Posterior Fossa Syndrome: Rehabilitation Across the Continuum

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Learning Objectives

At the conclusion of this session, participants will be able to:
1. Discuss the pathophysiology and clinical characteristics of Posterior Fossa Syndrome (PFS).
2. Discuss the role of each member of the interdisciplinary team in the comprehensive management of patients with PFS.
3. Identify and discuss appropriate evaluation tools and treatment strategies to address the impairments and functional limitations associated with PFS across a variety of settings.

The Posterior Fossa

Near the base of the skull
Contains the brainstem and cerebellum
- Brainstem: breathing, heart rate, swallowing, alertness, digestion
- Cerebellum: movement, posture, balance, coordination

Posterior Fossa Tumors

Account for 60-70% of all pediatric brain tumors
~40% to 50% of these are medulloblastoma

Incidence of PFS

Reported incidence following PF tumor surgery ranges from 2%-50%
Older studies often report lower numbers
- Failure to recognize the syndrome?
Gadgil et al. (2016) knowledge update
- Occurs in 8-24% of children following resection of PF masses
Robertson et al. (2006)
- Reported PFS in 24% of their study population (N~450)
Most common malignant brain tumor of childhood
- Accounts for 20% of all childhood brain tumors
- 250-500 children are diagnosed in the U.S. annually
- Primarily found in children < 16 years old

Risk Stratification

**Standard Risk**
- >3 years of age
- No detectable metastatic disease
- Near or total resection

**High Risk**
- <3 years of age
- Overt metastatic disease
- Gross residual disease

More recent studies indicate that medulloblastoma is made up of distinct molecular subgroups that respond differently to treatment
- WNT (10%, favorable)
- SHH (30%, relatively favorable)
- Non-WNT & non-SHH (60%, generally poorer prognosis)

Genetic alterations within these subgroups also contribute to prognostication and treatment decisions

Surgery
Radiation
Chemotherapy

5-year survival rates:
- Local disease: 70%-80%
- Metastatic disease: 60%

Common Terms
- Deficits
  - Neurologic (motor)
  - Neuropsychologic (cognitive and affective/behavioral)
  - Neurolinguistic
- Most commonly seen in children after posterior fossa tumor surgery
  - May also occur following trauma, vascular incidents, or infections

Posterior Fossa Syndrome (PFS)
Cerebellar Mutism (CM)
Transient Cerebellar Mutism (TCM)
Mutism and Subsequent Dysarthria (MSD)
Cerebellar Mutism Syndrome (CMS)
Cerebellar Cognitive Affective Syndrome (CCAS)
**Motor**
- Ataxia
- Dysphagia
- Dysarthria
- Hemiparesis
- Nystagmus
- Oculomotor problems
- Urinary retention/incontinence

**Speech/Language**
- Cerebellar mutism
- Naming problems
- Verbal fluency
- Dysarthria
- Slowed speech
- Decreased verbal output
- Short phrases
- Ticklish noises
- Prognostic phonemes
- Reduced volume
- Hypernasality
- Vocal tremor

**Affect/Behavior**
- Depression
- Anxiety
- Apathy
- Impulsivity

**Cognitive**
- Attention
- Memory
- Executive functioning
- Visuospatial skills
- Processing speed
- Verbal comprehension
- Reading/writing difficulties

**Postoperative Deficits**
- Decreased speech or mutism
- Dysphagia
- Hypotonia
- Ataxia
- Mood changes
- Neurological deficits

**Hallmark Characteristic: Mutism**
- **Transient mutism**
  - Delayed onset (0-15 days, mean 2 days)
  - Limited duration (1 day-2.5 years, mean 43 days)
  - Recovery period marked by dysarthria
  - Not uncommon for patient to speak a few words after surgery but unable to speak the next day

Not all patients become completely mute
- May be limited to single words or short sentences (not easily elicited)

**Speech Outcomes**
- Latent onset of 1-6 days
- Children have normal speech prior to onset
- Total absence of speech
- Not of nonverbal utterances such as crying, screaming

**Clinical Characteristics: Acute Stage**
- Latent onset of 1-6 days
  - Children have normal speech prior to onset
  - Total absence of speech
  - Not of nonverbal utterances such as crying, screaming
- Worsening neurological symptoms
  - Ataxia, pyramidal paresis, oculomotor dysfunction, diminished facial expression
  - Loss of bladder and bowel control
- Behavioral disturbances
  - Apathy, depressed affect, agitation, irritability, emotional lability

**When Speech Begins to Return**
- Slow rate: 33 patients
- Short phrases: 13
- Hypophonia: 10

**Most Common Deficits**
- Increased frequency
- Long duration
- Motor deficits
- Cognitive dysfunction
- Transient eye closure
- Transient mutism
- Depression
- Anxiety
- Apathy
- Impulsivity
- Worsening neurological symptoms
Kirk et al. (1995): Retrospective study of children after PF surgery

**Timeline of Onset**

<table>
<thead>
<tr>
<th>Postoperative Symptoms</th>
<th>Within 24-107 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neurologic status changes without an identifiable factor (e.g., no change in vitals, intracranial pressure monitoring, or radiographic abnormality)</td>
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**Postoperative Symptoms**

- Facial weakness and nystagmus
- Weakness of upper extremities
- Weakness of lower extremities, emotional lability, irritability, random nonpurposive movements of extremities, difficulty verbalizing, and mutism

**Onset, Severity, & Duration**

- More severe symptoms early in recovery → symptoms that persist longer
- Absence or reduction in speech 1-2 days post-op
- Mutism 2-7 days post-op: Profound axial hypotonia and ataxia
- Recovery of speech begins after 8 weeks (on average)

**Causes**

- Multiple theories, but no clear culprit
  - Damage to dentato-thalamo-cortical (DTC) pathway
  - Damage to the vermis
  - Bilateral dentate nuclei damage
- This damage may result from
  - Poor cerebellar perfusion due to vasospasm
  - Injury related to surgery
  - Postoperative edema

**Duration of Deficits**

- Avula et al. 2016
  - Prospective review of postoperative MRI
- Kupeli et al. (2011)
  - Pre and post-op neurologic and psychological evaluations of children with brain tumors having PF surgery (PFS developed in 25% of patients)
- Morris et al. 15
  - Preoperative Imaging
  - Rostral position of tumor within 4th ventricle associated with PFS (P<0.035)
Postoperative Imaging
- PFS group had bilateral multi-focal postop injury (edema)
  - 90% of PFS group had damage to ≥ 3 of the following: Pons, dentate nuclei, superior cerebellar peduncles, midbrain
    - None of the unaffected patients had ≥ 3 structures involved
- 80% of PFS group had bilateral involvement
  - Compared to 15% of patients without PFS

Risk Factors
- Causes: Morris et al\textsuperscript{15}
- Predictors found included:
  - Brainstem invasion
  - Midline tumor location
  - Younger age
  - Absence of radiographic residual tumor
- Conclusions:
  - Children with midline tumors exhibiting brain stem invasion are at increased risk for PFS
  - More aggressive surgeries may result in increased incidence of PFS

Risk Factors\textsuperscript{16}
- Retrospective study of 63 children with medulloblastoma; PFS developed in 18 patients (29%)
- Predictors found included:
  - Brainstem invasion
  - Midline tumor location
  - Younger age
  - Absence of radiographic residual tumor
- Conclusions:
  - Children with midline tumors exhibiting brain stem invasion are at increased risk for PFS
  - More aggressive surgeries may result in increased incidence of PFS

Looking Long-Term\textsuperscript{13,17,19}
- Many patients suffer from long-term sequelae
  - Mutism tends to be transient, but speech rarely returns to being completely normal
  - Increased risk for neurocognitive impairment
  - Neurological deficits, mainly ataxia
  - Decreased quality of life and environmental access

Long-Term Neurocognitive Outcomes\textsuperscript{17}
- Palmer et al. 2010
  - 25 patients with PFS following medulloblastoma resection
  - 25 matched patients without PFS being treated on same protocol
  - Significant differences (p<0.01) between groups
- Patients with PFS
  - Demonstrated significantly lower performance in processing speed, attention, working memory, executive processes, cognitive efficiency, reading, spelling, and mathematics

Long-Term Speech & Motor Outcomes\textsuperscript{5}
- Robertson et al. 2006
  - PFS present in 24% of patients (N=450)
  - 92% of patients presented with severe or moderate PFS
    - 47% severe, 49% moderate
  - Mutism and ataxia were most frequently judged as severe
Robertson et al. 2006

- 1-year post-diagnosis

Initially Rated Severe
- 92% had ataxia
- 66% had speech and language dysfunction
- 59% had some degree of global intellectual handicap

Initially Rated Moderate
- 88% had abnormal coordination
- 25% had speech and language dysfunction
- 17% had some degree of global intellectual handicap

Steinbock et al. (2003)

Brinkman et al. 2013

- In-home evaluations of brain tumor survivors ≥ 18 years old (N=78) and matched population-based controls (N=78)
  - Environmental access
  - Health related quality of life
  - Social participation
  - Demographic and treatment information
  - Physical performance
  - Cognitive function
  - Psychological distress
- Median age of survivors was 22 years (range 18-58)

Brinkman et al. 2013

BT survivors:
- Were more likely to avoid aspects of physical environment
- Were more likely to report they did not drive
- Were more likely to report decreased HRQOL
- Participated less in functional living and social activities in their community

Treatment of PFS

- Pharmacology
- Speech Therapy
- Neuropsych & Psychology
- Physiatry
- Physical Therapy
- Occupational Therapy
- Child Life

Rehabilitation Management
Evidence is significantly lacking regarding rehabilitation for patients with PFS. Primarily limited to case studies and case series.

This may come as a shock...

Initial rapid gain of skills
- During RT and during break before chemotherapy
- Critical period for rehab
- Inpatient rehab highly recommended during this time if appropriate

Plateau during chemotherapy
- Doing our best to “hang on” to skills gained
- Typically an appropriate time to order a custom WC if indicated

More progress after completion of chemotherapy, but much slower than initially seen
- Remaining deficits are often long-lasting

Rehab Trajectory: Our Experience

Acute Care Overview
- If severe PFS, patient may remain inpatient after surgery or be admitted directly if coming from an outside hospital
- May remain inpatient throughout scans and during the beginning of radiation therapy (RT), with a break between RT and chemotherapy
- Depending on physical function and burden on caregivers, patient may remain inpatient for duration of chemotherapy
- Interdisciplinary collaboration is key

Initial Evaluation

History
- Previous level of function, activity level, previous limitations
- Home location, accessibility issues, plans to return home
- Caregivers available for training, assisting patient, equipment management

Communication & Behavior
- Alertness and orientation
- Ability to follow commands
- Ability to communicate needs (yes/no, thumbs up/down, squeezing hand)
- Mutism/ability to voice
- Flat, emotional lability

Vision/Facial/Voice Screen
- Drooling, smiling (facial droop)
- Wet voice
- Ability to track objects, attend to objects
- Strabismus and/or nystagmus

ROM (AAROM, PROM) & Strength
- Muscle tone
- Clonus
- Reflexes
- Coordination and motor control (finger to nose/finger, ataxia)

Functional Mobility
- Bed mobility
- Sitting balance
- Sit -> stand
- Standing
- Transfers
- Ambulation and stair negotiation
- Gross motor abilities
- Equipment needs
Pediatric Balance Scale\textsuperscript{21,22} 

14-item instrument 
Examines functional balance 
- Steady state 
- Anticipatory 
Administration time < 20 minutes 
Validated for children with mild, moderate, and severe motor impairments 
- Athetosis, hemiplegia, hypotonia, spastic diplegia, s/p brain tumor resection 

Pediatric Balance Scale\textsuperscript{21,22} 

Cut off scores 
- Based on typical performance 
- Scoring below cut score may indicate decreased functional balance 
- Should be interpreted with findings from clinical examination 

Pediatric Balance Scale\textsuperscript{22} 

Minimal Clinically Important Difference (MCID) 
- 5.83 points for PBS total 
- 2.92 points for static items 
- 2.92 points for dynamic items
Goals for Acute Care

- Stay focused on discharge plan
- Teaching parents/caregivers safety with mobility and transfers
- Caregiver education on task carryover in home exercise program
- Maximizing patient ability to perform assisted/independent mobility/transfers and desired activities
- Standing and ambulation if possible
- Order appropriate equipment/orthotics

Goals for Acute Care (continued)

- Meet with team to communicate progress, updated goals, and discharge planning
- Interdisciplinary collaboration to incorporate behavior/speech goals into sessions → treating the whole person

Treatment Goals:

1. Patient will be able to perform a stand pivot transfer from bed to chair with moderate assistance with an assistive device with verbal cueing for sequencing and increased time allowed for activity to assist caregivers with mobility tasks.
2. Patient will be able to tolerate sitting at edge of bed with minimal assistance with bilateral LE support and use of bilateral UE on surface x 4 minutes with independent head control to assist with a dressing activity.

Acute Care Interventions

Bed Mobility
- Rolling to both sides (sequencing LEs, UEIs, and head)
- Supine ↔ sitting (propping on elbow, maintaining alignment)
- Repositioning of self for comfort, pressure relief (bridging, scooting in bed)

Sitting Activities
- May require assistance of two people
- Be aware of input being given and ability of patient to handle increased stimuli
- Position of support (anterior vs posterior)/
- Support surface (mat vs bed)
- Use of mirrors/stools/auditory/manual cueing/weights/cervical collar
- Consider ataxia and dysmetria present with movement

Acute Care Interventions (continued)

Transfers
- Dependent → sliding board, patient lift
- Use assistive devices as patient’s strength and balance improves
- Sit ↔ stand

Standing
- Static (tilt table, standing frame)
- Dynamic (parallel bars, walker)
  - Weight shifting
  - Postural control
  - Step-ups, weight bearing through weaker extremity

Acute Care Interventions

Static Sitting
- Initial position of head/neck/shoulders/trunk/pelvis
- Increasing length of time holding position
- Having patient attempt postural corrections

Dynamic Sitting
- Weight shifting
- Reaching inside and outside of base of support
- Ability to return to midline
- Scooting on surface
### Acute Care Interventions (continued)

**Ambulation**
- Parallel bars (forwards, backwards, lateral stepping)
- Walker (distance, weight shifting, step length control)
- Hand held assistance

**Strength & Endurance**
- Gentle stretching of trunk and extremities
- Strengthening of individual muscle groups
- Recumbent bike
- Sequencing of muscle groups to make exercises functional

### Special Considerations

- Daily education to family and staff
  - Allow patient to initiate task if able
  - Stretching
  - Educate on muscle tone
  - Carryover of activities
  - Short bouts of activity, allowing for rest breaks

- Consider attention and ability to follow commands
- Use activities familiar to patient
- Be prepared to modify session based on patient presentation
- Use interdisciplinary team members

### Acute Neurological Injury (ANI) Rounds

**Interdisciplinary team that meets biweekly**
- Neuropsychology & Psychology
- Speech, Occupational, & Physical Therapy
- School
- Child Life Services
- Clinical Nurse Specialists
- Social Work

**Discuss patient status, goals, and potential barriers**
- Plan interdisciplinary goal for each team member to work on with patient
- Goal example: Pt. will choose an activity in each session when presented with 2 options to increase initiation.

### Transition to Inpatient Rehab

**Critical time to maximize return of function**

- Can completely focus on PT, OT, ST
- No other rigorous daily treatments
- Less fatigue (no radiation or chemotherapy)

**16-year-old female**
- Diagnosis of medulloblastoma, status post gross total resection
- Presented to signs of PFS day >7 from surgery
- Global ataxia, emotional lability, dysphagia, mutism
- Patient underwent 6 weeks of RT and weekly vincristine
- Main patient and family goal was to return home

**Discharge planning**
- 3 publicly funded options: adult rehab center, pediatric ABI program (far from home), community based rehab
- Patient and family opted for community rehab to remain close to home
Outpatient Therapy

- Strengthening
- Stretching
- Balance Training & Coordination
- Gait Training
- Endurance
- Orthotic Prescription
- Equipment
- HEP

Goals for Outpatient Therapy

- Gain and maintain as much function as possible during chemotherapy
- Ongoing education regarding activity expectations and rehab trajectory
- Monitor equipment needs, order custom WC if appropriate

Treatment Goals:
1. Patient will ambulate 500' with least restrictive assistive device without LOB, provided SBA for balance and verbal cueing 25% of the time to increase step length and to narrow BOS.
2. Patient will reach outside of BOS anteriorly in standing to retrieve 5 objects with minimal A to achieve weight shift and to maintain balance.

Strengthening

- NuStep, Total Gym
- Emphasis on eccentric/graded control
- Squats (don’t pop the ball), stoop and recover
- TheraBand (control band back to starting position)
- Step-ups/downs
- Sit <-> stand
- Jumping, jumping down, hopping, descending stairs
- Jump/hop and freeze

Postural muscle strengthening
- Glutes, abdominals
- Emphasis on engaging abdominals/upright posture during functional tasks

Stretching

- Will sometimes perform in therapy sessions, but often have family/patient perform as part of HEP
- Ankle dorsiflexion
- Hamstrings
- Trunk rotation, extension

Balance Training & Coordination

- Control of dynamic movement
  - Weight shifting in sitting ➔ standing
  - Activation of glutes and abdominals to perform true weight shift

Movement in multiple planes

- Coordination
  - Timing, sequencing, amount of force, spatial awareness
  - Zip Ball, catching and throwing a ball, weighted therapy bar ball taps, squat <-> stand, jumping (in place, to a target)

Obstacle negotiation
- Small obstacles (hurdles, River Stones, ramps), unstable surfaces (AirEx foam, DynaDisc), unpredictable surfaces (grass, gravel)
### Balance Training & Coordination

**Narrowed base of support**
- Walking between balance beams
- Romberg position (eyes open, eyes closed)
- Tandem stance on line → balance beam → elevated balance beam
- Single limb stance
  - Trapping soccer ball
  - Flamingo freeze

**Balance Training & Coordination**

**Pre-gait activities**
- Foot to target
  - Make increasingly difficult: heel strike when bringing foot to target, weight shift onto limb once foot is on target, weight shift with step through to next target
- Step up and over therapy bench for stair prep

**LiteGait on treadmill or over ground**
- Ambulation with appropriate assistive device or in || bars
- Anterior walker, posterior walker, hemi walker, cane
- Ambulation through obstacle course

**Begin working on stairs, curb, and obstacle negotiation as skills progress**

### Gait Training

**Gait Training**

**LiteGait on treadmill or over ground**
- Ambulation with appropriate assistive device or in || bars
- Anterior walker, posterior walker, hemi walker, cane
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### Endurance

**Transfers**

**Standing**

**Ambulation**

**NuStep**

**Recumbent or adaptive bike**

**Advanced:**
- Floor hockey
- Soccer
- Gross motor bingo
- Yoga

### Orthotic Prescription

**Orthotic Prescription**

**Use of PRAFOs initially to prevent plantar flexion contractures, pressure wounds**

**Fit for appropriate orthotics ASAP**
- AFOs (solid, hinged, carbon fiber)
- ROMs
- Arch Support

**Consider use of anti-hyperextension or hinged knee sleeve with instability**

### Equipment

**Equipment**

**Often difficult to anticipate secondary to rapid improvements initially, followed by plateau**

**Begin with loaner equipment when possible**
- Tilt in space/Convaid Rodeo → Standard or Semi-custom upright → Custom upright
- Typically appropriate to purchase a custom wheelchair during chemotherapy

### Home Exercise Program

**Home Exercise Program**

**Daily practice is emphasized**

**Primarily functional mobility and gross motor tasks**

**Train families to practice with assistive devices outside of therapy**
Difficulty following commands
- Often due to motor deficits

Decreased/absent volitional speech
- May be able to voice when laughing or crying but not on command

Poor oral motor skills

Receptive skills often relatively intact
- May be difficult to detect due to motor and speech deficits
- Speak TO them, not at or in front of them

Role of Speech Therapy: Speech Outcomes

Initial goals and activities
- Alternative means of communication
  - Gestures
  - GoTalk
  - Alphabet board
  - Picture communication board
- Vocalizing on command
- Identifying pictures
- Following bodily commands

As speech-language skills progress
- Formal testing is initiated
- Address dysarthria, initiation, and executive functioning

Role of Speech Therapy: Swallowing Outcomes

Retrospective medical record review of 19 patients with PFS

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Number of Children</th>
</tr>
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<tbody>
<tr>
<td>Dysphagia</td>
<td>7 (37%)</td>
</tr>
<tr>
<td>Impaired gag reflex</td>
<td>3 (16%)</td>
</tr>
<tr>
<td>Facial weakness</td>
<td>4 (21%)</td>
</tr>
<tr>
<td>Institution of enteral/parenteral feeds</td>
<td>10 (53%)</td>
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Ability to swallow and mood typically improved before recovery of speech
- May not indicate normal swallow
- Mood changes may persist if patient is unable to communicate wants/needs effectively
- Some patients made full recovery; swallowing difficulties persisted in others (sometimes long term)

Significant UE ataxia
- Typically worse unilaterally

Visual deficits
- Nystagmus, diplopia

Decreased level of functional performance
Decreased participation in ADL & IADLs
Difficulty with motor planning
Sensory concerns, emotional lability
Difficulty following commands
Role of Occupational Therapy

Initial goals and activities
- Increasing independence with ADLs
  - Specifically dressing, toileting, and hygiene
- Increasing mobility to participate in ADLs
- Increasing visual skills
- Functional reaching and strengthening
- Provide toileting and bathing equipment

As speech-language skills progress
- Weight bearing activities (side sitting, quadruped)
- Fine motor activities to improve coordination and strength
- School based skills
- Handwriting
- Independence in higher level self care (tying shoes, buttons)
- Functional cognition

Barriers to Achieving Goals

1. Rigorous RT schedule, often with sedation
2. Side effects from chemotherapy
   - Nausea/emesis
   - Anemia
   - Thrombocytopenia
3. Infections
4. Slow progress due to nature of PFS
5. Cancer-related fatigue
6. Communication challenges
7. Psychosocial considerations

Guidelines for Safe Exercise

Myelosuppression is a major side effect of chemotherapy
- Potential for adverse events with stressful conditions (exercise)
  - Thrombocytopenia → bleeds
  - Severe anemia → cardiac arrhythmias
  - Neutropenia → sepsis

Retrospective chart review (Gilchrist and Tanner, 2017)
- Adverse events during or after 37 of 406 PT sessions
  - Most common event was tachycardia not requiring medical intervention
  - No serious adverse events occurred

Cancer-Related Fatigue

"A distressing, persistent subjective sense of physical, emotional, and/or cognitive tiredness or exhaustion related to cancer or cancer treatment that is not proportional to recent activity and interferes with usual functioning."

- National Comprehensive Cancer Network, 2017
Cancer-Related Fatigue

- Feeling tired, weary, exhausted even after a good night’s sleep
- Lack of energy/prolonged fatigue after activity
- Weakness, heaviness in arms/legs
- Listlessness or irritability
- Trouble starting or finishing tasks due to fatigue
- Needing to sleep during the day
- Unable or requiring help to do usual or desired activities
- Being too tired to eat
- Difficulty with concentration and memory
- Limiting social activities due to fatigue

Consistent therapist when possible
- May have to introduce self and role multiple times

One voice at a time
- 1-2 step commands
- Consider automatic movements
- This then that statements

Allow increased time for processing
- Collaborate with speech and psychology regarding communication and cognitive abilities

Published Case Studies

7-year-old male
- GTR medulloblastoma, 4th ventricle
- Post-op: inability to speak, left-sided weakness, irritability
- Transferred to inpatient rehabilitation hospital
  - PT, OT, ST; slow progress
  - Mute for a few days, then slow speech improvements but remained dysarthric with “robotic speech”
  - Gait unsteady, but able to walk without assistance; unable to negotiate stairs
- Challenging mood/behavior requiring risperidone during RT

Two years after completion of treatment
- Speech fluent, continuing to work with PT to address ongoing balance issues
- Behaviorally and emotionally at baseline

13-year-old male
- GTR medulloblastoma
- Post-op: paucity of speech, left-sided weakness, ataxia, VI CN palsy, emotional outbursts
- Transferred to inpatient rehabilitation hospital x 6 weeks
  - Made significant progress with speech and ambulation
  - Mood remained flat over course of RT

At 5-year follow-up
- Performing well academically, attending college
- Continued social and emotional struggles

3-year-old female
- Resection of posterior fossa ependymoma
- Post-op: dysarthria, right-sided weakness, unable to ambulate independently, emotional outbursts
- Began low dose risperidone to improve behavior
  - Allowed for safe participation in PT and ST and completion of RT

At 5-year follow-up
- Attending school full-time
- Behavior and speech issues fully resolved
- Ongoing challenges with balance → continuing to work with PT and OT regarding these issues

Harbourne et al. 2014
- 14-year-old female and 6-year-old female with PFS
  - Completed inpatient rehabilitation and outpatient programs, discharged due to lack of progress

Neuromodulation devices on the tongue
- Static and dynamic balance activities utilizing devices
- 3 days of intensive training, followed by IEP consisting of activities performed 5 days/week for 8 weeks

Clinical improvement noted in both participants
- Improved balance beyond MCID on BBT-P
- Increase in time standing on dynamic surface
- Increased gait speed and step length
Summary

- PFS occurs in up to 24% of patients who undergo posterior fossa tumor resection.
- Symptoms are often severe and last years beyond cancer treatment.
- The literature strongly advises participation in rehab, but specific strategies for management of this syndrome are lacking.
- More research is needed to determine the efficacy of specific rehab interventions for this population.

Questions?