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NEURO-ONCOLOGIC PHYSICAL THERAPY FOR THE OLDER PERSON

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Abstract

Due to the uncertainty of the course of diagnoses, patients with neuro-oncological malignancies present challenges to the physical therapist. At times, the presentation of impairments and disabilities of these patients with neuro-oncological diagnoses do not necessarily coincide with the involved area of the brain or spinal cord. It is our intention to provide guidance to the physical therapist who will be working with these patients with neuro-oncological diagnoses, in hopes that their encounters will be more productive and meaningful. This article describes a brief overview of common central nervous system malignancies, its medical treatment, as well as possible complications and side effects that would need to be considered in rehabilitating these patients. Special consideration is given to the elderly patients with neuro-oncological diagnoses. Pertinent physical therapy assessments and interventions are discussed.

Keywords

brain metastases; brain tumor; neuron-oncology; physical therapy; rehabilitation; spinal cord tumor

INTRODUCTION

Although the incidence of central nervous system (CNS) tumor is relatively low when compared with other cancers, CNS tumors can often cause dramatic functional deficits that may have sudden and/or severe consequences for the patient's role in their family, workplace, and their self identity. It is also important to note that many of the most prevalent primary cancer sites are also the most commonly found to metastasize to the brain and spinal cord. Cancer incidence increases with advancing age¹, thus more elderly will be diagnosed with CNS tumors due to the increasing number of people who comprise the older population.²

The complex nature of neuro-oncological diagnoses can make patients with these diagnoses challenging to assess and treat for the physical therapist. This article is intended to assist in providing helpful information to the physical therapist who will encounter these patients. A brief overview of the most common central nervous system malignancies and their signs and symptoms will be presented, as well as a summary of their most current medical and

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surgical treatment options. More emphasis will be put on considerations for the physical therapists in rehabilitating these patients, including the side effects of medical and surgical treatments, common rehabilitation measures and interventions, as well as special considerations for the older adult patient.

COMMON CNS MALIGNANCIES

The most common CNS malignancies for adults include: gliomas, meningiomas, and metastases in the brain; and metastases, meningiomas, and neurofibromas in the spinal cord.³

Gliomas are the largest group of primary brain tumor in adults. Glial cells are the support cells of the CNS and include astrocytes, oligodendrocytes, and microglia. Astrocytes outnumber neurons 10 to 1 and occupy 25–50% of the brain volume. Oligodendrocytes form the myelin sheaths in the CNS.^{4,5} Gliomas are named according to their tissue of origin such as: astrocytoma, oligodendroglioma, and oligoastrocytoma.

The World Health Organization (WHO) classification system is the most commonly used system to classify brain tumor. Grades are based on cellularity, atypical cells, mitosis, microvascular proliferation, and necrosis. Prognosis is inversely related to grade and patient age, and directly related to clinical condition at diagnosis.² Grading is based on biopsy, but may not always reveal the full picture due to a tendency for CNS tumors to be histologically heterogeneous.^{4,6} A grade I tumor is characterized by being slow growing and often discrete. It has a possibility of cure following surgical resection. Grade II tumors are generally infiltrating. They are initially slow growing but often recur or progress to a higher grade tumor. They possess only one abnormal histologic feature. Median survival is 5–10 years. Astrocytoma, oligodendroglioma, and oligoastrocytoma are all examples of grade II tumors. Grade III tumors demonstrate malignancy through increased mitotic activity, infiltrative capability, and anaplasia. Examples include anaplastic astrocytoma, anaplastic oligodendroglioma, and anaplastic oligoastrocytoma. Grade IV tumors are the highest grade in the WHO classification system and therefore the grade with the worst prognosis. It is a mitotically active, necrosis-prone tumor, generally associated with rapid disease progression.^{4,6}

Glioblastoma Multiforme (GBM) is grade IV tumor, and is the most common primary brain tumor in adults. It most often occurs in the 5th and 6th decade of life. It is a rapidly growing, highly malignant tumor identified by the presence of dead tumor cells. It frequently occurs in the frontal lobe but may also occur in the temporal, parietal, or occipital lobes, with rare occurrence in the cerebellum, brain stem or spinal cord. This is a tumor with one of the worst prognosis, with median survival of one year.^{4,5}

The second most common primary tumor in adults is meningioma, accounting for 20% of intracranial tumors in adults. This is a slow-growing extra-axial tumor which arises from arachnoid cells. Most meningiomas are considered to be benign though some may become malignant. It causes neurological deficits by compressing underlying structures. In most cases, cure is achievable with tumor resection. It is most commonly diagnosed in the 3rd to 6th decade of life.^{3,4} Etiology is often unclear. Some meningiomas are associated with heredity. Possible environmental risk factors include: ionizing radiation, petro chemicals, organic solvents, or viruses.³

In adults, metastases make up the majority of brain tumors and account for over 60% of all brain tumors.⁷ It is understood that metastases of a primary tumor to anywhere in the body is generally a sign of progression and worsening prognosis. No where is this more apparent than with metastases to the brain. Twenty to forty percent of all patients with cancer develop

brain metastases, including 50% of all patients with lung cancer, 15–20% of patients with breast cancer, and 10% of patients with melanoma. Other data suggests that melanoma has the greatest tendency to metastasize to the brain, with as much as 90% of patients with melanoma at autopsy in one report.⁸

Once a patient is diagnosed with brain metastases, prognosis is generally less than one year and treatment is often palliative.⁹ Breast, colorectal, and renal cell cancers are more likely to have single metastasis, while lung cancer and melanoma may have a tendency to cause multiple lesions.¹⁰ The most common pathway through which metastases occur is via the blood stream. The metastatic location is often near a cluster of small blood vessels near circulating cancer cells. A metastasis of a metastasis may occur, for example, colon cancer may spread to the liver then to the lungs then to the brain. Grading is not applicable to metastases. All systemic cancers are considered stage IV when brain metastases are present. Median survival after whole brain radiation is 4–6 months.⁹

Extradural metastases are the most common spinal cord tumor. They grow outside the dura mater and in the bones of the spine. They affect the spinal cord and nerves through compression. They usually metastasize from carcinomas of the lungs, breast, prostate, kidneys, or thyroid, or from myeloma or lymphoma. Both primary and secondary spinal cord tumors are most common at the thoracic level (70%) followed by the lumbosacral level (20%) then the cervical (10%). Metastases to the spine are often multiple, especially in the case of breast cancer. The most common primary spinal cord tumors are meningiomas and neurofibromas.³

SIGNS AND SYMPTOMS

The most common non-specific symptoms of intracranial tumors include headaches in approximately 65% of cases,^{11,12} nausea and vomiting due to increase in intracranial pressure in about 10% of cases⁹, and visual disturbance such as decrease visual acuity, diplopia and visual field deficits, in association with papilledema, are seen in approximately 30% of cases.^{11–13} Seizures occur in about 25% of patients with high-grade gliomas, 50% of patients with low-grade tumors, and 15% to 20% of patients with brain metastases.⁹ Change in cognitive functioning and consciousness occurs in about 75% of patients with brain metastases, and as much as 50% of patients with malignant gliomas.⁹ It is important to note that elderly patients are more likely to present with confusion, aphasia, or memory loss, and less likely to present with headache or seizures.¹⁴

Focal disturbances are usually due to direct invasion causing neural destruction in particular intracranial and intraspinal tumors. Compression may also result in a necrosis due to disturbance in circulation. Lethargy, drowsiness, irritability, and difficulty with ambulation may result from increase in intracranial pressure due to significant tumor mass or cerebral edema.^{11,15}

Lesions in the frontal lobe may produce changes in cognition, higher-level reasoning and judgment skills, and may present as inappropriate behavior, difficulty with concentration, or indifference. Apraxia and aphasia may be evident when the dominant frontal lobe is involved.¹¹

Spontaneous pain caused by nerve root irritation can be due to primary or metastatic intraspinal tumors. The pain can be deep, burning, and poorly localized (intramedullary), or sharp, knife-like, radicular pain, aggravated by coughing, sneezing or straining (extramedullary). Other changes may include motor weakness, muscle wasting, sensory changes, urinary frequency, syringomyelia-like symptoms, hyporeflexia/hyperreflexia, gait disturbance and sexual dysfunction.¹⁶

Brain metastases can have similar signs and symptoms as primary brain tumors, however, much more rapid progression of symptoms may occur. Cerebellar metastases may cause obstructive hydrocephalus and abrupt deterioration.¹⁶ Spinal metastases most commonly presents as back pain in 95% of cases. It is usually dull, worse at night, and may be localized in the spine, or may be radicular. It may progress quickly to weakness, sensory loss, and bowel and bladder problems.¹⁶

CURRENT MEDICAL AND SURGICAL TREATMENT

Medical treatment for primary or metastatic disease to the brain or spinal cord include either surgery, radiation, chemotherapy or a combination of all these, depending on the primary pathology.

Surgery is the primary definitive treatment for patients with low-grade gliomas. In patients with aggressive gliomas or metastatic disease, surgical options are generally offered to patients who have good performance status, to establish the diagnosis, as well as achieve the most reduction in tumor burden. Despite aggressive attempts at surgical resection, complete removal of the tumor is not always possible. This can be especially difficult in patients with primary aggressive GBM or in patients with brain metastases, where other sites of systemic disease are still present. Therefore, additional treatments such as adjuvant radiation or chemotherapy are often employed.

Specific types of tumors warrant tailored treatment options. In low-grade gliomas, maximal surgical resection may be the only treatment required followed by appropriate surveillance. In cases of aggressive GBM, adjuvant chemotherapy and radiation is typically offered after maximal surgical resection as it had been shown to improve overall survival.¹⁷ The most common chemotherapy currently used is the alkylating agent temozolomide. The combined chemotherapy and radiation typically lasts for about 6 weeks followed by chemotherapy alone until either intolerance or progression occurs. Treatment challenges also exist for elderly patients who are otherwise not great surgical candidates. Combined chemotherapy and radiation may therefore be given as primary treatment in the absence of surgery.¹⁸

The emphasis of treatment for patients with metastatic CNS disease or spinal cord compression is directed towards symptomatic control. This includes efforts to reduce pain, tumor compression, even restore neurologic function whenever possible. While systemic chemotherapy remains the cornerstone for treatment to address the systemic manifestations of the malignancy, localized therapy directed towards metastatic sites that involve either the brain or spinal cord is often utilized in the form of radiation.^{19,20} Multiple brain lesions warrant whole brain radiation. On occasion, surgery is also used especially if there is a single lesion and the involved metastatic site is amenable to surgical resection that would not cause undue significant neurologic deficit, and if treatment of the systemic disease would achieve a reasonable expectation of good control. There has been increasing interest with the use of radiosurgery as treatment especially if lesions are fewer (typically 1–3).²¹ Radiosurgery may also provide better quality of life, less neuro-cognitive deficits, less morbidity, and possibly better survival especially in elderly patients deemed to be at higher risk for surgical morbidity.

Supportive care treatments in patients with primary or metastatic CNS disease are often employed as an adjunct to the primary treatment. Corticosteroids are prescribed not only for reduction of inflammation and edema but also for pain control and palliation. In malignant gliomas, anticonvulsants are often used to control or eradicate seizures. There is also a potential for drug interactions between different anticonvulsants as well as the chemotherapy, for which the levels must be monitored closely.

Other emerging therapies, such as stem-cell based therapies and gene therapy, are novel approaches and have shown promise in treating brain tumors, but are currently investigational. No studies to date have been reported that specifically include elderly patients^{22–25} Biological therapies or targeted agents have evolved in the treatment of CNS malignancies. In refractory GBM, a monoclonal antibody against vascular endothelial growth factor called bevacizumab, has been approved as a treatment for patients who have progressed through temozolomide and radiotherapy.²⁶ Similarly, bevacizumab is being used in combination with chemotherapy for treatment of varying solid tumors such as lung, breast or renal cancer, all of which can metastasize to the brain.

CONSIDERATIONS IN REHABILITATION

Patients with neuro-oncological diagnoses frequently receive medical therapy that may place them at risk for developing complications or side effects that would interfere with their function. As such, it is important for the physical therapist to know what treatments the patient has had or is currently receiving to be able to develop the appropriate treatment plan and goals with the patient. Preparing the medical treatment summary of the patient is helpful to the clinician in determining whether current symptoms and/or complaints may be related to the lesions themselves, or possible consequences from prior or current exposures to their treatments. This summary should include the names of all chemotherapeutic agents and dates of administration, radiation treatments dates and locations, surgical procedures including sites and dates, and other interventions (steroid use, antiepileptic drugs, stem cell transplant, biologic agents).²⁷

Medical treatments may also impact timing of physical therapy intervention. When rehabilitating patients with neuro-oncological diagnoses, flexibility and frequent reassessment are required to address fluctuating functional status.³ Therapists should be aware of the patient's medical treatment schedule and remain flexible with the timing of the therapy session in order to ensure the patient's peak performance. As such, the physical therapist should consider the following when treating the older patient with neuro-oncological diagnosis for rehabilitation:

Complications of Surgery

Focal neurological deficits following surgical resection of brain tumors are dependent on the location of the tumor. Regional injuries may occur when normal or surrounding tissues are damaged or disrupted during the surgical procedure. Ataxia is a common deficit observed following surgery to the posterior fossa. Other complications of surgery may include increase intracranial pressure from hydrocephalus, hemorrhage and brain edema, infection, and development of seizures.²⁷

Side Effects of Radiation

Patients undergoing radiation therapy present with specific challenges. Radiation is typically given daily over a period of 6 weeks in patients undergoing treatment for GBM. This is coupled with the use of daily temozolomide for a duration of 42 doses while on radiation. The combined effects of chemotherapy, albeit a lower dose than that which is given when used alone, with radiation, brings about symptoms of fatigue, occasional nausea, and myelosuppression. The patient may also experience headaches, with or without worsening of neurological symptoms, which can be transient and controlled with corticosteroids.² Some physical effects such as hair loss over the radiated area can also be seen. Fatigue usually occurs by the 2nd or 3rd week. Some oncologists prescribe antibiotics for the prevention of pneumonia, which may result from immunosuppression brought about by the combined chemo-radiation. Early-delayed effects and late-delayed radiation injury can occur in the

first 3 months and months or even years, respectively, after completion of radiation therapy. These effects can include somnolence, loss of appetite, apathy, short term memory loss, or cognitive decline. The degree of cognitive decline may be more severe in temporal lobe lesions, or in older persons with mild dementia.² Early-delayed myelopathy may follow after radiation to the neck or upper thorax. It is characterized by Lhermitte's sign, an electrical sensation that runs down the spine that can be elicited by bending the neck forward, which resolves spontaneously. Late-delayed myelopathy often presents as Brown-Sequard syndrome and may occur after radiation treatments to the extraspinal tumors.²⁸

Side Effects of Chemotherapy

Chemotherapeutic and biologic agents have side effects that can directly effect patient participation in physical therapy, such as nausea and vomiting, fatigue, neuropathy, and thrombocytopenia (bone marrow depression). The side-effects from chemotherapy typically occur during treatment and depend on the type of agents, the effects may vary from patient to patient. Patients are also given medications that may help alleviate the side-effects, such as anti-nausea medications.

Thrombocytopenia is a potential sequelae of chemotherapy. It can also result from certain antibiotics used either as prophylaxis or treatment for varying infections while on chemotherapy. The timing of thrombocytopenia, or myelosuppression in general, depends on the chemotherapeutic agent used and when it was given. Thrombocytopenia is defined as platelet levels below 150,000 cells/ μ L.²⁸ Patients on cyclical chemotherapy typically reach a nadir of their counts in about 7–14 days after chemotherapy. While spontaneous hemorrhage typically does not occur unless platelet counts reach < 10,000–20,000 cells/ μ L,²⁹ strenuous exercise and straining could potentially precipitate a hemorrhage (e.g. skin, muscles, eyes and brain) in patients with thrombocytopenia. Blood pressure cuffs and compression garments should be used with caution. Spontaneous bleeding happens most often with fever or falling platelet levels.³⁰ Sources vary in terms of recommendations for activity level with thrombocytopenia and more research would be beneficial in this area. Most recommendations are for moderate exercise without resistance when platelet levels are below 50,000 cells/ μ L, and reduction in activity to activities of daily living (ADL) only, or light activity when platelets are below 20,000 cells/ μ L.^{28,31}

Anemia may also impact a patient's participation in exercise programming due to its impact on cardiopulmonary capacity and muscle performance. Recommendations vary with hemoglobin of less than 8–10 g/dL generally given as level to consider limiting participation in exercise.^{28,30,31} Although some authors argue that patients with chronic anemia may not demonstrate diminished capacity and advocate exercise participation based on symptoms including presence of dyspnea, lightheadedness, and chest pain, as well as vital signs. Anemia is less tolerated in the elderly and patients with chronic obstructive pulmonary disease.³⁰

Side Effects of Corticosteroids and Anti-convulsants

Corticosteroids often have both favourable and unfavourable consequences. Benefits include: reduction in inflammation, improvement in appetite, adjunctive treatment for pain management and nausea control. However, chronic use of corticosteroids is associated with the following significant side effects: morbid weight gain, cushingoid syndrome, hyperglycemia/diabetes, myopathy, increased susceptibility to infections, osteoporosis, psychiatric symptoms, and adrenal insufficiency.¹⁵

There can also be behavioral changes associated with the use of steroids. Of these, steroid psychosis is of a major concern. According to one report, this can either be affective (mania

and depression), occurring in about 75% of the cases, or toxic-organic (delirium and psychosis), occurring in about 25% of the cases. Early signs of the affective symptoms include irritability, euphoria, or hyperactivity. Early signs of toxic-organic symptoms include confusion, delusions, agitation, and even hallucinations.³² Advanced age or history of other psychiatric disorders has not been confirmed as risk factors for developing steroid psychosis.³³

Due to the possibility of seizures, patients may be given anticonvulsant medications, commonly levetiracetam, phenytoin, and carbamazepin. In turn, the patient may experience some slowing of their cognitive functioning, altered reaction time, confusion, and even movement disorders such as ataxia or dysarthria. Some anti-convulsants may cause side-effects such as rash, hematologic effects, or toxicity because of elevated levels. If the patient presents with episodes of lethargy, nausea, irritability, and skin rashes after taking anticonvulsants, it may be due to intolerance to the medication, and their physicians should be notified.³⁴

Venous Thromboembolism

Patients with malignancy have known hypercoagulability state placing them at risk for developing venous thromboembolism (VTE). Immobility secondary to neurological deficits and post-surgical risks can also contribute to the development of VTE.³⁵ Patients with malignant glioma have a 16–28% risk to develop VTE in the first year of diagnosis. This risk increases with major neurosurgery, age greater than 75 years, and glioblastoma histology.¹⁵

Cancer-Related Fatigue

Fatigue is the most commonly reported symptom among patients with any type of cancer, and is consistently found to cause the greatest effect on quality of life. Cancer-related fatigue (CRF) is defined as “an unusual persistent subjective sense of tiredness related to cancer or cancer treatment that interferes with usual functioning.”³⁶ Possible factors that can cause fatigue in patients include their cancer treatment, anemia, medications, changes in metabolism, infection, dehydration, loss of strength and muscle coordination, decline in physical condition, emotional distress, trouble sleeping, inactivity, pain, poor nutrition, and having other co-morbidities or medical conditions in addition to cancer.³⁷

Neuro-cognitive Changes

Neuro-cognitive changes may be caused directly by destruction or compression of the neural tissues, particularly in the frontal lobe. Studies have shown that whole-brain RT alone or in combination with chemotherapy result in more pronounced cognitive dysfunction than partial RT or chemotherapy alone. Similarly, surgery to the cerebral cortex and cerebellum are associated with the highest risk of significant cognitive morbidity. Use of steroids and antiepileptic drugs can also affect cognitive functioning.³⁸

Other Comorbidities

When developing a physical therapy program for the older patients with neuro-oncological diagnoses, bone health must be considered in order to avoid fracture. Bony metastases of the long bones may limit weight-bearing or lifting, or require use of assistive device. While bony metastases of the spine may result in use of a hard-shelled thoraco-lumbo-sacral orthosis (TLSO) during upright activity and need for review of body mechanics including avoiding twisting or extremes of forward or backward bending.³⁹ The elderly patient is also at higher risk of having under-lying osteopenia or osteoporosis. Other factors to consider when creating a treatment plan for patients with cancer are immunosuppression or

neutropenia, thrombocytopenia, anemia, fever or active infections, and limitations due to metastases or other illness.^{36,40}

PHYSICAL THERAPY MANAGEMENT

As with all comprehensive rehabilitation plans, treatment and assessment of the older patients with neuro-oncological diagnoses needs to be formulated according to the individual. There are a variety of factors to be considered including, tumor type, tumor aggressiveness, tumor location, tumor size, treatments and resulting side-effects, prognosis, as well as, baseline functional level, co-morbidities, family and social support, hobbies and activity level, and home environment. All of these will result in different clinical symptoms, impairments, and/or therapy needs. Common impairments which may respond to therapy intervention include fatigue, impaired aerobic capacity, impaired strength, impaired balance and coordination, spasticity, visual-perceptual impairment, impaired safety awareness and judgment, and pain.

When considering appropriate assessment and treatment of the older patients with neuro-oncological diagnoses, it may be helpful to keep in mind the four phases of care for patients with cancer as described by Dietz.⁴¹ These are described as the *preventative*, *restorative*, *supportive*, and *palliative* phases. In the preventative phase focus is on education and early intervention to slow the effects of the tumor and prevent functional loss. In the restorative phase treatment is focused on return to independence in all functional activities including work in patients whose disease is considered cured or controlled. The supportive phase puts more emphasis on goals related to ADLs in patients with progressive impairment. The focus during the palliative phase is on comfort and preservation of independence for as long as possible with support of both the patient and their family. In general, patients in this phase are in the end-stage of their disease.^{4,41}

Despite these additional challenges faced by the patient with brain or spinal cord injury related to cancer versus traumatic insult, research has shown that patients with brain tumors make functional gains equivalent to those made by patients with traumatic brain injury or stroke. Length of inpatient stay is often shorter for patients with tumor for unclear reasons, although some hypothesize that patients with tumor may have better psychosocial support and fewer behavioral issues compared with patients seen for traumatic injury which facilitate discharge planning.³ It should also be noted that some research demonstrates that age is not a factor in predicting quality of life for patients with brain tumor. Positive factors on quality of life include the following: freedom from depression, active social life, greater energy level, and fewer symptoms. Negative factors include: more extensive tumor involvement, poor functional status per Karnofsky scale, female gender, divorced status, being unable to work, undergoing chemotherapy, and tumor grade.⁶

There are differences from other neurological disorders that can be encountered when dealing with patients with neuro-oncological diagnoses, and these include uncertain prognosis, possibility of progression or recurrence of disease, fatigue, medical fragility, and side effects related to various treatments including, most commonly, from surgery, radiation, and chemotherapy, as well as, the use of high dose steroids.^{3,41} Many of the same therapeutic techniques and evaluation tools that we use for patients with brain injury, stroke, or spinal cord injury can be applied to the patient with neuro-oncological diagnosis. As such, impairments from direct insult to the central nervous system resulting from brain injury, stroke and spinal cord injury like motor weakness and sensory problems, will not be discussed here in full detail.

The following are common complaints that are encountered with older patients with neuro-oncological diagnoses:

Strength

Weakness related to paralysis is most prominent post-brain surgery. Strength may return over a period of weeks or months. In general, the earlier the return of strength, the greater the recovery. Muscles that are still completely paralyzed 4–8 weeks post-operatively generally remain so.⁴¹ As previously discussed, patients may also experience myelopathy related to radiation or myopathy, related to use of corticosteroids, as well as overall deconditioning for a variety of reasons.

The elderly and patients on high dosages of corticosteroids over a period of time are more susceptible to developing steroid myopathy. Notable examination findings for the patient with steroid myopathy include weakness in the neck flexors, and the muscles of the shoulder and pelvic girdle. Withdrawal of steroids and physical therapy are the only therapeutic options for steroid myopathy.³³ This weakness is potentially reversible if steroids are completely withdrawn, however, if steroids must be continued, then the smallest possible dose should be considered.³⁵

A recent study by Jones et al. demonstrates that cardiorespiratory fitness, isokinetic strength, and muscle cross-sectional area are significantly reduced in patients with malignant glioma. The results of their pilot study also appear to demonstrate that cardiopulmonary exercise testing could be a safe tool to evaluate function in patients with clinically stable, newly diagnosed and untreated post surgical primary glioma.⁴²

The American College of Sports Medicine (ACSM) recommends that exercise programs for patients with cancer diagnosis meet the goal of maintaining cardiovascular endurance, muscular strength, and function. Benefits include: decreased nausea, decreased fatigue, increased endurance, and improved quality of life.⁴³ The 2008 US Department of Health and Human Services (US DHHS) Physical Activity Guidelines for Americans recommend weekly aerobic activity of 150 minutes of moderate intensity exercise or 75 minutes of vigorous-intensity exercise or an equivalent combination. As well as two to three weekly sessions of strength training for major muscle groups and stretching of major muscle groups on days which other exercises are performed. The US DHHS state that people with chronic conditions such as cancer that can't meet guidelines "should be as physically active as their condition and abilities allow" and "avoid inactivity".⁴⁴ The National Comprehensive Cancer Network (NCCN) recommends 30 minutes per day, 5 days per week as a goal for exercise for patients with cancer. This may initially be broken into smaller increments such as 3 sessions per day of 10 minutes. It is important to begin slowly and progress incrementally. Alternative forms of exercise such as yoga or Tai Chi should be considered. Pools should be avoided if the patient is actively receiving radiation therapy due to risk of bacterial infection or skin irritation.^{36,40}

Fatigue

Fatigue is one of the most commonly complained of symptoms in patients with cancer diagnosis. It can also be one of the most difficult to treat. Regular exercise is one of the few treatments that has proved effective in addressing this issue in patients with cancer.^{45,44} Other techniques to address fatigue include energy conservation techniques, distraction, and psychosocial interventions. Energy conservation techniques include: pacing, delegating tasks, prioritizing activities, scheduling activities during the day according to peak energy levels, limiting naps to 20–30 minutes, and avoiding multi-tasking.^{36,40} The Brief Fatigue Inventory (BFI) is an 11-point Likert scale with 9 items and has been shown to be a reliable instrument when evaluating fatigue in patients with cancer.^{46,47}

Balance

Difficulties in balance can be multi-factorial. It can be directly due to injuries related to the tumor itself, as a complication from the medical therapies or a combination of both. The vestibular system may be affected directly dependent on tumor location, or indirectly through mass effect or edema. The musculoskeletal system may affect balance in patients with brain and spinal cord tumor through deficits in strength, decreased proprioception, and peripheral neuropathy. Visual deficits may also interfere with balance and are discussed further on in this paper. In patients with fear of falling, the Activities-specific Balance Confidence (ABC) Scale may provide helpful information.⁴⁸ Use of Berg Balance Scale and Performance Oriented Mobility Assessment (Tinetti) has been shown to predict falls in the elderly,^{49,50} and can be used for the neuro-oncologic patient.

Function

There are a variety of functional measures which can be helpful in evaluating function in patients with cancer diagnosis. The Cancer Rehabilitation Evaluation System (CARES) has been shown to be valid, reliable, and sensitive to change in status.⁴¹ In addition the short form of the CARES has also been shown to be sensitive to change over time.⁵¹ The Functional Independence Measure (FIM) and the Karnofsky Performance Status Scale (KPS) are also commonly used to evaluate function as well to predict prognosis in patients with cancer.⁴¹ The FIM is a 7-point scale that describes the amount of assistance the patient requires. It evaluates areas of self-care, sphincter control, mobility, locomotion, communication and social cognition.¹¹ The KPS rates performance on a 0 to 100 point scale which describes a patient's ability to perform activities.¹¹ KPS score of greater than 70 is a positive prognostic factor for patients with brain tumor.^{4,5}

When treating patients with spinal cord injury it is helpful to be familiar with the common scales used to define impairment level for this patient population. The American Spinal Injury Association (ASIA) scales and the Frankel Scales are the most common. They are ranked from A to E; with A being complete loss of sensory and motor function and E being normal. The Tokuhashi Scale has also been shown to be helpful in predicting prognosis and rehabilitation potential in patients with spinal cord tumor. Scores of 9 or above predict more positive outcomes with surgery and survival greater than 12 months.^{52,53}

Another quality of life measure that is frequently used with people with cancer is the Eastern Cooperative Oncology Group (ECOG). This scale is rated from 0 to 4 with 0 being fully active and 4 being completely disabled.³⁹ Tests such as the Timed-Up and Go (TUG) and the 6-minute walk test are relatively quick and easy to administer and provide valuable information on the patient's functional level including aerobic capacity and balance.

Pain

Patients with spinal cord tumor may experience both somatic and neuropathic pain. Pain can be related to bony metastases, spinal cord compression, or compression by the tumor on nerve roots. Pain caused by compression of the spinal cord is often worse in the recumbent position due to increase pressure. Neuropathic pain may respond to electrical stimulation.³ Use of heat or electrical stimulation should not be used over areas of acute trauma, tumor site, areas with impaired sensation, or with persons who are unable to provide feedback regarding pain due to cognitive or communication impairments.³⁹ The patient may also benefit from review of neutral posture and ideal body mechanics in relation to their specific area of injury. Pain related to spasticity may be alleviated with regular stretching and range of motion exercises.³ Patients with decreased mobility and sensation related to spinal tumor with bowel and bladder incontinence are at even greater risk of developing pressure ulcers due to the catabolic state of the body related to cancer.³ Therefore, training patients in

techniques to intermittently relieve pressure and perform skin checks is of great importance.³ Another common complaint of pain for patients with primary brain tumor is headache. Using techniques such as guided imagery, biofeedback, and breathing techniques may be beneficial to reduce pain and anxiety.³⁹ Advise patients to consult with their oncologists first before they take aspirin and NSAID, which inactivate platelet functions, for their pain.

Vision

It is common for patients with brain tumor to have visual problems due to compression to the optic nerves or visual processing areas of the brain caused either directly by the tumor or indirectly by pressure resulting from midline shift or edema. Patients may have visual field cuts, issues processing visual information, blurred or double vision. Often this is treated medically with steroids but patients may also benefit from treatment with patching or use of prisms.⁴¹ Patients and family can be educated in compensation techniques including scanning, reducing environmental hazards in home by removing throw rugs, obstacles, and using brightly colored tape to mark the edges of steps if depth perception is an issue. Patient may benefit from referral to a neuro-ophthalmologist in addition to an occupational therapist who specializes in vision rehabilitation. Also consider that older patients may already have underlying visual issues including glaucoma or cataracts.

Cognition

Although the Mini-Mental State Examination (MMSE) was created to assess dementia, it may not be sensitive enough for this patient population, as it does not detect problems in fronto-subcortical functioning like memory, learning, and processing speed.⁵⁴ The Montreal Cognitive Assessment (MoCA), which has been shown to be more sensitive than the MMSE in detecting mild cognitive deficits, and may be more useful in patients with brain tumor, but further validation in this patient population is needed at this time.⁵⁵ Attention, memory, and awareness can also be evaluated using clinical observation and activity analysis.⁵⁶ Observe the patient in a number of settings and activities, e.g. in a quiet versus busy room. Attention may vary by position change (lying, sitting). Determine which components of attention (e.g. concentration, focused or distracted attention, alternating or divided attention) are impaired or intact. For memory, consider if the patient is functioning in a structured versus unstructured environment. Try eliciting clarification from the patient, observe his awareness to his environment and his ability to utilize feedback. Finally, use a functional baseline measure by selecting a relevant functional task as the basis of your evaluation and assessment.⁵⁶ Patients with cognitive impairments may benefit from maintaining a regular routine and using tools such as journals and calendars to serve as reminders and document events.³⁹

CONCLUSION

The diagnosis of brain or spinal cord tumor can be devastating to anyone, especially to the elderly. Besides the uncertainties of the diagnosis and prognosis of this disease, its medical treatment can also be very difficult due to the many complications and side effects that can occur. Coupled with the multiple factors that already challenge the elderly, care for these patients can be very complex. Understanding the journey that these patients experience is the first step in being able to assist in their care. Physical therapists are essential members of the multidisciplinary team that serve these individuals. Our role as experts in function and mobility can greatly improve their quality of life even in end-of-life care. However, more evidence is still needed to prove the efficacy of our physical therapy interventions, and rehabilitation in general, for these patients with neuro-oncological diagnoses.¹⁵

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