Acaculcia

Description/Etiology
Acalculia is an acquired condition of impaired mathematical ability due to brain injury. Acalculia often occurs as a result of traumatic brain injury (TBI), intracranial hemorrhage or infarction (i.e., stroke), lesions/tumors, and/or neurodegenerative conditions (e.g., dementia). Depending on the degree of impairment, acalculia can be an incapacitating condition.

Math calculation is a complex process that involves verbal ability, spatial skills, memory, and executive function; impairment in one or more of these domains can result in acalculia. Signs and symptoms of acalculia are categorized in the four domains of transcoding impairment, impairment of a quantitative magnitude representation, oral and/or written calculation impairment, and impairment of conceptual mathematical thinking. One focus of current research is whether or not the type and severity of signs and symptoms are associated with the location of brain injury (see Food for Thought, below).

Diagnosis of acalculia is made based on patient history, physical examination, and results of tests that measure cognitive function and number/mathematic processing. The Mini Mental State Exam (MMSE) can be administered to screen for overall cognitive impairment. Although there are many different tools that can be used to assess mathematic abilities, the only standardized neuropsychologic test for acalculia is the EC301 battery. Results of the EC301 battery can provide clinicians with an understanding of the overall severity of mathematic impairment and the specific areas in which the patient requires support. The EC301 evaluates number and mathematic processing in the following 13 functions:

- Counting (e.g., by ones or tens)
- Dot counting
- Transcoding (e.g., from Arabic to alphabet code)
- Recognition and transcription of arithmetic signs (e.g., +, -) on dictation
- Number comparison (i.e., identifying which of two numbers is higher)
- Mental calculation
- Estimation of the result of a math problem
- Writing a number in the correct place on an analogic scale
- Writing a mathematic operation using the correct arithmetic signs
- Performing a written calculation
- Estimation of quantity
- Making a judgment about whether something is too little, enough, or too much depending on the given context
- Numeric knowledge (e.g., the numbers of days of the week)

Treatment of patients with acalculia is typically focused on managing the underlying brain injury and associated complications. In some patients, mathematic ability spontaneously returns along with other indicators of cognitive function in the first few months after injury. The likelihood of spontaneous recovery diminishes with time; in patients with sustained mathematic impairment, management focuses on long-term rehabilitation for retraining in basic arithmetic facts, calculation skills, and transcoding by a neuropsychology specialist, speech-language pathologist, and/or other clinician specialist in cognitive rehabilitation. Patient/family education and emotional support should be provided to
improve understanding of acalculia and its potential impact on quality of life, and to assist with coping.

**Facts and Figures**
The term *acalculia* was coined in 1919 by Salomon Henschen, a Swedish neurologist. Although the incidence of acalculia is unknown, there is a high incidence of math-related deficits in patients with neurologic dysfunction.

**Risk Factors**
Persons with TBI, neurodegenerative diseases, brain lesions/tumors, or stroke are at an increased risk of developing acalculia.

**Signs and Symptoms/Clinical Presentation**
Patients with acalculia have impairment in or complete loss of the ability to perform verbal or written mathematic tasks. Routine computations (e.g., making a transaction at a cash register, balancing a checkbook) can be extremely challenging or impossible for patients to perform. Many patients have impaired memory, attention, and language ability secondary to the underlying brain injury.

**Assessment**

› **Patient History**
  • Take a patient history, including asking about a brain tumor, stroke, TBI, or other cause of neurologic impairment
  • Ask about the onset, duration, and severity of signs and symptoms, including difficulty in attention, language, and memory

› **Physical Findings of Particular Interest**
  • Neurologic examination can have normal results or indicate deficits secondary to the underlying brain injury

› **Laboratory Tests**
  • No laboratory tests are performed to diagnose acalculia

› **Other Diagnostic Tests/Studies**
  • MMSE indicates intact cognition if the patient scores > 25 points out of 30
  • EC301 battery will be administered to evaluate varying levels of mathematical deficits

**Treatment Goals**

› **Promote Cognitive and Memory Rehabilitation**
  • Assess vital signs, mental status, and the impact of neurologic impairment on functional status and quality of life and review results of diagnostic testing. Report abnormal findings to the treating clinician and provide prescribed treatment
  • Follow facility protocols to support the patient’s recovery from brain injury (e.g., assist with ambulation and ADLs, maintain patient safety)
  • Request referral to a neuropsychology specialist, speech-language pathologist, and/or cognitive rehabilitation specialist, as appropriate
  • As appropriate, encourage practice with mathematic drills of arithmetic facts, calculation skills, and transcoding

› **Promote Emotional Well-Being and Educate**
  • Assess the anxiety level and coping ability of the patient/family, and for knowledge deficits about the diagnosis and management of acalculia; provide emotional support and patient/family education about acalculia and on components of the rehabilitative care plan
  • Request referral to a social worker to identify support groups for persons with brain injury and neurologic impairment, as appropriate

**Food for Thought**

› Acalculia should not be confused with dyscalculia, a developmental disorder of impaired numerical understanding that affects 3–6% of children

› Aphasia (i.e., a communication impairment that is characterized by loss of expressive and receptive language skills) often occurs in conjunction with acalculia in persons with left-hemispheric lesions

› Although acalculia in patients with right-hemisphere brain injury has generally been thought to be the result of visuo-spatial impairments, researchers in a study of 30 right-hemisphere damaged patients observed a higher rate of arithmetic errors than spatial errors (Benavides-Varela et al., 2016)
Red Flags

› Acalculia, which is an acquired disability, should be distinguished from dyscalculia, which is a learning disability that is identified in childhood

What Do I Need to Tell the Patient/Patient’s Family?

› Encourage family members to provide the patient with the appropriate level of support to complete tasks that require an understanding of mathematic concepts (e.g., counting money at a store, making bank transactions)
› As appropriate, educate about the importance of continued medical surveillance, including cognitive rehabilitation by a clinical specialist
› Educate the patient/family that Internet resources, educational information, and support groups are available (e.g., the Brain Injury Association of America at http://www.biausa.org/ or by calling 800-444-6443)

References