Chapter 4

Concomitant Cognitive Impairment in Persons with Spinal Cord Injuries in Rehabilitation Settings

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Sustaining a spinal cord injury (SCI) is a physically and psychologically traumatic experience. Individuals who incur an SCI face immediate, profound, and often permanent life changes. Following acute stabilization and treatment of their most serious physical concerns, many individuals with SCI are transferred to an inpatient rehabilitation environment, to undertake the difficult process of learning, practicing and integrating the myriad new skills required for daily living with an SCI. Due to both the nature by which the majority of SCIs occur and to a variety of possible sources of premorbid cognitive impairment, persons with SCI often confront the additional challenge of undertaking rehabilitation having pre-injury or accident-related cognitive impairment. Pioneering research of these issues suggested that 25\% to 57\% of persons with acute SCI might have a concomitant traumatic brain injury (TBI; Roth et al., 1989; Scheuman and Morris, 1982), and some cognitive impairment may be present in 67\% of individuals in SCI rehabilitation (Wilmot, Cope, Hall, and Acker, 1985). Most studies indicate that cognitive impairment affects between 40\% and 50\% of persons with SCI (Davidoff, Roth and Richards, 1992).

Morris, Roth and Davidoff (1986) suggest that individuals with a dual diagnosis of primary SCI and concomitant cognitive impairment are at substantial risk for both complicated rehabilitation programs and unfavorable outcomes. According to Davidoff and colleagues (1992), the sequelae of even mild cognitive impairment include “difficulties with

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attention, concentration, memory, problem solving, abstract reasoning, new learning, and high-level cognitive skills” (p. 275). Macciocchi, Bowman, Coker, Apple and Leslie (2004) suggest the presence of any brain injury may be sufficient to delay or offset skill acquisition in rehabilitation; their data indicate that, during acute rehabilitation, dual diagnosis of TBI and SCI may be associated with fewer functional gains in comparison to patients with SCI, but the association between TBI and overall response to SCI rehabilitation may be more complex than clinically assumed.

In addition to the problems that cognitive impairment presents for skill acquisition and integration in rehabilitation, two other dynamics underscore the importance of assessing and treating cognitive impairment in those with SCI. Morris and colleagues (1986) point out that proper diagnosis and treatment of cognitive impairment may reduce adverse reactions among rehabilitation treatment staff. They suggest that a closed head injury may provoke “increased irritability, poor judgment, impulsiveness, and a coarsening of personality” on the part of the patient. These behaviors, combined with the diminished ability to learn new information which often accompanies cognitive impairment, could lead staff to misconstrue a patient’s neuropsychological symptoms as a lack of cooperation or as stable personality characteristics. Rehabilitation staff may then become unsympathetic or hostile in response to the patient, resulting in a burned-out and demoralized treatment team who unwittingly compromise the patient’s care and any possibility of successful rehabilitation.

Considering the high frequency of cognitive impairment in persons with SCI, rehabilitation professionals must identify a patient’s cognitive obstacles to the comprehension and integration of new skills, using a detailed and comprehensive neuropsychological assessment (Davidoff, Roth, Haughton and Ardner, 1990; Macciocchi et al., 2004). It follows that rehabilitation professionals must also tailor interventions to fit each person’s cognitive abilities, in order to optimize an individual’s rehabilitation experience. Furthermore, by assessing and identifying each individual’s strengths and assets, rehabilitation professionals can help persons with SCI and cognitive deficits harness inherent abilities and skills that may modulate, to some extent, the otherwise overwhelming task of successfully transitioning back into community settings.

In this chapter, we review current information about the incidence and etiology of mild TBI concurrent with primary SCI. We then briefly discuss other potential sources of cognitive impairment in persons with SCI and argue for routine neuropsychological assessments of cognitive functioning among persons admitted for SCI rehabilitation. A discussion of research aimed at discerning profiles of cognitive function in patients with SCI is presented next. A description of appropriate methods for assessment and diagnosis of SCI-related cognitive impairment follows, with an emphasis on the effective assessment of individuals’ cognitive, social, and functional strengths and assets. Finally, implications for clinical practice in inpatient rehabilitation settings and for research are presented.

Incidence and Etiology of SCI and Concomitant Cognitive Impairment
The bulk of the research on SCI and concomitant cognitive impairment focuses on specifically estimating its incidence (e.g., Davidoff, Morris, Roth, and Bleiberg, 1985; Wilmot et al., 1985). Estimates of the frequency of cognitive impairment in those with SCI range from 10% to 60%, depending on the researcher’s definition of cognitive impairment and the methodology employed for data collection (Davidoff et al., 1992). In this section we review research related to SCI and cognitive impairment, with a focus on current estimates of incidence and etiological trends.

The various national databases used to track new SCI cases have not included indices of brain injury or cognitive impairment. While the lack of a mandatory national surveillance system makes ascertaining even the prevalence and incidence rates of SCI difficult, current reports estimate the prevalence of SCI variously between 15 and 40 cases per million nationally, with approximately 11,000 new cases each year (Jackson, Dijkers, DeVivo and Poczatek, 2004). Although these rates show SCI to be a fairly infrequent cause of disability overall, the tremendous social and financial costs of the disorder are disproportionate to its relatively low incidence (Jackson et al., 2004).

In an analysis of Model Spinal Cord Injury Systems admissions and data from the National Spinal Cord Injury Database, vehicular accidents (including all types of motor vehicles and bicycles) are the leading cause of injury to individuals age 45 and younger, and represent 45.6% of all SCIs (Jackson et al., 2004). Falls account for the second-highest source of injury, with 19.6% of injuries across age groups. As individuals age, fall-related SCI dramatically increases. For example, persons aged 16 to 30 sustain SCI’s due to falls at a rate of 10.8%, compared to 59.7% for persons aged 76 to 99 years. Falls are the most frequent cause of injury for persons 46 and older. Violence accounts for 17.8% of SCI across all age groups, with most violent injuries sustained by gunshot wounds, stabbings, and attacks with blunt objects. Injuries from sports-related accidents comprise 10.7% of SCI across age groups; diving is the most common cause of injury, although diving-related injuries are decreasing. The remaining 6.6% of injuries are sustained due to a variety of other causes, with the main sources being medical or surgical complications or unclassified causes.

Within these general trends, etiologies vary significantly by both gender and ethnicity (Jackson et al., 2004). In terms of gender, 80% of persons with SCI are men. The rates of etiology by category listed above match those typical for men, which is intuitive given the prevalence of men with SCI. Among the women who acquire SCI, approximately 26% are injured in vehicular crashes, 18% are injured in falls, 16% are injured related to violence, and 14% are injured related to sports. They report a slight increase in the number of women injured in vehicular crashes during the past 30 years, while the other sources of injury have been relatively stable. However, women evidence a startling increase in injuries related to “other” causes, going from approximately 6% of new SCI cases between 1973 and 1979 to 25% of women’s injuries after 2000. Norbunga, Go and Karunas (1999) suggest that medical and surgical complications are the source of this dramatic increase in injury for women, but do not specify the nature of these procedures or describe the resultant injuries.

Race and ethnicity also impact etiology in SCI. Vehicular crashes account for almost half the injuries in Caucasian Americans and nearly two-thirds of the injuries in Native Americans, while only one quarter of African Americans with SCI sustain their injuries in vehicular crashes (Norbunga et al., 1999). Caucasians sustain 74.8% of the injuries due to
vehicular accidents, followed by 13.6% for African Americans, 7.8% for Hispanic Americans, and 3.8% for persons of “Other” races or ethnicities (Jackson et al., 2004). These percentages generally hold across other categories of etiology, with dramatic exceptions in injuries caused by violence and sports accidents. African Americans sustain 52.2% of the injuries caused by violence, compared to violence-related injury rates of 23.9% for Caucasians and 21.1% for Hispanic Americans. Relative to their rates of injury in other categories, violent etiologies are much more frequent for African and Hispanic Americans. Caucasians are more likely than other racial or ethnic groups to be injured in sports-related accidents, sustaining 87.2% of sports-related injuries.

Etiology of SCI plays a central role in the incidence and prevalence of concomitant cognitive impairment. SCI's caused by vehicular crashes, falls, some types of violence, and sports accidents result from a rapid acceleration-deceleration event (Stover et al., 1986); frequently such events are powerful enough to also result in brain injury (Dowler et al., 1997). Davidoff et al. (1985) report that motor vehicle accidents account for the majority of closed head injuries, related to high rates of speed and the trauma incurred as a result of deceleration.

Unfortunately, due to the severity of problems associated with primary SCI, mild or moderate head injuries may be overlooked during initial assessment (Narayan, Gokaslan, Bontke and Berrol, 1990; Ricker and Regan, 1999). For example, Davidoff and colleagues (1985) examined rates of assessment for posttraumatic amnesia (PTA), a stage of confusion and disorientation that is indicative of brain injury following an accident. They reported that assessment of PTA occurred only 22% of the time in an emergency room, and that 91% of the assessed individuals showed PTA of at least 24 hours. In a subsequent study, Davidoff and colleagues (1988) reported that PTA lasting longer than one hour occurred at a rate of 29% in an SCI sample, suggesting mild brain injury in these individuals; 12% of these persons evidenced PTA of more than 72 hours, indicating at least moderate TBI. The assessment of self-reported loss of consciousness (LOC) at the time of injury onset – independent of any medical diagnosis of a concomitant brain injury – may have considerable clinical value: LOC was the only disability severity variable significantly associated with ineffective social problem-solving abilities among persons with recent-onset SCI (which in turn significantly predicted pressure sore occurrence over the subsequent three years; Elliott, Bush, and Chen, 2006). Given these data, the need for assessment of concomitant brain injury as soon as practical in one’s medical treatment for SCI seems clear. A discussion of assessment techniques is presented later in this chapter.

**Pre-Injury Sources of Cognitive Impairment**

**Alcohol and Drug Abuse**

Alcohol and drug misuse are common among persons with SCI and TBI. Bombardier, Stroud, Esselman and Rimmele (2004) report that between 35% and 49% of persons with newly acquired SCI have a self-reported history of significant alcohol-related problems, and alcohol is thought to contribute to the cause of the injury in 35% to 40% of individuals with
SCI. Rates of alcohol or drug intoxication at the time of SCI may range between 17% and 62% (McKinley, Kolakowsky and Kreutzer, 1999; Young et al., 1995). Individuals who evidence alcohol in blood tests are likely to have sustained more severe injuries (Kiwerski and Krauski, 1992). The rehabilitation outcomes for persons with heavy pre-injury drinking patterns are generally poor: Heinemann, Goranson, Ginsberg and Schnoll (1989) documented reports of limited participation in productive activities—such as rehabilitation therapies—in persons with a history of heavy drinking. Bombardier and colleagues (2004) speculated that “…limited participation in rehabilitation may lead to patients being discharged who are relatively unprepared to cope with the effects of their injuries and thereby at increased risk for postinjury medical complications” (p. 1488). A history of alcohol abuse also contributes to secondary medical complications at a predictable rate. For example, Elliott, Kurylo, Chen, and Hicken (2002) found rates of diagnosed pressure sores among persons in acute SCI rehabilitation were 2.5 times higher over the first three years of SCI among those with severe alcohol abuse histories prior to SCI onset, compared to their peers without alcohol use problems.

Given the high pre-injury rates of problematic alcohol use in persons with SCI, rehabilitation professionals need to be cognizant of the negative cognitive impact which can result from chronic alcohol abuse, and also of the immediate and significant neuropsychological effects of alcohol withdrawal. There is considerable scholarship investigating the role of chronic alcohol use on cognition. Arria and Van Thiel (1992) reviewed the main types of specific neurological disorders and general cognitive dysfunction related to heavy alcohol use. Under the category of specific neurological disorders, they state that alcoholic dementias account for approximately 10% of all adult dementias, although they assert that this rate is probably conservative given the possibility that dementias are often undiagnosed. They explain that alcoholic dementias have not been well studied. Arria and Van Thiel (1992) also describe Korsakoff’s Syndrome, another neurological disorder that results from a thiamine (vitamin B) deficiency. Korsakoff’s Syndrome develops as a result of the malnutrition and decreased absorption of thiamine which may accompany severe alcoholism. Thiamine deficiency first develops into Wernicke’s encephalopathy, which, if treated, does not have lasting effects in most individuals. Arria and Van Thiel (1992) explain that 25% of individuals with Wernicke’s encephalopathy develop Korsakoff’s Syndrome, the hallmarks of which are anterograde amnesia (the inability to recall recently learned events) and, in severe cases, widespread brain damage and cognitive dysfunction. Obviously, anterograde amnesia and brain damage would profoundly impact a person’s ability to benefit from instruction and skill acquisition in a rehabilitation setting.

Apart from specific neurological disorders, the general cognitive deficits associated with chronic alcohol consumption include decreased motor coordination, difficulty with abstract thought, deficits in attention and concentration, and loss of visual and verbal memory (Ryan and Butters, 1986). Chronic alcoholism also negatively affects higher-order cognitive processes, such as planning, organizing, and behavior regulation (Arria and Van Thiel, 1992). Furthermore, chronic alcohol users have a higher risk of head injury related to car accidents and falls; a history of brain trauma may also contribute to cognitive dysfunction in some alcohol-dependent individuals. In a study with particular saliency for rehabilitation, Seifert et al. (2003) found that persons in their first three days of alcohol withdrawal exhibited impaired...
memory; only those individuals being treated with carbamzepine (to alleviate withdrawal symptoms and prevent grand mal seizure) demonstrated memory impairment beyond three days. The authors speculated that this impairment was consistent with the effect of carbamzepine on memory in healthy adults. However, their sample included only individuals with mild and moderate alcohol dependency, while individuals with SCI also experience severe alcohol dependency at a disproportionately high rate. While it is likely that alcohol-dependent individuals with SCI will have weathered their most difficult withdrawal symptoms during inpatient hospital stabilization, rehabilitation staff should be watchful for evidence of alcohol withdrawal or cognitive impairment related to chronic alcohol use.

Related to the impact of chronic drug use on rehabilitation outcomes, clinicians must also consider a client’s drug use history. More than 30% of persons hospitalized for SCI had positive tests for illicit drugs at admission (Heinemann, Mamott, and Schnoll, 1990; Young et al., 1995). Some studies have linked chronic drug use to deficits in attention, abstraction, memory, decision-making, and visuospatial abilities (Block, Erwin, and Ghoneim, 2002). This research indicates that in an early stage of abstinence, chronic drug users performed poorly compared to controls in tests of achievement, memory, and abstraction and these impairments may be related to the effects of drug withdrawal. Block et al. (2002) also found that stimulant users performed worse than cocaine users on tests of intelligence, and worse than alcohol users with respect to intelligence, attention, memory, and reaction time. Furthermore, the authors noted that three months after the initial assessments, only memory test scores remained depressed. They speculated that improvements in other areas were representative of cognitive ability following acute withdrawal, while impaired memory may be a long-term consequence of chronic drug abuse. It is worth noting that Block et al. (2002) also found that drug users scored lower on achievement tests as fourth graders than did controls, after factoring out childhood socioeconomic status. They concluded that poor cognitive abilities might both predict and result from chronic drug use. Thus, both poor premorbid intellectual functioning and cognitive impairment related to drug use may impact cognitive functioning in individuals with SCI.

Individuals with SCI who also struggle with substance abuse face significant obstacles to successful rehabilitation. Given the high prevalence of chronic, pre-injury drug and alcohol abuse in the SCI population, and considering the cognitive impairment that may result from both acute withdrawal and more permanent, substance-related brain damage, appropriate assessment of drug and alcohol problems is essential. Recommendations for methods of assessing alcohol and drug use patterns will be made later in this chapter.

Additional Pre-Injury Sources of Cognitive Impairment

A number of additional premorbid sources of cognitive impairment may impact SCI patients’ rehabilitation. Our goal is not to describe these conditions in detail; rather, we briefly list them here as evidence that comprehensive neuropsychological assessments of individuals with SCI are essential for maximizing patient success in rehabilitation. Furthermore, the list is not exhaustive, but intended to highlight the most common pre-injury sources of cognitive impairment.
• **Premorbid brain injury.** Head injuries sustained at any time in a person’s life may impact his or her cognitive abilities. We know that moderate to severe brain injuries—including repeated concussions—can have lasting, negative cognitive, behavioral, and personality effects, particularly when the head injury occurs in childhood. A history of head injury may be indicated in the medical chart; family members may also be aware of a patient’s history of brain injury.

• **Poor premorbid intellectual, educational, or occupational functioning.** Individuals who have experienced difficulty in educational and occupational settings may likely face difficulty in rehabilitation. The presence of a learning disorder, developmental delay, or low intelligence must be identified, so that appropriate methods of instruction can be incorporated in the patient’s rehabilitation treatment plan. Processing speed, attention, and verbal learning can be impaired among persons with SCI in absence of documented LOC or TBI (Hess, Marwitz, and Kretzer, 2003). Verbal learning abilities, in particular, may be directly associated with observed and self-reported adjustment following rehabilitation (Hanks, Rapport, Millis, and Deshpande, 1999; Schmitt and Elliott, 2004). These matters should be considered in routine psychological evaluations (Elliott and Jackson, 1996), and some conditions may be documented in medical or educational records, or family members might be aware of any such diagnoses which could impact a patient’s comprehension, learning, processing, or information retention.

• **Age-related cognitive decline.** Those who track epidemiological trends note a gradual increase in age for persons sustaining SCI. As previously mentioned, falls represent the most frequent cause of injury for people over 65, followed by “other” causes and motor vehicle accidents, respectively. SCI injuries which include rapid deceleration—probable with a fall—are likely to result in concomitant cognitive impairment.

Apart from the cause of injury, individuals aged 65 and older are at increased risk for age-related cognitive decline. Normal aging brings changes in memory and processing speed, while comprehension is thought to remain normal. Individuals over 65 are also at risk for cognitive disorders such as mild cognitive impairment (MCI), a precursor to Alzheimer’s Disease that impair memory and thinking, while leaving activities of daily living relatively intact. Word memory tests are conventionally used to quickly screen individuals for MCI. The majority of individuals with MCI have not received a formal diagnosis of the condition. In more extreme cases, dementia and other neurological disorders impacting those over 65 may greatly inhibit progress in rehabilitation. For patients over 65, assessment of cognitive functioning and disorders associated with gerontological populations would be a boon to the rehabilitation program.

• **Prescription medications.** Many individuals with SCI will present for rehabilitation treatment with a complicated prescription medication regimen. A number of prescription medications may cause cognitive impairment. Analgesics, sedatives, anti-convulsant and anti-spasmodic medications are all likely to reduce an
individual’s cognitive abilities. Drug interactions may also increase cognitive impairment. Rehabilitation staff might find a reference list of such medications useful; scanning the medical chart for the presence of a current prescription which results in impaired cognitive performance could suggest important areas to focus on in assessment. Consulting with the patient’s intensive care treatment team and primary care physician can also elicit helpful information regarding current prescriptions. Interactions among prescription drugs, over-the-counter medications and natural dietary supplements can negatively impact physical and cognitive function. Patients and their families may not be aware of the potential danger, and may not think to mention these additional substances when asked to list medications. We suggest that a specific question regarding all ingested substances be included in the assessment.

- **Other medical conditions.** A host of medical conditions and treatments are known to cause cognitive impairment. A reference list of such diseases would allow rehabilitation staff to quickly check the patient’s medical record for illnesses whose symptoms include impaired cognition.

- **Psychiatric conditions and long-standing personality traits.** Several psychological disorders impact cognitive ability—most commonly, depression and schizophrenia. Diagnosed disorders will be listed in the patient’s medical file or known to the primary care physician. More often, psychological disorders will not have been formally diagnosed. Accordingly, neuropsychological assessment should include a measure of psychological function, with the twin aims of determining whether psychological symptoms are impacting cognition and planning appropriate psychological interventions.

As mentioned above, this list of premorbid conditions is not exhaustive. However, it is important to be aware that individuals who incur SCI are likely to present with one or more of these conditions, given their prevalence in the general population. We provide the list to accentuate the importance of a thorough neuropsychological assessment very early in every person’s rehabilitation treatment. It is essential that sources of cognitive impairment are identified, and, more importantly, that the effects of the impairments are delineated. These effects and strategies to address them should be integrated into an individual’s rehabilitation treatment plan if successful rehabilitation is to occur. When a thorough neuropsychological assessment is not possible, rehabilitation staff should endeavor early on to collect information about the patient’s history of alcohol or drug use patterns; premorbid brain injury; intellectual, educational, and occupational functioning; current prescriptions, over-the-counter medications and dietary supplements; medical conditions; and psychiatric functioning. The patient’s medical chart, family members, and the patient (whenever possible) are valuable resources for such information. Additionally, rehabilitation professionals should also consider the possibility of pre-existing, age-related, and undiagnosed mild cognitive impairment or dementia in older patients with SCI. Given the complexity of possible sources of cognitive impairment, a thorough neuropsychological assessment assures the patient the best chance of success in rehabilitation.
Additionally, there is reason to suspect that many individuals who incur a SCI may have an outstanding history of impulsive, imprudent risk-taking behavior that has placed them at risk for previous injury (Bourestrom and Howard, 1965; Fordyce, 1964; Mawson et al. 1996). This “accident proneness” (Kunce and Worley, 1996) profile has been well-known in clinical research, but the ramifications for clinical assessment and treatment planning for persons with a dual diagnosis have been less clear. It is possible that some patients may have undiagnosed, untreated cognitive impairments from incidents or activities that occurred prior to SCI onset, and these issues have not been adequately studied in the extant literature.

Profiles of Cognitive Function in Patients with SCI

Considering the various sources of cognitive impairment in persons with SCI, and knowing that different areas of the brain may sustain injury in a rapid acceleration-deceleration event, some researchers have attempted to document clinically useful profiles of cognitive functioning in this population. Dowler et al. (1997) investigated cognitive profiles in a chronic SCI sample of 91 individuals, and compared them to 75 controls. They administered a battery of 16 neuropsychological tests to the participants and, following a factor analysis, compared performance on composite scores across six clusters: memory, attention, speed, spatial ability, face processing, and mental flexibility.

Dowler and colleagues (1997) found that six distinct subgroups of cognitive function patterns emerged. The first and second groups appeared normal compared to controls, with the exception that memory functioning was approximately one standard deviation lower in the second group than in the first group. The researchers hypothesized that these groups may have sustained a head injury at the time of SCI, but that cognitive functioning was recovered after one year post-injury and that the mild memory impairment evidenced in the second group would not have prevented successful rehabilitation or adjustment.

The third group, whose members had the highest mean age (58.45 years), demonstrated significant deficits in attention and processing speed, accompanied by somewhat depressed performance in the other four domains. With this group, the authors hypothesized that a head injury sustained at the time of SCI could have exacerbated the cognitive decline associated with normal aging. They also speculated that individuals in the third group might have had poor premorbid cognitive functioning or frontal lobe injury.

Participants in the fourth, fifth, and sixth groups also showed cognitive deficit patterns associated with head injury. The fourth group showed impairment in processing speed, with relatively normal performance across other domains; unlike Group 3 members, who were impaired in both processing speed and attention, the fourth group demonstrated normal attention. The fifth group performed normally, with the exception of low scores in cognitive flexibility; according to the authors, cognitive flexibility is frequently impaired following TBI. The sixth group exhibited significantly lower performance in memory tasks, and evidenced low average processing speeds. The memory deficits evidenced in Group 6 had very small within group variability, indicating that memory was consistently impaired among members in this group.
Dowler et al. (1997) asserted that these various profiles match the cognitive patterns typically seen among head injured individuals in clinical settings. They stressed that these results point to the importance of conducting a complete neuropsychological evaluation of persons with SCI, to either rule out or to identify a concomitant head injury. Furthermore, the authors emphasize that individual differences are present in the profile patterns of cognitive functioning after head injury, and that these patterns are directly related to the success of rehabilitation and community integration outcomes. Moreover, given that the mean time since injury of their clinical sample was 17 years, the authors stress the necessity of routine neuropsychological evaluations for individuals with SCI in the years following their injury, accompanied by a periodic review of each patient’s skill development, emotional adjustment, and social functioning. Thus, the information gathered during the patient’s rehabilitation experience may serve as a foundation for future neuropsychological evaluation and intervention.

**Assessment of Cognitive Impairment among Persons with SCI**

The assessment of cognitive impairment in individuals with SCI can be a complicated task. However, understanding an individual’s cognitive abilities is imperative for creating a realistic and effective rehabilitation treatment plan. In the following section, we briefly describe the most commonly used measures for assessing TBI, and suggest how to use these measures in a treatment setting. Next, we present a description of the cognitive, emotional, and behavioral sequelae associated with TBI, and discuss how these conditions can impede successful rehabilitation. Next, we describe important components of patient, caregiver, and rehabilitation staff education. The section ends with suggestions for future research.

**Documented Loss of Consciousness**

LOC may occur at the time of a spinal cord injury. LOC is routinely documented by emergency personnel at the scene of an accident; additionally, this documentation is usually found in the admitting history and physical from the emergency room physician. However, clinicians cannot take the lack of this documentation face value. Individuals and/or witnesses may not report LOC at the time of the accident. The clinician is therefore advised to include a specific question about LOC in rehabilitation assessment protocols.

**Glasgow Coma Scale**

The Glasgow Coma Scale (GCS) was designed in to objectively measure the degree of unconsciousness following a TBI. It is the most widely used severity scale in United States emergency rooms and hospitals (Sorenson and Kraus, 1991). The GCS was developed in 1974 to standardize the clinical assessment of unconsciousness by examination of three
primary areas: motor response, verbal response and eye opening (Sternbach, 2000). In its current use, the GCS allows clinicians to determine severity, predict outcome and direct clinical management. A GCS score of 13 to 15 is considered a mild head injury, 9-12 is considered moderate and 8 or less is considered to be severe (Teasdale, Pettigrew, Wilson, Murray, and Jennett, 1998).

Post-Traumatic Amnesia

Posttraumatic amnesia (PTA) is a severity measure for traumatic brain injury. PTA has been described as the transient stage of confusion and disorientation characterized by intellectual and behavioral disturbances (Ahmed, Bierley, Shekh, and Date, 2000). PTA is considered to begin at the moment of injury and last until the time when a patient can provide a clear and consistent account of present events. PTA also provides some predictive utility in that longer duration of PTA is associated with increased cognitive, neurological and functional outcome deficits.

One of the most widely used measures of PTA is the Galveston Orientation and Amnesia Test (GOAT). The GOAT was developed by Levin (1979) to provide clinicians with a brief, quantitative measure of disorientation and amnesia in a closed head injury. The GOAT is easily used with patients in the acute hospital setting and has been determined to be very beneficial to make a diagnosis of PTA in the SCI population (Davidoff et al., 1988) The GOAT allows clinicians to identify the patient’s current orientation as well as estimate the period of PTA. Additionally, the GOAT may be used as a repeated measure in order to evaluate a patient’s progress from PTA onset to PTA resolution.

Medical Assessments

Medical assessments, such as routine skull films, computed tomography (CT) scans and magnetic resonance imaging (MRI) are frequently used to identify TBI. Skull films are also utilized in the emergency room to detect the existence of TBI. These diagnostic tools will also provide valuable clinical information about the likelihood and severity of cognitive impairment associated with SCI. However, the clinician must be aware that a negative finding on these types of measures does not mean that a traumatic brain injury has not occurred. For example, a mild traumatic brain injury resulting in a positive LOC may not be seen on an MRI yet still produces cognitive deficits.

Common Cognitive Sequelae of Traumatic Brain Injury

A variety of cognitive impairments are observed following a TBI, often resulting in significant challenges for the patient. Most commonly, deficits are seen in the areas of arousal, attention, memory, information processing and both receptive and expressive language skills. These deficits can be so apparent that the TBI rather than the SCI may be the first and primary treatment focus of the inpatient rehabilitation team. Specifically, Lemke
(1995) explains that treatment staff may choose to focus on cognitive and behavioral components of patient rehabilitation, until a patient is clearly able to retain learned information.

Among possible cognitive impairments, the ability to sustain attention and retain new information may be the most obviously impaired in rehabilitation. If patients cannot comprehend, retain, and apply new information, the vast amounts of SCI education provided in inpatient rehabilitation may have no effect. It is imperative, therefore, to identify memory and attention deficits early in inpatient rehabilitation to aid staff in developing the patient’s best strategies for learning. If the patient is not capable of learning strategies presented in rehabilitation, the family or designated caregivers will need to learn how to perform those daily tasks to maintain the patient’s health, well-being, and safety following the transition home.

**Executive Functioning Consequences of TBI**

Poor executive functioning following a TBI can significantly impair the course of rehabilitation. Executive functioning problems can include deficits in task initiation, problem solving, reasoning, decision making, and planning and organization (Sommer and Witkiewicz, 2004). These skills are essential for learning and accommodating the new cognitive and physical demands required in rehabilitation treatment. Even without cognitive damage, patients can find the learning requirements of all aspects of rehabilitation challenging. Therefore, without full executive capacity, SCI education and rehabilitation tasks can be difficult and frustrating for the patient. Maximum structure is often required to help patients learn necessary SCI skills.

Other deficits in executive functioning such as insight, shifting concepts, thought flexibility, and the ability to think abstractly can make inpatient rehabilitation extremely difficult. Patients with these deficits may not possess insight into their difficulties, nor do they understand the need for accommodation. For example, patients with SCI are forced to rapidly switch gears during therapies in a typical inpatient day. They may be required to go from a physical therapy session to an educational class on bowel management and then to an aquatics therapy with no break. As a consequence, it is necessary for patients to handle to rapid shifts in physical activities and cognitive demands during the day, which can result in frustration and decreased participation for the cognitively impaired patient.

Perseveration is a common consequence of brain injury in which patients can develop repetition of verbal or physical behavior as well as repetition of thought content. As a result, perseveration on a deficit in proprioception or pain can create a significant distraction for the patient as well as the family and staff who have to redirect the patient. Perseveration can cause a patient to be so internally and externally distracted that they are unable to engage in the necessary therapy task or education being provided, which results in overall functional limitations.

The rehabilitation environment itself provides an immense challenge for those with executive functioning deficits because it is a novel environment. Patients are suddenly forced from their routine life into a strange and unfamiliar environment without the cognitive
capacity to manage the dramatic environmental change. Every task and term is new to the majority of patients, and even the most routine of functions, such as bowel and bladder maintenance, is significantly altered. Patients are separated from family and loved ones and for patients with cognitive damage, this sudden and complete environmental change may provide a barrier to learning and incorporating new skills. Treatment areas bombard the patient with visual and auditory stimuli; unannounced shifts in environments occur that force patients to reorient themselves multiple times each day. Cognitive fatigue can occur quickly, negatively impacting a patient’s physical performance. Ironically, the treatment environment and intervention approaches that work well for the cognitively intact client with SCI can inhibit the performance and progress of the dual diagnosis patient.

**Behavioral and Emotional Consequences of Traumatic Brain Injury**

Behavioral and emotional consequences of TBI span a broad range. Apathy, emotional lability, aggression and depression can all follow TBI (Sommer and Witiewicz, 2004). The physical impairments resulting from SCI can exacerbate these emotional responses. Commonly, patients with SCI report frustration resulting from to their diminished independence. This frustration is intensified in patients with cognitive impairment because their capacity to handle frustration is reduced; treatment providers will often see increased patient agitation when this occurs.

Depression, the most common reported consequence of either SCI or TBI, can be compounded when a patient has a concomitant injury. As a consequence, patients may display increased depressive symptoms which impact their overall functioning and quality of life. Depression can be associated with cognitive dysfunction (Castaneda, Tuulio-Henriksson, Marttunen, Suvisaari, & Lönnqvist, 2008). The ability to learn adaptive coping mechanisms for depression is also compromised when cognitive deficits impair learning and retention of cognitive behavioral strategies. If a patient cannot retain information learned in a psychotherapy session then the therapeutic strategies will be ultimately ineffective.

Behavioral problems are also intensified by patient’s lack of inhibition secondary to the brain injury. This can be seen in a variety of areas, including sexuality. Patients with SCI have to learn how to cope with significant bodily changes, including the physical limitations related to sexual functioning and body image issues. Patients with cognitive deficits may have an increased tendency to “test the waters,” especially with treatment staff of the opposite gender in an attempt to reassure themselves about their own sexuality and ability to be seen as sexual by others. If there is also disinhibition secondary to a brain injury, this type of behavior can be heightened by the inability to control their responses.

**Implications for Clinical Practice**

Patient Education and Task Building
Patient education and skill acquisition lie at the heart of rehabilitation treatment. Educating the patient with SCI and concomitant cognitive impairment can be a challenging endeavor, especially related to specific tasks which must become habitual to ensure the patient’s health and well-being following rehabilitation. It is often assumed during inpatient rehabilitation that a patient has mastered a task when he or she is able to demonstrate that task without the assistance of a staff member. For example, when asked to perform a pressure relief by a physical therapist, a patient may demonstrate the ability to do so. However, when patients have cognitive deficits, a single demonstration of a task may not necessarily mean that the patients have fully incorporated the skill into their repertoire. Cognitive deficits can impair retention of a new skill, especially in unstructured situations. When patients leave rehabilitation they generally have no structure to help with task repetition, and as a consequence the task does not occur. There are several strategies for increasing the likelihood of task repetition, including simplification of the task, visual or auditory reminders to perform the task, repetition of instructions and consistency of instruction among treating staff.

When teaching patients with cognitive deficits about a pressure relief it is critical to make the information simple and concise. Poor attention and deficient short-term memory require that tasks are simple, and limiting instructions to one or two steps is helpful. For some patients, a reminder about performing a task can be helpful. Timers with an auditory signal can be set to help remind patients to perform pressure reliefs on a consistent basis. Visual reminders such as memory notebooks and cards can help patients remember the steps of critical tasks as well.

In addition to frequent repetition of task instruction, it is essential that staff members and therapists display consistency in their presentation of information. For example, if a patient with paraplegia and cognitive deficits is attempting to learn how often to do a pressure relief, he or she will have great difficulty establishing an appropriate routine if he or she is told by one therapist to do the task every twenty minutes for a one minute duration and told by another therapist to do the task every thirty minutes for a two minute duration. Consistency of information is absolutely necessary to help patients with cognitive deficits incorporate and retain novel material.

Patient education must also be tailored for each individual, and patients with cognitive impairment must be given special attention in the way education is provided. For example, autonomic dysreflexia (AD) is a potentially life threatening condition for spinal cord injured patients with a T7 lesion or higher. For a cognitively intact patient, it may be adequate for the signs and symptoms of AD to be explained in a group setting with supplemental literature provided at the end. For the cognitively impaired patient, however, this format may be completely inappropriate. In a group education format—a modality common to many rehabilitation centers—the patient can be easily distracted by the group itself, and may be unable to sustain attention to the group content. Although the educator might expect patients to be independent with pertinent reading materials, patients with cognitive deficits may lack the initiative and attention needed to engage in independent reading. An assessment of the specific cognitive deficits of the individual patient should result in recommendations regarding how information can best be presented (e.g., as visual stimulus, or through repetitive individual instruction) to optimize the patient’s learning and retention.
Family and Caregiver Education

Families especially need to have information and education regarding the nature of SCI and concomitant TBI. Often the family’s focus is on the spinal cord injury as it is more overt and obvious than are the subtle effects of a mild brain injury. However, families need education about both TBI and SCI, because they need to understand how the cognitive deficits can reduce independence and require more from caregivers. Caregiving produces enormous strain on families, especially for an injured loved one who will require assistance with most physical tasks. However, if a cognitive deficit causes the patient to react behaviorally or emotionally (e.g., the inability to control anger directed at a family member) the stress and caregiver burden are significantly increased, especially from an emotional standpoint. Cognitive deficits such as memory loss and poor carryover often mean patients cannot perform relatively straightforward tasks, which also increases caregiver stress. For example, individuals with a paraplegic injury and normal cognitive functioning can independently perform routine pressure relief, while similar individuals with cognitive impairment will require assistance with pressure relief because they lack the memory skills to engage in routine behaviors; such impairments require increased caregiver attention and thus add to caregiver burden.

Inpatient rehabilitation treatment providers play an essential role in teaching families how to assist in necessary tasks, thereby increasing caregivers’ comfort level and enhancing the chances that these tasks will be appropriately performed at home. Often psychological support is necessary to prepare families for the emotional challenges inherent in caregiving. Encouraging family members to engage in stress reduction techniques and to take time for themselves outside of the caregiving role is important in reducing caregiver distress; furthermore, it allows families to start planning for long term care provision if necessary.

Rehabilitation Staff Education

Rehabilitation staff members working with SCI need to be familiar with the cognitive deficits that occur as a result of mild to moderate brain injury. Neuropsychologists and Rehabilitation Psychologists should assess and identify cognitive impairment as members of the inpatient treatment team. Including cognitive assessment results in treatment team case conferences is critical so that the team can develop appropriate strategies for physical and occupational therapy tasks. If a Neuropsychologist or Rehabilitation Psychologists is not available for assessment during inpatient rehabilitation, all treatment staff should be aware of details in the patient’s medical chart that might indicate cognitive impairment. For example, inpatient staff should know to examine the medical chart for documented LOC, to understand the severity levels of the GCS, and to look for documented behaviors (e.g., agitation) suggesting a possible cognitive deficit. Furthermore, treatment staff should be aware of common symptoms of TBI and be able to identify when those symptoms are impacting the rehabilitation of the patient. Nursing staff in particular should have a strong understanding of
the impact of TBI, as they are often closely involved in teaching patients the most important aspects of self care, including bowel, bladder and skin management.

**Maintaining the Emotional Heath of the Rehabilitation Staff**

The patient with dual diagnosis can present significant emotional challenges for rehabilitation treatment providers. Treatment teams who exclusively focus on the SCI can feel uncomfortable and frustrated by patients with brain injury who don’t seem to “get it” the way a cognitively intact individual might. Therapists may develop a general pessimism toward patients who are agitated, angry and frustrated during therapy sessions. It is especially important that clinicians understand that cognitively-impaired patients are not “personality problems;” rather, they are experiencing significant deficits in the ability to modulate emotion, especially within the stressful context of inpatient rehabilitation. Nurses can be particularly frustrated by patients’ behavioral difficulties such as frequent calls and refusal to participate in self-care tasks, requiring increased effort and energy from the nursing staff. Therefore, it is important that staff find methods to reduce burnout when working with dually-diagnosed patients, such as venting work-related frustrations with supervisors rather than directing frustration at the patient. Team conferences are also a good place to vent difficulties. Additionally, psychologists working with the inpatient teams need to educate staff about potentially challenging patients and helping reduce treatment providers’ frustrations. Stress-management education can be particularly valuable for treatment staff, especially when there is a high case load or several complicated cases on the unit. Providing staff with opportunities to cope with the emotional toll of concomitant SCI and TBI treatment is essential as this will enhance the overall hospital environment which in turn benefits the patients and their families.

**Implications for Research**

Research on the long-term concomitants of TBI among persons with SCI is limited, yet given the high rates of cognitive impairment in SCI, such research is desperately needed. Similarly, problems such as depression and anxiety are commonly present, but empirically-based research describing effective treatments in this population is severely lacking. Depression, for example, while considered the most common psychological consequence of SCI and TBI, has no significant body of literature to suggest an effective treatment for the condition among persons with SCI (Elliott and Kennedy, 2004). Family and other interpersonal relationships are strained following SCI (Elliott and Rivera, 2003) and TBI (Ricker and Regan, 1999), so it is reasonable to assume that a person with a dual-diagnosis would encounter significant problems with social support, intimate relationships and subsequent community integration, yet this has not been empirically examined. Other problems often observed among community-residing persons with SCI, including suicide, decreased leisure and vocational activities, pressure sore occurrence, and other secondary complications, may be more prevalent among persons with dual-diagnoses than observed among persons with SCI who have no measurable cognitive impairment. Identifying the combined medical
sequelae from both SCI and TBI is an important area for research, especially in the acute phases of the injury. Pain, both chronic and acute, can be a consequence of SCI, TBI or both. Interventions for pain management for a person with SCI may be compromised by cognitive deficits. Therefore, pain assessment and intervention research in SCI rehabilitation should take into account possible TBI.

Systematic tracking of cognitive trends and the application of successful interventions following concomitant injury require longitudinal study. While there are large national data sets on both TBI and SCI that provide a great deal of longitudinal data, there is no information in the spinal cord database on cognitive impairment.

Social discrimination is a problem faced by both groups. Social discrimination can affect an individual’s ability to return to the community after injury, including return to work, ability to obtain housing, and general acceptance in social settings. Both the spinal cord injured and traumatically brain injured population have taken advocacy roles in reducing discrimination. It is unclear, however, what effect combined SCI and TBI have on discrimination.

Generally, the literature concerning SCI and concomitant TBI has been plagued by inconsistent means of diagnosing mild to moderate brain injury, and a failure to account for possible brain injuries that may have occurred prior to SCI onset. Behaviors attributed to suspected mild TBI, then, may be related to other long-standing behavioral patterns that predate the SCI. Longitudinal research has yet to found meaningful empirical differences over time between persons with and without loss of consciousness at injury onset, or by level of injury or completeness of lesion (Richards, Brown, Hagglund, Bua, and Reeder, 1988). Consequently, the empirical scrutiny of concomitant TBI and SCI should be a recognized priority in rehabilitation psychology.

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