40 Neuropsychological Assessment of Adults Being Considered for Mechanical Circulatory Support

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Overview of Heart Failure

Heart failure (HF) is a complex clinical syndrome characterized by impaired myocardial performance and neurohormonal abnormalities that lead to circulatory insufficiency and congestion [1]. In practice, the determination of HF is a clinical diagnosis based on the patient's history and physical examination, as no single test alone is diagnostic [2]. While the presentation of patients with HF can range from asymptomatic to critically decompensated, the cardinal features are commonly fatigue, dyspnea (shortness of breath), and peripheral edema [3]. Ischemic cardiomyopathy is the most common etiology of HF in the industrialized countries followed by hypertensive, dilated, and metabolic (i.e., diabetes mellitus, hypothyroidism) cardiomyopathies. While heart failure can result from disorders of the myocardium, pericardium, and endocardium, the majority of HF patients have symptoms related to left ventricular dysfunction [2].

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Epidemiology

Heart failure has been described as a growing pandemic and serious public health issue, contributing to an estimated $39 million in costs in the United States [4]. Approximately 5 million individuals in the United States have HF, with 550,000 newly diagnosed patients annually [5]. It is estimated that by 2030, over 8 million Americans will be living with HF [6]. In the United States, African-Americans have the highest risk for developing HF, followed by Hispanic, Caucasian, and Chinese Americans [7]. At 40 years of age, both men and women have a similar one in five lifetime risk of developing HF [7]. Epidemiological research indicates that HF is primarily a condition of the elderly [8], with an incidence approaching 10:1000 after the age of 65 [2]. Consequently, approximately 80% of patients hospitalized for HF are over 65 years old [9], and HF represents the most common discharge diagnosis for patients on Medicare and cause for readmission within 60 days [7].

Neurocognitive Impact of HF in Adults

Although the prevalence of cognitive impairment in patients with HF varies depending on sample and disease characteristics, rates have generally been reported to range from 25% to 75%. Because

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HF can ultimately result in low systolic blood pressure, poor cerebral perfusion, and impairment in cerebral neurohormonal autoregulation [10–13], there can be a range of secondary effects on neuronal functioning. This secondary impact of HF on the brain can be followed by neuropathology, decline in cognitive functioning, and reduced ability for independent management of daily activities. Such functional losses can all contribute to lower quality of life.

In patients with HF, reduced cardiac output and associated ischemic brain damage have been proposed as being the primary contributors to some of the structural abnormalities found on neuroimaging [12]. The most apparent findings include more severe white matter hyperintensities relative to healthy individuals, along with the presence of small vessel disease [14]. Mesial temporal regions, which are particularly sensitive to hypoxia, also show neuronal loss [15]. Grey and white matter changes have been described in the frontal insula, as well as in subcortical structures (e.g., mammillary bodies, putamen) [16–18].

Chronic HF has been associated with global cognitive deterioration as assessed by brief screening measures [19, 20], although a more focal profile of impairment in aspects of attention, executive functioning, processing speed, and memory has also been reported when more extensive neuropsychological batteries were utilized [19, 21].

Depression is also a common comorbidity. Approximately 55% of patients with HF have depression, with 20% at clinically significant levels [22, 23]. Depression has been found to be a risk factor for poorer cognitive performance in patients with HF, particularly when there is also memory impairment [24], and may in fact play an interactive role. It has been suggested that depression in some HF patients may reflect underlying structural changes in the brain [25]. This may be consistent with proposals of a vascular depression associated with deep white matter hyperintensities [26].

Patients with HF have also been found to have higher rates of self-reported impairment in managing instrumental activities of daily living (IADLs), with cognitive impairment as an independent predictor of level of IADL functioning, including driving and medication management [27]. Heart failure patients diagnosed with mild cognitive impairment (MCI) via screening measures were found to have adequate knowledge regarding HF but significantly poorer scores on a HF self-care scale [28]. The consistent deficits observed in attention, processing speed, and executive functioning in this population likely interfere with a patient's ability to manage medication regimens, respond to changes in symptoms, and seek treatment [29, 30]. These types of difficulties are likely to be magnified when patients with HF are required to manage a life-saving medical device.

The Left Ventricular Assist Device (LVAD)

In patients with refractory HF, a heart transplant is generally considered the best option for treatment, with high rates of 1-year survival and up to 60% survival over 10 years [31, 32]. However, the viability of this option is limited by organ availability. Furthermore, some patients may not be suitable transplant candidates, or their risk profile may increase (due to health decompensation) while on waiting lists. This has led to the use of methods for mechanical circulatory support (MCS) to increase patient survival, improve quality of life, and reduce morbidities.

While there are many methods for MCS, the left ventricular assist device (LVAD) is one of the most commonly used. The LVAD is an implantable pump designed to provide support to the left ventricle in order to maintain adequate blood flow. It was first approved by the Food and Drug Administration (FDA) in 1994 with the initial indication of serving as a bridge to transplantation in patients with advanced HF who were not expected to survive until a transplant option became available. While this continues to represent a large majority (up to 80%) of LVAD cases [33], there has been a rise in patients implanted with an LVAD as a destination therapy (DT) in those deemed ineligible for a transplant, either due to comorbidities or other risk factors. This change in treatment indication to include DT has changed some of the prior age-related limitations for surgical eligibility. The mean age of patients undergoing DT increased from 52.7 to 61.7 years [34, 35].

Modifications in LVAD treatment indications have occurred with changes to the technology. The first generation of LVAD devices were larger, contained more moving parts, and were more prone to postsurgical complications than current models. They operated using a pulsatile flow technology, which was designed to mimic the natural conditions of human hemodynamics. Newer generation LVAD devices have the advantage of being smaller and quieter, with fewer moving parts and increased durability, and operate via continuous flow [35]. Surgery involves implantation of an internal pump through a sternotomy, with a lead connecting via a driveline to an externally worn control unit requiring a constant power source (e.g., battery).

Risks and Outcomes

Although outcomes are better than with medical therapy alone for select patients [36], the risk/benefit profile for this method of MCS is complex. Apart from advances in technology and surgical technique, LVAD outcomes are based in large part on the appropriate screening and selection of candidates [37, 38]. The cardiac team considers the severity of HF, as well as a number of other cardiac and noncardiac factors. Although a comprehensive review of all the medical considerations reviewed by the cardiac team is beyond the scope of this chapter, in brief, cardiac and anatomical risk factors that are associated with postoperative complications or mortality include right ventricular dysfunction [39], extremes in body weight [40], and arrhythmias [41]. Noncardiac factors that impact patient selection due to their association with negative outcomes include advanced age [34], systemic illnesses with short predicted survival [42], irreversible or progressive neurological conditions (e.g., stroke with severe impairment, dementia), psychiatric comorbidities [38], and poor social support.

The greatest mortality risk associated with LVAD surgery occurs during the immediate postoperative period prior to discharge [43]. Acute complications can involve organ failure, right ventricular failure, infection, or embolic events [44, 45]. More long-term post-implant risks include stroke, renal dysfunction, gastrointestinal bleeding, infection, and device malfunction/failure [33]. The 1-year survival rate with the newer continuous-flow devices is 74% [34, 46].

While some studies have examined neuropsychological outcomes in LVAD recipients, few have included a presurgical baseline assessment to provide a basis for comparison. Additionally, the contribution of cognition and mood has tended to be examined separately [47] making a distinction between etiologies challenging. Comparisons of preimplantation baseline data to postsurgical evaluations conducted at ~2 to ~15 months post LVAD placement indicate significant improvement in verbal memory with stability in other cognitive domains [47]. While most patients do appear to exhibit improvement in cognition after implantation, cognitive decline has also been reported to occur in approximately 25% of patients 1 year postsurgery, with older age and destination therapy as predictors of change [48].

In terms of mood, studies have generally found either no significant adverse mood outcomes or even some improvement in symptoms of depression and anxiety [47, 49]. While LVAD patients typically report improved health status and fewer mood symptoms than other HF patients who receive medical management alone, this improvement is typically not to the same degree as that seen in heart transplant recipients. This difference may be partially due to patients having frequent reminders that they are living with an LVAD device (e.g., needing to clean and maintain parts of the device), necessitating some adjustment and reconceptualization of their “normal” routine and lifestyle [50, 51].

The LVAD Team

In order to best identify the range of patient characteristics that are associated with optimal outcome and/or best management of risk for morbidity/mortality, a multidisciplinary team is needed. Current standards call for such a team to include, at a minimum, a heart failure physician, a dietician, and a pharmacist [52]. Recently published guidelines and consensus statements also emphasize the importance of evaluating neurological, neurocognitive, psychological, and psychosocial functioning when considering an individual's candidacy for LVAD placement [53, 54]. For example, understanding the patient's neurological status (e.g., presence of severe neurological disorder), whether patients have the fundamental neurocognitive ability to manage the LVAD equipment, and whether they have achieved psychological and behavioral readiness to live with MCS are all important factors in the risk/benefit assessment of patients being considered for LVAD placement.

Patients with HF who may be candidates for LVAD implantation generally undergo a staged evaluation process by the team. The cardiologist will review the medical history, as well as complete a physical exam, cardiopulmonary testing, blood panel, and other tests (e.g., electrophysiology and imaging) as appropriate to determine if the patient is a medically suitable LVAD candidate. Once this first criterion is met, other disciplines, such as social work, palliative care, psychiatry, and neuropsychology, are asked to perform assessments of the patient. Some of the overarching goals of these later evaluations are to identify, and manage if possible, risk factors for a poor outcome, as well as better understand a patient's ability to care for themselves following surgery. The social worker tends to focus on psychosocial factors that could potentially impact living with an LVAD, including financial concerns and lifestyle adjustments. Consultation with a psychiatrist is undertaken to evaluate for psychological processes (e.g., significant mood disorder) and/or active substance abuse that may be a barrier to the patient's commitment to the complexities of living with an LVAD. Finally, the neuropsychological evaluation aids in helping the team determine whether the patient has a progressive neurodegenerative process (dementia being a rule out for eligibility) or cognitive impairment that could affect their ability to manage postsurgical care.

Presentation and Settings

Although the presentation of HF patients can vary widely, common symptoms that prompt acute medical intervention can include increasing fatigue, shortness of breath, and difficulty with exertion. When LVAD placement is being considered in these HF patients, the neuropsychologist may be asked to perform an evaluation when patients are in acute medical crisis, medically stabilized but still in an inpatient setting, or in the outpatient clinic following some level of adequate medical management of cardiac decompensation.

In the more acute scenarios, it is not unusual for patients to have medically decompensated over the previous weeks or months. The neuropsychologist may encounter these patients in the cardiac intensive care unit, perhaps still intubated or having just been extubated. When receiving such a referral, part of the initial assessment will involve determining whether the patient has sufficient arousal and stamina to engage adequately with the evaluation process. Communication with the cardiac team may be sufficient for this purpose. However, these patients may have a waxing and waning status that requires the neuropsychologist to directly determine if an assessment with the patient is possible. Ultimately, because of the patient's compromised medical condition, neuropsychological assessment in this setting may be quite limited, as will conclusions from the exam. Nevertheless, any screening that is performed can be used to track the patient's changing cognitive status as they become more medically stabilized. Although objective data may be limited in these exams, at the very least, the neuropsychologist's interview with the family will help contribute to an understanding of cognitive symptoms that may have been present prior to the most recent cardiac decompensation.

Probably the most common setting for performing a pre-LVAD neuropsychological evaluation is the inpatient cardiac care unit. In this setting, patients may be encountered in bed sitting up or even sitting up in a chair. A more typical inpatient neuropsychological exam can then be conducted. However, it is important to keep in mind that patients will often have low energy, thereby limiting their ability to participate in sustained periods of cognitive testing. Furthermore, as can be surmised from the list above, many different specialists will be seeking time with the patient, who may be moved on and off the unit as various medical tests are performed. These interruptions will require the neuropsychologist to be strategic with how the battery is developed and the testing completed.

On rare occasions, it may be possible to schedule patients for outpatient neuropsychological assessment should the patient be stabilized sufficiently for discharge while the pre-LVAD surgical planning is completed. However, to accommodate the timeline that is often needed in this situation, the neuropsychologist must be able to integrate these patients into their outpatient schedule within a few days of the hospital discharge. Even in this outpatient situation, the patients are frequently easily fatigued, necessitating a somewhat limited testing session.

In order to optimize timing and access to these patients, good communication with the cardiac team is critical. For the neuropsychologist who is just beginning work with a multidisciplinary LVAD team, it can be extremely helpful to meet with the cardiac team coordinators (often a nurse practitioner) to educate them on the necessary requirements for completing a neuropsychological exam. Although it may be self-evident to readers of this chapter, the requirement for uninterrupted periods of time and a patient who is awake and communicative may not be initially appreciated by our cardiology colleagues and their support staff (Table. 40.1).

Table 40.1 Common etiologies of cognitive impairment in LVAD candidates

Acute compromise of cardiac functioning (e.g., low ejection fraction)
Delirium
Mild cognitive impairment due to vascular disease
Vascular dementia (e.g., due to strategic infarct, Binswanger's disease)
Alzheimer's disease (AD)
Mixed (AD/vascular) dementia
Depression

History and Interview

This patient population typically has a litany of cardiac and other health conditions, many of which pose risk for cerebrovascular disease and associated cognitive impairment. At the time of the LVAD work-up, patients are frequently low in energy, cognitively compromised due to their medical status (e.g., ejection fractions are often <20%), and generally not feeling well. In this context, it is rare that a patient can tolerate several hours of interaction with the neuropsychologist. Furthermore, when evaluations are performed on an inpatient basis, there are many other specialists who need access to the patient and other presurgical tests that need to be performed. Therefore, the neuropsychologist must be strategic in how their time is spent with the patient in terms of clinical interview and testing.

By the time the neuropsychologist becomes involved, the cardiologist has already critically reviewed the complex medical history and entered it into the electronic medical record (EMR). Thus, after reviewing available EMR information, the neuropsychologist's time with the patient is likely better spent on developing the timeline and progression of any cognitive symptoms or functional decline, as well as the details of any neurological history (e.g., cardiology notes may document "CVA" though there may be little information on cognitive sequelae) that can impact interpretation of the test scores and estimations of prognosis for cognitive change following LVAD placement. For example, a patient who describes intact occupational and daily functioning followed by acute health and cognitive decline in the weeks or month leading up to hospitalization may have a very different trajectory of cognitive recovery or cognitive risk following an LVAD implantation compared to a patient who has experienced progressive cognitive decline over a longer time period. As in all settings where cognition may be significantly compromised, obtaining collateral information from a family member or close friend can be critical to this process.

Review of psychiatric history and current mental health presentation is also a component of the patient selection criteria for establishing their ability to be compliant with the medical care associated with LVAD placement [38, 55]. Although a separate psychiatric consult may be part of the pre-LVAD screening process, psychiatry services may not be available in every setting. Thus, the neuropsychologist could be called upon to perform a psychiatric screening and assessment as part of their neuropsychological evaluation. Significant psychiatric or substance abuse history, past compliance with and response to mental health treatment, as well as current psychiatric/substance use status can have a significant impact on a patient's eligibility for LVAD placement. In addition, the patient's overall interest in extending their life must be ascertained as this is also a critical factor in determining the appropriateness of life-extending surgery. For example, in patients who report ambivalence or express apathy regarding the prospect of surgery, there is concern about their commitment and willingness to be active participants in their postsurgical care. In more extreme circumstances, such as when patients are suffering from major depression (particularly with suicidal ideation), the risk of misusing the LVAD equipment in a suicide gesture/attempt is higher. Finally, one could imagine that other forms of medically refractory severe psychiatric symptoms (e.g., thought disorder, delusions, hallucinations) can prohibit a patient's ability to operate the LVAD equipment. In these and related circumstances, putting a patient through the process of LVAD placement and all the associated postoperative life changes would not be consistent with the medical edict of "do no harm."

A significant psychiatric or substance abuse history would not necessarily preclude a patient from consideration for LVAD placement if their symptoms are currently well managed (i.e., regular follow-up with a psychiatrist/psychologist, medication adherence). Evaluating for this, as well as whether symptoms have ever previously adversely impacted their self-care, is important. There must typically be some indication that the patient can follow medical and mental health treatment plans and, if relevant, contract to abstinence of any substances of abuse and undergo counseling/rehabilitation.

Another important component of the pre-LVAD screening assessment process involves gaining an understanding of the patient's psychosocial context. In the initial postsurgical period following discharge, patients are often largely (if not completely) dependent on caregivers to implement and adhere to the home care regimen [56–58]. Therefore, it is important to discuss with the patient (and any collateral sources) exactly who would be available to assist with follow-through on medical recommendations and appointments and be available in case of device malfunction [55]. In addition to asking who would comprise the patient's support network, it can also be important to determine what the patient's own perception of their support system is, as it has been found that even perceived social support in patients with HF has been associated with better self-care behaviors (e.g., diet and medication adherence) [59] and confidence in one's own self-care abilities [28]. As many cardiac teams will have a social worker who performs much of this aspect of the pre-LVAD screening process, the neuropsychologist may be able to access this information from the EMR and not need to duplicate efforts in this area.

Through the course of the interaction with the patient, it can be extremely enlightening to elicit their understanding of the procedure, their knowledge of how life will change following implantation of the LVAD equipment, and their postsurgical hopes and expectations. The downstream consequences of a mismatch between what has been communicated to the patient and what the patient's understanding is can be quite detrimental to quality of life. Asking patients to briefly describe their understanding of the treatment regimen can be useful for this purpose. For the reader's edification, instructions and responsibilities that are typically communicated to the patient and caregiver include general information on operating the device and interpreting the digital display indicators, care requirements for the LVAD and its components, maintenance of daily records (e.g., temperature, weight, LVAD readings), medication adherence, compliance with infection precautions, and avoidance of any high-impact activities that can cause damage or trauma to the LVAD and driveline. It can also be informative to determine what the patient's specific goals are should they receive the LVAD and experience an improvement in their functioning. Some patients may respond in a way that indicates they have expectations for outcome that are not feasible (e.g., expressing a desire to engage in water or contact sports) or are otherwise unrealistic. When a discrepancy between patient and physician expectations is discovered, the neuropsychologist can provide feedback to the cardiac team so that additional patient education can be given.

Approach to Neuropsychological Assessment

As described earlier, the prevalence of cognitive impairment in patients with HF has been reported to range from 25% to 75%. However, the cognitive profile in HF patients who are specifically candidates for mechanical assistive devices has not been as well characterized. One study found that 67% of LVAD candidates met criteria for mild cognitive impairment when assessed using a brief screening measure [60]. When a cross section of patients with advanced HF was examined and grouped by disease severity, the results indicated generalized cognitive decline, with the worst performance noted in patients being considered for a mechanical assistive device [61]. These authors found that the earliest abnormalities detected in the outpatient group with less severe HF were in motor speed and grip strength. With progression of cardiac disease, specific deficits were observed in verbal recall, nonverbal memory, and processing speed [61]. Another study using a smaller sample set but with more comprehensive tests revealed that 89.5% of pre-implant patients had impairment in executive functioning, with approximately half of patients performing below expectations on specific measures of rapid set-shifting and letter fluency [47].

There are both transient and static factors that contribute to neuropathology and associated cognitive dysfunction in this population, and, as a result, the goals of the neuropsychological evaluation in the pre-LVAD screening process are twofold. First, it is critical to rule out frank dementia as such a condition renders a patient ineligible for LVAD placement. Second, based on the literature, it is clear that various manifestations of MCI are quite common in this population. It is important for the neuropsychologist to characterize the nature and extent of any cognitive impairment in order to help the team understand how any cognitive deficits might impact the patient's ability to learn to operate and maintain the LVAD equipment. Given these parameters and the multitude of variables that must be considered when developing an assessment approach (e.g., age, educational background, premorbid ability, linguistic and cultural background), prescribing a fixed battery of tests for the purposes of "evaluating LVAD candidacy" is a nearly impossible task. However, the following guidelines for how to focus the assessment approach and suggestions for tools that may be useful are offered.

When considering an approach to evaluating this population of patients, there are a few factors that must be weighed heavily. First, as indicated, the evaluation must be brief. The low energy these patients often present with and the limited access the neuropsychologist may have in terms competing with other consult services and procedures for the patient's time can be significantly rate limiting. Focusing the evaluation on key domains of functioning will help with truncating length. Specifically, attention, memory, and executive functioning are all fundamental to determining if the patient has the cognitive capability for learning how to use the LVAD device, completing the responsibilities of care and maintenance, and using judgment when critical decision-making is required (e.g., understanding warning lights on the digital display and ascertaining appropriate lifesaving next steps that may need to be completed in a very short amount of time).

Some domains of cognitive ability may not be a critical focus of the test battery. For example, while assessment of processing speed is relevant in many clinical settings, virtually every patient assessed in this population is likely to demonstrate psychomotor slowing due to their medical circumstance. Thus, specific efforts to evaluate processing speed are likely to yield the same outcome (impairment) in nearly every patient and therefore offer very little in new and helpful diagnostic information.

When considering specific test selection, for the reasons stated, there should be emphasis on brief repeatable measures. The availability of multiple alternate forms is helpful as patients may require follow-up assessment during the course of their hospitalization or following their surgery. Screening measures for a brief characterization of global cognitive ability are often a useful place to start. Tools such as the Dementia Rating Scale-2 (DRS-2) [62] that have an alternate form and touch on several different cognitive domains are helpful in this regard. In patients who are younger or where there is less of a concern for dementia, the DRS-2 may be omitted or placed lower on the priority of tests to administer.

Assessment of memory for the purposes of ruling out dementia and determining the presence and type of MCI is a necessary element in any battery of tests in this referral context. The Repeatable Battery for the Assessment of Neuropsychological Status (RBANS) [63] is particularly helpful in this population as it not only includes three memory subtests but also integrates a selection of other tasks that screen attention, visuomotor processing speed, language, and visuospatial/visuoconstruction ability. The availability of up to four alternate forms provides additional advantages and flexibility. The RBANS has been shown to produce different profiles of impairment across index scores depending on etiology [64, 65], which can be helpful in detecting the subcortical profile of deficits that can emerge in the context of cerebrovascular cognitive impairment. Additionally, the RBANS has shown a relationship to functional impairment based on informant report [66], particularly with performance on the Immediate Memory and Total Scale indices [67].

As the RBANS does not include tests of executive functioning, supplementing the battery with measures of set-shifting and problem solving is important. Researchers have utilized the Trail Making Test, part B [68], in some studies as the sole criterion of cognitive decline, citing the range of frontal functions requisite in completing this measure and the availability of multiple forms, as well as the extensive support in the literature for this task as being sensitive to cardiac and vascular neurological impairments [69–72]. That said, it may not sufficiently assess problem solving skills of the type needed for triaging action points related to the LVAD digital displays and care/maintenance of the LVAD equipment. Addition of a higher-order executive function tasks such as the Wisconsin Card Sorting Test-64 (WCST-64; [73]) can be helpful in understanding how a patient manages novel situations, whether there are concerning difficulties with perseveration, and even how they tolerate frustration in a challenging situation.

As mentioned previously, it is extremely important to assess mood in these patients. Whether the neuropsychologist is the sole mental health provider on the team or whether there is also a psychiatrist performing a separate diagnostic interview, it is often helpful to supplement the psychiatric interview with brief, self-report inventories of mood symptoms. Although the Beck inventories (Beck Depression Inventory-II, [74]; Beck Anxiety Inventory, [75]) are certainly useful, HF patients generally have multiple health comorbidities that can drive endorsement of somatic symptoms on such measures. Therefore, questionnaires that minimize physiological symptoms, such as the Geriatric Depression Scale (GDS; [76]), may be more useful, regardless of the patient's age.

Table 40.2 LVAD assessment at NYU Langone Medical Center

Dementia Rating Scale-2 (DRS-2)
Repeatable Battery for the Assessment of Neuropsychological Status (RBANS)
Trail Making Test A and B
Wisconsin Card Sorting Test-64 (WCST-64)
Other common supplemental measures
Digit span
Verbal fluency
Beck Depression Inventory-II (BDI-II) or Geriatric Depression Scale (GDS)
Beck Anxiety Inventory (BAI)

A list of the typical measures administered at NYULMC is summarized in Table 40.2.

Feedback to the Treatment Team

The results of the neuropsychological evaluation performed for the purposes of understanding LVAD eligibility are generally needed by the treatment team within 24–36 h of when the testing was completed. In addition to accommodating the requirement of rapid report turnaround, there are other features of working with this type of treatment team that influence how the neuropsychologist may approach report writing in this setting. Unlike other referral sources (e.g., behavioral neurologists, psychiatrists) who may be somewhat more interested in the details of the patient's background or the neuropsychological test data, the cardiology treatment team is often primarily interested in the "bottom line" (e.g., answers to the referral questions described above) with less concern for how the neuropsychologist reached their conclusions. Furthermore, as stated, the team is less likely to need the neuropsychologist to recapitulate the complex medical history that has already been carefully laid out in the EMR by the cardiac team leader. Thus, a brief 1–1.5-page report is often sufficient to meet the needs of the care team.

Writing a very short and focused communication can be more challenging than writing the more traditional neuropsychological consultation report. The example report appended at the end of this chapter is provided to facilitate a better understanding of what is most likely to be needed in this treatment context. Within the narrative, it is important to mention any environmental (e.g., interruptions, noise) or patient-specific (e.g., extreme fatigue limiting the scope of the exam) factors that may have compromised the data. As in any clinical evaluation, the history of cognitive impairment and functional decline (as supported by a collateral report) is also important to include. This information facilitates drawing preliminary conclusions about whether any identified (or suspected) cognitive impairment represents a dementia or whether the patient might be expected to improve in terms of neurocognitive function once heart functioning is improved with MCS. The clinician's best hypotheses on these issues should be plainly stated, and the method for follow-up clearly delineated in the Conclusions section of the report.

Case Example: Model Report

Referral Mr. Doe is a 69-year-old, right-handed Caucasian man referred for neuropsychological testing as part of a presurgical work-up for LVAD placement.

Past Medical History Cardiomyopathy, CHF, Afib, ICD implantation (2010), CVA (2010–? embolic etiology with full recovery), COPD, NIDDM, and BPH. *Psychiatric History:* No past psychiatric contact or report of mood disorder. Situational anxiety in the context of his recent health decline and the proposed surgery. *Social History:* Married, 2 adult children. Completed HS; no history of LD or academic difficulties. Worked in auto repair for most of his life; in the last 3 years, he has worked part-time sorting mail. When feeling well, he likes to go on walks, visit friends and casinos, and go on cruises. He denied any cognitive difficulties; his wife feels he is more forgetful, particularly in the last 3 months. Both agree that the only changes in his ability to perform IADLs are related to his health problems.

Tests Administered Test of Premorbid Functioning (TOPF); Wechsler Abbreviated Scale of Intelligence-II (WASI-II) two-subtest; Dementia Rating Scale-2 (DRS-2); Repeatable Battery for the Assessment of Neuropsychological Status (RBANS) – Form A; Trail Making Test (TMT); Wisconsin Card Sorting Test-64 item (WCST-64); Beck Depression Inventory (BDI-II); Beck Anxiety Inventory (BAI).

Behavioral Observations Testing was conducted at bedside within the CCC unit. Speech output was normal; thought content was coherent and goal directed. He was cooperative and engaged with the examiner but easily fatigued; testing was split into two segments. Mobility was slightly limited owing to the various IVs and medical monitoring devices.

Test Results Premorbid general intellectual functioning is estimated to be in the average range. Performance was within normal limits on an extended mental status exam (138/144). His global performance on a neuropsychological screening measure was generally at expectations; however, his ability was somewhat uneven across domains.

When test performance is taken together with observations, the fundamentals of expressive and receptive language functioning were considered to be within normal limits. Immediate span of auditory attention was adequate; however, verbal working memory was impaired. In terms of verbal memory, although his rate of learning was mildly diminished, he demonstrated the capacity for encoding and retention when given sufficient learning opportunities.

On visually mediated tasks, he struggled with visuospatial processing and visual reasoning. On some measures he was slow to visually scan a page for target identification. Memory for visual information was poor. Overall slow processing speed (likely related to fatigue) clearly affected his performances on timed measures. Due to diplopia (and his associated efforts to compensate by closing one eye), interpretation of these low scores on visual scanning, visuospatial construction, and nonverbal memory tasks is limited.

Aspects of executive functioning were impaired. Specifically, marked difficulty on untimed and timed measures of cognitive flexibility, novel problem solving, and hypothesis testing was noted.

On self-report questionnaires, he denied significant mood-related symptoms (BDI-II = 2; BAI = 6). Though he is very frustrated with the limitations his health condition has imposed on his very busy daily life, he is in good spirits and future oriented.

Impression Overall, this screening revealed a pattern of neurocognitive strengths and weaknesses that meet criteria for at least MCI. Given the history of recent onset cognitive decline in the context of normal adaptive functioning (from a cognitive perspective), it is likely that many of the cognitive weaknesses seen in this exam are related to his currently declining cardiac status. Some of the low scores seen in this exam could be secondary to peripheral factors (e.g., double vision) and will therefore not be integrated into the formulation at this time.

It is reassuring that Mr. Doe's verbal memory is intact, suggesting adequate ability to learn the procedures associated with LVAD use. His difficulty with cognitive flexibility and problem solving is more concerning. To compensate for these difficulties and to optimize his surgical outcome, it will be important for the cardiac team to train him on the device hardware in a distraction-free environment and working on one thing at a time. He does not easily switch between tasks or subjects (he becomes rather confused when faced with multiple choices and the need to apply different rules/procedures for different situations). In addition, because of the observed difficulty with efficient problem solving, it may be helpful to have him demonstrate with the LVAD hardware how he would go about handling various scenarios with regard to the alarms and readouts requiring an action from the patient. This will help the team understand his ability to grasp basic concepts and if additional training is needed.

Finally, there are no indications of current mood disorder and the patient is future oriented. He is anxious to proceed with LVAD placement so that he may resume many activities that contribute to his quality of life. He was able to acknowledge that LVAD placement would lead to some restrictions in his daily life.

Clinical Pearls

- It is critical to provide the cardiac team with education regarding how a neuropsychological evaluation can be performed validly.
- Get educated on the procedure and device the patient is being evaluated for. Our clinical battery changed after they provided us with an in-service and we became more familiar with all the cognitive elements needed to operate the device and manage the equipment.
- Obtaining a collateral interview is key for ascertaining whether cognitive impairment occurred exclusively in the context of acute cardiac decompensation.
- Be short and be creative with your approach to cognitive assessment.
- Be brief and to the point in consultation reports. Do not provide pages of history and test descriptions.

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