Brain Tumors in Childhood: Speech Therapy

Indexing Metadata/Description

 › **Title/condition:** Brain Tumors in Childhood: Speech Therapy
 › **Synonyms:** Astrocytomas; CNS tumors; ependymomas; glioblastomas; gliomas; medulloblastomas; neurofibromas; schwannomas; tumors, brain, in childhood: speech therapy
 › **Anatomical location/body part affected:** The brain; the central nervous system
 › **Area(s) of specialty:** Pediatric genetic and/or neurological disorders
 › **Description:** Brain tumors are abnormal masses within the intracranial space that can be benign or malignant. (1,2,3) Primary brain tumors do not result from metastatic disease; a secondary brain tumor is a metastatic lesion from another type of primary cancer (e.g., lung cancer, breast cancer). (1,2,3) Brain tumors can affect the brain tissue, meninges, pituitary gland, or blood vessels. (3)

 › **ICD-9 codes**
  • 191 malignant neoplasm of the brain
    – 191.0 malignant neoplasm of cerebrum, except lobes and ventricles
    – 191.1 malignant neoplasm of frontal lobe
    – 191.2 malignant neoplasm of temporal lobe
    – 191.3 malignant neoplasm of parietal lobe
    – 191.4 malignant neoplasm of occipital lobe
    – 191.5 malignant neoplasm of ventricles
    – 191.6 malignant neoplasm of cerebellum NOS
    – 191.7 malignant neoplasm of brain stem
    – 191.8 malignant neoplasm of other parts of brain
    – 191.9 malignant neoplasm of brain, unspecified site
  • 198.3 secondary malignant neoplasm of brain and spinal cord
  • 225 benign neoplasm of brain and other parts of nervous system
    – 225.0 benign neoplasm of brain
    – 225.1 benign neoplasm of cranial nerves
    – 225.2 benign neoplasm of cerebral meninges
    – 225.3 benign neoplasm of spinal cord
    – 225.4 benign neoplasm of spinal meninges
    – 225.5 benign neoplasm of other specified sites of nervous system
    – 225.9 benign neoplasm of nervous system, part unspecified
  • 237.5 neoplasm of uncertain behavior of brain and spinal cord
  • 239.6 neoplasm of unspecified nature of brain
  • V76.81 special screening for malignant neoplasms, nervous system

 › **ICD-10 codes**
  • C71 malignant neoplasm of brain
    – C71.0 cerebrum, except lobes and ventricles
    – C71.1 frontal lobe
    – C71.2 temporal lobe
    – C71.3 parietal lobe
    – C71.4 occipital lobe

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October 30, 2015
–C71.5 cerebral ventricle
–C71.6 cerebellum
–C71.7 brain stem
–C71.8 overlapping lesion of brain
–C71.9 brain, unspecified
• C79.3 secondary malignant neoplasm of brain and cerebral meninges
• C79.4 secondary malignant neoplasm of other and unspecified parts of nervous system
• C70 malignant neoplasm of meninges
  –C70.0 cerebral meninges
  –C70.1 spinal meninges
  –C70.9 meninges, unspecified
• C72 malignant neoplasm of spinal cord cranial nerves and other parts of central nervous system
  –C72.2 olfactory nerve
  –C72.3 optic nerve
  –C72.4 acoustic nerve
  –C72.5 other and unspecified cranial nerves
  –C72.8 overlapping lesion of brain and other parts of central nervous system
  –C72.9 central nervous system, unspecified
• C75 malignant neoplasm of other endocrine glands and related structures
  –C75.1 pituitary gland
  –C75.2 craniopharyngeal duct
  –C75.3 pineal gland
• CNS lymphoma
  –C82 follicular (nodular) non-Hodgkin's lymphoma
    - C82.0 small cleaved cell, follicular
    - C82.1 mixed small cleaved and large cell, follicular
    - C82.2 large cell, follicular
    - C82.7 other types of follicular non-Hodgkin's lymphoma
    - C82.9 follicular non-Hodgkin's lymphoma, unspecified
  –C83 diffuse non-Hodgkin's lymphoma
    - C83.0 small cell (diffuse)
    - C83.1 small cleaved cell (diffuse)
    - C83.2 mixed small and large cell (diffuse)
    - C83.3 large cell (diffuse)
    - C83.4 immunoblastic (diffuse)
    - C83.5 lymphoblastic (diffuse)
    - C83.6 undifferentiated (diffuse)
    - C83.7 Burkitt's tumour
    - C83.8 other types of diffuse non-Hodgkin's lymphoma
    - C83.9 diffuse non-Hodgkin's lymphoma, unspecified
  –C85.1 B-cell lymphoma, unspecified
  –C85.7 other specified types of non-Hodgkin's lymphoma
  –C85.9 non-Hodgkin's lymphoma, unspecified type
• B21 human immunodeficiency virus (HIV) disease resulting in malignant neoplasms
  –B21.1 HIV disease resulting in Burkitt's lymphoma
  –B21.2 HIV disease resulting in other types of non-Hodgkin's lymphoma
• D33 benign neoplasm of brain and other parts of central nervous system
  –D33.0 brain, supratentorial
  –D33.1 brain, infratentorial
  –D33.2 brain, unspecified
  –D33.3 cranial nerves
  –D33.4 spinal cord
  –D33.7 other specified parts of central nervous system
–D33.9 central nervous system, unspecified
• D32 benign neoplasm of meninges
  –D32.0 cerebral meninges
  –D32.1 spinal meninges
  –D32.9 meninges, unspecified
• D35 benign neoplasm of other and unspecified endocrine glands
  –D35.2 pituitary gland
  –D35.3 craniopharyngeal duct
  –D35.4 pineal gland
• D43 neoplasm of uncertain or unknown behavior of brain and central nervous system
  –D43.0 brain, supratentorial
  –D43.1 brain, infratentorial
  –D43.2 brain, unspecified
  –D43.3 cranial nerves
  –D43.7 other parts of central nervous system
  –D43.9 central nervous system, unspecified
• D42 neoplasm of uncertain or unknown behavior of meninges
  –D42.0 cerebral meninges
  –D42.1 spinal meninges
  –D42.9 meninges, unspecified
• D44 neoplasm of uncertain or unknown behavior of endocrine glands
  –D44.3 pituitary gland
  –D44.4 craniopharyngeal duct
  –D44.5 pineal gland
• D47.9 neoplasm of uncertain or unknown behavior of lymphoid, hematopoietic and related tissue, unspecified
• D18 hemangioma and lymphangioma, any site
  –D18.0 hemangioma, any site
  –D18.1 lymphangioma, any site

› (ICD codes are provided for the readers’ reference, not for billing purposes)

• **Reimbursement**: Reimbursement for therapy will depend on insurance contract coverage; no specific special agencies are applicable for this condition. No specific issues or information regarding reimbursement have been identified

• **Presentation/signs and symptoms**: Patients with brain tumors will have different symptoms depending on the size, location, and type of tumor as well as patient’s age.\(^1\) The outward symptoms of brain tumors result from increased intracranial pressure or focal brain damage from the tumor.\(^1\) For very young children, the diagnosis of brain tumor can be delayed because the symptoms are similar to common childhood illnesses.\(^1\) Signs and symptoms associated with childhood brain tumors include but are not limited to:
  – Blurred vision\(^1\)
  – Bowel and bladder deficits\(^1\)
  – Clonus (rapidly alternating muscular contraction and relaxation)\(^1\)
  – Delayed puberty\(^1\)
  – Difficulty walking\(^1\)
  – Diplopia (double vision)\(^1\)
  – Disorders of equilibrium\(^1\)
  – Emaciation\(^1\)
  – Euphoria\(^1\)
  – Failure to thrive\(^1\)
  – Gaze palsy\(^1\)
  – Hand preference (in infants)\(^1\)
  – Headache\(^1,2,3,38\)
- Hemiparesis
- Hyperreflexia
- Hypothyroidism
- Increased appetite
- Irritability
- Lethargy
- Multiple cranial nerve palsies
- Nystagmus
- Papilledema (swelling of the optic disc)
- Precocious puberty
- Reduced coordination
- Seizures
- Sensory changes
- Subtle changes in personality, mental functioning, or speech
- Vomiting

Causes, Pathogenesis, & Risk Factors

**Causes:** The exact cause of brain tumors in childhood is largely unknown. The following causes have been linked to brain tumors:

- Certain familial and hereditary syndromes cause brain tumors, accounting for about 5% of cases in the United States.
  - Familial syndromes that cause brain tumors include neurofibromatosis type 1 and type 2, von Hippel-Lindau syndrome, tubular sclerosis, Li Fraumeni syndrome, Turcot syndrome, and nevoid basal cell carcinoma syndrome.
- Gliomas, meningiomas, and nerve sheath tumors have been linked to exposure to high levels of ionizing radiation.
- In utero exposure to cell phone towers has not been shown to cause brain tumors. Cell phone use is considered a possible risk factor for brain tumors; however, the evidence is weak and inconsistent.

**Pathogenesis**

- According to the World Health Organization (WHO), the most common types of brain tumors in children are:
  - Pilocytic astrocytoma (PA) and medulloblastoma/primitive neuroectodermal tumor (PNET) in children aged 0-14 years.
  - PAs and pituitary tumors in adolescents aged 15-19 years.
- The Childhood Brain Tumor Consortium reports the following distribution of tumor location in children:
  - Infratentorial (tumors that arise below the cerebrum) (43.2%)
  - Supratentorial (tumors that arise above the tentorium sheath) (40.9%)
  - Multiple sites (11%)
  - Spinal cord (4.9%)

**Risk factors**

- Age (children < 7 years of age at greater risk than older children)
- Exposure to ionizing radiation
- Sex (male > female)
  - Higher incidence of medulloblastoma and ependymoma in males
- Genetics/certain hereditary syndromes

**Overall Contraindications/Precautions**

- Brain tumors increase intracranial pressure. In some cases, increased intracranial pressure leads to a herniation syndrome.
  - The most common syndrome is herniation of the temporal lobe
  - The earliest sign of this type of herniation is ipsilateral pupillary dilation
The symptoms that follow are stupor, coma, decerebrate posturing (rigid extension of the arms and legs, downward pointing of the toes, and backward arching of the head), and respiratory arrest.

If ipsilateral pupillary dilation is noted during examination or treatment of patients with brain tumors, send the patient to the emergency room immediately.

See specific Contraindications/precautions to examination and Contraindications/precautions under Assessment/Plan of Care.

**Exam**

**Contraindications/precautions to examination**

- The U.S. National Cancer Institute SEER Program reports that at least 50% of all children who are long-term survivors of childhood brain tumor will experience chronic neurological deficits that will require multidisciplinary interventions. It is important when evaluating a child who has had a brain tumor to review both evaluation and treatment reports from other disciplines (physical and occupational therapy, psychology, audiology) as well as the reports from the child’s parents and teachers.
- During the evaluation, it is of utmost importance to be aware of a patient’s pain tolerance, fatigue, and level of frustration. The time of day and the number of previous evaluations can affect the patient’s alertness and performance. A patient’s culture and native language should also be considered to determine the appropriateness of examination questions and materials.
- The examination of children who have had a brain tumor must consider the fact that many of these children were still developing speech and language at the time the brain tumor presented.

- Speech-language pathologists (SLPs) must utilize tools specifically designed to evaluate children whenever possible.
- SLPs must remember that prior to the brain tumor, the child might not have fully mastered the respiration, phonation, resonation, or articulation required for “normal” speech.
- SLPs must involve the child’s parent in all stages of the evaluation to determine:
  - Child’s previous speech, language, cognitive, and swallowing abilities
  - Differences noted by parents following the brain tumor/medical intervention

**History**

**History of present illness/injury:** When was the child diagnosed with the brain tumor? Where is the brain tumor located? What type of brain tumor does the child have? What grade (I-IV) is the brain tumor? What type(s) of treatment has the child received thus far (e.g., surgery, radiation)? What type(s) of treatment are planned for the future (e.g., surgery, chemotherapy)?

- **Mechanism of injury or etiology of illness**
  - What were the initial signs and symptoms associated with the tumor? Have any symptoms improved or worsened since onset?
  - Review neurological testing and physician reports for information on the site and the size of the tumor.

- **Course of treatment**
  - **Medical management:** Treatment will depend on the type and site of the tumor. Medical treatments include:
    - Anticonvulsant/antiseizure medications
    - Surgical removal/excision/debulking of the tumor
    - Radiation therapy
    - Delaying or avoiding cranial radiation therapy (and instead treating patients with intensive chemotherapy) when medically possible in pediatric patients with brain tumor might reduce the risk of persistent neuropsychological, academic, social-emotional, and behavioral disturbances over time.
    - Chemotherapy
    - Corticosteroids to reduce swelling in the brain
  - **Medications for current illness/injury:** Determine what medications physician has prescribed; are they being taken? Obtain a list of the medication side effects to determine if child is experiencing them. Common medications for use with brain tumors include:
    - Anticonvulsants – such as phenytoin and fosphenytoin
    - Chemotherapy – such as carmustine, cisplatin, and lomustine
- Corticosteroids\(^{(2,3,4)}\) – such as dexamethasone\(^{(3)}\)
- Histamine-receptor antagonists\(^{(1)}\) – such as cimetidine, famotidine, and ranitidine\(^{(3)}\)

- **Diagnostic tests completed:** Note the results of any neurological (e.g., MRI, CT scan), blood, neuropsychological, or psychological/cognitive tests that have been completed; if the child is of school age, review reports from the classroom teacher and any therapists or specialists working with the child at school
- Exact diagnosis and staging of a brain tumor can only be accomplished through histologic examination of the tumor following biopsy or excision\(^{(2)}\)

- **Home remedies/alternative therapies:** Document any use of home remedies or alternative therapies (e.g., acupuncture) and whether or not they help
- **Previous therapy:** Document whether patient has had speech, occupational, or physical therapy for this or other conditions and what specific treatments were helpful or not helpful

- **Aggravating/easing factors**
- Does the child communicate better in certain environments?
- Do certain circumstances (e.g., busy restaurant, public places) aggravate the child’s symptoms?
- Is the child aware of communication difficulties? Is the child frustrated by communication difficulties?

- **Nature of symptoms:** Document nature of symptoms
- Interviews with the child’s parent or other caregiver are helpful to determine which aspects of speech, language, or swallowing have been negatively impacted by the brain tumor
- Additionally, note physiological symptoms, including but not limited to headache, seizures, vomiting, and motor, visual, or sensory deficits\(^{(1,2,3)}\)
- See *Presenting signs/symptoms*, above, for a list of symptoms commonly associated with childhood brain tumors
- **Rating of symptoms:** Use a visual analog scale (VAS) or 0-10 scale to assess symptoms at their best, at their worst, and at the moment (specifically address if pain is present now and how much)
- **Pattern of symptoms:** Document changes in symptoms throughout the day and night, if any (A.M., mid-day, P.M., night), and in different environments (e.g., noisy vs. quiet)
- **Sleep disturbance:** Sleep disturbances occur in up to 50% of survivors of pediatric brain tumor\(^{(2)}\)
- Sleep disturbances in survivors of pediatric brain tumor can result from damage to the hypothalamus\(^{(2)}\)
- Document number of wakings/night

- **Other symptoms:** Document other symptoms patient might be experiencing that could exacerbate the condition and/or symptoms that could be indicative of a need to refer to physician (e.g., ipsilateral pupillary dilation, dizziness, bowel/bladder dysfunction, saddle anesthesia)

- **Respiratory status:** Does the child require supplemental oxygen? Nasal cannula? Does the child have a tracheostomy tube? Does the child require ventilator support?
- **Psychosocial status:** Psychosocial disturbances, personality changes, and behavior problems can arise in children with brain tumor, either as a direct result of the tumor or due to frustration with cognitive difficulties\(^{(8,9,10)}\)
- Note psychosocial status; inquire about symptoms of depression and anxiety on the part of the patient and/or parents/caregiver; refer to psychiatric professional for intervention as appropriate
- In a qualitative study conducted in Canada with 12 pediatric brain tumor survivors (ages 9-18), researchers assessed subjective descriptions of quality of life as well as reported coping strategies. The children in the study reported a variety of symptoms, including fatigue, headaches, cognitive and physical impairments, and sleep disturbances. Despite these symptoms, most children in the study described their quality of life as “good,” which researchers suggested might reflect a change in frame of reference or point of view after having experienced cancer and cancer treatment. Coping strategies reported by the children in this study included taking breaks, taking medicine, volunteering, laughing, and using assistive devices\(^{(46)}\)
- Does the child experience frustration with communication receptively or expressively? How does the child communicate with friends? With family?

- **Hearing:** Document hearing ability
- Chemotherapy has been linked to acquired hearing loss in children with brain tumors\(^{(11)}\)
- A hearing screening with an audiometer is within the scope of practice of an SLP and should be performed prior to all pediatric speech and language evaluations\(^{(12)}\). If a child fails to achieve a threshold of 20dB across the speech frequencies (500, 1000, 2000, and 4000Hz), a referral to audiology should be made for a full audiological evaluation
Barriers to learning
- Are there any barriers to learning? Yes__ No__
  - If Yes, describe__________________________

Medical history
- Past medical history
  - Previous history of same/similar diagnosis: Does the child have another type of cancer in addition to the brain tumor?
    Has the child had a previous brain injury, stroke, hearing loss, or brain infection? Did the child have a premorbid communication disorder such as language delay, articulation disorder, stuttering disorder, learning disability, intellectual disability, or cerebral palsy?
  - Comorbid diagnoses: Ask child’s parent or caregiver about other problems, including diabetes, cancer, psychiatric disorders, and orthopedic disorders
  - Medications previously prescribed: Obtain a comprehensive list of medications prescribed and/or being taken (including over-the-counter drugs)
    - Chemotherapy has been linked to acquired hearing loss in children and adolescents with brain tumors (11)
  - Other symptoms: Ask child and parent/caregiver about other symptoms the child might be experiencing
    - Survivors of pediatric brain tumor are at increased risk of being underweight (10)

Social/occupational history
- Patient’s goals: Document what the child and family/parent hope to accomplish with therapy and in general
- Functional limitations/assistance with ADLs/adaptive equipment: Does the child use a walker, wheelchair, leg braces, etc.? Does the child have a hearing loss? Does the child require/wear hearing aids or cochlear implants? Does the child require/wear glasses? What are the child’s functional communication limitations? Is the child able to get his or her needs and wants met? Is the child able to eat with age-appropriate independence? Are modifications to the child’s food or eating environment necessary?
- Living environment: Stairs, number of floors in home, with whom child lives, (e.g., parents/caregivers, siblings)
- School/classroom environment: Does the child attend daycare or school? Does the child have an individual family service plan (IFSP) or individualized education plan (IEP)? What support services does child receive in school (or in the home for 0-3)?

Relevant tests and measures: (While tests and measures are listed in alphabetical order, sequencing should be appropriate to patient medical condition, functional status, and setting)
- Arousal, attention, cognition (including memory, problem solving): Children with brain tumors often present with cognitive deficits such as impaired attention (especially sustained and selective attention), problem solving, processing speed, visual-spatial memory, executive functioning, memory, and judgment. (8, 9, 13, 14, 15) It is important to establish the patient’s areas of cognitive deficit in order to develop a proper treatment plan. The results of these tests might also assist the child’s physical and occupational therapists in planning their own treatment sessions. Performance factors such as fatigue or reduced concentration might also be present and might cause the child’s deficits to appear more severe. (16) Refer to teachers’ reports for school-aged children
  - In a meta-analysis examining the neurocognitive functioning of pediatric brain tumor survivors, authors found that these patients frequently exhibited extensive impairments in intellectual functioning and attentional abilities. (35) In this meta-analysis, overall IQ scores were on average .54 to .9 standard deviations below the normative samples, and typically performance IQ (perceptual organization and processing speed) scores were lower than verbal IQ scores (verbal comprehension and working memory) (35)
  - In a study conducted in France with 29 children aged 6-11 years who had been treated for cerebellar tumors, researchers found that these children had increased learning difficulties in school as compared to their typically developing classmates; more difficulties were reported in mathematics and reasoning versus reading (17)
  - In a study conducted in the United Kingdom, researchers compared the cognitive functioning of 34 children (ages 2 to 16) with brain tumors soon after their diagnosis and 1 year post diagnosis to that of a group of healthy, matched controls. (44) The children with brain tumors had significantly reduced cognitive performance in tests of performance IQ, processing speed, verbal and visual memory, and selective attention early post diagnosis compared with the control group. Improved performance over 12 months was seen in the children with brain tumors as well as, for some measures, in controls. One year post diagnosis, the children with brain tumors exhibited impairments of verbal IQ, processing speed, visual and verbal immediate memory, and selective attention. Researchers reported that tumors in an infratentorial site, high-grade...
tumors, history of hydrocephalus, treatment by radiotherapy, and treatment by chemotherapy were associated with poorer cognitive functioning in this sample. Possible tests for language-related cognitive skills include:

- **Test of Problem Solving – Elementary, Revised (TOPS-Elementary)**: standardized test for children aged 6-11 assessing the following areas: problem solving, determining solutions, drawing inferences, empathizing, predicting outcomes, using context cues, and vocabulary comprehension.

- **Test of Problem Solving – Adolescent (TOPS-Adolescent)**: standardized test for children aged 12-17 years, 11 months with 5 subtests: Making Inferences, Determining Solutions, Problem Solving, Interpreting Perspectives, Transferring Insights.

**Assistive and adaptive devices**: Assess need for and ability to use augmentative and alternative communication (AAC). For additional information on assessment and treatment for AAC with children, see the series of Clinical Reviews on this topic.

**Oral structure and oral motor function**: Complete a full oral mechanism exam. The child might present with reduced lingual, labial, or velar strength, range of motion, and rate of movement. Strength and speed of the labial and lingual muscles might be assessed through diadochokinetic rates (repetition of syllables /pa/, /ta/ and /ka/) or by using a miniature lip or tongue pressure transducer such as the Entran Flatline transducer. Laryngeal and velopharyngeal function should also be examined during the oral mechanism examination. This might be accomplished by analyzing voice samples formally (using computer programs such as the Kay Elemetrics Multidimensional Voice Program) or informally by perceptually evaluating and describing voice samples.

**Perception** (e.g., visual field, spatial relations): The child might experience perceptual deficits. Chemotherapy has been linked to acquired hearing loss in children and adolescents with brain tumors. Following chemotherapy treatments, an audiologist should complete a full audiological evaluation. An ophthalmologist should complete a full visual examination. If during the exam it appears the patient has altered perception, refer to audiology, ophthalmology, or neurology for further testing.

**Sensation**: Patients with a brain tumor might experience deficits in sensation. Informal tests for sensation include normal touch, light touch, pinprick, position sensation, vibration, and temperature. An occupational therapy evaluation would include more extensive testing for touch sensation; review available reports regarding sensory deficits prior to evaluation.

**Speech and language examination (including reading)**: A complete and detailed evaluation of patient’s communication ability is necessary. Several sessions might be required to complete the initial evaluation so that a proper treatment program might be developed.

- **Speech**
  - An SLP can analyze a sample of spontaneous speech documenting evidence of articulation errors, fluency disorders, or a voice disorder.
  - Respiration must be intact in order for the child to produce adequate phonation for speech. Respiratory function might be analyzed with spirometric (such as a spirometer) and kinematic (such as a respiratory inductance plethysmograph) procedures.
  - In some cases, complete mutism can occur in children with brain tumor.
  - Posterior fossa syndrome (PFS), also known as cerebellar mutism syndrome, occurs in 8-25% of children who have had surgery to remove a cerebellar tumor.
    - In addition to postoperative mutism, PFS is associated with emotional lability (e.g., irritability, crying, apathy, agitation), neurobehavioral abnormalities, and neurological manifestations (e.g., paresis, incontinence, visual disturbances).
    - PFS typically manifests 1-2 days postsurgery and can last from 1 day to several months postsurgery.
    - Following resolution of the complete mutism associated with PFS, patients often exhibit severe dysarthria of speech.
  - A motor speech evaluation should be performed to identify or rule out coexisting apraxia and/or dysarthria in children with brain tumor.
  - Brain tumors in the cerebellum are associated with symptoms characteristic of ataxic dysarthria (e.g., slurred, distorted, irregular, and imprecise production of consonants and vowels, excess and equal stress, slow rate of speech, mono-pitch/mono-loudness, explosive speech with poor control of pitch and loudness).
- For information on assessment and treatment of apraxia, see "Clinical Review... Apraxia of Speech (Acquired)"
- Standardized tests of speech/articulation include:
  - Children’s Speech Intelligibility Measure (CSIM):\(^{21,22}\) standardized test of a child’s intelligibility; allows clinician to monitor the effects of therapeutic intervention and alter the therapy plan as needed to facilitate progress; for children ages 3; 0 to 10; 11
  - Fisher-Logemann Test of Articulation Competence (F-LTOAC):\(^{5,19,21,22}\) standardized test for patients from preschool age through adulthood; test provides both a method for eliciting spontaneous responses for each phonemic occurrence as well as a framework for analysis of data
  - Frenchay Dysarthria Assessment-second edition (FDA-2):\(^{5,19,21,22}\) standardized test for the differential diagnosis of dysarthria; divided into 11 sections: reflex, respiration, lips, jaw, palate, laryngeal, tongue, intelligibility, rate, sensation, and associated factors; provides norms for ages 12 through adult
  - Verbal Motor Production Assessment for Children (VMPAC):\(^{22}\) standardized test divided into three main sections: Global Motor Control, Focal Oromotor Control, and Sequencing; two supplemental sections: Connected Speech and Language Control and Speech Characteristics

Language: Receptive and expressive language impairment can occur in children with brain tumors.\(^{8,9}\) Language skills in children with brain tumors can vary from typical to severely impaired; case studies of children with brain tumors have even reported language skills that are above average after treatment for brain tumor.\(^{36}\) Because a child with brain tumor might have still been developing speech and language at the time the brain tumor presented, it is important to determine premorbid level of linguistic functioning through parent interview or review of teacher reports prior to assessing current language skills.\(^{5}\) A child whose brain tumor develops after the child has mastered expressive and receptive language is less likely to experience language impairment.\(^{36}\) A history of brain tumor does not necessarily mean that a child will have a language impairment. In a case study in Australia of a female patient who was treated for a medulloblastoma with fractionated cranial radiation therapy (delivery of smaller individual doses of radiation at a rate of accumulation that is up to 50% faster than that of standard delivery in order to reduce the duration of therapy and the potential for tumor repopulation) at age 10 years, 3 months, authors reported language and semantic processing abilities on par with age-matched, typically developing peers at 14 years of age.\(^{36}\) Testing might include any or all of the following diagnostic tests:
- Clinical Evaluation of Language Fundamentals – Preschool – Second Edition (CELF-P-2):\(^{16}\) standardized test of language for children aged 3 years through 6 years, 11 months; provides Receptive, Expressive, and Total Language Scores
- Peabody Picture Vocabulary Test – Fourth Edition (PPVT-IV):\(^{16}\) standardized test of receptive vocabulary for patients aged 2 years 6 months through 90+
- Test of Language Development – Fourth Edition (TOLD-4):\(^{16}\) standardized test for children aged 4-8; seven subtests: Picture Vocabulary, Oral Vocabulary, Grammatic Understanding, Sentence Imitation, Grammatic Completion, Word Discrimination, and Word Articulation

Fluency: Children who have or have had brain tumors sometimes exhibit symptoms of acquired stuttering, or dysfluency.\(^{26,27}\) Types of disfluencies include blocks, prolongations, part or whole word repetitions, phrase repetitions, interjections, word changes/unfinished words, and phrase repetitions.\(^{26}\) Analysis of disfluency is achieved by video-taping the child speaking and analyzing the following aspects of the speech sample:\(^{27}\)
- Percentage of disfluent speech – number of disfluent words/total number of words in sample
- Average and maximum number of repetitions per disfluency
- Types of disfluencies
- Location (initial, medial, final) of disfluency in the word/sentence
- For additional information about stuttering with a known neurological cause, see *Clinical Review... Stuttering: Neurogenic;* Accession Number: 5000014250

**Voice:** Children who have had brain tumors sometimes present with voice disorders\(^{(11,20)}\)

- Dysphonia from vocal cord paralysis can result from tumors in the brainstem (medulla oblongata)\(^{(28)}\)
- A complete voice evaluation should be completed to determine the presence or absence of dysphonia. (For additional information on assessment and treatment of dysphonia, see the series of *Clinical Reviews* on that topic)

**Reading/writing:** Assess reading and writing skills as part of a complete evaluation of communication abilities in school age children; portions of standardized tests for language provide standardized tests of both reading and writing. Also administer age-appropriate standardized phonological awareness tests
- In a study conducted in the United States with 18 adult survivors of childhood brain tumor and 19 healthy, demographically matched control subjects, researchers found that the integrity of childhood brain tumor survivors’ white matter influenced processing speed for reading. Word reading ability in adulthood was significantly associated with the white matter integrity of the inferior fronto-occipital fasciculus and the parietotemporal-occipitotemporal connection\(^{(47)}\)

**Swallow examination:** Dysphagia is one of the most common complications of brain tumors in childhood.\(^{(9,11)}\) Children with suspected dysphagia will require an examination of their swallowing function. A bedside (or “chairside”) swallowing evaluation might be performed by the SLP initially; however, further evaluation might be accomplished with a modified barium swallow study in conjunction with radiology

**Tracheostomy examination:** If present, assess tracheostomy tube and document date of placement, current respiratory status, and use of speaking valve; for information on assessment of patients with tracheostomies, see *Clinical Review... Dysphagia: Children with Tracheostomy;* Accession Number: 5000011947; for information on assessment of a tracheostomy tube and use of a speaking valve, see *Clinical Review... Passy-Muir Tracheostomy & Ventilator Swallowing and Speaking Valve;* Accession Number: 5000010572

**Special tests specific to diagnosis**
- Because brain tumors (and the medical treatment associated with brain tumors) can cause global deficits (e.g., cognitive deficits, speech/language deficits, motor problems, emotional disturbances), it might be appropriate to administer an assessment of adaptive functioning\(^{(29)}\)
  - Vineland Adaptive Behavior Scales (VABS)\(^{(29)}\)
    - Formal assessment of adaptive behavior assessing domains of communication, daily living, socialization, and motor skills
    - Normed for children and youth aged 0 to 18 years, 11 months

**Assessment/Plan of Care**

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**Contraindications/precautions**

- Only those contraindications/precautions applicable to this diagnosis are mentioned below, including with regard to modalities. Rehabilitation professionals should always use their professional judgment
- Patients with brain tumors are at risk for falls; follow facility protocols for fall prevention and post fall prevention instructions at bedside, if inpatient. Ensure that the patient and family/caregivers are aware of the potential for falls and educated about fall prevention strategies. Discharge criteria should include independence with fall prevention strategies
- Children with brain tumors are at risk for swallowing and feeding difficulties. Ensure that the patient and family/caregivers are aware of potential aspiration risks and educated about strategies to prevent aspiration when appropriate
- The U.S. National Cancer Institute SEER Program reports that at least 50% of all children who are long-term survivors of childhood brain tumor will experience chronic neurological deficits that will require multidisciplinary interventions.\(^{(1)}\) It is important when treating a child who has had a brain tumor to refer to both evaluation and treatment reports from other disciplines (e.g., physical and occupational therapy, psychology, audiology) as well as the reports from the child’s parents, caregivers, and teachers when devising a treatment plan
- The relative benefits and risks of intensive therapy should be evaluated on a case-by-case basis. Individual therapy for children with brain tumors will focus on remediation and compensatory strategy development for the patient’s specific speech, language, cognitive, or swallowing impairment(s). Treatment gains should be clearly documented
• To ensure relevance and appropriateness of treatment programs, decisions about goals and course of therapy should be made in collaboration with the patient, the caregivers, and other healthcare professionals. The patient’s cultural background, language preference, occupation (if relevant), and interests must also be considered.

》 Diagnosis/need for treatment: The diagnosis of a communication disorder in a child with a brain tumor will depend on the results of the full speech-language-cognitive evaluation. A child with a brain tumor might present with apraxia, dysarthria, dysphagia, dysphonia, articulation problems, or language disorders as well as a range of cognitive impairments. The need for treatment will be determined by the SLP, the child, and the child’s family and is based on the presence of a communicative, cognitive, or swallowing disorder, the child’s potential ability to make improvements, and the child and family’s desire to participate in the therapy program. Collaborate with the child’s teacher(s) and/or school therapists in order to best address the child’s communication, social-emotional, and academic needs.

》 Rule out: The child’s medical team will rule out the following diagnoses when diagnosing brain tumor in a child:

• Abscess
• Demyelinating disease
• Metastatic tumors
• Primary central nervous system lymphoma
• Stroke

》 Prognosis: According to data from the U.S. National Cancer Institute SEER Program, > 70% of pediatric brain tumor patients will be long-term survivors. At least half of the children surviving a brain tumor experience chronic neurological, motor, sensory, developmental, learning, speech/language, swallowing, or neuroendocrine deficits.

• According to a best evidence statement (BEST) guideline, available on the National Clearinghouse Guideline Web site, it is recommended that pediatric patients with acquired brain injury (including brain tumor) use computer-assisted cognitive rehabilitation with an SLP to decrease deficits in processing speed, attention, working memory, inhibition, memory, and problem solving.

• In a 15-year follow-up study conducted in the United States with survivors of high-grade childhood gliomas (median age at diagnosis 8.8 years), researchers found that survivors demonstrated mean intellectual functioning within the low-average range; half of the participants in the study performed within or above normal limits.

– In contrast, 75-90% of the survivors assessed in this follow-up study performed in borderline to impaired ranges in tests of visual learning, memory, and psychomotor processing speed.

– Researchers also found that female sex, tumor location (midline or posterior fossa), and younger age at the time of treatment for brain tumor were independent risk factors associated with lower neuropsychological, quality of life, social-emotional, and behavioral functioning.

• In a study of 67 children in the Netherlands with PA, researchers found that a younger age at diagnosis correlated with more severe cognitive impairments and academic problems in school.

• In a meta-analysis examining the neurocognitive functioning of pediatric brain tumor survivors, authors found that both treatment by cranial radiotherapy and/or chemotherapy and longer time since diagnosis were factors associated with poorer long-term intellectual functioning.

• Delaying or avoiding cranial radiation therapy (and instead treating patients with intensive chemotherapy) when medically possible in pediatric patients with brain tumor might reduce the risk of persistent neuropsychological, academic, social-emotional, and behavioral disturbances over time.

》 Referral to other disciplines: All children with a brain tumor should have a neurologist, neurosurgeon, and oncologist. If the child does not have all of these specialists actively involved in his or her case, referrals should be made.

• Patients should all be referred to physical and occupational therapy for evaluation and treatment.

• Referral to psychology, psychiatry, social work, or neuropsychology should be made if the child and/or caregiver/parent report feelings of depression, hopelessness, or other psychosocial or behavioral disturbance.

• Referral to ophthalmology should be made if child appears to present with visual field cut or poor vision.

• Referral to audiology should be made if the child appears to present with hearing loss or has received ototoxic chemotherapy.
- Referral to dietician if appropriate; survivors of pediatric brain tumor have increased risk of being underweight; patient might require supplements or supplemental feedings.

Treatment summary: Speech therapy following pediatric brain tumor is part of a multidisciplinary rehabilitation effort. Speech therapy is conducted to improve the specific symptoms as identified by the speech, language, cognitive, and swallowing evaluation.

- In a case study from the United States of a 4-year-old bilingual (Armenian and English), male patient who was treated for a cerebellar medulloblastoma, the author described the child’s speech therapy intervention:
  - Upon initial evaluation, the patient presented with mild ataxic dysarthria, monotone prosody, vocal tremor secondary to decreased overall muscle tone, as well as developmental articulation substitutions.
  - The patient suffered seizures and required a VP shunt as part of his treatment for the brain tumor.
  - In therapy, the SLP initially saw the patient with his mother present for sessions, once weekly for 20-30 minutes. Short sessions were due to patient fatigue.
  - The patient exhibited reduced selective attention and required minimal distractions in the therapy room to adequately attend to therapy tasks.
  - Areas of strengths included story part sequencing, drawing airplanes and trains, puzzles, word searches, and building toy structures.
  - At the conclusion of the case study, the author reported that in addition to being cancer-free 5 years post diagnosis, there were improvements in attention levels and reduced fatigue documented. Additionally, the patient was able to interact well with peers and participate in recess and adaptive physical education (PE) classes. He continued to receive speech, occupational, and physical therapy as well as social support services and a resource program. He was in a general education classroom but required additional instruction for reading and writing (currently at 1st-grade level).

<table>
<thead>
<tr>
<th>Problem</th>
<th>Goal</th>
<th>Intervention</th>
<th>Expected Progression</th>
<th>Home Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dysarthria (if present)</td>
<td>Increase functional speech production</td>
<td><strong>Dysarthria therapy</strong></td>
<td>Progression through therapy tasks will vary with respect to the patient and family’s goals</td>
<td>Home program will vary with respect to the patient and family’s goals</td>
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<tr>
<td></td>
<td></td>
<td>Therapy will vary according to the results of a full speech/language evaluation. Treatment might include education regarding speech intelligibility strategies and oral motor strengthening exercises</td>
<td>For information on assessment and treatment of dysarthria, see the series of Clinical Reviews on that topic</td>
<td></td>
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<tr>
<td>Dysphagia (if present)</td>
<td>Increase swallow safety</td>
<td><strong>Dysphagia therapy</strong></td>
<td>Progression through therapy tasks will vary with respect to the patient and family’s goals</td>
<td>Home program will vary with respect to the patient and family’s goals</td>
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<td>Therapy will vary according to the results of a swallow evaluation. Treatment might include strategies for airway protection, strategies for facilitating oral phase of swallowing, and dietary adjustments</td>
<td>For information on treatment of dysphagia, see the series of Clinical Reviews on this topic</td>
<td>For information on treatment of dysphagia, see the series of Clinical Reviews on this topic</td>
</tr>
<tr>
<td>Dysphonia (if present)</td>
<td>Improve functional voice production</td>
<td><strong>Dysphonia therapy</strong></td>
<td>Therapy will vary according to the results of a complete voice evaluation. Dysphonia evaluation and treatment might be performed in conjunction with an otolaryngologist</td>
<td>For information on assessment and treatment of dysphonia, see the series of Clinical Reviews on that topic</td>
</tr>
<tr>
<td>Articulation disorders (if present)</td>
<td>Increase functional speech production</td>
<td><strong>Articulation therapy</strong></td>
<td>Progression through therapy tasks will vary with respect to the patient and family’s goals</td>
<td>Home program will vary with respect to the patient and family’s goals</td>
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<td></td>
<td>Therapy will vary according to the results of a full speech/language evaluation. Treatment might include modeling, phonetic placement cues, successive approximation or biofeedback</td>
<td>For information on assessment and treatment of articulation disorders, see the series of Clinical Reviews on this topic</td>
<td>For information on treatment of aphasia in children, see <em>Clinical Review... Aphasia, Acquired Childhood</em>; Accession Number: 5000009881</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Childhood aphasia (if present)</th>
<th>Increase expressive and/or receptive language skills</th>
<th><strong>Language therapy</strong></th>
<th>Progression through therapy tasks will vary with respect to the patient and family’s goals</th>
<th>Home program will vary with respect to the patient and family’s goals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Therapy will vary according to the results of a full speech/language evaluation. Treatment might include modeling or word-finding strategies or parent/caregiver education</td>
<td>For additional information on assessment and treatment of developmental language disorders in children, see the series of Clinical Reviews on this topic</td>
<td>For information on treatment of aphasia in children, see <em>Clinical Review... Aphasia, Acquired Childhood</em>; Accession Number: 5000009881</td>
</tr>
<tr>
<td>Stuttering disorders (if present)</td>
<td>Increase speech fluency</td>
<td><strong>Stuttering therapy</strong>&lt;br&gt;Therapy will vary according to the results of a full speech/language evaluation; treatment might include fluency-shaping techniques or altered auditory feedback</td>
<td>Progression through therapy tasks will vary with respect to the patient and family’s goals</td>
<td>Home program will vary with respect to the patient and family’s goals</td>
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</table>

**Desired Outcomes/Outcome Measures**

- Improved functional communication
- Attainment of age-appropriate speech and language milestones
- Improved speech intelligibility/articulation
  - CSIM
  - F-LTOAC
  - FDA-2
  - VMPAC
- Improved receptive and expressive language abilities
  - CELF-P-2
  - CELF-5
  - PPVT-IV
  - TOLD-4
- Improved reading and writing abilities
- Increased speech fluency
- Improved vocal quality
- Improved cognitive-linguistic skills
  - TOPS-Elementary
  - TOPS-Adolescent
- Functional swallowing ability to tolerate the least restrictive diet
  - Bedside swallow examination
  - Instrumental swallow examination

**Maintenance or Prevention**

- Abilities obtained in speech therapy are best maintained through continued use of speech, language, and swallowing skills in the child’s home, community, and school environments
- The child’s school curriculum might be tailored to meet the child’s current and future needs throughout his or her educational career in order to promote success in school

**Patient Education**

- It is essential to provide education to the child’s parents, caregivers, and teachers about the child’s specific communication-related strengths and weaknesses and goals of speech therapy
• A pilot school liaison program was designed to enhance social and educational experiences of children with brain tumors and was tested in a study in Canada; the school liaison provided advocacy, support, and consultation with parents, education staff, and health professionals about each specific child. Researchers found that having this school liaison improved communication between parents and teachers and resulted in a better ability to meet the child’s overall educational needs, more realistic expectations from both parents and the teachers, improved access to resources for the child, and improved ability to predict the child’s future needs.\(^{(32)}\)

• In a study conducted in Australia, researchers examined parent and teacher understanding of the neuropsychology reports of pediatric survivors of brain tumor as well as implementation rates at home and in school of recommendations and their perceived effectiveness. Researchers reported that collaboration and clear communication among the patient, teacher, parent, and therapist was essential in meeting patient needs. Both parents and teachers reported that the types of recommendations that were the most beneficial were those that were relevant, realistic, and practical. Recommendations that were followed most frequently at home were those that were the least disruptive to the family routines and required minimal extra effort (e.g., removing visual/auditory distractors from the homework area, providing the child with short and simple directions and repeating as necessary); recommendations most followed at school were those that reflected standard teaching practice. The most common barriers to implementation of neuropsychologist recommendations were patient reluctance (e.g., the child not wanting to feel singled out) and lack of parent willingness to adopt recommendations.\(^{(45)}\)

> American Brain Tumor Association, http://www.abta.org
> National Brain Tumor Society, http://www.braintumor.org

**Note**

> Recent review of the literature has found no updated research evidence on this topic since previous publication on June 12, 2015

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**Coding Matrix**

References are rated using the following codes, listed in order of strength:

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>Published meta-analysis</td>
</tr>
<tr>
<td>SR</td>
<td>Published systematic or integrative literature review</td>
</tr>
<tr>
<td>RCT</td>
<td>Published research (randomized controlled trial)</td>
</tr>
<tr>
<td>R</td>
<td>Published research (not randomized controlled trial)</td>
</tr>
<tr>
<td>C</td>
<td>Case histories, case studies</td>
</tr>
<tr>
<td>G</td>
<td>Published guidelines</td>
</tr>
<tr>
<td>RV</td>
<td>Published review of the literature</td>
</tr>
<tr>
<td>RU</td>
<td>Published research utilization report</td>
</tr>
<tr>
<td>QI</td>
<td>Published quality improvement report</td>
</tr>
<tr>
<td>L</td>
<td>Legislation</td>
</tr>
<tr>
<td>PGR</td>
<td>Published government report</td>
</tr>
<tr>
<td>PFR</td>
<td>Published funded report</td>
</tr>
<tr>
<td>PP</td>
<td>Policies, procedures, protocols</td>
</tr>
<tr>
<td>X</td>
<td>Practice exemplars, stories, opinions</td>
</tr>
<tr>
<td>GI</td>
<td>General or background information/texts/reports</td>
</tr>
<tr>
<td>U</td>
<td>Unpublished research, reviews, poster presentations or other such materials</td>
</tr>
<tr>
<td>CP</td>
<td>Conference proceedings, abstracts, presentation</td>
</tr>
</tbody>
</table>

**References**


30. Lewis FM, Murdoch BE. Intact language skills and semantic processing speed following the use of fractionated cranial irradiation therapy for the treatment of childhood medulloblastoma: a 4-year follow-up study. *Neurocase*. 2011;17(4):332-344. (C)


