Chapter 17

Rehabilitation of patients with glioma

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Abstract

Disabling sequelae occur in a majority of patients diagnosed with brain tumor, including glioma, such as cognitive deficits, weakness, and visual perceptual changes. Often, multiple impairments are present concurrently.

Healthcare staff must be aware of the “biographic disruption” the patient with glioma has experienced. While prognostic considerations factor into rehabilitation goals and expectations, regardless of prognosis the treatment team must offer cohesive support, facilitating hope, function, and quality of life. Awareness of family and caregiver concerns plays an important role in the overall care.

Inpatient rehabilitation, especially after surgical resection, has been shown to result in functional improvement and homegoing rates on a par with individuals with other neurologic conditions, such as stroke or traumatic brain injury.

Community integration comprises a significant element of life satisfaction, as has been shown in childhood glioma survivors. Employment is often affected by the glioma diagnosis, but may be ameliorated, when appropriate, by addressing modifiable factors such as depression, fatigue, or sleep disturbance, or by workplace accommodations.

Further research is needed into many facets of rehabilitation in the setting of glioma, including establishing better care models for consistently identifying and addressing functional limitations in this population, measuring outcomes of various levels of rehabilitation care, identifying optimal physical activity strategies, delineating the long-term effects of rehabilitation interventions, and exploring impact of rehabilitation interventions on caregiver burden. The effective elements of cognitive rehabilitation, including transition of cognitive strategies to everyday living, need to be better defined.

INTRODUCTION

Although comprising just 1.4% of all malignancies, brain and other nervous system tumors hold a prominent place in cancer rehabilitation because of their extremely high rate of disabling sequelae, including physical, cognitive, and psychosocial effects (Lehmann et al., 1978). Advances in early diagnosis and treatment have improved survival rates of cancer in general over recent decades (Zeng et al., 2015). While still limited, the improvement is also evident in malignant tumors with origin in the brain and nervous system (Weller et al., 2014). Even in the setting of cure, cancer survivors often face lifelong challenges that hamper their function and quality of life (Burg et al., 2015).

A glioma diagnosis spans a wide range of factors that affect rehabilitation, including variations in neurologic presentation, age, treatment effects, and prognosis.
The incidence of malignant primary brain tumor increases with age, and in adults, survival decreases with more advanced age at diagnosis (Asklund et al., 2014; Howlader et al., 2015). Median age at diagnosis of primary brain tumor is 56 years. However, also of note, brain and central nervous system tumors comprise the most common childhood neoplasm (Ostrom et al., 2014). Among primary brain tumor diagnoses, the most common tumor types vary with age. Embryonal/neuroectodermal tumors and pilocytic astrocytomas are most common in childhood, and meningioma and malignant gliomas are the most common brain tumors among adults (see Chapter 1 and Buckner et al., 2007).

Rehabilitation for patients with glioma incorporates principles derived not just from studies directly examining this group, but rather springs from a broader base, including the brain tumor population as a whole, and, even more pertinently, the greater bodies of neuro-rehabilitation (particularly traumatic brain injury and stroke) and cancer rehabilitation treatment paradigms. Care must be approached in a broad context, addressing physical, cognitive, and psychologic needs. Both restorative and palliative mindsets may need to be spawned, requiring an approach which is both highly personalized and systematic. While rehabilitation inherently centers on optimizing function, other concerns that interface with this care include focus on symptom management, quality of life, social (family, work, etc.) and environmental factors, as well as a knowledge of the underlying medical situation and illness trajectory. Since both the long-term survivor and the individual at end of life will have issues relating to many of the topic areas within this manuscript, we do not separate our content by prognostic category, but rather attempt to weave both points of view in an integrated format.

GLIOMA AND DISABILITY

Life context

Brain tumors affect patients’ well-being at many different levels depending on the localization of the tumor and the patient’s individual circumstances (Vargo, 2011). Physical performance and psychosocial capacity are frequently encumbered, which may result in decreased ability to cope. Close relatives and other supports are put under pressure. The disease and treatment often undermine ability to work and actively participate in daily social interactions (Salander et al., 2000), which may lead to isolation and financial problems and further aggravate grief, affecting not only the patient but the whole family. Impairments related to the tumor itself, surgery, radiotherapy, and chemotherapy can be evident as long-term effects present during treatment and persisting afterwards. Additionally, late-appearing effects can also emerge at various time points after the conclusion of active treatment.

Despite the known disabling sequelae, it is not common for patients with malignant brain tumor to be referred for specialized rehabilitation (Sherer et al., 1997; Locke et al., 2008; Hassler et al., 2010). While this may relate to lack of knowledge, or paucity of routine protocols, another concern relates to the possibility of defeatism among hospital staff, i.e., the poor prognosis makes rehabilitation efforts seem superfluous. However, it is not self-evident that patients themselves share this view. Of course, some patients do become long-term survivors (Asklund et al., 2014). Just as notably, patients affected by diseases with poor prognosis, including malignant glioma, commonly are eager to connect to everyday life. In these cases, hope may be connected to fulfilling life experiences and not to a prospect of cure (Salander et al., 2000). Physical and cognitive rehabilitation may, in the process of addressing functional goals, facilitate coping and quality of life, assisting in overcoming a “biographic disruption” (Bury, 1982).

Those working in the field of neuro-oncology must have an open mind towards these complex needs when meeting patients and families affected by brain tumors. The concept of personalized medicine is just as valid in the process of rehabilitation as it is for tailoring drug treatments. Every affected individual requires personal guidance, including appropriate rehabilitation attention through the whole pathway from diagnosis to end of life, or voluntary end of healthcare system involvement.

Specific impairments

When systematically assessed, potentially remediable rehabilitation needs have been found in more than 80% of central nervous system tumor patients, a higher percentage than seen in any other type of malignancy (Lehmann et al., 1978). Although well-controlled clinical data are limited, the degree of disability is often substantial and for many patients lifelong (Burg et al., 2015). Among brain tumor patients undergoing acute rehabilitation, common impairments have been found to include cognitive deficits (80%), weakness (78%), and visual-perceptual deficits (53%). Multiple concurrent neurologic deficits are also the norm, with the same series of patients, described by Mukand et al. (2001), exhibiting three or more impairments in 75% of cases, and five or more deficits in 39%.

One small study of 38 long-term survivors of low-grade astrocytoma of childhood (Aarsen et al., 2006) found that 61% had residual neurologic or endocrine impairments, and 45% had residual disability, including 10% with severe disability. Motor deficits were seen in 47% and visual field deficits in 31%. Behavioral and
social problems were also common, sometimes becoming evident years later. Internalized social behavior with verbal hypospontaneity was particularly noteworthy in many of the children.

Cognitive changes are important to emphasize (see Cognition section, below). In one study of 68 adult patients undergoing neuropsychologic testing, Hahn et al. (2003) found glioblastoma patients exhibited slower psychomotor speed and more impaired visual tracking than patients with other types of brain tumor. In a large study of 1877 survivors of childhood central nervous system malignancy, among which glial tumors were the most common type (65.7%), survivors of childhood astrocytoma and glial tumors showed impaired cognition, especially attention, processing speed, and memory, related to cranial radiation dose (Armstrong et al., 2009).

Regarding pediatric brain tumor, besides radiation therapy, which across studies appears to be the most consistent predictor of impaired intellectual outcomes, other factors associated with relatively poorer cognitive status include younger age at diagnosis, tumor size in the cerebral hemisphere, and hydrocephalus treated with shunt (Reimers et al., 2003). In general, survivors of childhood brain tumor are more likely to have adverse outcomes in employment (deBoer et al., 2006), are more likely to experience long-term disabling sequelae, and more likely to be living in their parental home as adults (Hjern et al., 2007) compared to controls and compared to survivors of other types of cancer.

**ADVERSE TREATMENT EFFECTS**

**Surgery**

In the setting of underlying or recurrent malignancy and recent craniotomy, patients often emerge with significant functional deficits. Symptom control (pain, sleep, fatigue) and supportive medical management needs (thromboembolic prophylaxis, anticonvulsant management, nutrition) also may be heightened during this period. An inpatient rehabilitation admission to restore function and symptom control to a level that permits homegoing is often indicated (Bartolo et al., 2012) (see Inpatient Rehabilitation section, below).

**Radiation therapy**

Radiation encephalopathy can be divided into acute (onset days to weeks) early delayed (1–6 months after completion of therapy), or late delayed (>6 months) forms (Greene-Schloesser et al., 2012). While risk has decreased with modern protocols, rehabilitation specialists need to consider radiation effects in the differential diagnosis of patients’ decline or lability in performance during care. With acute radiation encephalopathy, symptoms include headaches, decreased alertness, and worsening of existing focal symptoms. These symptoms are generally more frequent and severe in individuals with increased intracranial pressure (Dropcho, 2010), responding to increase in corticosteroid dosing (Lee and Westcarth, 2012). Patients with early delayed encephalopathy, which is related to demyelination from radiation injury to the oligodendrocytes, develop a somnolence syndrome, which is typically reversible, with recovery usually aided by corticosteroids. A syndrome of “pseudoprogression” has also been described in up to 25% of glioblastoma patients with recent radiation therapy and concurrent daily temozolomide therapy, in which the tumor appears larger or brighter on imaging, as a posttreatment effect, sometimes associated with transient clinical worsening (Dropcho, 2010). Distinguishing from tumor progression can be challenging. Late delayed encephalopathy includes focal necrosis that can be life-threatening and occurs after high doses of radiation, affecting 10–15% of glioblastoma or anaplastic glioma patients surviving more than a year after diagnosis (Dropcho, 2010). Vascular abnormalities are usually seen, and damage is thought to be related to dynamic interactions between multiple cell types in the brain, including astrocytes, microglia, endothelium, and neurons, with proinflammatory changes, and eventual neuronal damage related to oxidative stress (Greene-Schloesser et al., 2012).

On a more chronic basis, cognitive changes occur in up to 50–90% of adult brain tumor patients who survive >6 months postradiation, occasionally progressing to dementia with progressive memory loss, ataxia, and urinary incontinence (Greene-Schloesser et al., 2012). In one study, examining performance on various neuropsychologic testing batteries in 57 primary brain tumor patients, 18 of whom had glioblastoma or anaplastic glioma, radiation to the corpus callosum, left frontal white matter, right temporal lobe, bilateral hippocampi, subventricular zone, and cerebellum predicted cognitive changes. Regions that did not predict global cognitive outcomes at any dose included frontal pole, anterior cingulate, right frontal white matter, and the right precentral gyrus (Peiffer et al., 2013). Children are highly vulnerable to developing chronic cognitive changes after radiation therapy, and in fact the greatest risk is in the very young, especially before age 3, as well as in patients older than age 5 (Dropcho, 2010).

Currently there are no available biomarkers to predict vulnerability to postradiation cognitive changes. Areas of investigation into therapeutics with potential to prevent or ameliorate radiation-induced cognitive changes include anti-inflammatory agents, angiotensin-converting enzyme inhibitors, angiotensin type-1 receptor blockers,
and stem cell therapies. On a symptomatic level, there is some limited favorable data on use of stimulants such as methylphenidate (Greene-Schloesser et al., 2012). There have been reports of improvement with other agents, including pentoxyfylline, warfarin, and vitamin E (Lee and Westcarth, 2012). Recently, in a phase III trial, Rapp et al. (2015) proposed that the neurotransmitter modulator donepezil improves some cognitive function domains in patients undergoing cranial irradiation for brain tumors. Improvements were greater in patients with greater baseline cognitive impairment. Donepezil is a reversible inhibitor of acetylcholinesterase that has direct effects on neuronal function.

Chemotherapy and corticosteroid complications

Although temozolomide, part of routine management in the treatment of high-grade glioma, is relatively well tolerated, adverse effects, in addition to hematologic effects, can include fatigue, constipation, and headache, which themselves may require supportive management. While generally not dose-limiting, fatigue has been reported as the most common side-effect, occurring in more than 50% of individuals (Thomas et al., 2013). Studies of antiangiogenic agents, such as the anti-vascular endothelial growth factor antibody bevacizumab, have shown relatively low frequencies of side-effects; however, the survival benefit is limited and the long-term effects are not known (Chinot et al., 2014; Gilbert et al., 2014).

Symptomatic corticosteroid myopathy occurs in about 10% of brain tumor patients receiving dexamethasone for more than 2 weeks, with two-thirds of patients having onset between weeks 9 and 12 (Dropcho and Soong, 1991). Corticosteroid myopathy is most common in the elderly and when prolonged use of high doses is required (Wen et al., 2006). In the authors’ experience, corticosteroids are sometimes overused in clinical management. Because electrodiagnostic and laboratory findings tend to be nonspecific, it may be difficult to distinguish from other etiologies of weakness, especially deconditioning.

A FACILITATING ENVIRONMENT IN THE DISEASE CONTINUUM

The patient–physician relationship

The patient–physician relationship is rarely regarded as a psychologic intervention per se. However, it bears great impact on the psychologic well-being of brain tumor patients and carers, especially as the physician is the “structure of hope” (Salander et al., 1996). In psychosocial oncology literature, the physician as communicator of information is emphasized, and there are numerous published papers based on questionnaires that conclude that it is in the interest of patients to know “everything,” and that patients also want to know everything (Fallowfield and Jenkins, 2004). Studies more naturalistically designed, however, arrive at more complex conclusions: people with cancer do not necessarily wish to know all information or they wish to have it paced while accentuating context (Innes and Payne, 2009; Salmon et al., 2012).

It is undoubtedly the physician’s duty to communicate the essentials in the severe situation, i.e., diagnosis, treatment, and some words about the future. The last part is the tricky part. A balancing act exists between erring on the side of being too muddled or giving false prospects on the one hand, and being too precise (prognosis in months) and causing possible demoralization on the other, with an injurious effect on the patient’s chance to live the rest of his/her life in a meaningful way. While avoiding inaccurate information, the physician can be a “facilitating environment” for the patient’s own “hope work” (Perakyla, 1991). It is up to the physician to facilitate this process by communicating in a way that gives sufficient mental space for the patient to elaborate the serious facts about the new life situation (Salander et al., 1996). This position concerning the provision of information is confirmed by a review showing that patients with malignant glioma vary considerably in their awareness of the severity of their illness, and not all patients want to know the full facts of their prognosis (Davies and Higginson, 2003). As the disease progresses, patients often move from wanting to know and then not wanting to know (Halkett et al., 2010).

Enabling the hope work is part of providing the patient with a helping relationship. As noted previously, due to the impact on the patient’s life the brain tumor may be experienced as a significant “biographic disruption” in daily life (Bury, 1982). From studies in other malignancies, we have learned that healthcare characterized by closeness, continuity, competence, and coordination, i.e., constituted as a closely connected system, can be experienced as a secure base, i.e., a “helping system” for patients to rely on (Lilliehorn et al., 2010; Isaksson et al., 2014).

The rehabilitation team

The rehabilitation team conventionally includes the physiatrist, rehabilitation nurse, physical and occupational therapist, speech pathologist, rehabilitation psychologist, and social worker or case manager, with availability of other services such as nutrition and respiratory therapy. To provide the best care for patients with glioma, a strong collaborative relationship with neuro-oncology staff, and, sometimes, palliative care specialists, is essential.
In the rehabilitation setting, the biographic disruption described above is confronted and negotiated. Rehabilitation focuses on restoring or, in many patients, supporting function, and addressing safety, comfort, and quality of life, to help the patient re-establish the best possible normal living routine. Mobility and self-care strategies include gait training, balance and fall prevention, strengthening and reconditioning, stretching, energy conservation techniques, and compensatory approaches for visual or other perceptual deficits. Equipment needs should be evaluated, including potential utility of assistive devices (cane, walker, or wheelchair), orthotics, and home adaptive equipment for safety. Deficits in cognition, speech, language, and swallowing are addressed, as are nutrition, skin integrity, and bowel and bladder function. Unrelated to the brain tumor or as a secondary complication, there may be musculoskeletal pain disorders that also need attention (Silver and Gilchrist, 2011). The physiatrist coordinates an individualized treatment regimen, including the rehabilitation therapies mentioned, adjunctive medications (as for pain control, sleep, cognitive symptoms), and other interventions. The rehabilitation psychologist specializes in adjustment to disability strategies and, when appropriate, can be consulted for neuropsychologic evaluation.

During rehabilitation, issues commonly arise regarding the patient’s processing and understanding of the brain tumor diagnosis. The impact of neurologic deficits on daily living becomes more deeply realized, and the new reality settles in. The patient usually has considerable one-on-one treatment time with rehabilitation staff, engendering discussion. As a result of these factors, questions often arise about difficult issues, such as prognosis or long-term functional changes. During the initial stage of care, some of this information may already have been provided, but the patient was not yet able or ready to absorb it. Or, some of these challenging long-term issues may naturally become clearer as time progresses, while the patient is in the midst of rehabilitation. The above-noted (see previous section) communication issues, including individual patient differences in ability and readiness to hear difficult information, can also remain a significant dynamic, towards which rehabilitation staff should be sensitive. Excellent trust and communication between neuro-oncology and rehabilitation staff is crucial so that patients can be optimally supported in addressing these complex questions.

The patient–spouse relationship

Family and caregiver needs must also be addressed, with concerns including dealing with family issues (changing roles and relationships, financial concerns, and patient need for assistance), managing challenging behaviors, dealing with personal feelings, and navigating through the medical system, including communicating with the physician and understanding the system of care (Schubart et al., 2008). With patients immersed in treatment and their “hope work,” their spouses are standing aside, resulting in the possible development of their own crisis trajectories. The brain tumor has a significant impact on the everyday life of the spouse and the family, inevitably influenced by the patient’s functional and mental status (Salander, 1996). Families provide comfort and assistance in the continuum from diagnosis to a new everyday life, facilitating the patient’s “biographic repair” (Wideheim et al., 2002). At the time of diagnosis the relationship may be characterized by “closeness”; later on, as the disease progresses, it may be characterized by “changed mutuality” and even a “loss of mutuality.” A healthy partner may, sooner or later, find him/herself living with a person who, due to cognitive decline and personality change, is no longer experienced as the same. The change may be dramatic but also subtle as a loss of a deeper dimension in the relationship. Others beside the spouse may not detect this subtle change, and the spouse may therefore feel left alone (Salander, 1996).

Spouses are more than supporters to a diseased partner. They are their own persons in a difficult life situation, with their own prospects for the future. Compared to their partners, they are more eager to know “what comes,” i.e., prognosis (Horowitz et al., 1996; Davies and Higginson, 2003). It has been suggested that spouses should have physician contact for themselves as a part of developing a “mental platform” of their own (Salander, 1996). As will be shown below, a specialist nurse can be given a similar function.

A specialist nurse

Due to the devastating character of malignant brain tumor and its psychosocial impact, in some systems specialist nurses have been implemented in order to bridge the gap between the family and healthcare, assuming a key role in “the helping system.” There are different kinds of specialist nurses in neuro-oncology, the most common being nurse-led telephone follow-up of patients (Sardell et al., 2000), but other specialist nurses assume a broader focus, contacting carers as well as the patients (Curren, 2001), or having face-to-face interactions with the patient and family, including accompanying them to their healthcare appointments (Spetz et al., 2005, 2008).

Despite differences in designs of the specialist nurse function, evaluations consistently evidence a high level of satisfaction. More importantly, in clinical reality, patients and carers make extensive use of the nurse specialist and, when doing so, raise important questions.
relating to both biomedical and personal matters (Curren, 2001; Spetz et al., 2005, 2008). The majority of contacts relate to informational questions, primarily concerning treatment and side-effects. It is also worth noting that the number of calls between nurse and carer was far more than the number of contacts between nurse and patient (Curren, 2001; Spetz et al., 2008). Supportive care needs of people with brain tumors and their carers involve dimensions that can be provided by a specialist nurse function: dedication, accessibility, and proactive information (Janda et al., 2006; Spetz et al., 2008).

**REHABILITATION SETTINGS**

**Inpatient rehabilitation**

For brain tumor patients exhibiting significant disability, especially after surgical resection, studies have consistently shown that brain tumor patients in acute rehabilitation settings make comparable functional gains, as do patients undergoing rehabilitation for other brain disorders such as stroke or traumatic brain injury (O’Dell et al., 1998; Huang et al., 1998; Greenberg et al., 2006; Geler-Kulcu et al., 2009). In the USA, medical necessity for acute inpatient rehabilitation is supported if an individual requires interdisciplinary rehabilitation therapies (at least one of them being physical or occupational therapy), can participate in 3 hours a day of such therapies at least 5 days a week, and requires the supervision of a rehabilitation physician, and an intensive, coordinated interdisciplinary team approach (Inpatient Rehabilitation Facility Prospective Payment System, 2013).

In general, patients with brain tumor have comparable or shorter length of rehabilitation stay and comparable rate of discharge to the community, compared to individuals undergoing rehabilitation for stroke or traumatic brain injury. Concurrent radiation therapy has been reported as being associated with better (Marciniak et al., 1996), worse (O’Dell et al., 1998), or no different (Tang et al., 2008; Roberts et al., 2014) outcomes. Concurrent chemotherapy has not been shown to affect rehabilitation outcomes (Tang et al., 2008; Roberts et al., 2014). The initial course of acute rehabilitation is likely to demonstrate better functional gains than a repeat admission (Marciniak et al., 2001). Some studies have shown significant improvement in motor but not cognitive function, as measured via the Functional Independence Measure, or FIM (Kidd et al., 1995; Garrard et al., 2004; Tang et al., 2008; Fu et al., 2010), possibly influenced by the fact that medical necessity criteria for acute rehabilitation favor individuals with motor impairments, though some studies have shown significantly improved cognitive performance too (Marciniak et al., 2001; Roberts et al., 2014). Rehabilitation outcomes are generally comparable between those with malignant vs. benign brain tumor, and those with primary vs. metastatic brain tumor (Marciniak et al., 2001; Tang et al., 2008). This is likely because care needs related to surgical recovery often predominate at this point in the clinical trajectory, rather than long-term prognostic factors.

One study, conducted in the rehabilitation unit of a cancer center, found longer length of stay and greater total functional gains in patients with high-grade astrocytoma compared to patients with low-grade astrocytoma undergoing acute rehabilitation, though there was no significant difference in FIM efficiency (functional gains per unit of time) (Fu et al., 2010).

Rates of discharge to home are high across virtually all studies. Possible reasons, compared to individuals with traumatic brain injury, generally speaking, include strong social supports, aggressive focus on discharge planning because of prognosis, and likely favorable behavioral profile (Kirshblum et al., 2001).

But cancer rehabilitation patients, including those with brain tumor, have a higher incidence of interrupted stay (transfer back to acute care, usually unplanned), typically ranging from 25% to 35% (Marciniak et al., 1996; Alam et al., 2008), whereas usual rates for rehabilitation patients hover around 10–12% (Alam et al., 2008). Infection (Alam et al., 2008) and neurosurgical complications (Asher et al., 2014) have been reported as common reasons for transfer back to acute care, with associated factors of low functional status (FIM score <35/126), feeding tube, or modified diet (Asher et al., 2014). Malignant compared to benign brain tumor status has not been found to affect risk of interrupted stays (Alam et al., 2008). Presumably, as with outcomes, in this inpatient rehabilitation phase of care, the recent neurosurgical intervention and overall neurologic severity predominate, rather than long-term prognosis.

Recent studies have raised the possibility of survival advantages related to rehabilitation. Tang et al. (2008) found that higher functional gain during acute rehabilitation, as well as lower initial corticosteroid dose, were predictive of longer survival in patients with glioblastoma as well as those with brain metastases. Roberts et al. (2014) reported significant functional gains, especially with mobility, in glioblastoma patients receiving acute rehabilitation, and similar survival as those who did not receive rehabilitation, speculating that a survival advantage could have been conferred, as the inpatient rehabilitation patients received rehabilitation due to their lower functional status (baseline Karnofsky scores of 70.5 in the rehabilitation group compared to 80.8 in the nonrehabilitation group).

Gaps in the literature include incomplete understanding of the glioma population specifically, lack of long-term follow-up beyond several months (Huang et al.,
noted to safeguard the clinical validity and relevance of the findings (Salander, 2010).

A recent Cochrane review concluded that there is need for high-quality research to explore the effectiveness of multidisciplinary rehabilitation in brain tumor care (Khan et al., 2013). Limitations of existing data were noted to be lack of randomized or case-controlled studies, lack of comparison of different settings or intensities of care, and lack of assessment of longer-term outcomes (participation, quality of life), cost benefits, or caregiver burdens or needs.

**Outpatient rehabilitation**

Functional outcomes among outpatients with brain tumor have not been as systematically described as for acute rehabilitation settings, in part because of the lack of standardized metrics and databases, such as the FIM, that exist for inpatient rehabilitation. In one study, the Barthel index was a useful measure of functional status among outpatients undergoing radiation therapy, correlating with the Karnofsky performance score and showing prognostic value in terms of survival (Brazil et al., 1997). Compared to inpatient rehabilitation, care may be less focused on global status, and rather target specific domains such as cognition, communication, strength, or balance. Progress can be monitored at the impairment level by neurologic examination, range of motion, and strength testing, including grip dynamometry. Function can be further assessed and monitored by tools related to specific domains. Comprehensive review is beyond the scope of this chapter but can include assessments such as the Berg Balance Score (Berg et al., 1992) for balance, the Montreal Cognitive Assessment (MoCA) (Nasreddine et al., 2005) for mild cognitive dysfunction, Disabilities of the Arm Shoulder and Hand (DASH) (Hudak et al., 1996) for upper-limb function, and the Motor-Free Visual Perceptual Test (MVPT) (Colarusso and Hammill, 2003) for visual-perceptual function (see Cognition section, below, for further discussion). Quality-of-life tools, which typically include some content items related to functional status and to symptoms, may be employed, such as Functional Assessment of Cancer Therapy (Weitzner et al., 1995) and the European Organization for Research and Treatment of Cancer quality of life questionnaire (EORTC QLQ), both of which have brain subscales, and the M.D. Anderson Symptom Inventory Brain Tumor Module (MDASI-BT), which are of potential utility in identifying or monitoring rehabilitation needs (Taphoorn et al., 2010).

In a small series of 13 patients who underwent outpatient rehabilitation, a mean time of 75 months after diagnosis of primary malignant brain tumor treated with surgical resection, radiation, and chemotherapy, 6 subjects demonstrated increased independence (decreased need for assistance or supervision), and 8 subjects demonstrated increased productivity (avocational, educational, or work status), per a rating scale that was developed for each category (Sherer et al., 1997). In a more recent study of outpatient rehabilitation for patients with malignant brain tumor, significant improvements were seen, especially with mobility, as measured by the DayROS tool, which showed higher sensitivity than the Disability Rating Scale (Shahpar et al., 2014).

Functional gains have also been found with home-based rehabilitation among 39% of a series of 121 patients with malignant brain tumor (including 62 glioblastomas), at an intensity of 1 hour, three times a week, for 3 months, as measured by the Barthel index (Pace et al., 2007).

**Vocational rehabilitation**

Per analysis of 1433 American cancer survivors 1–5 years after diagnosis, survivors of brain tumor and other neurologic system malignancies are less likely to be working than other cancer survivor groups (odds ratio, 2.2 for unemployment) (Short et al., 2005). Job loss occurs earlier than with most other forms of cancer (Park et al., 2008). Per Finnish Cancer registry data from 12,542 cancer survivors, 45% of those with history of central nervous system malignancies were employed 2–3 years after diagnosis, as opposed to 69% of age- and sex-matched controls (Taskila-Abrandt et al., 2004).

US Childhood Cancer Survivor Study data indicate that nearly 32% of adult survivors of pediatric central nervous system cancers report functional impairments, such as need for help with personal care, instrumental activities of daily living, or disability interfering with work or school. The odds ratio of 18 for functional impairment compared with siblings represents the highest percentage seen in survivors of any type of malignancy (Ness et al., 2005). In a meta-analysis examining data from 34 studies inclusive of 12 nations, childhood brain tumor survivors have been found to be five times less likely to be employed than healthy controls, with predictors of unemployment among childhood cancer survivors, including younger age at diagnosis, lower education or intelligence quotient, female gender, motor impairment or epilepsy, and radiation therapy history (DeBoer et al., 2006). Among employed childhood cancer survivors, those with history of brain tumor and those with history of cranial radiation are less likely to be employed in professional occupations than other survivors (Kirchhoff et al., 2011).
One study examining life satisfaction in young adult survivors of childhood central nervous system tumors (18% of patients with history of astrocytoma) found that, while employment was a significant predictor of life satisfaction, community integration, measured by the Community Integration Questionnaire, was an even stronger predictor (Strauser et al., 2012). Factors that can affect vocational outcomes include underlying health and demographics, symptoms, functional deficits, work demands, and work environment (Feuerstein et al., 2010). While paradigms to integrate return to work into cancer care have been proposed, these efforts are not widespread, and have not been specifically focused on brain tumor patients (Chan et al., 2008; Feuerstein et al., 2010; Tamminga et al., 2010; Munir et al., 2013), who often experience dual challenges, relating to disability and prognosis.

But life after treatment for malignant glioma can be considerably varied. By introducing the concept of “time of everyday life” and “time of disease” it was shown in a small study that, for a third of patients, life continuity was lost, experiencing only “time of disease.” Among others who were judged to experience “time of everyday life” and who were of working age, nearly two-thirds were able to resume work or studies on a parttime basis. Including all patients, the mean “time of everyday life” turned out to be almost equal to “time of disease” – 6.1 and 5.4 months, respectively (Salander et al., 2000). In a study of 95 working adults with malignant brain tumor, higher levels of work limitations and time off work were reported compared to a control group without chronic disease. Factors associated with work limitations included depressive symptoms, fatigue, cognitive limitation, sleep changes, and negative problem-solving orientation. The authors concluded that modifiable factors accounted for most of the variance in work limitations (Feuerstein et al., 2007). Attention to symptom management and workplace flexibility is important in maximizing success with employment for cancer survivors in general (Pryce et al., 2006).

**EXERCISE AND FITNESS**

While research to date has demonstrated consistent benefits of physical activity for cancer patients and survivors (Ballard-Barbash et al., 2012; Singh et al., 2013; Buffart et al., 2014), brain tumor survivors have received only limited attention. As a consequence of both the disease and the treatment, cancer survivors have a hampered physical capacity related to reduced cardiopulmonary fitness, reduced muscle mass and strength, increased fat mass, reduced bone health, and fatigue. This is also evident for brain tumor patients. For example, pediatric posterior fossa tumor survivors have been found to be less fit than children with pulmonary disease and healthy controls and approximately as fit as survivors of other types of childhood cancer. Reduced fitness may be related to late effects of diagnosis and treatment, including cardiovascular, endocrine, psychologic, and neurocognitive difficulties, and clearly emphasize the need for cardiorespiratory fitness strategies in this group of survivors (Wolfe et al., 2012).

Studies of cancer survivors have consistently shown reduced cardiopulmonary capacity, including reduced peak oxygen uptake, compared to healthy controls. Exercise during and after cancer treatment is associated with improvement in oxygen uptake, compared to non-exercise controls. In addition to cardiopulmonary conditioning, optimal exercise aims for reduction of muscle wasting and fat mass, factors known to be associated with decreased responsiveness to cancer treatment, poor prognosis, and increased morbidity and mortality (Lustberg et al., 2012; Steins Bisschop et al., 2012; Strasser et al., 2013). The positive value of exercise for cancer patients is evident for the whole pathway during the disease – pretreatment, during and after treatment, as well as in the palliative setting (Ballard-Barbash et al., 2012; Singh et al., 2013; Buffart et al., 2014). Several studies have shown an improved disease-free and overall survival. Even reduced hospital length of stay, an important prognostic marker for a positive surgical outcome, has been suggested.

The beneficial effects of physical activity have also been proposed for patients with brain tumors. Exercise behavior was shown to be a strong independent predictor of survival that provides incremental prognostic value to the Karnofsky performance score as well as traditional markers of prognosis in malignant recurrent glioma (Ruden et al., 2011). Recently, decreased risk of brain tumor mortality has been reported in association with running and walking (Williams, 2014).

In one study, investigating exercise preferences (Jones et al., 2007) in brain tumor patients who had predominantly anaplastic astrocytoma or glioblastoma diagnoses, individuals were much more open to exercise after than during treatment (84% vs. 47%), walking was the preferred form of exercise both during and after treatment (51–53%), and home was the preferred site for exercise. Therefore, developing realistic home exercise programs, or exploring alternative settings that will be reasonable and appealing, are needed approaches.

Physical activity is particularly important for individuals receiving corticosteroids, as physical exercise is the main treatment for corticosteroid myopathy (Wen et al., 2006). Resistance and endurance exercise training has been found to significantly reverse muscle atrophy and weakness in noncancer clinical populations treated with corticosteroids (Horber et al., 1985; Czerwinski et al., 1987; Hempen et al., 2002).
Expert organizations, like The American College of Sports Medicine (Schmitz et al., 2010), American Cancer Society (Kushi et al., 2012), and British Association of Sport and Exercise Science (Campbell et al., 2011), have recommended that exercise should be a part of the standard of care for all cancer survivors provided that general condition allows it. Recommendations include at least 150 minutes per week of moderate-intensity or 75 minutes per week of vigorous-intensity aerobic physical activity, or an equivalent combination of both. Muscle-strengthening activities of major muscle groups are recommended for at least two sessions per week. Precautions should be incorporated when appropriate for issues such as shoulder problems, or risk of skeletal fractures, falls, seizures, bleeding, or infection.

The recommendations above are still rather generic, and additional research is needed to develop optimal exercise approaches for patients with brain tumor. Until shown otherwise, the evidence basis consistently documenting benefits of exercise for cancer patients in general is presumably applicable to brain tumor survivors.

**MANAGEMENT OF SPECIFIC COMPLICATIONS AND SYMPTOMS**

While exhaustive coverage of the topic areas below is beyond the scope of this discussion, the sections below highlight management of common clinical issues that interface with rehabilitation care of the patient with glioma.

**Fatigue**

Cancer-related fatigue is the most common side-effect or late effect of cancer and its treatment (NCCN, 2013), and is present in >80% of individuals receiving cranial radiation (Armstrong and Gilbert, 2012). At a basic level, fatigue may be approached as peripheral or central, depending on whether it is activity-dependent or independent. Fatigue mechanisms remain poorly understood but are considered to relate to energy balance (such as cardiac, pulmonary, hematologic, skeletal, nutritional effects), stress (with fatigue in the middle of a reactive continuum between tiredness and exhaustion) and neuroendocrine status (effects on the hypothalamic–pituitary axis, circadian rhythms, serotonin regulation, vagal afferent nerve activation, and cytokine regulation) (Wang, 2008; Mitchell, 2010). Hybrid models (Wang, 2008), including interactions of cognitive function, sleep, nutrition, and muscle endurance, have also been described. Specifically in the setting of brain tumor, inflammation related to cranial radiation is thought to play a role in fatigue (Armstrong and Gilbert, 2012).

There is much overlap between measures to treat fatigue and those to promote optimal cognitive function (especially attention) and sleep. On a practical level, the approach entails a multifaceted analysis, assessing for deconditioning, endocrine-metabolic abnormalities, infection, anemia, depression, sleep disturbance, nutritional factors, and treatment adverse effects, including chemotherapy, radiation, and drug (pain, anticonvulsant, psychoactive agents) effects (Franklin and Packel, 2006). Recently fatigue was shown to be a strong independent predictor of survival that provides incremental prognostic value to the traditional markers of prognosis in recurrent high-grade malignant glioma (Peters et al., 2014).

Multiple approaches can be used to counteract cancer-related fatigue, including physical activity, psychosocial interventions, and pharmacologic treatment. Physical training has been studied extensively in other forms of cancer and has shown moderate effects when focused on improving muscle strength and endurance (Cramp and Daniel, 2008). Increasingly, complementary and alternative medicine strategies are also being explored. Adequate fluids and dietary protein should be encouraged.

A Cochrane review reported moderate effects of psychosocial interventions in decreasing cancer-related fatigue (Goedendorp et al., 2009). Patients can receive education, including anticipatory guidance, tailored recommendation for exercises, sleep and rest, energy conservation, supportive counseling, and formal cognitive behavioral therapy for sleep, pain, or mood (Wang, 2008; Armstrong and Gilbert, 2012).

The effects of pharmacologic interventions remain controversial, and treatment approaches have included medications to optimize sleep, mood, and pain control. Medications that may be aggravating fatigue should be changed or discontinued, when possible. While data are not entirely consistent, favorable effects have been noted with psychostimulants, especially methylphenidate (Minton et al., 2008) for cancer-related fatigue (Evans and Lambert, 2007; Armstrong and Gilbert, 2012). However, side-effects such as insomnia and increased blood pressure may limit tolerance. Selective serotonin uptake inhibitors and other medications have been studied in small studies, with inconsistent findings (Wang, 2008).

Proposed complementary and alternative medicine strategies include supplements (L-carnitine, or ginseng) (Finnegan et al., 2013), acupuncture, yoga, healing touch, reiki, massage, and mindfulness-based stress reduction (Wang, 2008; Finnegan et al., 2013).

The need persists to find a comprehensive model in optimally describing cancer-related fatigue. These efforts must include basic research and development of treatment strategies, including both prevention and rehabilitation paradigms.
On a separate note, Radbruch et al. (2008) raise the idea that fatigue may offer “protection and shielding from suffering” at end of life, and that aggressive treatment of fatigue in that setting may be inadvisable.

Motor and sensory impairments

Focus of therapy includes strengthening, safety, deficit awareness, and prevention of secondary complications, such as contracture of the shoulder, ankle, or other joints. Bracing, assistive devices, or home equipment may be needed, and can be assessed by physical and occupational therapists. Spasticity management includes stretching, therapeutic heat or cold, positioning, oral medications, and use of botulinum toxin, or even, in some cases, baclofen pump. Virtual-reality programs have been shown to augment conventional occupational therapy in restoring arm dexterity in individuals with brain tumor (Yoon et al., 2015). Dysesthetic pain may be ameliorated by measures including adjunctive medications (often anticonvulsant or antidepressant medications), or, if focal enough, transcutaneous electric nerve stimulation unit or nerve blocks. Psychologic strategies to help pain coping may also be of benefit.

Sleep disturbance

In the setting of brain tumor, especially brain radiation, it has been postulated that neuroinflammation leads to variation in endogenous melatonin production and aberrant central molecular clock activity, with excessive daytime sleepiness and nighttime insomnia (Armstrong and Gilbert, 2012). Corticosteroids have also been associated with prolonged sleep onset, and decreased sleep duration and efficiency (Zhao et al., 2013).

Basic nonpharmacologic approaches include maintaining a conducive environment, avoiding noise and nighttime interruptions. Comorbidities interfering with sleep should be addressed, including depression, anxiety, pain, infection, night sweats, and metabolic, bladder, or bowel disturbance. Stimulant substances may produce insomnia, or medications producing excessive daytime sedation, such as many anticonvulsants, antidepressants, antihistamines, and antihypertensives, may interfere with nighttime sleep. Evaluation for sleep-disordered breathing should also be considered (Greenwald and Lombard, 2011). Some common sedatives should be used with caution in individuals with brain disorders. For example, benzodiazepines may cause daytime hangover, posing fall risk, memory impairment, and paradoxical agitation. Antihistamines have anticholinergic effects that are particularly disadvantageous in the setting of neurocognitive impairment (Greenwald and Lombard, 2011). Commonly used agents include trazodone, zolpidem, melatonin, eszopiclone, ramelteon, and zaleplon (Greenwald and Lombard, 2011; Armstrong and Gilbert, 2012).

Cognition

Brain tumor patients may benefit from cognitive or sometimes even formal neuropsychologic assessments – knowing the capacity may facilitate adjustment (Janda et al., 2006) and long-term planning. For childhood brain tumor survivors, due to high incidence of neurocognitive sequelae, which are sometimes delayed, prospective monitoring has been advocated (Packer et al., 2003). Of the 12 cognitive subtests of the Repeatable Battery for the Assessment of Neuropsychological Status, one study found that four subtests (Figure Copy, Coding, List Recognition, and Story Recall) captured 90% of the impaired subgroup among patients with glioma (Lageman et al., 2010).

In order to test the effectiveness of early cognitive rehabilitation for inpatients affected by primary brain tumors, 58 out of 109 consecutive patients were randomly assigned to a rehabilitation group or to a control group. The rehabilitation consisted of 16 1-hour individual sessions of therapist-guided cognitive training, spread over 4 weeks, combining computer exercises and metacognitive training. Patients in the control group received usual care without cognitive training. All patients were evaluated by means of a comprehensive neuropsychologic battery at admission and after 4 weeks. Patients in the rehabilitation group showed a significant improvement of cognitive functions, especially evident in visual attention and verbal memory compared to the control group (Zucchella et al., 2013).

Furthermore, in a comprehensive randomized trial including 140 patients with gliomas, salutary effects were seen on short-term cognitive complaints, and on longer-term cognitive performance and mental fatigue, especially in younger patients. The intervention incorporated attention retraining as well as instruction in compensatory strategies for attention, memory, and executive functioning. The study was based on both subjective assessment of cognitive status and use of a battery of various neuropsychologic tests (Gehring et al., 2009, 2011).

In addition, few and rather small studies of cognitive strategies such as problem-solving and calendar skills have been conducted in adults, with no clear consensus (Locke et al., 2008). A comprehensive single case study of a glioma patient, focused on rehabilitation of working memory, which specifically included an “ecologic rehabilitation” component, incorporating simulations of real-life situations, showed promising results (Duval et al., 2008). Patients with malignant gliomas have been shown to have a preserved capacity to use
visual imagery to boost memory performance (Salander et al., 1995).

Despite some favorable findings, the question of how to achieve sustained cognitive benefits which effectively translate to everyday living remains. Due to methodologic challenges and problems, future research should be aimed at clarifying the effectiveness of neurocognitive rehabilitation (Gehring et al., 2010), including patient characteristics that predict neuropsychologic improvement, identification of the most effective elements in rehabilitative programs, and study of the effects of treatment extension to everyday life. More consistently defined and widespread intervention paradigms are also needed (Castellino et al., 2014).

Among the pharmacologic options used for cognitive dysfunction, methylphenidate has been best studied. Benefits on cognitive testing parameters were seen in a study of 30 malignant glioma patients employing testing pre- and postmedication, but without a control group (Meyers et al., 1998). A randomized controlled study among pediatric cancer survivors, most of whom had brain tumor diagnoses, found significant improvement in a rating of sustained attention in the methylphenidate group, as well as caregiver report of increased attentional ability (Thompson et al., 2001). A later study by the same group found that both parent and teacher ratings indicated significant improvement with methylphenidate on an attentional rating scale, and by teachers on a social skills rating scale (Mulhern et al., 2004) (see Radiation Therapy section, above, for additional discussion of pharmacologic strategies).

Exercise deserves further study due to benefits on cognitive function in groups including healthy older adults (Asher, 2011), Alzheimer’s disease (Baker et al., 2010), and traumatic brain injury (Devine and Zafonte, 2009).

**Depression**

Major depression is common in patients attending cancer clinics, and many with major depression go untreated (Sharpe et al., 2014). However, as suggested from a well-performed study, major depression can be treated effectively, even in patients with a poor-prognosis cancer (Walker et al., 2014).

Depression may be detected in various ways, such as scoring on self-rating scales, or assessed in clinical interviews. Due to these and other methodologic differences, the prevalence of depression among patients with brain tumors varies, with a median of 15% in studies based on clinical interviews, and 27% in studies based on rating scales, the former estimation probably being more valid (Rooney et al., 2011). The prevalence in population studies is 2–5% (Ayuso-Mateos et al., 2001).

Diagnosing depression in brain tumor patients is complicated, as most signs of a depressive syndrome may also be signs of the biomedical tumor process or treatment. Furthermore, the understandable sadness due to a radically changed life situation is common, and must be differentiated from clinical depression requiring active treatment. The common treatments for clinical depression are antidepressants and psychotherapy (National Institute for Health and Clinical Excellence, 2009). As antidepressants have a variety of side-effects, including potential neurologic side-effects, and as there is a lack of prospective study in gliomas evaluating the risk/benefit of the treatment, cautious prescription with close follow-up is recommended (Rooney et al., 2014). Bupropion and clomipramine should be avoided because of their effect of lowering the seizure threshold (Alper et al., 2007). We must also keep in mind that most patients with gliomas deal fairly well with their vulnerable situation. The supportive framework of the “helping system” may be sufficient (Lillichorn et al., 2010; Isaksson et al., 2014).

**Seizures**

The reader is referred to Chapter 16 for discussion of seizure management in the setting of glioma. Anticonvulsant management commonly interfaces with rehabilitation in that these agents may have cognitive side-effects (Klein et al., 2003). Slow-growing tumors are most epileptogenic, with epilepsy seen in up to 90% of patients with low-grade gliomas (van Breemen et al., 2007). With the low-grade nature of the lesions, these individuals may be dealing with such side-effects for a long period of time. Due to multidrug resistance or loss of receptor sensitivity, more than one agent may be required to control seizures (van Breemen et al., 2007), therefore exposing the patient to side-effects of multiple medications. First-line drugs include valproic acid, levetiracetam (as first-line or add-on), and topiramate (van Breemen et al., 2007; Ruda et al., 2012; Bruna et al., 2013). Some patients may require surgical treatment for their epileptogenic focus (Ruda et al., 2012). Though little is systematically known about rehabilitation needs after such procedures, some will have restorative needs through the recovery process. Efficacy and side-effect profiles may play a role in the selection of anticonvulsant agents. Prophylaxis is not generally recommended, due to uncertain benefit and potential for side-effects. Side-effects can include cognitive deficits, hematopoietic, dermatologic, and liver toxicity, Stevens–Johnson syndrome (in association with cranial radiation therapy while receiving phenytoin, carbamazepine, or phenobarbital) (van Breemen et al., 2007), and cytochrome P-450 induction (phenobarbital, primidone,
carbamazepine, phenytoin), the latter producing interaction with chemotherapy agents.

Antiepileptic drugs are commonly prescribed for a variety of other disorders, which may need to be concurrently addressed during rehabilitation and supportive care, including neuropathic pain syndromes and mood and impulse control disorders (Thompson et al., 2006). Selection of agents may be influenced by side-effect profile. For example, topiramate and zonisamide are associated with weight loss, lamotrigine is weight-neutral, and phenytoin, valproic acid, and carbamazepine can cause weight gain. Gabapentin and pregabalin have anxiolytic properties (Thompson et al., 2006). Epileptogenic agents such as tricyclic antidepressants, neuroleptics, and bupropion should be avoided (van Breemen et al., 2007).

Sexuality concerns

Even when sexual interest and function remain intact in the setting of cancer and specifically brain tumor, patients may have difficulty approaching the topic with partners and caregivers (Krychman et al., 2004). Open discussion is the most important intervention (McKee and Schover, 2001). Often a mismatch in expectations exists between cancer patients and healthcare providers (Hordern and Street, 2007). Specific strategies include addressing physical issues that may be interfering with sexual function, such as pain, anxiety, fatigue, or urinary symptoms (McKee and Schover, 2001), and approaching the sexual relationship with a flexible attitude, in what has been described as “flexible coping” (Reese et al., 2010) or “renegotiating” (Gilbert et al., 2009a) the sexual relationship. Flexible coping involves rethinking both one’s cognitive understanding of what is entailed in a sexual relationship, and shifting behavior. Similarly, renegotiators have been described as most successful in attaining a satisfying relationship, by emphasizing positive communication and the relationship context, which results in emphasizing affectionate behaviors, and other potential strategies (massage, vibration, etc.). Partners may also have barriers to success of the sexual relationship, including lack of desire, exhaustion, seeing the patient as an asexual or “sick” partner, and uncertainty about what is appropriate (Gilbert et al., 2009b). Limited information is available about brain tumor patients specifically, though childhood cancer survivor data have not found significant difference in self-reporting of long-term sexual issues by type of cancer, including brain tumor survivors (Zebrack et al., 2010).

Thromboembolic disease

Thromboembolic disease interfaces with rehabilitation management due to decision making for safe physical activity in the settings of active thrombosis or supratherapeutic anticoagulation. A high index of suspicion should be maintained. Actual reported incidence of thromboembolic disease is variable due to differences in extent of thromboprophylaxis and method of detection, but is estimated at 7–28% over the 1-year postoperative period. Among cancer diagnoses, glioblastoma and adenocarcinoma patients face the greatest risk of thromboembolic disease (Perry, 2012), and relative risk for brain cancer patients developing thromboembolic disease is 21.4 compared to age-matched controls, whereas the relative risk is 3.6 for cancer patients as a whole compared to controls.

After surgery, a combination of mechanical and medical prophylaxis with low-molecular-weight heparin is recommended (Perry, 2012). Larger tumors seem to be associated with increased risk of thromboembolic disease. This may relate to higher presence of the procoagulant tissue factor (Perry et al., 2007), and also to more severe weakness from neurologic impairment. Chemotherapy is also a risk factor for thrombosis, as are antiangiogenic agents. While historically, risk of intracranial hemorrhage is a concern with anticoagulation, studies have shown that mechanical measures and chemoprophylaxis, usually unfractionated or low-molecular-weight heparin, are superior to mechanical measures alone, with safest time frame to start about 24 hours postoperatively (Goldhaber et al., 2002; Chao et al., 2011). In the setting of diagnosed clot, full anticoagulation is usually considered safe, favoring a low-molecular-weight heparin product (Perry, 2012). In cancer patients, low-molecular-weight heparin is generally well tolerated, and there is evidence that maintaining it over the full course of treatment may be more effective than warfarin in preventing recurrent thromboembolic events (Wen et al., 2006). Inferior vena cava filters can be problematic due to high complication rate in up to 62% of patients (Levin et al., 1993).

Headache

Headaches have been reported in about 50–75% of brain tumor patients (Lovely, 2004). In one series, 77% exhibited the tension type, and 9% a migraine pattern. Headache was the worst reported symptom in 45% of patients (Forsyth and Posner, 1993). Tumor itself should be suspected as the cause of the headache in the setting of nausea and vomiting, new neurologic abnormality, or change in headache pattern (Forsyth and Posner, 1993). Tumor-related headaches are thought to be caused by local traction on pain-sensitive structures, such as arteries, veins, venous sinuses, cranial nerves, and portions of the dura (Lovely, 2004). Management of headache related to tumor includes addressing the primary
lesion, and, often, use of corticosteroids. Analgesics will be required after craniotomy. If worsening of tumor has been ruled out as producing the headache, management can proceed empirically according to treatment for the symptom pattern, especially tension versus migraine, as seen in other conditions, such as posttraumatic headaches (Lew et al., 2006; Lucas, 2011; Watanabe et al., 2012; Brown et al., 2015).

Both pharmacologic and nonpharmacologic therapies can be used, often in combination. Nonpharmacologic therapies include physical therapy, relaxation or biofeedback training, aerobic exercise, and counseling. Medications can include simple analgesics (aspirin, acetaminophen, nonsteroidal anti-inflammatory agents), antiepileptics and related medications (especially valproic acid, also gabapentin, topiramate), beta-blockers (such as propranolol), calcium channel blockers, and muscle relaxants (cyclobenzaprine, methocarbamol, tizanidine), and antidepressants (selective serotonin reuptake inhibitors). Supplements such as magnesium and riboflavin may also be considered (Lucas, 2011). For severe headache, especially postoperatively or in the setting of advanced disease, opioid analgesics can be necessary. Attention to possible rebound headache is important in individuals taking pain medication on an as-needed basis more than 2–3 days/week or 10 days/month (Lucas, 2011). Medication dosing should be started low. As with most symptom management, selection of headache medications can be tailored to target other symptoms, such as mood or sleep disturbance.

DYSPHAGIA

As with other brain disorders, such as stroke or brain injury, individuals with brain tumor are at risk for oral-pharyngeal dysphagia, which is found in nearly two-thirds (63%) of individuals presenting to acute rehabilitation. The dysphagia typically improves, with 50% of these patients consuming a regular diet by time of discharge home (Wesling et al., 2003). At end of life, dysphagia occurs in 85% of brain tumor patients (Pace et al., 2009).

ORGANIZATIONAL SUPPORTS

Organizations exist towards which patients, families, and caregivers can turn for support and information in navigating challenges such as family issues (relationships, financial), managing challenging behaviors, emotional adjustment, and navigating through the medical system (Schubart et al., 2008). Options include the International Brain Tumor Alliance (theibta.org), which is a global network for brain tumor patient organizations, the National Brain Tumor Foundation (http://www.braintumor.org), the American Brain Tumor Association (http://www.abta.org), and the Children’s Brain Tumor Foundation (http://www.cbtf.org).

CONCLUSION

Individuals with glioma have a high incidence of disabling sequelae. A prominent challenge in the setting of glioma is that rehabilitation must adapt to a wide range of prognostic implications, from restorative care, to ongoing supportive management, to end-of-life comfort and safety. Glioma also affects individuals of various ages, from childhood to elderly, impacting goals and expectations of care. Rehabilitative efforts incorporate the life context, including specific functional needs, impact on coping, relationships, and life roles. Evidence to date supports rehabilitation efforts as beneficial, especially for inpatient rehabilitation. Promising data are emerging for cognitive rehabilitation. Patients and families must be supported emotionally and also assisted with the complex logistics of healthcare. Physical activity should be encouraged, and for some patients, vocational and neuropsychologic interventions are appropriate. Concurrent symptom management necessarily supports rehabilitation goals.

REFERENCES


