training and experience.
- A psychometrist or psychometrician who administers and scores psychological tests under the supervision of a licensed doctoral-level psychologist, and whose services are billed by the supervising psychologist. The supervising psychologist must have face-to-face contact with the member at intake and during the feedback session and is responsible for final test interpretation, report writing and final signature of approval.
- A credentialed psychiatrist who attests to meeting all of the following requirements:
  - Recognized certification in neurology through the American Board of Psychiatry and Neurology or accreditation in behavioral neurology and neuropsychiatry through the American Neuropsychiatric Association;
  - State medical licensure does not include provisions that prohibit neuropsychological testing service;
  - Evidence of professional training and expertise in the specific tests and/or assessment measures for which authorization is requested;
  - Physician and supervised psychometrist adhere to the prevailing national professional and ethical standards regarding test administration, scoring and interpretation.

See the following: Psychological and Neuropsychological Testing.

CLINICAL EVIDENCE

Attention Deficit Hyperactivity Disorder (ADHD)

In a systematic review, Hall et al. (2015) describe the current evidence base for the use of neuropsychological continuous performance tests (CPTs) and objectively measured activity to support the diagnostic procedure and medication management for children with attention-deficit hyperactivity disorder (ADHD). Four databases (PsycINFO, Medline, Allied and Complementary Medicine (AMED), and PsycARTICLES) were systematically searched to understand the current evidence base for (1) the use of CPTs to aid clinical assessment of ADHD; (2) the use of CPTs to aid medication management; and (3) the clinical utility of objective measures of activity in ADHD. Sixty relevant articles were identified. The search revealed six commercially available CPTs that had been reported on for their clinical use. There were mixed findings with regard to the use of CPTs to assess and manage medication, with contrasting evidence on their ability to support clinical decision-making. There was a strong evidence base for the use of objective measures of activity to aid ADHD/non-ADHD group differentiation, which appears sensitive to medication effects and would also benefit from further research on their clinical utility. The findings suggest that combining CPTs and an objective measure of activity may be particularly useful as a clinical tool and worthy of further pursuit.

Thaler et al. (2010) compared patterns of attention, learning, and memory impairment on the Test of Memory and Learning (TOMAL) between 80 children with ADHD and 80 normal comparisons who were matched for age and gender. Results demonstrated that children with ADHD performed significantly worse than matched controls on the Attention/Concentration Index and the Sequential Recall Index. ROC analysis indicated that these two indices had good classification accuracy. Significant correlation between the TOMAL Index scores and tests of intelligence and visuomotor integration supported the convergent and discriminant validity of the test. According to the investigators, these results provide support for the validity of the TOMAL in assessing neurocognitive deficits in children with ADHD.

Bechtel et al. (2012) evaluated whether boys with epilepsy-related ADHD and developmental ADHD share a common behavioral, pharmaco-responsive, and neurofunctional pathophysiology. Seventeen boys with diagnosed combined epilepsy/ADHD, 15 boys with developmental ADHD, and 15 healthy controls (aged 8-14 years) performed on working memory tasks (N-back) while brain activation was recorded using functional magnetic resonance imaging. On a behavioral level, boys with epilepsy-related ADHD as well as those with developmental ADHD performed similarly poorly on tasks with high cognitive load when compared to healthy controls. On the functional level, both patient groups showed similar reductions of activation in all relevant parts of the functional network of working memory when compared to controls. The study data showed strong similarities between epilepsy-related and developmental ADHD.
on the behavioral, pharmaco-responsive, and neural level, favoring the view that ADHD with and without epilepsy shares a common underlying neurobehavioral pathophysiology.

**Dementia, Possible Dementia, Memory Loss, and Memory Impairment**

For memory impairment or dementia screening, a single test of global measures of function or a measure of cognitive function is usually administered along with a test of behavioral or emotional symptoms. In addition to brief screening tests, for some patients, comprehensive neuropsychological testing may be indicated to confirm a diagnosis, evaluate effects of treatment, and assist in designing rehabilitative or intervention strategies for the patient. Standardized test batteries are too long for most patients with dementia; specialized dementia batteries or an individualized test battery is usually more appropriate.

A definitive diagnosis of Alzheimer’s disease is based on the presence of memory deficits along with deficits in at least one other aspect of cognition, and in some cases is made on neuropsychological test results alone (Talwalker, 1996). Impairment in primary (short-term) memory alone is not a useful diagnostic marker for Alzheimer’s disease in the early stages. Tests of delayed recall (long-term memory) and retrieval of facts of common knowledge have been shown to be the most useful measures to distinguish normal aging and early Alzheimer’s disease. Dementia due to Alzheimer’s disease can be distinguished from dementia due to vascular disease by differences in pattern of memory impairment and the progressive nature of Alzheimer’s disease. Careful interpretation of test results, taken in conjunction with medical findings, allows differentiation of Alzheimer’s disease from normal memory loss due to aging, and from vascular dementia.

Yoon et al. (2015) evaluated whether olfactory and neuropsychological tests can aid in the differentiation of dementia with Lewy bodies (DLB) from Alzheimer’s disease (AD) at the mild cognitive impairment (MCI) stage since the early differentiation of DLB from AD may be important to delay disease progression. The study included 122 MCI patients who were monitored until they developed dementia or until their condition stabilized; the follow-up period averaged 4.9 years (range: 3.9-6.2 years). Baseline olfactory function as measured with the Cross-Cultural Smell Identification (CCSI) test and neuropsychological data were compared. During the follow-up period, 32 subjects developed probable AD (MCI-AD), 18 had probable DBL (MCI-DLB), 45 did not convert to dementia (MCI-stable), and eight developed a non-AD/DLB dementia. The mean CCSI score was significantly lower than that of MCI-AD patients and MCI-stable patients. The area under the curve of the receiver operating characteristic to discriminate MCI-DLB from MCI-AD using CCSI scores was 0.84. Frontal-executive function and visuospatial ability was worse in patients with MCI-DLB, while verbal recognition memory impairment was greater in those with MCI-AD. The authors concluded that olfactory and neuropsychological tests can help predict conversion to DLB or AD in patients with MCI.

Madureira et al. (2010) determined the extent to which the performance in neuropsychological tests would be able to predict the clinical diagnosis of dementia. The LADIS (Leukoaraiosis and Disability) is a prospective study that evaluates the impact of white matter changes (WMC) on the transition of independent elderly to disability. The subjects were evaluated at baseline and yearly during 3 years with a comprehensive clinical, functional and neuropsychological protocol. At each visit, dementia was classified according to clinical criteria. The performance in the neuropsychological batteries was compared according to the clinical diagnosis of dementia. From the initially enrolled 639 subjects, 480 were evaluated at year 3. Dementia was diagnosed in 90 participants. The demented subjects had worse performance in almost all the baseline cognitive tests. Using receiver operating characteristic curves, the investigators found that the Vascular Dementia Assessment Scale (VADAS) battery had higher sensitivity and specificity rates to identify dementia compared with the Mini-Mental State Examination (MMSE) and Alzheimer’s Disease Assessment Scale. Worse performances on baseline MMSE were predictors of dementia. The investigators concluded that performance on the MMSE and the VADAS battery were important predictors of dementia at a 3-year period.

Pseudodementia, a dementia of "nonorganic" etiology, is due to profound depression and can be difficult to differentiate from true dementia. The Geriatric Depression Scale is commonly used for evaluating depression in elderly people. Prospective studies have shown increased accuracy in differentiating pseudodementia from true dementia with repeated testing 12-18 months later (Yousef, 1998). This is a vital distinction to make, as organic dementia is often progressive and is usually not reversible, while dementia associated with depression may reverse or resolve with treatment.

**Developmental Disorders**

In general, empirical data, rather than evidence from prospective studies with long-term follow-up, support the use of neuropsychological testing for developmental disorders in infants and children. For the Test of Infant Motor Performance, there is evidence from a longitudinal study with subjects stratified by postconceptional age, medical risk, and race or ethnicity that this test has predictive validity for identifying infants at risk for poor developmental outcome (Campbell, 1995).
In a national cohort of extremely low birth weight (ELBW) children, neuropsychological test profiles were assessed in 4 groups defined according to a neurological examination at 5 years of age: normal neuromotor status (N = 56), motor coordination problems (N = 32), multiple subtle neuromotor signs including both motor coordination problems and deviant reflexes (N = 20), and spastic diplegia (N = 12). The neurocognitive assessment included a test of intelligence, the Wechsler Primary and Preschool Scale of Intelligence-Revised (WPPSI-R) and 14 subtests of attention and executive functions, verbal functions, manual motor functions, visuoconstructual functions and verbal learning. The children with normal neuromotor status performed within the average range; children with motor coordination problems had widespread impairment; and children with spastic diplegia and children with multiple minor neuromotor signs had uneven test profiles with stronger verbal results but weaknesses in attention and executive functions, and in manual motor and visuoconstructual tasks. According to the investigators, very early gestation children with neuromotor signs, including motor coordination problems, are at risk for neurocognitive impairment, in spite of average intelligence. More impaired children have more irregular test profiles. Follow-up and neuropsychological assessments of very preterm children with minor neuromotor signs are therefore indicated (Korkman, 2008).

Hartman et al. (2010) examined the motor skills and executive functions in school-age children with borderline and mild intellectual disabilities (ID). Sixty-one children aged between 7 and 12 years diagnosed with borderline ID (33 boys and 28 girls; 71 < IQ < 79) and 36 age peers with mild ID (24 boys and 12 girls; 54 < IQ < 70) were assessed. Their abilities were compared with those of 97 age- and gender-matched typically developing children. Qualitative motor skills, i.e., locomotor ability and object control, were evaluated with the Test of Gross Motor Development (TGMD-2). Executive functioning (EF), in terms of planning ability, strategic decision-making and problem solving, was gauged with the Tower of London (TOL) task. Compared with the reference group, the full ID cohort scored significantly lower on all assessments. According to the investigators, the study results support the notion that besides being impaired in qualitative motor skills, intellectually challenged children are also impaired in higher-order executive functions. The authors conclude that deficits in the two domains are interrelated, so early interventions boosting their motor and cognitive development are recommended.

**Traumatic Brain Injury**

Longitudinal and case controlled studies along with numerous case reports support the use of neuropsychological tests to assess the severity of injury and the prognosis for patients with closed head trauma, to monitor progression, and to provide measures of outcome for determining degree of recovery (Carlozzi, 2015; Baum, 2008; Kalmar, 2008; Greve, 2008). Sufficient scientific evidence from a variety of sources exists to prove the efficacy of neuropsychological testing in the immediate and long-term evaluation of brain-injured patients (Williams, 2013; Boake, 2001; Atchison, 2004).

**Other Disorders**

Neuropsychological testing may have a role in the clinical management of the following medical disorders:
- Brain lesions including abscesses, tumors, and arteriovenous malformations in the brain (Walsh, 2016; Cochereau, 2016; Ivovne, 2011; Krupp, 2009; Visani, 2006)
- Demyelinating disease including multiple sclerosis (Benedict, 2006; Caceres, 2011; Glanz, 2012)
- Encephalopathy (Poh, 2012; Martin, 2006; Skinner, 2009; Stewart 2010)
- Epilepsy and seizure disorders (Wilson, 2015; Filippini, 2016; Potter, 2009; Jackson, 2012)
- Neurotoxin exposure (Nascimento, 2016 R)
- Stroke (Nascimento, 2016 ;Chen, 2015; Wiberg, 2012)

**Computerized Neuropsychological Testing for Concussion**

Kontos et al. (2014) performed a meta-analysis assessing the effects of sport-related concussion as measured by computerized neurocognitive tests (NCT) 1-week post injury. Thirty-seven studies involving 3960 participants between 2000 and 2011 were included. Code substitution, visual memory, processing speed, and memory tasks demonstrated negative effects for concussion. Younger adolescents had lower NCT performance than older adolescents and college aged athletes. ImPACT studies demonstrated a negative effect for concussion as did those involving contact sports. The authors found that computerized neurocognitive testing results suggest athletes suffer impairments within one week of a concussion. Several factors such as age, type of neurocognitive test, and test administrator may lead to more pronounced impairments. The authors indicated that no single tool can or should be used to measure the effect of concussion. Instead, clinicians and researchers should adopt a comprehensive approach to assessing this injury.

Echemendia et al. (2013) critically reviewed the literature from the past 12 years regarding key issues in sports-related neuropsychological assessment of concussion. Based on the review of the literature, the authors concluded that traditional and computerized neuropsychological tests are useful in the evaluation and management of concussion. Brief cognitive evaluation tools are not substitutes for formal neuropsychological assessment. According to the authors, there is insufficient evidence to recommend the widespread routine use of baseline neuropsychological testing.

Bruce et al. (2014) examined the 1 year test-retest reliability of ImPACT in a multilingual sample of professional hockey players. A total of 305 professional hockey players were tested 1 year apart using ImPACT. Reliable change confidence intervals were calculated and test-retest reliability was measured using Pearson and Intraclass correlation.
coefficients. Results indicated that the 1-year test-retest reliabilities for the Visual Motor and Reaction Time Composites ranged from low to high (.52 to .81). In contrast, 1-year test-retest reliabilities for the Verbal and Visual Memory Composites were low (.22 to .58). According to the authors, the 1-year test-retest results provided mixed support for the use of Visual Motor and Reaction Time Composites in select samples; in contrast, the Verbal and Visual Memory Composites may not be sensitive to clinical change.

Broglio et al. (2007a) examined the test-retest reliability of 3 commercially available computer-based neurocognitive assessments using clinically relevant time frames in 118 healthy student volunteers. The participants completed the ImPACT, Concussion Sentinel, and Headminder Concussion Resolution Index tests on 3 days: baseline, day 45, and day 50. Each participant also completed the Green Memory and Concentration Test to evaluate effort. Intraclass correlation coefficients were calculated for all output scores generated by each computer program as an estimate of test-retest reliability. All participants demonstrated high levels of effort on all days of testing, according to Memory and Concentration Test interpretive guidelines. The investigators concluded that computer-based concussion evaluations did not provide stable measures of cognitive functioning in healthy adults and that inconsistent performance on concussion assessments may lead clinicians to inaccurate determinations of cognitive function. According to the authors, clinicians should be cautious in interpreting findings of concussion assessments and should use a multifaceted approach.

Nakayama et al. (2014) examined the test-retest reliability of the ImPACT between baseline, 45 days, and 50 days. Eighty-five physically active college students (51 male, 34 female) volunteered for this study. Participants completed the ImPACT as well as a 15-item memory test at baseline, 45 days, and 50 days. Intraclass correlation coefficients (ICCs) were calculated for ImPACT composite scores, and change scores were calculated using reliable change indices (RCIs) and regression-based methods (RBMs) at 80% and 95% confidence intervals (CIs). The respective ICCs for baseline to day 45, day 45 to day 50, baseline to day 50, and overall were as follows: verbal memory (0.76, 0.69, 0.65, and 0.78), visual memory (0.72, 0.66, 0.60, and 0.74), visual motor (processing) speed (0.87, 0.88, 0.85, and 0.91), and reaction time (0.67, 0.81, 0.71, and 0.80). All ICCs exceeded the threshold value of 0.60 for acceptable test-retest reliability. All cases fell well within the 80% CI for both the RCI and RBM, while 1% to 5% of cases fell outside the 95% CI for the RCI and 1% for the RBM. According to the authors, the study results suggest that the ImPACT is a reliable neurocognitive test battery at 45 and 50 days after the baseline assessment. The current findings agree with those of other reliability studies that have reported acceptable ICCs across 30-day to 1-year testing intervals, and they support the utility of the ImPACT for the multidisciplinary approach to concussion management. The authors state that when managing concussed athletes, the ImPACT should not be used as a stand-alone measure.

In a cross-sectional study, Resch et al. (2013) evaluated test-retest reliability for the computerized neuropsychological test battery (ImPACT) using 2 different clinically relevant time intervals. Study participants included Group 1 (n = 46) which consisted of 25 men and 21 women (age = 22.4 ± 1.89 years) and Group 2 (n = 45) which consisted of 17 men and 28 women (age = 20.9 ± 1.72 years). Both groups completed ImPACT forms 1, 2, and 3, which were delivered sequentially either at 1-week intervals (group 1) or at baseline, day 45, and day 50 (group 2). Group 2 also completed the Green Word Memory Test (WMT) as a measure of effort. Intraclass correlation coefficients (ICCs) were calculated for the composite scores of ImPACT between time points. Repeated-measures analysis of variance was used to evaluate changes in ImPACT and WMT results over time. The authors found variable test-retest reliability for ImPACT metrics. Visual motor speed and reaction time demonstrated greater reliability than verbal and visual memory. According to the authors, current data support a multifaceted approach to concussion assessment using clinical examinations, symptom reports, cognitive testing, and balance assessment.

Elbin et al. (2011) investigated the 1-year test-retest reliability of the ImPACT online version in a sample of high school athletes. A total of 369 varsity high school athletes completed 2 mandatory preseason baseline cognitive assessments approximately 1 year apart as required by their respective athletics program. No diagnosed concussion occurred between assessments. Intraclass correlation coefficients (ICCs) for ImPACT online indicated that motor processing speed (.85) was the most stable composite score, followed by reaction time (.76), visual memory (.70), and verbal memory (.62). Unbiased estimates of reliability were consistent with ICCs: motor processing speed (.85), reaction time (.76), visual memory (.71), and verbal memory (.62). The authors concluded that the online ImPACT baseline is a stable measure of neurocognitive performance across a 1-year time period for high school athletes. This was an uncontrolled case series and this limits the validity of the study.

Schatz et al. (2006) evaluated the diagnostic utility of the composite scores of Immediate Post-Concussion Assessment and Cognitive Testing (ImPACT) and Post-Concussion Symptom Scale scores (PCSS). Recently concussed high school athletes (n=72) were tested within 72 hours of sustaining a concussion, and data were compared to non-concussed high school athletes with no history of concussion (n=66). A discriminant function analyses was conducted to measure the ability of the five ImPACT composite scores, as well as the PCSS to classify concussion status. One discriminant function was identified that consisted of the Visual Memory, Processing Speed, and Impulse Control composite scores PCSS, which correctly classified 85.5% of the cases. Approximately 82% of participants in the concussion group and 89% of participants in the control group were correctly classified. Using these data, the
sensitivity of ImPACT was 81.9%, and the specificity was 89.4%. The investigators concluded that as part of a formal concussion management program, ImPACT is a useful tool for the assessment of the neurocognitive and neurobehavioral sequelae of concussion, and can also provide post-injury cognitive and symptom data that can assist a practitioner in making safer return to play decisions. According to the investigators, when used appropriately, by a trained neuropsychologist and in conjunction with a thorough clinical interview, the utility of ImPACT is likely to be further enhanced. This was a retrospective study, and this limits its validity.

Broglio et al. (2007) investigated the sensitivity of concussion-related symptoms, a postural control evaluation, and neurocognitive functioning in concussed collegiate athletes. From 1998 to 2005, all high-risk athletes completed a baseline concussion-assessment battery that consisted of a self-reported symptom inventory, a postural control evaluation, and a neurocognitive assessment. Postconcussion assessments were administered within 24 hours of injury to 75 athletes who had physician-diagnosed concussion. Individual tests and the complete battery were evaluated for sensitivity to concussion. The computerized Immediate Post-Concussion Assessment and Cognitive Testing and HeadMinder Concussion Resolution Index (neurocognitive tests) were the most sensitive to concussion (79.2 and 78.6%, respectively). These tests were followed by self-reported symptoms (68.0%), the postural control evaluation (61.9%), and a brief pencil-and-paper assessment of neurocognitive function (43.5%). When the complete battery was assessed, sensitivity exceeded 90%. According to investigators, currently recommended concussion-assessment batteries accurately identified decrements in one or more areas in most of the athletes with concussion. These findings support previous recommendations that sports-related concussion should be approached through a multifaceted assessment with components focusing on distinct aspects of the athlete's function.

Randolph et al. (2005) assessed the criteria that should be met in order to establish the utility of neuropsychological (NP) instruments as a tool in the management of sport-related concussion and to review the degree to which existing tests have met these criteria. The authors completed a comprehensive literature review of MEDLINE and PsychLit from 1990 to 2004, including all prospective, controlled studies of NP testing in sport-related concussion. The data synthesis indicated that the effects of concussion on NP test performance are so subtle even during the acute phase of injury (1-3 days postinjury) that they often fail to reach statistical significance in group studies. Thus, this method may lack utility in individual decision making because of a lack of sensitivity. In addition, most of these tests fail to meet other psychometric criteria (e.g., adequate reliability) necessary for this purpose. Finally, it is unclear that NP testing can detect impairment in players once concussion-related symptoms (e.g., headache) have resolved. Because no current guideline for the management of sport-related concussion allows a symptomatic player to return to sport, the utility of NP testing remains questionable. The authors concluded that despite the theoretic rationale for the use of NP testing in the management of sport-related concussion, no NP tests have met the necessary criteria to support a clinical application at this time. Additional research is necessary to establish the utility of these tests before they can be considered part of a routine standard of care, and concussion recovery should be monitored via the standard clinical examination and subjective symptom checklists until NP testing or other methods are proven effective for this purpose.

Maerlender et al. (2010) compared scores on the ImPACT battery to a comprehensive battery of traditional neuropsychological measures and several experimental measures used in the assessment of sports-related concussion in 54 healthy male athletes. Convergent validity was demonstrated for four of the five ImPACT domain scores. Two cognitive domains often compromised as a result of mild TBI were not directly identified by the ImPACT battery: sustained attention and auditory working memory. Affective symptoms correlated with performance on measures of attention and working memory. In this healthy sample, the correlations between the domains covered by ImPACT and the neuropsychological battery supports ImPACT as a useful screening tool for assessing many of the cognitive factors related to mild traumatic brain injury. However, the narrow construct structure of ImPACT would limit interpretation, particularly with regard to the important functions of working memory and response accuracy. This may make ImPACT testing difficult to interpret for the untrained professional. According to the investigators, the study suggests that other sources of data such as a traditional neuropsychological testing including verbal memory, visual memory, and working memory need to be considered when identifying and managing concussions.

In a consensus statement, the 4th International Conference on Concussion in Sport states that the use of neuropsychological testing contributes significant information in concussion assessment. No specific recommendations are made regarding computerized neuropsychological testing. The statement does not advocate the use of neuropsychological testing alone in determining the presence of concussion or in the concussion management process. The consensus statement suggests that baseline neuropsychological testing may be useful in interpreting the test but is not required as a mandatory component due to insufficient evidence to support recommending routine use of baseline testing (McCroryet al., 2013).

**Baseline Neuropsychological Testing for Concussion**

Nelson et al. (2016) examined the rates and predictors of invalid baseline performance for 3 computerized neuropsychological tests (CNTs): Automated Neuropsychological Assessment Metrics (ANAM), Axon Sports, and Immediate Post-Concussion and Cognitive Testing (ImPACT). High school and collegiate athletes (N = 2063)
completed 2 of 3 CNTs each during preseason evaluations. All possible pairings were present across the sample, and the order of administration was randomized. Examiners provided 1-on-1, scripted pretest instructions, emphasizing the importance of good effort. Profile validity was determined by the manufacturers’ standard criteria. The overall percentage of tests flagged as of questionable validity was lowest for ImPACT (2.7%) and higher for ANAM and Axon (10.7% and 11.3%, respectively). The majority of invalid baseline profiles were flagged as such because of failure on only 1 validity criterion. Several athlete and testing factors (e.g., attention deficit hyperactivity disorder [ADHD], estimated general intellectual ability, administration order) predicted validity status for 1 or more CNTs. Considering only first CNT administrations and participants without ADHD and/or a learning disability (n = 1835) brought the rates of invalid baseline performances to 2.1%, 8.8%, and 7.0% for ImPACT, ANAM, and Axon, respectively. Invalid profiles on the Medical Symptom Validity Test (MSVT) were rare (1.8% of participants) and demonstrated poor correspondence to CNT validity outcomes. That investigators concluded that the validity criteria for these CNTs may not identify the same causes of invalidity or be equally sensitive to effort. According to the investigators, the validity indicators may not be equally appropriate for some athletes (e.g., those with neurodevelopmental disorders).

Haran et al. (2016) examined differences between the baseline-referenced and norm-referenced approaches for determining decrements in Automated Neuropsychological Assessment Metrics Version 4 TBI-MIL (ANAM) performance following mild traumatic brain injury (mTBI). ANAM data were reviewed for 616 US Service members; with 528 of this sample having experienced an mTBI and 88 were controls. Post-injury change scores were calculated for each sub-test: (1) normative change score = in-theater score - normative mean and (2) baseline change score = in-theater score - pre-deployment baseline. Reliable change cut-scores were applied to the change and the resulting frequency distributions were compared using McNemar tests. Receiver operator curves (ROC) using both samples (i.e., mTBI and control) were calculated for the change scores for each approach to determine the discriminate ability of the ANAM. There were no statistical differences between the approaches. When the area under the curve for the ROCs were averaged across sub-tests, there were no significant differences between either the norm-referenced (0.65) or baseline-referenced (0.66) approaches. The investigators concluded that overall, the findings suggest there is no clear advantage of using the baseline-referenced approach over norm-referenced approach.

MacDonald and Duerson (2015) examined the test-retest reliability of a computerized neurocognitive test used for baseline assessments in high school athletes over 1 year. Study participants included high school athletes (N = 117) participating in American football or soccer. All study participants completed 2 baseline computerized neurocognitive tests taken 1 year apart at their respective schools. The test measures performance on 4 cognitive tasks: identification speed (Attention), detection speed (Processing Speed), one card learning accuracy (Learning), and one back speed (Working Memory). Reliability was assessed by measuring the intraclass correlation coefficient (ICC) between the repeated measures of the 4 cognitive tasks. Pearson and Spearman correlation coefficients were calculated as a secondary outcome measure. The measure for identification speed performed best and the measure for one card learning accuracy performed worst. All tests had marginal or low reliability. The authors concluded that in a population of high school athletes, computerized neurocognitive testing performed in a community setting demonstrated low to marginal test-retest reliability on baseline assessments 1 year apart. The authors stated that further investigation should focus on (1) improving the reliability of individual tasks tested, (2) controlling for external factors that might affect test performance, and (3) identifying the ideal time interval to repeat baseline testing in high school athletes. According to the authors, this study adds to the evidence that suggests in this population baseline testing may lack sufficient reliability to support clinical decision making.

In a study conducted by Schmidt et al. (2012), 1,060 collegiate student-athletes completed baseline testing as part of an ongoing clinical program. Gender-specific normative means were obtained from a subset of 673 athletes with no history of self-reported concussion, learning disabilities, or attention deficit disorders. Concussions were later diagnosed in 258 athletes who had completed baseline testing. Athletes completed a computerized neurocognitive test (Automated Neuropsychological Assessment Metrics), postural control assessment, and a 15-item graded symptom checklist at baseline and again following injury. Two post-concussion difference scores were computed for each outcome measure: (1) Baseline comparison = post-concussion score - individualized baseline score; and (2) Normative comparison = post-concussion score - normative mean. Athletes were considered impaired if post-concussion difference exceeded the reliable change parameters. The baseline comparison method identified 2.6 times more impairments than the normative comparison method for Simple Reaction Time- Test 1. The normative comparison method identified 7.6 times more impairments than the baseline comparison method for Mathematic Processing. No other disagreements were observed for postural control or symptom severity. The authors concluded that when using these concussion assessment tools, clinicians may consider using normative data in lieu of individualized baseline measures. This may be especially useful to clinicians with limited resources and an inability to capture baselines on all athletes.

Randolph (2011) reviewed the risks associated with sport-related concussion, and the clinical validity and reliability data for the most commonly used baseline test, the ImPACT program. The authors found no published prospective controlled study of the current version of ImPACT that would allow a determination to be made as to whether ImPACT is capable of detecting impairment in a significant percentage of athletes once they are symptom free. According to
the authors, the bulk of the evidence suggests that ImPACT is not particularly sensitive to the effects of concussion, particularly once subjective symptoms have resolved. The poor sensitivity and low reliability of this test is associated with a high false negative rate (i.e., classifying a player's neurocognitive status as normal, when in fact, it is not). The use of baseline neuropsychological testing, therefore, is not likely to diminish risk. The clinical utility of baseline testing in clinical decision-making was not addressed.

**Mindstreams® Cognitive Health Assessment**

Shopin et al. (2013) compared a computerized battery of neuropsychological tests for memory, attention and executive functions (MindStreams®) with the Montreal Cognitive Assessment (MoCA) to detect mild-to-moderate cognitive impairments in poststroke patients. A total of 454 patients with transient ischemic attack (TIA) or stroke enrolled to the TABASCO (Tel Aviv Brain Acute Stroke Cohort) study, a prospective study which includes consecutive first-ever mild-to-moderate stroke patients, were included. All participants underwent neurological and cognitive evaluations. The patients’ mean MoCA and MindStreams® scores were lower than normal; however, the TIA group presented significantly better scores using either method. The correlation between the MoCA and the computerized global score was 0.6. A significant correlation was found between the subcategory scores (executive function, memory and attention). However, the MoCA identified many more subjects with low scores (<26) compared to the MindStreams® (70.6 vs. 15.7%).

Punchik et al. (2015) retrospectively analyzed patients referred to a comprehensive geriatric assessment unit with screening instruments to determine if further comprehensive cognitive assessment was necessary. Cognitive screening and assessment included visual-spatial components: the Mini Mental State Examination, the Clock Drawing Test, the Montreal Cognitive Assessment Test, and the Neurotrax (Mindstreams®) computerized cognitive assessment battery. The average age of the 190 eligible patients was 81.09±5.42 years. Comparing the individual tests with that of the visual-spatial index of Neurotrax, the investigators found the Trail Making B test to be most sensitive (72.4%) and the Cube Test to have the highest specificity (72.8%). A combination of tests resulted in higher sensitivity and lower specificity. The authors concluded that the use of a combination of visual-spatial tests for screening in neurocognitive disorders should be evaluated in further prospective studies.

Dwolatzky et al. (2010) examined the validity of the Mindstreams® battery designed specifically for evaluating those with moderate cognitive impairment. One hundred and seventy participants over the age of 60 years performed the computerized battery in addition to standard clinical evaluation. Staging was according to the Clinical Dementia Rating Scale (CDR) on the basis of clinical data but independent of computerized cognitive testing results, thus serving as the gold standard for evaluating the discriminant validity of the computerized measures. Seven participants received a global Clinical Dementia Rating (CDR) score of 0 (not impaired), 76 were staged as CDR 0.5 (very mildly impaired), 58 as CDR 1 (mildly impaired), 26 as CDR 2 (moderately impaired), and 3 as CDR 3 (severely impaired). Mindstreams® Global Score performance was significantly different across CDR groups, reflecting poorer overall battery performance for those with greater impairment. This was also true for the domain summary scores, with Executive Function and Memory distinguishing best between CDR 0.5 and 1, and Orientation best differentiating among CDR 1 and 2. The investigators concluded that the Mindstreams® battery for moderate impairment differentiates among varying degrees of cognitive impairment in older adults, providing detailed and distinct cognitive profiles. Limitations of this study include lack of a control group and small sample size.

Achiron et al. (2007) compared the Mindstreams® test battery with the Neuropsychological Screening Battery for Multiple Sclerosis (NSBMS), which is considered the reference standard for cognitive screening in MS, in patients with MS (n=58) and in a control group of healthy volunteers (n=71) who were matched for age, education, gender, handedness, and computer use. The 71 controls were randomly selected from 410 individuals who were used to establish normative values for the Mindstreams® system. Five of the 7 index scores (memory, executive function, attention, information processing, and motor skills) significantly discriminated MS patients from controls, while visuospatial and verbal-function indexes did not. However, the NSBMS system was not assessed in a similar manner; only correlation coefficients of the Mindstreams® index scores and NSBMS system outcomes were presented. As with the study by Ritsner et al. (2006), all of the correlations were statistically significant, but the magnitude of the correlation coefficients indicates only moderate correlation at best. This study, therefore, demonstrates the capability of the Mindstreams® system to differentiate MS patients from healthy volunteers across 5 of 7 cognitive domains, but the data are insufficient to establish the equivalence of the Mindstreams® system to the standard of care or to demonstrate a benefit of Mindstreams® assessment on clinical outcomes.

Overall, the available evidence is insufficient to establish the validity of Mindstreams® computerized cognitive testing compared with traditional tests for the assessment of cognitive impairment.

**Intermittent Explosive Disorder**

There are no clear underlying medical issues associated with intermittent explosive disorder, nor are there published clinical trials that support the use of neuropsychological testing for this disorder. According to the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV), published by the American Psychiatric Association, the following criteria must be met in order for a patient to be diagnosed with intermittent explosive disorder:
• Recurrent behavioral outbursts that represent a failure to control aggressive impulses as manifested by one of the following:
  o Verbal aggression (e.g., temper tantrums, tirades, verbal arguments or fights) or physical aggression towards property, animals, or other individuals, occurring, on average, twice weekly for a period of three months. The physical aggression does not result in damage or destruction of property and does not result in physical injury to animals or other individuals.
  o Three behavioral outbursts involving damage or destruction of property and/or physical assault with physical injury against animals or other individuals occurring within a 12-month period.
• The magnitude of aggressiveness expressed during the recurrent outbursts is grossly out of proportion to the provocation or any precipitating psychosocial stressors.
• The recurrent aggressive outbursts are not premeditated (i.e. are impulsive) and are not committed to achieve some tangible objective (e.g., money, power, intimidation).
• The recurrent aggressive outbursts cause either marked distress in the individual or impairment in occupational or interpersonal functioning, or are associated with financial or legal consequences.
• Chronological age is at least 6 years (or equivalent developmental level).
• The recurrent aggressive outbursts are not better explained by another mental disorder and are not attributable to another medical condition or to physiological effects of a substance.

Headaches Including Migraine

Literature addressing the neuropsychological consequences of migraine headaches is not conclusive. Studies on the relationship between migraine and cognitive functioning have demonstrated conflicting results. Some studies show a detrimental effect of migraine on cognitive skills (Calandre, 2002). Other studies have shown no difference in cognitive skills for patients with migraine headaches (Gaist, 2005; Pearson, 2006).

Dresler et al. (2012) evaluated three neuropsychological tests (Trail Making Test (TMT), Go/Nogo Task and Stroop Task) that were completed by four headache patient samples (chronic CH, episodic CH in the active or inactive period, and migraine patients) and compared to healthy controls. Analyses revealed that patients with chronic and active episodic CH appeared particularly impaired in tests relying more on intact executive functioning (EF) than on basal cognitive processes. Within the CH groups performance decreased linearly with increasing severity. The authors stated that impaired EF could also result from medication and sleep disturbances due to active CH. The authors went on to say that because decreased performance was also present outside the attacks it may hint at generally altered brain function, but does not necessarily reflect clinically relevant behavior.

Mongini et al. (2005) evaluated whether neuropsychological tests demonstrate a frontal lobe dysfunction in patients with chronic migraine. The Gambling Task (GT), the Tower of Hanoi-3 (TOH-3) and the Object Alternation Test (OAT) were administered to 23 female patients previously treated for chronic migraine and to 23 healthy women who were similar to the patients in age and educational level, and the mean test scores of the two groups were compared. The patient group scored significantly higher than the controls on the TOH-3 and, especially, the OAT. In the patients, no significant relationship was found between the neuropsychological test scores and those for the Minnesota Multiple Personality Inventory (MMPI), the Spielberg State-Trait Anxiety Inventory (STAI), and the Beck Depression Inventory (BDI). The investigators concluded that the data suggest a relationship between chronic headache and dorsolateral function (as tested by the TOH-3) and orbitofrontal function (as tested by the OAT). The decision-making function related to ventromedial prefrontal cortex (tested by the GT) did not show a statistically significant difference between patients and controls. These neuropsychological findings seem to be partly independent of the patient’s psychological traits and psychiatric disorders. This study was limited by as small sample size.

There is insufficient clinical evidence to conclude that the use of neuropsychological testing for patients with migraine headaches without associated cognitive disorders can be used effectively for clinical decision making to improve management of this condition. No published clinical trials were found that support the use of neuropsychological testing for clinical decision making to improve management for patients with other types of headaches who did not have associated cognitive disorders.

History of Myocardial Infarction

Literature addressing the neuropsychological consequences of myocardial infarction is not conclusive. Studies on the relationship between myocardial infarction and cognitive functioning have demonstrated conflicting results. Some studies show a detrimental effect of myocardial infarction on cognitive skills (Sauve, 2009; Almeida, 2008). Other studies have shown no difference in cognitive skills for patients with myocardial infarctions (Ahto, 1999, Grubb, 2000).

In a systematic review, Cameron et al. (2015) the diagnostic accuracy of cognitive screening instruments in screening for mild cognitive impairment (MCI) in heart failure (HF) patients. Inclusion criteria for the review were as follows: primary studies examining cognitive impairment in HF, administration of a cognitive screening instrument and neuropsychological test battery, and cognitive impairment indicated by performance on neuropsychological tests 1.5 SDs less than that of normative data. The precision, accuracy, and receiver operating characteristic curves of the Mini
Neuropsychological testing data were gathered from 46 healthy controls, 42 cardiac patients referred for percutaneous coronary intervention (PCI), and 43 cardiac patients referred for coronary artery bypass grafting (CABG). Fourteen cognitive function tests were utilized at baseline and at three time points after surgery (3 weeks, 4 months, 1 year). No clear pattern of group differences or change at follow-up emerged. A greater percentage of CABG patients than controls worsened in seven tests (three at 1 year), but a greater percentage of PCI patients than controls also worsened in seven tests (three at 1 year). Generalized estimating equations showed only two tests (Wechsler Adult Intelligence Scale, Third Edition, Digit Symbol, and Hopkins Verbal Learning Test, Revised, Total Recall) to be significantly different between groups from baseline to 1 year. Compared with healthy controls, more PCI patients than CABG patients worsened in the former of those two tests, whereas more PCI and CABG patients improved on the latter. The investigators concluded that current CABG procedure does not appear to create cognitive decline (Sweet, 2008).

There is insufficient clinical evidence to conclude that the use of neuropsychological testing for patients with myocardial infarction without associated cognitive disorders can be used effectively for clinical decision making to improve management of this condition.

**Professional Societies**

**American Academy of Neurology (AAN)**

In an evidence-based guideline update for the evaluation and management of concussion in sports, the AAN states that it is likely that neuropsychological testing of memory performance, reaction time, and speed of cognitive processing, regardless of whether administered by paper-and-pencil or computerized method, is useful in identifying the presence of concussion (sensitivity 71%–88% of athletes with concussion). This is based on evidence from 1 Class II study and multiple Class III studies. The AAN also states that both types of testing (paper-and-pencil or computerized) generally require a neuropsychologist for accurate interpretation, although the tests may be administered by a non-neuropsychologist. According to AAN, there is insufficient evidence to support conclusions about the use of neuropsychological testing in identifying concussion in preadolescent age groups. The AAN goes on to say that inexperienced licensed health care providers (LHCPs) should be instructed in the proper administration of standardized validated sideline assessment tools. This instruction should emphasize that these tools are only an adjunct to the evaluation of the athlete with suspected concussion and cannot be used alone to diagnose concussion (Level B – probably effective). The AAN further states that LHCPs caring for athletes might utilize individual baseline scores on concussion assessment tools, especially in younger athletes, those with prior concussions, or those with preexisting learning disabilities/attention deficit/hyperactivity disorder, as doing so fosters better interpretation of postinjury scores (Level C - Possibly effective) (Giza 2013).

In a position statement on sports concussion, the AAN made the following recommendations (AAN, 2010, updated 2013):

- Any athlete who is suspected to have suffered a concussion, regardless of severity, is to be removed immediately from participation in a game or practice.
- A licensed health care professional, such as a neurologist, whose scope of practice includes proper training in the evaluation and management of concussion, must clear the youth athlete before he or she can return to play. This includes sports recognized by high school athletic associations as well as youth and recreational leagues run by other entities.

The AAN published a report regarding neuropsychological testing of adults. This report indicates that neuropsychological testing is most useful for management planning in patients with suspected dementia, multiple sclerosis, Parkinson's disease, traumatic brain injury, stroke, and HIV encephalopathy. It is also useful for detecting deficits in patients with particularly high premorbid intelligence levels in which bedside-type clinical testing may be insensitive to mild alterations. Neuropsychological testing also has an important role in evaluating patients undergoing epilepsy surgery (Cummings, 1996).

The Quality Standards Subcommittee of the AAN published an evidence-based review for the early detection of dementia. (Petersen, 2001) The recommendations state that neuropsychologic batteries are useful to identify patients with dementia, particularly when administered to an increased-risk population (i.e., those with cognitive impairment).

A practice parameter for the screening and diagnosis of autism developed by the American Academy of Neurology and the Child Neurology Society indicates that neuropsychological, behavioral, and academic assessments should be
performed as needed, in addition to the cognitive assessment, to include social skills and relationships, educational functioning, problematic behaviors, learning style, motivation and reinforcement, sensory functioning, and self-regulation for the diagnosis of autism (Filipek, 2000).

In a practice parameter update on the evaluation and management of driving risk in dementia, the AAN states that there is insufficient evidence to recommend neuropsychological testing to predict driving capability among patients with dementia (Iverson et al. 2010).

In a practice parameter update on the care of the patient with amyotrophic lateral sclerosis (ALS), the AAN states that the domain of cognitive and behavioral impairment in ALS is a rapidly evolving field and there is little consensus regarding diagnostic criteria and assessment methods. Screening tests of executive function may be considered to detect cognitive impairment in patients with ALS prior to confirmation with formal neuropsychological evaluation (Level C) (Miller et al. (2009).

American Psychological Association (APA)
The American Psychological Association published updated guidelines for the evaluation of dementia and age-related cognitive change. The guidelines include the following information regarding neuropsychological testing for this condition (American Psychological Association, 2012):

- Neuropsychological evaluation and cognitive testing remain among the most effective differential diagnostic methods in discriminating pathophysiological dementia from age-related cognitive decline, cognitive difficulties that are depression-related, and other related disorders. Even after reliable biological markers have been discovered, neuropsychological evaluation and cognitive testing will still be necessary to determine the onset of dementia, the functional expression of the disease process, the rate of decline, the functional capacities of the individual, and hopefully, response to therapies.
- Comprehensive neuropsychological evaluations for dementia and cognitive change include tests of multiple cognitive domains, typically including memory, attention, perceptual and motor skills, language, visuospatial abilities, reasoning, and executive functions. Measures of mood and personality may be relevant in many cases. Psychologists are encouraged to refer to current compendia resources and the clinical research literature in selecting assessment instruments. Psychologists are encouraged to use standardized, reliable, and valid tests.
- Technology assisted assessments (e.g., computer administered cognitive batteries, tele-health visits) are rapidly advancing but appropriate psychometric properties and normative data are nascent. These technologies may have significant advantages for older persons with limited mobility or health-care access, but may also disadvantage older persons with limited experience and expertise interacting with technology.

American Psychiatric Association
In its guidelines on the treatment of Alzheimer's disease and other dementias, the American Psychiatric Association states that neuropsychological testing may be helpful in deciding whether a patient with subtle or atypical symptoms actually has dementia. Neuropsychological testing is particularly useful in the evaluation of individuals who present with mild cognitive impairment, which requires evidence of memory and/or other cognitive difficulties in the presence of intact functioning, and in the evaluation of individuals with the onset of dementia early in life. Testing may help to characterize the extent of cognitive impairment, to distinguish among the types of dementias, and to establish baseline cognitive function that a variety of research definitions for mild cognitive impairment are in place, but there is no consensus on the optimal definition. The most widely accepted definition requires the following (American Psychiatric Association, 2007):

- Subjective cognitive complaints,
- Evidence of objective deficits in cognitive function based on age- and education-adjusted norms on standardized neuropsychological tests,
- Intact daily functioning,
- Evidence of cognitive decline from a prior level, and
- Evidence of not meeting the criteria for dementia.

American Academy of Pediatrics (AAP)
A joint statement for learning disabilities, dyslexia, and vision from the American Academy of Pediatrics, Section on Ophthalmology, Council on Children with Disabilities; American Academy of Ophthalmology; American Association for Pediatric Ophthalmology and Strabismus; and the American Association of Certified Orthoptists states that children who exhibit signs of learning disabilities should be referred for educational, psychological, neuropsychological, and/or medical diagnostic assessments (AAP, 2009).

In a policy statement on sport-related concussion in children and adolescents, the AAP states that neuropsychological testing can be helpful to provide objective data to athletes and their families after a concussion. Neuropsychological testing is one tool in the complete management of a sport-related concussion and alone does not make a diagnosis or determine when return to play is appropriate. According to the AAP, testing is performed by using one of several computerized neuropsychological tests including ANAM (Automated Neuropsychological Assessment Metrics), CogState,
HeadMinder, and ImPACT or through pencil-and-paper testing administered by a neuropsychologist. Each of the computerized tests has published data on test-retest reliability, and all have demonstrated deficits in concussed athletes compared with their baseline assessments. One critique of the computerized tests is that the vast majority of studies have been conducted by the developers of the tests, which raises some concern for bias, because some independent study results have suggested slightly less reliable results. More rigorous pencil-and-paper testing conducted formally by a neuropsychologist is also an option, although test-retest reliability has been questioned. If an athlete is suffering from postconcussive symptoms over several months or has had multiple concussions, formal assessment by a neuropsychologist may be beneficial, specifically to identify areas for which the athlete may need academic accommodations (Halstead and Walter, 2010; Reaffirmed August 2014).

American Academy of Child and Adolescent Psychiatry (AACAP)
Practice parameters from the American Academy of Child and Adolescent Psychiatry (Volkmar et al. 2014) neuropsychological correlates of autism spectrum disorder include impairments in executive functioning (e.g., simultaneously engaging in multiple tasks) (Ozonoff et al. 1991), weak central coherence (integrating information into meaningful wholes) (Happe and Frith 2006), and deficits in theory-of-mind tasks (taking the perspective of another person) (Baron-Cohen et al. 1985).

International Society for Hepatic Encephalopathy and Nitrogen Metabolism (ISHEN)
A guideline prepared by the Commission on Neuropsychological Assessment of Hepatic Encephalopathy appointed by the ISHEN states that neuropsychological testing is an established methodology for quantifying cognitive impairment due to various forms of encephalopathy, including low-grade or minimal hepatic encephalopathy (Randolph, 2009).

National Academy of Neuropsychology (NAN)
In a policy for the evaluation of childhood learning disorders, the NAN states that when comprehensive information about a child’s brain-related strengths and weaknesses is necessary to understand potential sources of the problem and implications for functioning, a neuropsychological evaluation is most often the best choice (Silver, 2006).

In a position paper on the diagnosis and management of sports-related concussion, the NAN states that neuropsychological evaluation is recommended for the diagnosis, treatment, and management of sports-related concussion at all levels of play (Moser, 2007).

American Academy of Clinical Neuropsychology (AACN) and National Academy of Neuropsychology (NAN)
A joint position paper of the AACN and NAN sets forth their position on appropriate standards and conventions for computerized neuropsychological assessment devices (CNADs). The authors state that CNADs are subject to, and should meet, the same standards for the development and use of educational, psychological, and neuropsychological tests (American Psychological Association, 1999) as are applied to examiner-administered tests. The authors also state that those employing CNADs have the education, training, and experience necessary to interpret their results in a manner that will best meet the needs of the patients they serve (Bauer 2012).

American Medical Society for Sports Medicine
In a position statement for concussion in sport the American Medical Society for Sports Medicine provided an evidence-based, best practices summary to assist physicians with the evaluation and management of sports concussion (Harmon et al. 2013). The following statements were made regarding neuropsychological (NP) testing:

- NP tests are an objective measure of brain-behavior relationships and are more sensitive for subtle cognitive impairment than clinical exam. Most concussions can be managed appropriately without the use of NP testing.
- Computerized neuropsychological (CNP) testing should be interpreted by healthcare professionals trained and familiar with the type of test and the individual test limitations, including a knowledgeable assessment of the reliable change index, baseline variability and false-positive and false-negative rates.
- Paper and pencil NP tests can be more comprehensive, test different domains and assess for other conditions which may masquerade as or complicate assessment of concussion.
- NP testing should be used only as part of a comprehensive concussion management strategy and should not be used in isolation.
- The ideal timing, frequency and type of NP testing have not been determined. In some cases, properly administered and interpreted NP testing provides an added value to assess cognitive function and recovery in the management of sports concussions.
- It is unknown if use of NP testing in the management of sports concussion helps prevent recurrent concussion, catastrophic injury or long-term complications.
- Comprehensive NP evaluation is helpful in the post-concussion management of athletes with persistent symptoms or complicated courses.
NeuroTrax Corp., the manufacturer of Mindstreams®, submitted a 510k premarket notification to the FDA on March 9, 2007, however, the FDA determined that the Mindstreams® device was not substantially equivalent to other devices and declined the application in a letter dated December 21, 2007, which explained that the FDA considered the device to be Class III device. NeuroTrax Corp. appealed this decision on April 10, 2008, but the FDA maintained its earlier decision and notified the company of such on December 4, 2008. On March 15, 2012, the FDA sent a warning letter to NeuroTrax Corp. stating that the Mindstreams® device was being marketed in the United States without FDA marketing clearance or approval. NeuroTrax Corp. was required to cease marketing in the United States within 15 days of receipt of the warning letter. See the following website for more information: http://www.fda.gov/ICECI/EnforcementActions/WarningLetters/2012/ucm296778.htm. (Accessed April 2016)

No FDA clearance was located in the FDA database for MindStreams® Cognitive Health Assessment or for NeuroTrax BrainCare™.

REFERENCES

The foregoing Oxford policy has been adapted from an existing UnitedHealthcare national policy that was researched, developed and approved by UnitedHealthcare Medical Technology Assessment Committee. [2016T0152N]


Neuropsychological Testing Under the Medical Benefit
UnitedHealthcare Oxford Clinical Policy

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Effective 10/01/2016


**POLICY HISTORY/REVISION INFORMATION**

<table>
<thead>
<tr>
<th>Date</th>
<th>Action/Description</th>
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<tbody>
<tr>
<td>10/01/2016</td>
<td>Reformatted and reorganized policy; transferred content to new template</td>
</tr>
<tr>
<td></td>
<td>Added reference link to policy titled Maximum Frequency Per Day</td>
</tr>
<tr>
<td></td>
<td>Revised conditions of coverage/special considerations; added language to indicate:</td>
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<tr>
<td></td>
<td>- Precertification is required for services covered under the Member's General benefits package when performed in the office of a participating provider</td>
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<tr>
<td></td>
<td>- For Commercial plans, precertification is not required, but is encouraged for out-of-network services performed in the office that are covered under the Member’s General benefits package; if precertification is not obtained, Oxford may review for medical necessity after the service is rendered</td>
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<tr>
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<td>Updated benefit considerations; added instruction to check the member specific benefit plan document and any federal or state mandates, if applicable, before using this policy</td>
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<td>Revised coverage rationale:</td>
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<td>- Modified list of proven/medically necessary conditions for evaluating patients when the result of testing will influence clinical decision making:</td>
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<td></td>
<td>- Replaced “space-occupying brain lesion including brain abscess, brain tumors, and arteriovenous malformations within the brain” with “space-occupying brain lesion including, but not limited to, brain abscess, brain tumors, and arteriovenous malformations within the brain”</td>
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<td>- Replaced ”stroke or more than one transient ischemic attack” with “stroke”</td>
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<td>- Replaced language indicating “baseline neuropsychological testing in asymptomatic persons to manage potential sport-related concussions is unproven and not medically necessary” with “baseline neuropsychological testing is unproven and not medically necessary in asymptomatic persons at risk for sport-related concussions”</td>
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<tr>
<td></td>
<td>- Revised language pertaining to Mindstreams® Cognitive Health Assessment to indicate:</td>
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<td>- Computerized cognitive testing such as Mindstreams® Cognitive Health Assessment and BrainCare™ is investigational, unproven, and not</td>
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<td>medically necessary for diagnosing dementia or mild cognitive impairment</td>
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<td>- Available clinical trials have failed to document a beneficial effect of computerized cognitive testing on long-term clinical outcomes</td>
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<td>- The evidence is insufficient to establish the validity of computerized cognitive testing compared with traditional tests for the assessment of dementia and cognitive impairment</td>
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<tr>
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<td>- No U.S. Food and Drug Administration (FDA) clearance was located in the FDA database for MindStreams® Cognitive Health Assessment® or for BrainCare™</td>
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<td>• Updated supporting information to reflect the most current description of services, clinical evidence, FDA information, and references</td>
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<td>• Archived previous policy version BEHAVIORAL 026.3 T2</td>
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