Psychosocial Assessment and Treatment of Bariatric Surgery Patients

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More than 700 million adults worldwide will be obese by 2015. As reviewed elsewhere in this book, obesity is linked to greater morbidity and mortality (Adams et al., 2006; Ogden, Yanovski, Carroll, & Flegal, 2007), as well as multiple medical and mental health problems (O’Brien, Dixon, & Brown, 2004). Rapidly growing evidence demonstrates that obesity is also associated with poor neurocognitive outcomes. These adverse effects of obesity have been detected across the life span, using a broad range of methodologies (e.g., cognitive testing, neuroimaging, neuropathology), and from countries around the globe. Due to their significant excess weight and many medical comorbidities, bariatric surgery candidates appear to at very high risk for these adverse cognitive consequences.

The current chapter will briefly review the existing literature on the neurocognitive effects of obesity and highlight the findings most important for health care providers working with bariatric surgery patients. To do so, the chapter is divided into four sections:

- Patterns of cognitive impairment in obese persons
- Mechanisms for cognitive impairment in obesity
- Cognitive effects of bariatric surgery
- Neuropsychological assessment of bariatric surgery candidates
Information will also be provided to identify those areas most in need of further empirical studies, with the ultimate goal of optimizing surgical outcomes in this population.

Patterns of Cognitive Impairment in Obese Persons

Though findings vary somewhat across studies, higher rates of memory and frontal/subcortical dysfunction are generally found in overweight and obese adults. This section will introduce a subset of the studies in this area. Particular emphasis will be placed on those studies that have examined impulsivity, a construct closely linked to weight status in multiple samples.

Memory

There is evidence that obesity is associated with memory deficits. In an early study, Elias, Elias, Sullivan, Wolf, and D’Agostino (2003) examined the influence of obesity and hypertension on cognitive performance in middle-aged and older participants in the Framingham Heart Study. Body mass index (BMI) and blood pressure were assessed 4 to 6 years prior to cognitive testing. The authors found independent and cumulative adverse effects of hypertension and obesity on learning and memory for males, but not for females.

Kuo et al. (2006) explored cognitive function in 2,684 elderly people aged 64 to 94 years. They found a nonlinear relationship between cognitive performance and BMI in normal weight, overweight, and obese older people. In this study, overweight participants exhibited better performance on memory tests than normal weight individuals. However, this association was attenuated after other cardiovascular risk factors were included in the analyses. Obese individuals did not perform significantly better or worse on memory tasks than normal weight people.

With respect to middle-aged adults, a French study (Cournot et al., 2006) reported an independent association between memory deficits (word list learning) and high BMI in 2,223 healthy men and women. Gunstad and colleagues (2006) also described the relationship between memory performance (word list learning) and obesity in young and middle-aged adults. Obese individuals learned and recognized fewer words than overweight and normal weight individuals. These findings were confirmed by a more recent study conducted by the same research group (Gunstad, Lhotsky, Wendell, Ferrucci, & Zonderman, 2010). That cross-sectional examination of 1,703 participants of the Baltimore Longitudinal Study of Aging showed that obesity indices (BMI, waist circumference, waist–hip ratio) were significantly related to reduced memory performance.
Attention

Several studies have also found reduced attention abilities in overweight/obese people. For example, individuals with attention deficit/hyperactivity disorder (ADHD), who have attentional problems by definition, are at a higher risk of being overweight or obese (Altfas, 2002; Fleming, Levy, & Levitan, 2005; Levy, Fleming, & Klar, 2009). However, research based on cognitive tests provides mixed results regarding this proposed association. For instance, a French study (Cournot et al., 2006) reported an association between higher BMI and lower performance on a selective attention test that was significant in women, but not men. The findings of a Hungarian-Belgian study (Cserjési, Luminet, Poncelet, & Lénárd, 2009) revealed increased depressive symptoms and reduced sustained attention capacity in obese people. More specifically, they reported that obese women performed significantly worse on the d2 attention test than normal weight women, and that sustained attention was not associated with negative emotional status. In contrast, cross-sectional results of the Baltimore Longitudinal Study of Aging published by Gunstad, Lhotsky, and colleagues (2010) showed that participants with higher BMI, waist circumference, and waist–hip ratio exhibited better performance on the Trail Making Test A than persons with lower body composition indices. In another study Gunstad et al. (2007) found no differences in attention performance between healthy overweight/obese individuals and normal weight subjects. When explaining these unexpected results, the authors cited the relatively healthy status of their sample, which was characterized by the absence of medical and psychiatric conditions, including ADHD.

Executive Function

The concept of executive function includes higher-order cognitive abilities that are necessary to engage in goal-directed behavior, to respond in an adaptive manner in novel situations, and for self-control (Miller & Cohen, 2001; Barkley, 2001; Lezak, 2004). These executive control processes are thought to be located in the prefrontal cortex and frontal systems. They are relevant when alternative behaviors must be compared with each other and prioritized on the basis of their consequences. The term executive function combines the actions of planning, inhibitory control, strategy development and use, flexible sequencing of actions, maintenance of behavioral set, interrupting ongoing responses, and resistance to interference. Executive control and impulsivity, defined as a tendency toward unplanned actions (Moeller, Barratt, Dougherty, Schmitz, & Swann, 2001), are linked such that elevated impulsivity is associated with poorer executive control.

There is evidence that heightened levels of impulsivity are involved in overweight/obesity and dysregulated eating (Nederkoorn, Smulders,
Havermans, Roefs, & Jansen, 2006). For example, cognitive and motivational aspects of impulsivity, in particular urgency and sensitivity to reward, seem to be associated with eating disorder psychopathology in overweight and obese individuals (Mobbs, Crépin, Thiéry, Golay, & van der Linden, 2010). In overweight individuals with binge eating, level of impulsivity predicted the amount of test meal consumption (Galanti, Gluck, & Geliebter, 2007). Pilot data (Mueller, Fischer, Mitchell, & de Zwaan, unpublished data) suggest high rates of impulse control disorders (ICDs) among morbidly obese individuals that did not significantly differ from those assessed in a psychiatric inpatient sample (Mueller et al., unpublished data). Based on structured clinical interviews, a current ICD rate of 19% was found, primarily pathological skin picking (8%), compulsive buying (6%), and intermittent explosive disorder (5%).

Based on neuropsychological tasks, several studies found that obese individuals are less able to inhibit a response and more often choose an instant reward over a larger delayed reward. Performing the Iowa gambling task, obese adults preferred high immediate gain, but larger future losses, versus lower immediate gain, but smaller future loss (Davis, Levitan, Muglia, Bewell, & Kennedy, 2004; Pignatti et al., 2006). With respect to other decision-making tasks, the findings are inconsistent. For instance, Nederkoorn, Smulders, Havermans, Roefs, and Jansen (2006) did not find compelling differences between obese women and lean controls on the delay discounting task with hypothetical money reward. Potentially, differences in income (not assessed in that study) may have influenced the result. The delay discounting task was also used in a study conducted by Weller, Cook, Avsar, and Cox (2008). Independent of age, income, or IQ, obese female but not male students discounted delays to a greater extent than normal weight women.

Recently, Davis, Patte, Curtis, and Reid (2010) assessed obese women with and without binge eating disorder, and normal weight women on both the Iowa gambling task and the delay discounting task. The two obese groups performed worse on both tasks compared to normal weight controls, but did not differ from each other. Of note, when education level was included into the analyses the group differences no longer reached statistical significance. Using data from Brain Resource International Database, in which persons with significant medical and psychiatric conditions were excluded, Gunstad and colleagues (2007) found reduced executive function (verbal interference, maze errors) in overweight/obese adults relative to normal weight adults. Findings support the association between excess weight and reduced planning and response inhibition. Waldstein and Katz (2006) examined executive function in healthy middle-aged and older adults using Trail Making Test B and the Stroop Color Word Test. Independent of several confounding factors (e.g., metabolic syndrome), the
authors noted interactive relations between central obesity and hypertension with regard to executive function. Recently, the link between reduced executive abilities and adiposity was confirmed in samples of morbidly obese individuals seeking surgical treatment (Cserjési et al., 2009; Boeka & Lokken, 2008; Lokken, Boeka, Yellumahanthi, Wesley, & Clements, 2010). Bariatric surgery candidates exhibited deficits on tasks of problem solving, planning, and mental flexibility in comparison to normative data (Boeka & Lokken, 2008; Lokken et al., 2010; Gunstad et al., in press). With regard to possible influence of emotional status, Cserjési and colleagues (2009) described a mediating role of depression in the relationship between obesity and response inhibition. Published data on executive function in children or adolescents are sparse. However, the few existing publications suggest that similar to adults, obese children and adolescents tend to exhibit deficits in executive functioning (Li, Dai, Jackson, & Zhang, 2008; Lokken, Boeka, Austin, Gunstad, & Harmon, 2009; Verdejo-García et al., 2010).

Conclusion

There is growing evidence that obesity is associated with reduced cognitive abilities, including memory, attention, and executive function. Although many studies provide support for this link, the question whether obesity itself or indirectly (i.e., via metabolic changes) leads to cognitive decline remains unresolved. In addition, it is unknown whether adiposity is a cause or a result of reduced cognitive function. Poor cognitive abilities, elevated levels of impulsivity, and reduced inhibitory control are plausible explanations for overeating, binge eating, or loss of control eating. The impaired ability to delay gratification may negatively affect weight maintenance after successful surgical treatment. Furthermore, it is unclear whether a subgroup of patients who significantly lose weight due to bariatric surgery subsequently develop or increase impulsive behaviors (e.g., compulsive buying, pathological skin picking, exercise dependence) beyond those associated with food, such as overeating, binge eating, or loss of control eating.

Mechanisms for Cognitive Impairment in Obesity

Given the many physiological changes associated with obesity, it appears likely that its adverse neurocognitive effects are the product of a combination of related processes. Work is just beginning to clarify the causal pathways in this complex phenomenon and will likely involve an interaction of established and novel risk factors.

For example, obesity is associated with a number of known risk factors for poor neurocognitive outcome. Obese individuals often exhibit comorbid hypertension and type 2 diabetes; in turn, each of the conditions is associated with pathological changes to the brain and reduced cognitive function.
Closely related to these conditions are circulating biomarkers that may be important contributors to the cognitive impairment found in obese individuals. One such mechanism involves altered levels of adipokines, which are secreted by adipose tissue and are linked to both neurocognitive dysfunction and structural brain abnormalities (Scharf & Ahima, 2004; Pannacciulli, Le, Chen, Reiman, & Krakoff, 2007; Gunstad, Paul et al., 2008). The pro-inflammatory state associated with increased BMI reflects another potential mechanism, as it is a known contributor to poor neurocognitive outcomes in other populations (Sweat et al., 2008; Bastard et al., 2006; Jefferson et al., 2007; Rosenberg, 2009). Recent work on biomarkers traditionally examined for eating and weight behavior such as leptin and ghrelin has shown an important, though still unexplained, link to cognitive function (see Gunstad, Spitznagel et al., 2008b regarding leptin; Spitznagel et al., 2010 regarding ghrelin). Future work will undoubtedly reveal many additional biomarkers important for these relationships.

Although the exact mechanisms are currently unclear, a growing number of studies demonstrate brain abnormalities on neuroimaging or pathology studies in obese individuals. On structural imaging, obese individuals exhibit global brain atrophy and reductions in both frontal and temporal brain regions (Ward, Carlsson, Trivedi, Sager, & Johnson, 2005; Taki et al., 2008; Gunstad, Paul et al., 2008a; Pannacciulli et al., 2006; Raji et al., 2010; Walther, Birdsell, Glisky, & Ryan, 2010; Jagust, Harvey, Mungas, & Haan, 2005; Gustafson, Lissner, Bengtsson, Bjorkelund, & Skoog, 2004). White matter abnormalities can also be found, including reduced volume, increased white matter hyperintensities, and decreased functionality connectivity measured by diffusion tensor imaging (Gustafson, Steen, & Skoog, 2004; Jagust et al., 2005; Haltia et al., 2007; Stanek et al., 2011). Neurochemical evidence also suggests white matter injury in obese persons, with reduced concentrations of N-acetylaspartate in frontal, parietal, and temporal white matter, as well as reduced concentrations of choline-containing metabolite in frontal white matter (Gazdzinski, Kornak, Weiner, & Meyerhoff, 2008). Finally, pathology studies have found increased expression of Alzheimer’s disease–related markers, including tau protein, amyloid precursor protein, and amyloid-β peptide (Mrak, 2009).
In summary, overweight and obesity appear to be most strongly associated with the cognitive domains associated with frontal/subcortical brain function (such as attention, working memory, speeded cognitive processing, and executive function) as well as memory. Behavioral manifestations of these reduced cognitive functions may include increased impulsivity, poor self-monitoring, and behavioral constraint, as well as diminished planning and problem solving (Fuster, 2008). In turn, these behavioral expressions of reduced cognition may impact adherence and outcome in the bariatric surgery patient. For example, reduced ability to plan and problem solve may hinder maintenance of postsurgical lifestyle changes, or impulsivity may lead to difficulty adhering to dietary restrictions. Similarly, these difficulties are also associated with increased risk for mood disturbance (Savitz & Drevets, 2009), which could further worsen outcomes.

Cognitive Effects of Bariatric Surgery

One of our current projects is directly examining the possible cognitive effects of bariatric surgery. We are conducting prospective, comprehensive cognitive assessment in 250 bariatric surgery patients and obese controls at preoperative, 12 weeks postop, 12 months postop, and 24 months postop. As bariatric surgery patients often exhibit alleviation or even resolution of medical conditions associated with cognitive dysfunction (e.g., hypertension, type 2 diabetes), we hoped that the postsurgical weight loss might improve cognitive test performance.

The first paper from this study has just been published and compared cognitive test performance in surgery patients and controls at baseline and 12-week time points (Gunstad et al., in press). Three important findings emerged from this initial comparison. First, cognitive dysfunction was prevalent in bariatric surgery candidates, with many having clinically meaningful impairments on testing (i.e., >1.5 standard deviations below normative values). For example, nearly a quarter of patients had clinically meaningful deficits on measures of learning of new information and recognition memory. This is far more prevalent than would be expected in a nonobese sample.

Next, we compared rates of cognitive decline from baseline to 12 weeks in both surgery and control patients to examine whether bariatric surgery might produce cognitive dysfunction. Many major surgeries have been linked to adverse, acute cognitive impairment (e.g., cardiovascular surgeries), and it was unknown if bariatric surgery patients would show a similar pattern. No such pattern emerged in the sample, indicating that uncomplicated bariatric surgery does not impair cognitive function at 12-week follow-up.

Finally, we examined the possible cognitive improvements and found that bariatric surgery patients exhibited improvement in multiple
cognitive domains, including memory, attention, and executive function. When accounting for those abilities that also improved in controls (thus accounting for any possible practice effects), bariatric surgery patients showed consistent improvements in memory function at 12 weeks. At the time of this writing, longitudinal analyses are currently under way to better understand these effects over a longer interval (i.e., 12 months, 24 months), as weight loss is rapid during the first 6 months postoperatively and continues until 24 months, where weight loss often plateaus or starts to regress (O’Brien et al., 2004).

Neuropsychological Assessment of Bariatric Surgery Candidates

On the basis of these and other findings, the coming years will likely produce increased awareness of cognitive impairment in bariatric surgery patients. The American Society for Bariatric Surgery has recently recommended neuropsychological evaluation in bariatric surgery candidates. Importantly, many third-party payers have now agreed to reimburse providers for these services, granting access to a larger number of patients and important data to health professionals. Similar policies in persons undergoing surgery for cardiovascular disease (e.g., coronary artery bypass graft) resulted in rapid gains in knowledge regarding the physiological mechanisms that predict short- and long-term patient outcomes.

The best measures for assessing neuropsychological function in bariatric surgery patients have not yet been empirically established. Below, we suggest an initial approach based on our clinical and research experience in this population, though further work is needed to determine the sensitivity and predictive validity of these and other measures in this population. The selected tests are commonly used instruments that are widely available, and many are known to be sensitive to the cognitive deficits associated with cardiovascular disease and type 2 diabetes—conditions frequently comorbid to obesity.

Neuropsychological testing for bariatric surgery patients would ideally be sensitive to both cognitive impairment during preoperative visits to help tailor interventions and possible postoperative changes in cognitive function due to surgical complications. Each of these approaches is briefly presented below.

Preoperative Evaluations

Prior to surgery, neuropsychological evaluation should test for impairment in all primary cognitive domains, including global cognitive function, as well as multiple aspects of attention, executive function, memory, language, visuospatial, and motor function. See Table 6.1 for a listing of suggested tests. These tests should be considered in addition to traditional
<table>
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<tr>
<th>Domain</th>
<th>Measures</th>
<th>Cognitive Ability</th>
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<tr>
<td>Effort</td>
<td>Test of memory malingering</td>
<td>Effort during testing</td>
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<tr>
<td>Global cognitive function</td>
<td>Modified Mini Mental State Exam</td>
<td>Estimate of global function</td>
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<td>Attention/executive functioning</td>
<td>Digit span</td>
<td>Basic auditory attention</td>
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<td>Letter number sequencing</td>
<td>Working memory</td>
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<td></td>
<td>Trail Making Tests A and B</td>
<td>Psychomotor speed, set shifting</td>
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<td></td>
<td>Stroop Color Word Test</td>
<td>Cognitive inhibition</td>
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<td></td>
<td>Wisconsin Card Sort Test</td>
<td>Hypothesis testing, reasoning</td>
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<td></td>
<td>Iowa gambling task</td>
<td>Response inhibition, decision making</td>
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<td></td>
<td>Tower of Hanoi</td>
<td>Planning</td>
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<td>Continuous Performance Test</td>
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<tr>
<td>Memory</td>
<td>Auditory Verbal Learning Test</td>
<td>Verbal list learning and memory</td>
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<td>Complex Figure Test Recall</td>
<td>Nonverbal memory</td>
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<td>Logical memory</td>
<td>Verbal story memory</td>
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<td>Language Boston Naming Test</td>
<td>Confrontation naming</td>
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<td></td>
<td>Controlled Oral Word Association Test</td>
<td>Phonemic verbal fluency</td>
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<td>Animal naming</td>
<td>Semantic verbal fluency</td>
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<tr>
<td>Visuospatial</td>
<td>Complex figure test-copy</td>
<td>Complex visuoconstruction</td>
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<td></td>
<td>Hooper Visual Organization Test</td>
<td>Motor-free perceptual organization</td>
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<tr>
<td>Motor</td>
<td>Grooved pegboard</td>
<td>Speeded dexterity</td>
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<tr>
<td>Reading</td>
<td>WRAT-4 Word Reading</td>
<td>Basic reading skills</td>
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<tr>
<td></td>
<td>WRAT-4 Sentence Comprehension</td>
<td>Basic comprehension</td>
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<tr>
<td>Psychopathology/mood</td>
<td>MMPI-RF</td>
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<td></td>
<td>Patient Health Questionnaire (PHQ)</td>
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measures of psychopathology and mood that are sensitive to dysfunction in this population. As described above, obesity has been associated with cognitive dysfunction in multiple domains, and a comprehensive evaluation will minimize the risk of overlooking an important cognitive skill that could adversely impact long-term outcomes.

We also encourage clinicians to closely examine each patient’s level of executive function and memory prior to surgery. In addition to being frequently impaired in obese individuals, executive function and memory abilities are closely related to adherence to medical regimen and patient outcomes in other populations (Feil et al., 2009; Hayes, Larimer, Adami, & Kaye, 2009). It is easy to imagine that patients with deficits in problem solving or memory could experience difficulties in adhering to the complex postoperative medical regimen and thus be at elevated risk for poor outcomes. For example, our preliminary work shows that bariatric surgery patients with better memory function at baseline lose weight more quickly postoperatively. Though many possible explanations exist, a likely explanation is that such persons more closely adhere to the prescribed regimen and thus have better outcomes. We are examining this possibility at the time of this writing.

Consistent with this, a better understanding of the cognitive profile of obese older adults and adolescents is much needed. Even normal aging is associated with reductions in executive function and memory, and it is likely that the mechanisms responsible for these changes may interact with obesity changes to exacerbate cognitive impairment. As a result, the growing number of older adults seeking bariatric surgery may be at elevated risk for cognitive impairment and thus encounter difficulties adhering to both pre- and postoperative care guidelines. Similarly, recent work shows adolescents presenting for bariatric surgery exhibit cognitive dysfunction (Lokken et al., 2009), and its impacts on treatment outcomes are not fully understood.

A final consideration for preoperative assessment of cognitive function in bariatric surgery candidates is patient reading level. Bariatric surgery patients are frequently given large amounts of text to independently read and understand. Even subtle difficulties in comprehension may promote medical complications, weight regain, or significant emotional distress. For example, one of us heard the story of a patient that was functionally illiterate but was not identified as such until several months postoperatively. This individual was asked to read a large collection of materials prior to this time without detection. Although these cases are likely very rare, determination of a patient’s ability to read and comprehend written materials may help optimize short- and long-term outcomes. Similarly, the written materials provided to patients should be routinely examined to ensure that the reading level is appropriate, especially when describing complex concepts or multistep activities.
Postoperative Evaluations

In addition to a comprehensive evaluation prior to surgery, screening of cognitive function at postoperative visits may also be helpful to optimize patient outcomes. Bariatric surgery patients are at risk for vitamin deficiencies with known neurological consequences, including low levels of iron, folate, and B12 (Clegg, Colquitt, Sidhu, Royle, & Walker, 2003; Skroubis et al., 2002; Berger, 2004; Choi & Scarborough, 2004; Escalona et al., 2004; Loh et al., 2004). These changes occur in a small number of patients, but are known to emerge up to 20 months postoperatively (Abarbanel, Berginer, Osimani, Solomon, & Cherugi, 1987; Berger, 2004; Thaisetthawatkul et al., 2008). Screening for postoperative changes in cognitive function can be conducted in just a few minutes and could be incorporated into the routine follow-up visits (see Table 6.2). These evaluations could be similar to those for delirium or other inpatient settings and quickly screen global cognitive abilities, attention, executive function, and memory function. Using alternate forms of the measures used during the preoperative assessment is strongly recommended to detect such changes, though studies are needed to determine reliable change indices for this population. As noted above, we found that patients who underwent uncomplicated bariatric surgery did not exhibit significant cognitive changes. However, it appears likely that cognitive dysfunction would be more likely in patients with a more complicated recovery, and early detection could provide many benefits.

Summary and Conclusion

The growing evidence for cognitive impairment in obese individuals has significant implications for persons working with bariatric surgery patients. This population is at elevated risk for problems with memory and executive function—cognitive abilities important for adhering to pre- and postoperative regimens. Comprehensive evaluation of neuropsychological function prior to surgery and regular monitoring after surgery may help to optimize patient outcomes. Additional research is much needed to clearly determine the most sensitive and specific tests in bariatric surgery patients, particularly older adults and other special populations.
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