Spasticity in the Medically Complex Child

Kavita Parikh, MD
Olga Morozova, MD
Melanie Anspacher, MD
Neha Shah, MD
Spasticity

Describe the signs, symptoms and complications of spasticity

Identify the patient with spasticity that is not optimally managed

Summarize the different pharmacologic and non-pharmacologic treatment modalities

Plan a basic approach to managing spasticity in a patient

Identify the role of the consultant (PM&R) in helping with management

Identify the patient with baclofen withdrawal and initiate management
Spasticity = Motor Disorder

Velocity Dependent
Spasticity

Learning Objectives
Definition
Etiology & Pathophysiology
Impact of Spasticity & Outcome Measures
Exam Features
Treatment Plan
Treatment Options
Medications
Intrathecal Baclofen
Selective Rhizotomy
Chemodenervation
Summary
References & Resources

Velocity dependent
Stretch dependent
UMN signs
Muscle over-activity
## Spasticity

### Upper Motor Neuron Syndrome

#### Positive Symptoms
- Spasticity
- Clonus
- Flexor/extensor spasm
- Hyper-reflexia

#### Negative Symptoms
- Weakness
- ↓ dexterity
- Paralysis
- Fatigability
- ↓ movement

---

### Learning Objectives
- Definition
- Etiology & Pathophysiology
- Impact of Spasticity & Outcome Measures
- Exam Features
- Treatment Plan
- Treatment Options
- Medications
- Intrathecal Baclofen
- Selective Rhizotomy
- Chemodenervation
- Summary
- References & Resources
| Complex Care Curriculum | Spasticity |
Spasticity

Brain Injury
- traumatic brain injury, cerebral palsy, stroke, bacterial meningitis, encephalitis, tumor, MS

Spinal Cord Injury
- tumor, infection, trauma, MS

Neuromuscular
- ALS, Friederich ataxia

Genetic disorders and degenerative diseases
- Sjogren-Larsson syndrome, Tay-Sachs disease, and Rett syndrome
Spasticity

Cerebral Palsy:

• Disorders of movement and posture causing activity limitations

• Non-progressive disturbances of developing brain

Underlying lesion is static, but musculoskeletal pathology is progressive
Musculoskeletal Progression in Cerebral Palsy

**Static**
- CNS Lesion

**Progressive**
- Musculoskeletal deformity
  - Upper Motor Neuron Syndrome
  - Spasticity and Weakness
  - Failure of longitudinal muscle growth
  - Fixed contracture
  - Bony torsion
  - Joint instability
  - Joint dislocation
  - Joint and bone degenerative changes

Must repeatedly screen children for joint dislocation as they grow
Spasticity
Spasticity

Motor Control

Bowel/Bladder

Skeletal & Skin

Self Esteem
Spasticity

Muscle Tone
- Ashworth Scale
- Modified Ashworth Scale

Muscle reaction at different velocity of stretch
- Tardieu Scale

Range of Motion
Muscle Strength
Disability/Function
Overall Motor Function
### Ashworth Scale

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No increase in tone</td>
</tr>
<tr>
<td>1</td>
<td>Slight increase in tone giving a 'catch' when the limb is moved in the flexion or extension</td>
</tr>
<tr>
<td>2</td>
<td>More marked increase in tone, but limb is easily flexed</td>
</tr>
<tr>
<td>3</td>
<td>Considerable increase in tone, passive movement difficult</td>
</tr>
<tr>
<td>4</td>
<td>Limb rigid in flexion or extension</td>
</tr>
</tbody>
</table>
# Spasticity

## Modified Ashworth Scale

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No increase in tone</td>
</tr>
<tr>
<td>1</td>
<td>Slight increase in tone - a catch and release at the end of the range of motion</td>
</tr>
<tr>
<td>1+</td>
<td>Slight increase in tone - catch, followed by minimal resistance in remainder of range</td>
</tr>
<tr>
<td>2</td>
<td>More marked increase in tone through most of range</td>
</tr>
<tr>
<td>3</td>
<td>Considerable increase in tone, passive movement difficult</td>
</tr>
<tr>
<td>4</td>
<td>Affected parts rigid in flexion or extension</td>
</tr>
</tbody>
</table>
## Spasticity

<table>
<thead>
<tr>
<th>Tardieu Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>V1:</strong> As slow as possible (minimizing stretch reflex)*</td>
</tr>
<tr>
<td><strong>V2:</strong> Speed of the limb segment falling under gravity**</td>
</tr>
<tr>
<td><strong>V3:</strong> As fast as possible (faster than the rate of the natural drop of the limb segment under gravity)**</td>
</tr>
</tbody>
</table>

*V1 measures passive range of motion (PROM)

** V2 and V3 used to rate spasticity
Spasticity
## Learning Objectives

<table>
<thead>
<tr>
<th>Observation of function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identify movement disorder</td>
</tr>
<tr>
<td>Assess sensibility</td>
</tr>
<tr>
<td>Determine active and passive ROM</td>
</tr>
<tr>
<td>Evaluate spasticity, strength, and reflexes</td>
</tr>
<tr>
<td>Evaluate posture, gait, and balance</td>
</tr>
</tbody>
</table>
Spasticity
Spasticity

Treatment Plan ↔ Patient Goals

Impact Patient Function?

Impact Daily Care?
Spasticity

Learning Objectives

Definition

Etiology & Pathophysiology

Impact of Spasticity & Outcome Measures

Exam Features

Treatment Plan

Treatment Options

Medications

Intrathecal Baclofen

Selective Rhizotomy

Chemodenervation

Summary

References & Resources

Decrease Tone

Increase range of motion

Improve fit and use of orthoses

Decrease contractures

Delay surgery

Improve position for care

Improve function

Decrease caregiver burden
Spasticity

Disease Factors
- Generalized vs. Focal
- Comorbidities
- Chronicity
- Prognosis

Patient Factors
- Patient and family motivation
- Availability of services and resources
- Compliance

Treatment Factors
- Drug formulation
- Drug Frequency
- Drug delivery
- Side effects
- Cost

Disease

Patient

Treatment

Complex Care Curriculum

Learning Objectives
Definition
Etiology & Pathophysiology
Impact of Spasticity & Outcome Measures
Exam Features
Treatment Plan
Treatment Options
Medications
Intrathecal Baclofen
Selective Rhizotomy
Chemodenervation
Summary
References & Resources

Intrathecal Baclofen
Etiology & Pathophysiology
Learning Objectives
Impact of Spasticity & Outcome Measures
Exam Features
Treatment Plan
Treatment Options
Medications
Intrathecal Baclofen
Selective Rhizotomy
Chemodenervation
Summary
References & Resources
Spasticity

Evaluate Patient: Does spasticity present a problem?

YES:
- Patient and Caregiver objectives
- Functional objectives
- Technical objectives

NO:
- No treatment
  - Continual re-assess

NO

Initiate comprehensive spasticity management program
Spasticity Management Team

- Patient
- Caregiver
- Pediatrician
- Physiatrist (PMR)
- Neurologist
- Orthopedic surgeon
- Neurosurgeon
- Therapist: PT, OT, Speech
- Orthotist and Durable Medical Equipment provider
- Other: Social Work, Dietician, Education specialist

As children age, they may be more likely to need orthoses and surgery.
<table>
<thead>
<tr>
<th>Learning Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definition</td>
</tr>
<tr>
<td>Etiology &amp; Pathophysiology</td>
</tr>
<tr>
<td>Impact of Spasticity &amp; Outcome Measures</td>
</tr>
<tr>
<td>Exam Features</td>
</tr>
<tr>
<td>Treatment Plan</td>
</tr>
<tr>
<td>Treatment Options</td>
</tr>
<tr>
<td>Medications</td>
</tr>
<tr>
<td>Intrathecal Baclofen</td>
</tr>
<tr>
<td>Selective Rhizotomy</td>
</tr>
<tr>
<td>Chemodenervation</td>
</tr>
<tr>
<td>Summary</td>
</tr>
<tr>
<td>References &amp; Resources</td>
</tr>
</tbody>
</table>

**Spasticity**

**What is the Role of the Physiatrist?**

- Function at home and in the community
- Orthoses and therapeutic equipment
- Altered muscle tone
- Facilitating the ability of the child and family to set functional goals
Spasticity

Development

Muscle Tone

Pain

Dysautonomia

Learning Objectives

Definition

Etiology & Pathophysiology

Impact of Spasticity & Outcome Measures

Exam Features

Treatment Plan

Treatment Options

Medications

Intrathecal Baclofen

Selective Rhizotomy

Chemodenervation

Summary

References & Resources
Spasticity
Spasticity

Surgical and Pharmacologic Treatment

Oral Medications
- Intrathecal baclofen

Selective dorsal rhizotomy

Reversible
- Chemo-denervation

Local corrective surgery

Permanent

Focal

Learning Objectives

Definition

Etiology & Pathophysiology

Impact of Spasticity & Outcome Measures

Exam Features

Treatment Plan

Treatment Options

Medications

Intrathecal Baclofen

Selective Rhizotomy

Chemodenervation

Summary

References & Resources
Spasticity

- Oral medications
- Intrathecal baclofen
- Chemo-denervation
- Selective dorsal rhizotomy

Learning Objectives
Definition
Etiology & Pathophysiology
Impact of Spasticity & Outcome Measures
Exam Features
Treatment Plan
Treatment Options
Medications
Intrathecal Baclofen
Selective Rhizotomy
Chemodenervation
Summary
References & Resources
<table>
<thead>
<tr>
<th>Complex Care Curriculum</th>
<th>Spasticity</th>
</tr>
</thead>
</table>


# Spasticity

## Medications

<table>
<thead>
<tr>
<th>Medication</th>
<th>Mechanism of Action</th>
<th>Most Common Side Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baclofen</td>
<td>- Spinal cord&lt;br&gt;- GABA B agonist</td>
<td>- Lowers seizure threshold</td>
</tr>
<tr>
<td>Benzodiazepines:</td>
<td>- GABA A agonist&lt;br&gt;- Spinal cord, brain</td>
<td>- Drooling</td>
</tr>
<tr>
<td>Diazepam, clonazepam</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tizanidine (Zanaflex)</td>
<td>- Alpha-2 agonist&lt;br&gt;- Spinal cord, brain</td>
<td>- Hypotension&lt;br&gt;- Hepatotoxicity</td>
</tr>
<tr>
<td>Dantrolene</td>
<td>- Calcium channel blocker&lt;br&gt;- Muscle</td>
<td>- Hepatotoxicity</td>
</tr>
<tr>
<td>Trihexyphenidyl</td>
<td>- Anticholinergic&lt;br&gt;- Central muscarinic receptors</td>
<td>- Dry mouth</td>
</tr>
<tr>
<td>(Artane)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Learning Objectives

- Etiology & Pathophysiology
- Impact of Spasticity & Outcome Measures
- Exam Features
- Treatment Plan
- Treatment Options
- Medications
- Intrathecal Baclofen
- Selective Rhizotomy
- Chemodenervation
- Summary
- References & Resources
# Spasticity

## Medication

<table>
<thead>
<tr>
<th>Medication</th>
<th>Initial Dose</th>
<th>Maximum per day</th>
<th>Doses/Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baclofen</td>
<td>2.5-5 mg x 2-3/day 0.6 mg/kg/d tid for &lt;12 mo</td>
<td>40-90 mg (age dependant)</td>
<td>3-4</td>
</tr>
<tr>
<td>Diazepam</td>
<td>0.12-0.8mg/kg</td>
<td></td>
<td>3-4</td>
</tr>
<tr>
<td>Clonazepam</td>
<td>0.01-0.03 mg/kg/day</td>
<td>0.1-0.2 mg/kg/d</td>
<td>2-3</td>
</tr>
<tr>
<td>Tizanidine</td>
<td>2 mg/day</td>
<td>36 mg/day</td>
<td>2-3</td>
</tr>
<tr>
<td>Dantrolene</td>
<td>25 mg/day (0.5mg/kg daily)</td>
<td>12 mg/kg/day or 400 mg/day</td>
<td>2-4</td>
</tr>
<tr>
<td>Artane</td>
<td>1 mg/day</td>
<td>15 mg/day</td>
<td>2</td>
</tr>
</tbody>
</table>

---

**Learning Objectives**

**Definition**

**Etiology & Pathophysiology**

**Impact of Spasticity & Outcome Measures**

**Exam Features**

**Treatment Plan**

**Treatment Options**

**Medications**

**Intrathecal Baclofen**

**Selective Rhizotomy**

**Chemodenervation**

**Summary**

**References & Resources**
Sedation is one of the common side effects with all oral medications.

To minimize potential sedation, always start low and titrate up slow.

Abrupt withdrawal can result in seizures.

If NPO, can use IV Diazepam.
AVOID MEDICATION ERROR

- Concentration is variable
- $1 \text{ ml} \neq 1 \text{ mg}$

When prescribing oral baclofen, the dose MUST be verified to avoid fatal medication errors!
Spasticity
Intrathecal baclofen: 50x response of oral baclofen
Spasticity

Who is a candidate?

Severe, generalized tone

Not successfully managed with oral medications

Improvement with test dose of intrathecal baclofen given via lumbar puncture
**Spasticity**

**PROS:**
- GABA inhibition without side effects in the brain
- Programmable to set best dose

**CONS:**
- Complications of device
- High maintenance of pump
**Complex Care Curriculum**

**Spasticity**

- **Mechanical**
  - CSF leak
  - Catheter malfunction
  - Infection

- **Medical**
  - Overdose
  - Withdrawal

**Learning Objectives**

- Definition
- Etiology & Pathophysiology
- Impact of Spasticity & Outcome Measures
- Exam Features
- Treatment Plan
- Treatment Options
- Medications
- Intrathecal Baclofen
- Selective Rhizotomy
- Chemodenervation
- Summary
Complex Care Curriculum

Spasticity

Baclofen withdrawal

Early signs:
- Pruritis
- Dysphoria
- Irritability
- Spasticity
- Tachycardia
- Fever
- Hypertension
- Respiratory Distress

Late signs:
- Hyperthermia
- Seizures
- Rhabdomyolysis
- DIC
- Altered Mental Status
- Psychomotor agitation
- Respiratory Distress
- Multisystem Organ Failure

Death

Learning Objectives
- Definition
- Etiology & Pathophysiology
- Impact of Spasticity & Outcome Measures
- Exam Features
- Treatment Plan
- Treatment Options
- Medications
- Intrathecal Baclofen
- Selective Rhizotomy
- Chemodenervation
- Summary
- References & Resources
Spasticity

Troubleshooting Pump Failure

1. Medications
2. Radiographs
3. Spiral CT

Call Neurosurgeon!

Complex Care Curriculum

Learning Objectives
Definition
Etiology & Pathophysiology
Impact of Spasticity & Outcome Measures
Exam Features
Treatment Plan
Treatment Options
Medications
Intrathecal Baclofen
Selective Rhizotomy
Chemodenervation
Summary
References & Resources
Complex Care Curriculum

Spasticity
What is Selective Rhizotomy?

NERVES

Isolated  Targeted  Destroyed

Improved Spasticity
Who is a Good Candidate?

- Ages between 4 and 7 years
- “Pure” spasticity
- Ambulatory
- Absence of fixed contractures
- Cooperation with intensive therapy
Spasticity

Learning Objectives

Definition

Etiology & Pathophysiology

Impact of Spasticity & Outcome Measures

Exam Features

Treatment Plan

Treatment Options

Medications

Intrathecal Baclofen

Selective Rhizotomy

Chemodenervation

Summary

Copyright © [2001] Professional Postgraduate Services®. All rights reserved.
| Complex Care Curriculum | Spasticity |
# Spasticity

## Learning Objectives

- Definition
- Etiology & Pathophysiology
- Impact of Spasticity & Outcome Measures
- Exam Features
- Treatment Plan
- Treatment Options
- Medications
- Intrathecal Baclofen
- Selective Rhizotomy
- Chemodenervation
- Summary
- References & Resources

## Summary

<table>
<thead>
<tr>
<th>Mechanism of Action</th>
<th>Botulinum Toxin Type A</th>
<th>Phenol</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Onset</strong></td>
<td>24-72 hours</td>
<td>&lt; 1 hour</td>
</tr>
<tr>
<td><strong>Duration</strong></td>
<td>6-12 weeks (3-6 months functional outcome)</td>
<td>2-36 months</td>
</tr>
<tr>
<td><strong>Side Effects</strong></td>
<td>Weakness</td>
<td>Dysesthesia, skin necrosis</td>
</tr>
<tr>
<td><strong>Pros</strong></td>
<td>Easy to inject&lt;br&gt; Limited dose of toxin</td>
<td>Low cost</td>
</tr>
<tr>
<td><strong>Cons</strong></td>
<td>Cost</td>
<td>Difficult to inject</td>
</tr>
</tbody>
</table>
### Advantages
- Temporary*
- Minimally invasive
- Increase ROM
- Learn normal movement patterns
- Safely repeated
- Mimic surgical outcome
- Allows age-selective timing of surgery

### Disadvantages
- Temporary*
- May decrease functional tone
- Total body dose of toxin limited (BTX-A)
- Cost (BTX-A)
Who is a Good Candidate?

- Focal increase in muscle tone
- Absence of fixed contractures
- Absence of bony/joint problems
- No underlying bleeding disorder
Spasticity

Timing of Botulinum Treatment

Early Years

- May allow postponement, simplification, avoidance of surgery

Later Years

- May provide pain relief, improved ease of care, functional goals

Complex Care Curriculum

Learning Objectives
Definition
Etiology & Pathophysiology
Impact of Spasticity & Outcome Measures
Exam Features
Treatment Plan
Treatment Options
Medications
Intrathecal Baclofen
Selective Rhizotomy
Chemodenervation
Summary
References & Resources
Spasticity
Spasticity

Spasticity = 1 component of the UMN syndrome

Spasticity = velocity dependent increased resistance to passive stretch

Underlying lesion is static, but musculoskeletal pathology is progressive

Treatment plan is not “one-size fits all”, but should be customized to patient’s goals

Most spasticity medications CANNOT be stopped abruptly. Should be weaned to avoid seizures, or switched to IV if patient is NPO.
# Spasticity


