FLEX CEUs

Pediatric Physical Therapy: Overview & Considerations

Introduction

The field of pediatric physical therapy is complex and involves many different conditions, diagnostic tools, and interventions to implement into care. In pediatrics, an interdisciplinary team is involved in the care of children including guardians, parents, the child, therapists (physical, occupational, and speech), pediatricians, specialist physicians, and dietitians. This course will discuss everything from the recognition of different pediatric conditions to the intervention and education around the management of the disorders, within the scope of physical therapy. This course will prepare physical therapists and physical therapist assistants to manage the care of the pediatric population.

Overview of Pediatric Physical Therapy [1]

Pediatric physical therapy is a specialized field within the broader field of physical therapy. It is the rehabilitation of children to help achieve their best possible development through physical milestones. Therapists that specialize in pediatric physical therapy need to know some additional information about their patients including whether they have met developmental milestones and how their parental support is. Pediatric physical therapists both help children achieve milestones to catch up with their peers and educate their parents and teachers on how to carry out therapy recommendations.

Pediatrics Age Range [1]

Children may need physical therapy services from early on in life, throughout their childhood, and even a couple of years into adulthood. Physical therapists work with newborn infants including in neonatal intensive care units. Therapists work with children to achieve developmental milestones until they are adolescents. Children can still receive pediatric physical therapy until they are twenty-one years old for optimizing how they move and interact with the world. The frequency of visits and whether or not a child will need physical therapy are determined by a team of providers (including a physical therapist) and parents. Physical therapists may see infants, children, and adolescents in many settings of practice. One of these settings includes home health in birth to three programs that emphasize early development. Another setting includes school physical therapy where therapists help their patients succeed in school by

compensating and remediating any physical and participation challenges they have. The final setting in which therapists see pediatric patients is outpatient in pediatric or general orthopedic or neurologic clinics. This can happen at any age from infancy to twenty-one years old. The outpatient setting has the most variety in terms of diagnoses because children with normal development and their parents may also seek outpatient treatment for general orthopedic conditions such as a sprained ankle or a healing humeral fracture. Overall, settings and age ranges vary among pediatric physical therapy and pediatric physical therapists should be specialized in their patient population to serve the needs of their patients.

Common Pediatric Conditions

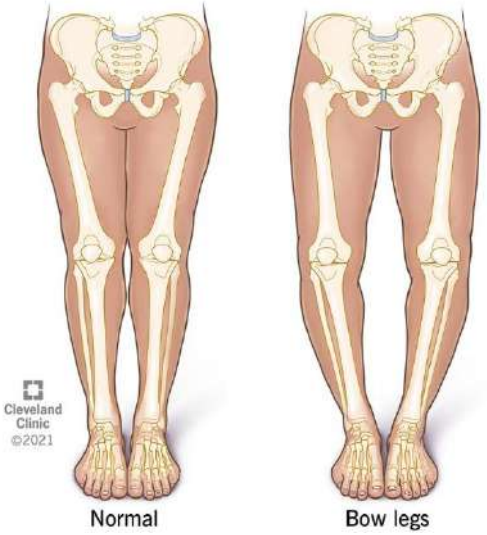
Physical therapists have a role in treating patients with virtually any pediatric medical condition that impacts physical health. These conditions could be orthopedic, neurologic, cardiovascular, pulmonary, connective tissue related, or from an injury. Each of these categories will be described in the following sections, along with their prevalence among children. It is important for children who need physical therapy to receive it to reduce dysfunction as much as possible before reaching adolescence and adulthood.

Orthopedic and Musculoskeletal Conditions [2]

Many orthopedic concerns in children are inherited and others are typically caused by accidents. Children should never be treated as small adults because they are growing and developing. It is imperative to address any orthopedic concerns when they are first recognized to avoid lifelong problems. The general focus of pediatric physical therapy regarding orthopedics is improving range of motion, strength, and pain, and helping children keep up with normal development. This section will detail common orthopedic conditions in pediatrics and the prevalence of each.

Genu Varum (Bow Legged) [3]

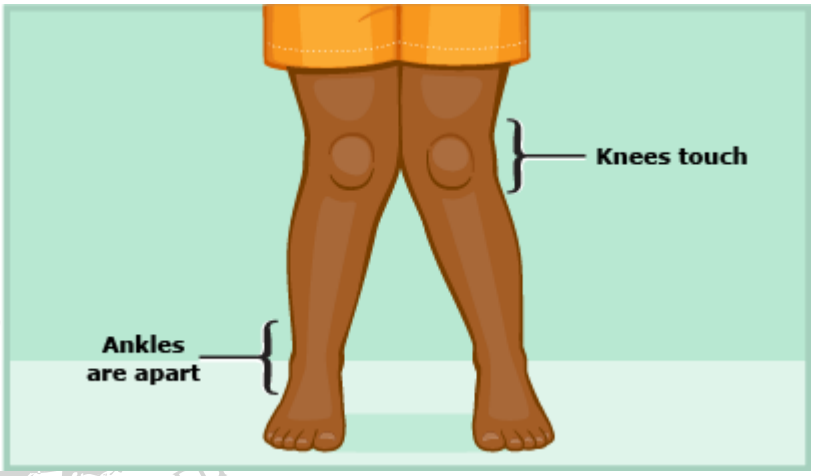
Genu varum is most common at birth due to development in the small space of the uterus. The femur and tibia go through rotation in the womb as the fetus grows. Infants at a higher height and weight typically are more bow-legged than their peers at



normal or below average size. Some sources state that the majority of infants will have some degree of genu varum until they reach toddler age. Most babies will grow into normal knee alignment by around 1.5 years of life. If genu varum does not resolve through activation of lower extremity and trunk muscles through play, crawling, and walking by two years of life, other sources could be the problem. Some other causes of bow-leggedness are growth disorders, Rickets (vitamin D deficiency causing weak bones), bone dysplasia, and dwarfism. After two years of age, genu varum that persists should be tested to determine the source. This would include imaging and blood tests. Bracing and splints may be necessary to help correct genu varum in early childhood.

Genu Valgum (Knock Knees) [4]

Genu valgum describes when the lower extremities rotate medially and the knees are closer together than the feet or hips. This is common in children from toddlers to five years old and should improve by age eight. Genu valgum is usually part of normal development but could be from things like a fracture, dysplasia, or Rickets. If genu valgum does not improve by age nine to ten, parents should mention their concerns to the child's physician who may perform tests.

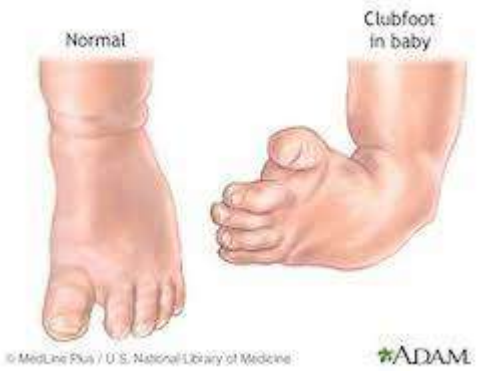


https://www.connecticutchildrens.org/health-library/en/parents/az-genu-valgum

Intoeing (Pigeon Toes) [5,6]

With intoeing, the foot deviates medially, usually bilaterally. This is quite common in babies as they begin walking and typically resolves over time, up to about eight years old. Intoeing is typically caused by metatarsal misalignment, which occurs from birth. For example, the metatarsus adductus creates a misalignment where metatarsals are pointed medially (adducted) compared to normal alignment, making the entire foot turn in. Intoeing in toddler years (1-3) can be caused by internal rotation of the tibia, creating a medial displacement of the foot. This typically also resolves on its own in a couple of years. Another common presentation that appears to be intoeing occurs at the hip and is called femoral anteversion. The femur is rotated internally usually due to development in the small space of the womb. This will usually present noticeably at an average age of four to five years old and also resolve on its own over time.

Other causes of intoeing which may be chronic include cerebral palsy (discussed in another section), talipes equinovarus (clubfoot), and developmental hip abnormalities. Idiopathic clubfoot is congenital (present at birth) and is typically a result of a short Achilles tendon. There are other causes of clubfoot, due to neurologic or developmental disorders that will be discussed in later sections. Clubfoot occurs twice as much in boys as girls and at a prevalence of 1 in 1,000 infants. Babies with talipes equinovarus will need casting and bracing to correct the deformity until around age five, and will typically have no restrictions from it.



Pes Planus (Flat Feet) [7]

Pes planus is another name for flat feet and is characterized by arch collapse with foot contact with the ground. The ankle everts as well, causing pronation. Flat feet are very common, as nearly all babies and around half of the children from three to six have them. Only one in seven adults will still have flat feet from childhood. Usually, pes planus resolves as the child gains strength in the feet and as the ligaments in the foot develop. If feet are painful or if the problem persists into middle school, physicians may suggest orthotics for comfort and physical therapy.

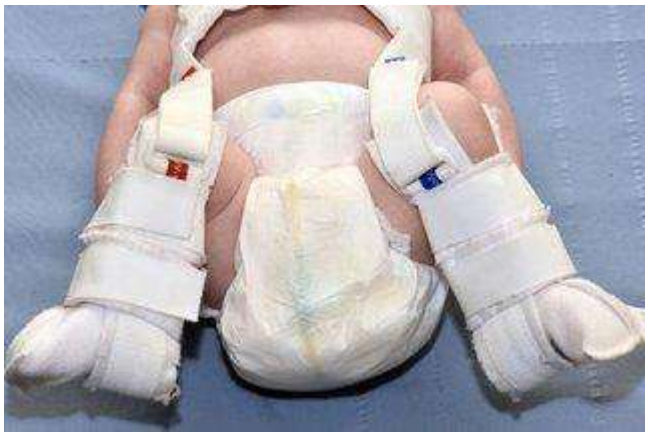
Congenital Muscular Torticollis (CMT) [8]

CMT is noted at birth and occurs when one side of the neck is very stiff due to a shortened sternocleidomastoid muscle causing lateral flexion toward the stiff side and rotation away from the stiff side. CMT most often occurs in large babies due to cramped space in utero and pressure on the sternocleidomastoid muscle during delivery. Babies with CMT must be referred to physical therapy early on to initiate a stretching protocol and educate caregivers on how to complete this as well. Infants may develop plagiocephaly if not treated properly, which involves flattening of the head due to laying disproportionally on that spot. CMT occurs in less than one percent of births.

Developmental Dysplasia of the Hip (DDH) [9]

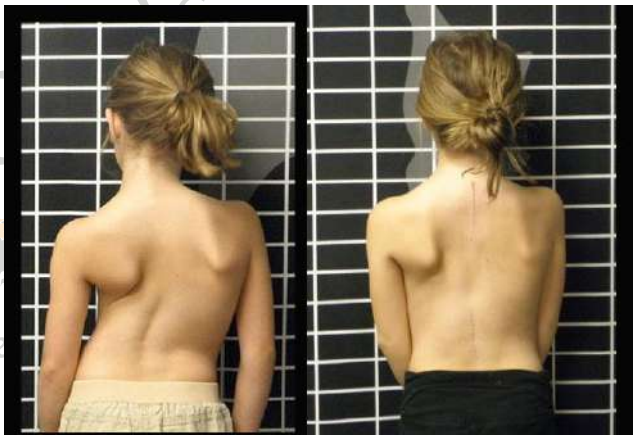
With DDH, the femur and acetabulum of the hip do not articulate or form correctly as the acetabulum is too small. This occurs in two out of 1,000 newborns where treatment is necessary. Babies that have unstable hips upon newborn examination will be sent for a scan around one-month-old to monitor if the dysplasia improves. Treatment would include a splint called a Pavlik harness which would allow the hips to grow and stabilize.

This harness needs to be worn at all times for a few weeks to be effective. Surgery is necessary as a last resort at six months old and consists of reduction to place the head of the femur inside the acetabulum. Surgery is followed by casting for three months.



Pediatric Scoliosis [10]

Scoliosis is characterized by excessive curving and rotation of the spine which can range from mild to severe cases. It affects around two percent of the population. Idiopathic scoliosis is common and occurs from an idiopathic/unknown cause. Congenital scoliosis is discovered at birth and neuromuscular scoliosis is a side effect of conditions like cerebral palsy and spina bifida. Mild cases of scoliosis often go undetected, making it important for healthcare providers to screen for it. A physical examination determining the balance of muscles and bones in the spine will often be enough for diagnosis and is sometimes reinforced by imaging. If curves in the spine are more than 25degrees, a child may need bracing and if curves are greater than 45 degrees surgery may be necessary.



https://pediatricscoliosissurgery.com/case-studies/meghan-pediatric-scoliosis-case/

Common Injuries

Pediatric patients are very prone to injury as they grow and develop strength, balance, and coordination. It is common for children to fracture bones and sprain ligaments from falls and playing. Nearly half of children will break a bone at some point during childhood. Many child-specific injuries occur more often due to the process of development.

Little League Elbow and Shoulder [11]

This occurs due to repetitive activity to the shoulder or elbow in children who play ball sports or swim from ages 10 to 14. Little league shoulder involves tearing of the cartilage surrounding the proximal humerus and little league elbow involves damage to the

ligaments surrounding the elbow. This is most commonly treated by physical therapy and activity modification.

Osgood-Schlatter [12]

This occurs due to a traction injury from the apophysis of the proximal tibia at the patellar tendon insertion and presents with edema and prominence at the anterior knee at the proximal tibia. Children who play sports are most at risk for this knee condition. It occurs in 20 percent of active children from the age of 10 to 15. Osgood-Schlatter typically occurs in children who are undergoing rapid growth spurts. Management includes conservative (physical therapy and activity modification) and nonconservative (surgical) management.

Ankle Sprain [13]

Most ankle sprains are minor and heal with rest and activity modification. Sprain grades range from Grade 1 with a small tear to Grade 3 with a full tear of the ligament. The most common ligament is the anterior talocrural ligament on the lateral aspect of the ankle. Kids are susceptible to ankle sprains due to developing ligaments and coordination. Sprains as children are more likely to develop into unstable ankles prone to sprains as adults. The prevalence of ankle sprains in children is around 5-10 out of 1,000.

ACL Tear [14]

The anterior cruciate ligament stabilizes the knee and is commonly torn from twisting or jumping sports. The ACL attaches from the anterior and medial part of the tibial plateau to the posterior and medial part of the lateral femoral condyle. An ACL tear is a common injury in children who play basketball, football, soccer, and volleyball. ACL reconstruction is typically needed in children who are attempting to return to a sport. This is typically followed by a course of physical therapy to return optimal knee function for daily life and sport. The prevalence of ACL tears in children is 7 out of 100,000.

Spondylolysis [15]

Spondylolysis is a stress fracture in one of the lumbar vertebrae at the pars interarticularis and occurs from high-impact sports such as track and field, weight lifting, and gymnastics. These sports create the demand for a lumbar extension which puts the spine at risk of fracture. Spondylolysis usually heals with conservative management including rest and activity modification. Children are at risk for spondylolysis due to their bones continuing to grow and mature. Nearly one in 20 people have spondylolysis within their lifetime.

Neurological Conditions

Several neurologic conditions occur in the field of pediatrics. These are disorders that affect the central or peripheral nervous system, a child's development, and ability to participate in normal activities. These conditions also occur in adults but this section will focus on the implications for children.

Spinal Cord Injury (SCI) [16]

Spinal cord injury occurs when a portion of the spinal cord is damaged from contact with one of the vertebrae, an outside object, or as a result of disease or spinal infection. Trauma from things like a fall, car accident, or a gunshot can damage the spinal cord, leaving a patient partially or fully unable to use their lower or upper extremities depending on the level of injury. Diseases such as polio, spina bifida, and spinal tumors can also cause SCI. Children are just as susceptible to SCI as adults. An SCI at the cervical spine will affect upper extremity and lower extremity functioning, sensation, and coordination, and an SCI at the thoracic or lumbar spine will cause lower extremity dysfunction and poor sensation. A complete SCI means there is no motor/muscle function below the spinal cord segment that was injured. An incomplete SCI means there is some communication with motor neurons below the site of injury and has a much better prognosis for returning to function. Patients with SCI often struggle with spasticity or flaccidity of muscles, bowel and bladder control, and regulation of blood pressure with different positions. Children who sustain an SCI are around 90% likely to develop scoliosis if the injury occurs before puberty. This is due to the skeleton developing in response to the injury or fracture that caused the SCI, curving the spine. The prevalence of SCI in children is around 2 out of 100,000 and most commonly happens from crashes and falls.

Spina Bifida [17]

Spina bifida has a variety of types with different severity and is a class of disorders involving a neural tube defect. It occurs due to the neural tube not closing in fetal development and can happen anywhere along the spine. Three common types of spina bifida are myelomeningocele, meningocele, and spina bifida occulta. Myelomeningocele is severe and results in a collection of fluid with the spinal cord and nerves entering this space. This causes often severe disability of motor and sensation function at that spinal level and below. Meningocele means that there is a fluid sac off of a spinal segment, but no nervous tissue exists within this space. Due to no nervous involvement, there are only minor disabilities associated with it. Spina bifida occulta is very mild and there is a

gap among spinal vertebrae at a certain spinal level. This is typically not diagnosed until later in life than adolescence. Spina bifida has an unknown etiology which may be from genetics or environmental factors and the risk is reduced if the baby has a safe environment for gestation (avoiding very warm temperatures, enough folic acid, etc.). Spina bifida affects approximately 7 out of 10,000 births in the United States.

Cerebral Palsy [18,19]

Cerebral palsy (CP) is a group of neurologic disorders that range from mild to severe in presentation. CP occurs from a problem with brain development in utero or a complicated birth that deprives the brain of oxygen. CP is linked to damage within the white matter and the deprivation of oxygen to the brain during development, also called periventricular leukomalacia. CP causes problems with posture, movement, muscle function, intellect, vision, hearing, and speech. Children with CP present with differing severity of spasticity or muscle shortening and stiffening, dyskinesia or involuntary movements, and ataxia or problems with coordination and balance. Nearly 50% of children with CP have a type of cognitive impairment which causes developmental delay, poor language development, mental health problems such as depression and anxiety, and a struggle to keep up with peers.

Spastic cerebral palsy is the most common type and affects nearly 80% of people with CP. Children with spastic CP will typically have muscle stiffness, Spasticity affects the tone of muscles, causing resistance in lengthening a muscle. Spastic diplegia affects the stiffness in muscles of the lower extremities, most often in the calves, hip internal rotators, and knee flexors. The most common gait pattern is scissoring and toe walking. Spastic hemiplegia is muscle stiffness on just one side of the body (one arm and leg). People with spastic hemiplegic CP can usually walk and struggle with the use of their arms more than their legs. Spastic quadriplegia impacts all limbs and the trunk muscles. People with this type of CP are usually unable to walk and struggle with intellect, vision, hearing, and speech, and may have seizures.

Dyskinetic cerebral palsy is a group of CP types including athetoid, choreoathetoid, and dystonic CP. People with dyskinetic CP struggle to control the mobility of their limbs due to varying levels of tone ranging from stiffness to loosening (hypertonicity to hypotonicity) throughout time. Children and adults with this type of CP struggle to stay still and move controllably in all mobility and at rest activities.

Ataxic cerebral palsy impacts balance and coordinated movements the most. Children with ataxic CP will have trouble with steadiness when walking and fine motor tasks like

using a utensil to eat and write. Fast movements such as turning quickly to change directions walking and controlled movements like drawing things are difficult.

Mixed cerebral palsy involves symptoms of a couple of types of CP. The most common mixed type is spastic-dyskinetic CP, which would result in difficulty controlling movements with spasticity in muscles.

Recognition of CP is important to help children grow and develop to the best of their abilities as early as possible. Some children with mild types may not be diagnosed until a couple of years of life when developmental delay and poor gait mechanics can be detected. Nearly one in 1,000 children born around the world will have a type of CP. CP is the most common disability of the muscles and motor function in children and is most common in children with low birth weight.

Muscular Dystrophy [20]

Muscular dystrophy (MD) is an inherited progressive neuromuscular disorder with nearly thirty different types. This collection of disorders all create myopathy or dysfunction in varying muscle groups in the body. Duchene muscular dystrophy (DMD) is a common type and occurs due to a defective dystrophin gene. This impairs muscle function quickly due to dystrophin's crucial role in muscle development. DMD follows x-linked recessive inheritance, meaning males are mostly affected due to a fifty percent chance of inheritance if their mother carries it (mother passes on the X chromosome while father passes on the Y chromosome). Females only have a fifty percent chance of being a carrier if their mothers carry the defective gene for dystrophin. People with Duchene muscular dystrophy used to rarely live beyond their teenage years. With advances in medical care, patients are living into their third to fifth decades. Becker muscular dystrophy (BMD) develops due to the same affected gene but is milder in presentation than DMD. Weaknesses with DMD occur before age five while weaknesses in BMD happen in adolescence or adulthood. Proximal weakness in the arms and legs is a hallmark of DMD and BMD. The disease can eventually affect the organs and spine. People with DMD most often die from cardiac or respiratory failure. DMD affects nearly six out of 100,000 children in North America and Europe. BMD affects one out of 20,000 boys in the US. Another type of muscular dystrophy is facioscapulohumeral muscular dystrophy (FSHD) which affects four out of 100,000 US citizens. This type weakens facial, scapular, and arm muscles. There are many other types of MD, which affect other specific muscle groups.

Hydrocephalus [21,22]

Hydrocephalus is a disorder where fluid accumulates in the brain. Neurologic injury, headaches, and increased size of the head can occur within the central nervous system including the brain when cerebrospinal fluid within the nervous system is not reabsorbed into the bloodstream. Hydrocephalus can be caused by space-occupying lesions (tumor, cysts), birth defects, and bleeding in the brain. It increases pressure within the skull and pushes on the brain, causing damage if not resolved. Children will typically receive a shunting procedure to drain the cerebrospinal fluid from their brain before it damages tissue. If the fluid is not drained in time, neurologic deficits will result. These include brain damage causing issues with mobility, walking, speaking, and other tasks. The prevalence of hydrocephalus in children is 85 in 100,000 worldwide.

Chiari Malformation [23]

Chiari malformations are characterized by the cerebellum exiting the skull through the foramen magnum. Type 1 and Type 2 Chiari malformations are the most common. Type 1 is mild with some symptoms of headache, numbness, vision and swallowing problems, and balance and coordination issues. Type 1 does not reduce life expectancy typically, but if symptoms are severe, surgery is an option. Type 2 is often accompanied by myelomeningocele spina bifida and its symptoms and abnormal development in the spinal cord. The overall prevalence of Chiari malformations is less than 1 in 1,000 births.

Autism [24]

Autism is a disorder where behavior, verbal speech, and social interaction skills are impaired. Children with autism have impaired neurodevelopment which causes an impaired perception of the world around them. There are known contributing causes for the development of autism, but they are not well understood. Some of these causes include genetics, behavioral factors, and environmental factors. Autism is very common affecting around 1 in 100 children.

Down Syndrome (DS) [25]

Down syndrome is a neurodevelopmental hereditary disorder also known as trisomy 21. Trisomy 21 occurs when a child inherits three chromosomes at chromosome position 21 instead of just a pair. An extra chromosome is responsible for intellectual disability, and problems in the cardiovascular, digestive, immune, endocrine, musculoskeletal, renal, and neurological systems. Characteristics of DS are lax joints, hypotonicity in muscles, a slant upward of the eyes, one large palm crease, and flattened facial features. Around one in 700 babies born in the world have Down Syndrome, and it is the most common

chromosomal disorder. The lifespan for people with DS is around 60 years due to medicine managing the comorbidities of the condition. In the 1980s lifespan was under 30 years. There have been many recent studies that look at the efficacy of physical therapy in improving motor skills, balance, and strength in people with Down Syndrome to help improve their quality of life.

Cardiovascular Conditions [26]

Cardiovascular conditions in children are typically present at birth (congenital). Congenital heart defects affect approximately four out of 1000 births. In addition to congenital heart problems, more children are becoming susceptible to lifestyle-related cardiovascular conditions, such as hypertension and cardiovascular disease. This is typically due to higher rates of obesity among children.

Ventricular Septal Defect (VSD) [27]

A VSD is congenital and occurs when an infant's heart has a gap in the septum between the heart's ventricles. With a VSD, blood rich with oxygen coming from the lungs gets mixed with oxygen-depleted blood coming from the body. The severity of this ranges from low with a small size VSD to high with large VSDs. Surgical repair as an infant is often necessary for children with large or medium-sized VSDs. Small VSDs are often detected in childhood or even adulthood at regular checkups where a physician finds a heart murmur. Nearly one in 240 infants in the United States are born each year with a ventricular septal defect.

Tetralogy of Fallot [28]

Tetralogy of Fallot consists of four congenital birth defects related to the heart. The combination of the defects allows oxygen-depleted blood to leave the heart and reach tissues instead of oxygen-rich blood. The defects are pulmonary valve stenosis, ventricular septal defect, an aortic shift, and right ventricular hypertrophy. This is typically diagnosed in infancy or soon after and presents with symptoms of breathing trouble, losing consciousness, cyanosis of the skin, and irritability. Some troubles that children with Tetralogy of Fallot can experience are heart or valve infection, disability, and death. Many infants will need open heart surgery for the best outcome to correct some of the defects. Nearly 1 in 3,000 births will be affected by Tetralogy of Fallot.

Transposition of the Great Arteries [29]

This is a congenital heart defect where the aorta and pulmonary arteries are reversed which causes oxygen-rich and oxygen-depleted blood to go to the lungs and body,

respectively. The pulmonary artery comes from the left ventricle and the aorta comes from the right ventricle with this defect. Another name for the switch of these arteries is a complete transposition of the great arteries. Congenitally corrected transposition is less common but occurs when the ventricles in the heart are reversed. The left ventricle is switched and on the right side of the heart, receiving blood from the right atrium and the right ventricle is on the left side of the heart receiving blood from the left atrium. Oxygen-rich blood does travel to the body and oxygen-depleted blood to the lungs, but this can cause problems over time because the ventricles are different in size and strength. Children with transposition of the great arteries will face complications like complete heart block, heart valve disease, poor oxygenation in the body, heart failure, and poor heart contraction for pumping blood. The prevalence of transposition of the great arteries is 1 in 5,000 births.

Atrioventricular Septal Defects (AVSD) [30]

AVSD occurs with gaps within the ventricle and atria of the heart, along with valve problems. A complete AVSD causes blood to permeate all four chambers of the heart because there is a gap at the very center of the heart. A partial AVSD involves a gap within the atrial or the ventricular wall, not both. With AVSDs, blood that is not oxygenated and that is oxygenated mix and flow to the wrong parts of the body. These are diagnosed in pregnancy or soon after birth. Children with AVSD will nearly always need surgery to close the gaps within the heart. The prevalence of AVSD is 1 in nearly 2,000 infants.

Coarctation of the Aorta [31]

This occurs when the aorta is thin compared to normal, typically after the aortic arch. This narrowing prevents oxygen-rich blood from reaching the body. Babies born with this condition will typically have labored breathing, irritability, pallor, and excess sweating signaling they are in distress. Babies will need a procedure to increase the diameter of the aorta soon after symptoms are noticed. This is typically accomplished through cardiac catheterization, a balloon angioplasty, or a stent. Nearly 1 in 1,800 babies in the United States will be born with this congenital heart defect.

Patent Ductus Arteriosus (PDA) [32]

PDA is a heart defect that may require surgery or catheterization, depending on the severity. It occurs when the ductus arteriosus between the aorta and pulmonary arteries does not close. Excess blood then flows from the heart to the lungs instead of to the systemic tissue. The ductus arteriosus should only be present during in utero

development as it allows blood to skip going through the lungs and straight to the tissues, relying on the mother's oxygenated blood from the placenta. Babies with this condition may appear in distress with labored breathing, have a heart murmur, an inability to gain weight, fatigue, and be subject to respiratory infections. Small PDAs will be monitored and given medication to manage the possibility of fluid accumulation while closing and medium and large PDAs require catheterization or surgery. This defect occurs in approximately 80 out of 10,000 births.

Hypoplastic Left Heart Syndrome [33]

This condition develops in utero and occurs due to improper development of the left side of the heart. Some common poor developments are a small or poorly developed left ventricle, mitral valve, aortic valve, or the ascending aorta. These problems prevent adequate circulation from reaching the body due to reduced cardiac output on the left side of the heart. Babies born with hypoplastic left heart syndrome will have labored breathing, cyanotic skin, rapid heartbeat, and poor pulse strength. Babies will typically need surgery or medication to manage this condition depending on the severity. Surgeries aim to redirect blood flow in the heart by changing artery position to allow more oxygen-rich blood to reach the body. Around 1 out of 3,900 babies are born with this condition.

Pulmonary Conditions

Pulmonary conditions consist of problems with the lungs and affect children and adults. Children who have pulmonary disorders typically develop them at birth congenitally or shortly after birth. This section will discuss common pulmonary pediatric conditions and their prevalence of them.

Asthma [34]

Asthma typically develops when children are young and can carry on to adulthood. Asthma creates trouble breathing due to blockages in the airway. These blockages are from inflammation which can worsen and improve over time. People with asthma will wheeze, cough, and experience chest tightness. The bronchus and bronchioles of the lungs become inflamed and the smooth muscle in the airways constricts, creating even less space for air to flow. The severity of asthma varies a lot from mild attacks triggered by exercise to severe spells which can be life-threatening when a child cannot get enough oxygen. Asthma develops for a few reasons, suspected to be genetics, environmental exposure to pollution or smoke, infections in the lungs, and allergens.

Asthma is very common affecting 1 out of 12 children in the United States at varying severities.

Stridor [35]

Stridor is also known as loud breathing and is most common in infants. Stridor is caused by a small airway that is obstructed by the trachea or glottis causing uneven air flow. The most common type of stridor in three-quarters of cases is called laryngomalacia, which is a chronic stridor affecting inspiration. This occurs due to poor formation and softening of the larynx. If babies are having severe symptoms, surgery to stabilize the tissues may be needed. Children may outgrow stridor as well. Between the ages of 6 months to three years, 6 out of 100 babies have stridor.

Cystic Fibrosis (CF) [36]

Cystic fibrosis is a recessively inherited disorder with a mutation in the transmembrane conductance regulator (CFTR) protein. People with CF experience respiratory, endocrine, digestive, and reproductive symptoms. The hallmark of CF is increased heavy and viscous mucus which creates blockages in the lungs, affecting stool and digestive function, and even blocking the vas deferens in males. Nearly all males with CF are sterile. CF is usually diagnosed before two years of life by a test that determines if the skin has elevated chloride levels. Depending on the severity, children and adults with CF need to take enzymes that help the body break down protein and fat. They also need airway clearance treatment to help clear the lungs of mucus and ingest liquid medicine that reduces lung infection risk. CF is present in one of 3,200 births in the US and life expectancy is around 30 years due to respiratory complications.

Bronchopulmonary Dysplasia [37]

Bronchopulmonary dysplasia (BPD) occurs most often when an infant is born more than eight weeks prematurely. It occurs due to the lungs lacking full development when an infant is born at low birth weight. BPD is also called chronic lung disease of premature babies, neonatal chronic lung disease, and respiratory insufficiency. Infants with poorly developed lungs will often require oxygen/mechanical ventilation and neonatal care. This oxygen is necessary to help with breathing and survival but it can damage the alveoli in the lungs. This damage can lead to BPD, along with infant lung infections. Babies with respiratory distress syndrome (RDS) who are born without enough surfactant on the lungs are at an increased risk of BPD as well. A lot of infants recover from this without any long-term complications, but some continue to have trouble breathing into childhood and even adulthood. Babies with BPD will likely have a

multifaceted approach to help them breathe including mechanical ventilation and medications like bronchodilators, steroids, and diuretics to ease the demand on the lungs. Nearly 15,000 babies born in the US have BPD and nearly 30,000 infants have respiratory distress syndrome in the United States each year.

Connective Tissue Disorders

Connective tissue disorders represent problems with immune response, structural issues with tissue, and genetic abnormalities. Connective tissue disorders vary immensely in severity and are crucial to diagnosing as young as possible in children and infants. This section will discuss common connective tissue disorders in children.

Osteogenesis Imperfecta (OI) [38]

OI is characterized by weak, brittle bones and is a genetically inherited disorder. Type 1 OI is mild and typically fractures of bones only occur in early childhood, resolving by adulthood. Type 2 OI is very severe and typically lethal due to bones being very brittle and complications at birth. Many other types of OI fall between the type 1 and type 2 categories. The prevalence of OI is 1 in around 15,000 people globally. Management of OI focuses on preventing fractures and assisting the child with independence. There are no effective medications or surgeries to prevent complications.

Ehlers-Danlos Syndrome (EDS) [39]

EDS is an umbrella term for many disorders of connective tissue. They are typically inherited disorders that present with varying symptoms from minor to severe. Hypermobile EDS is the most common type in which children will have lax skin and loose joints. Children who experience many joint subluxations, bruise easily, experience more than “growing pains” and who take a long time for wounds to heal may have hypermobile EDS. Classic EDS is the second most common type in which people will present with a lot of bruising, loose joints, skin that tears easily, wounds that heal slowly, and heart valve problems. Vascular EDS is rare and severe affecting the connective tissue lining organs. People with this type may experience a stroke or an organ rupture quite easily and have a shorter life span due to this. All the types of EDS have a prevalence of about one in 5,000 births.

Chondromalacia Patellae [40]

Chondromalacia patellae occurs when the patella is not aligned with dynamic movement and due to a weakening of the cartilage inferior to the patella. The patella comes into

contact with the femur rather than stay within its cartilage track. Children will complain of pain on stairs, after sitting for a while, and during sports. Crepitus may be heard from the patella when the knee is extended, then flexed. Children who are overweight, extremely active, or who have pes planus are most at risk for this syndrome. Chondromalacia patella is often associated with other knee disorders such as patellofemoral pain syndrome and is very common. Prevalence is as high as 29% in children.

Marfan Syndrome [41]

Marfan syndrome affects the connective tissue of the eyes, the skeletal system, and the cardiovascular system. Children will be diagnosed based on clinical presentation and genetic testing and the severity of complications varies among patients a lot. Some characteristics are tall height, long arms and fingers, a deformity of the sternum, joint laxity, hyperextension of the knees, pes planus, scoliosis, and a high incidence of inguinal hernias. Patients are at risk for sudden retinal detachment, severe myopia, sudden pneumothorax, headaches, back pain, incontinence, an aortic aneurysm, and valve prolapse. Life span is reduced to about 70 years. Prevalence is around one in 5,000 people. Treatment includes symptom management including bracing for scoliosis, medication, and surgery for the cardiovascular system.

Osteochondrodysplasias [42]

Osteochondrodysplasia represents improper bone and cartilage development resulting in dwarfism and shortened limbs. Dwarfism is officially when someone grows to be shorter than 4’ 10”. Diagnosis is made based on x-rays when limbs appear shortened. In some cases, surgeons can do limb lengthening surgeries and replace the joints of people with this disorder. The prevalence of osteochondrodysplasia is one in 25,000 births.

Section 1 Key Words

Spasticity – refers to involuntary muscle contraction that causes muscles to become rigid in response to a central nervous system problem

Flaccidity – refers to muscle paralysis where muscles relax and become smaller (atrophy) typically in response to a spinal cord or peripheral nerve injury

Dyskinetic – difficulty controlling the voluntary movement of body parts; in this case refers to dyskinetic cerebral palsy

Section 1 Summary

This section discussed common and rare disorders that children and infants can face in the cardiovascular, pulmonary, connective tissue, neurologic, and musculoskeletal systems. With these disorders and injuries, the diagnosis must be made early on so children can have a better prognosis and appropriate course of treatment. Physical therapists play a large role in the management of these disorders, which will be discussed in later sections. Therefore, it is crucial to have an understanding of these disorders to be able to help infants, children, and parents make progress in managing them.

Evaluation

Every pediatric physical therapist should have well-developed skills in evaluating children for development and normal milestones. This section will go through clinical evaluation strategies that physical therapists should be following to gain a comprehensive understanding of what aspects of a child's development and skills to intervene on. It will outline what normal developmental milestones are as well.

Evaluation Outline and Clinical Diagnostics

A pediatric evaluation begins with a thorough subjective history with parents or caretakers, a review of medical history, and what milestones have already been met. The therapist should determine what tasks the child is struggling with at home, and observe and assess the child's skills, strengths, and difficulties.

Strength Testing

Physical therapists working with children and infants must have strategies to examine the strength of their patients. This is performed in a few different ways as very young patients cannot understand manual muscle testing that adolescents and adults are appropriate for.

Observation [43]

PTs need to be able to observe their patients and compare the ability of them to complete functional skills based on normal developmental sequencing. A list of developmental milestones is found later in this section. To observe developmental strength, therapists would need to challenge the skills at normal developmental levels.

For example, a therapist may try to have a 12-month-old stand supported or facilitate a squat and determine what muscles are weak based on this. If this child is unable to squat without falling, they likely have weaknesses in their gluteals, abdominals, and quadriceps. Observation should be used in very young children or children unable to understand traditional strength testing due to cognition or behavioral challenges.

Manual Muscle Testing [43]

PTs can conduct standard muscle testing for children and adolescents who are cognitively able to understand the directions. Therapists would perform a muscle "break" test trying to overpower specific movements (hip flexion, knee extension, ankle dorsiflexion, etc.) to determine a muscle grade of strength. Muscle testing has questionable reliability from therapist to therapist but is reliable as a test-retest measurement in lower extremity muscles. The table here shows manual muscle testing grades to test muscles across the upper and lower extremities. Therapists should always conduct tests in appropriate positions (side-lying, sitting, prone, etc) and should reference a reliable source to remember the test positions if necessary.

Table 1. Manual Muscle Test Scores[a]

Score	Description
0	No palpable or observable muscle contraction
1	Palpable or observable contraction, but no motion
1+	Moves limb without gravity loading less than one half available ROM[b]
2–	Moves without gravity loading more than one half ROM[b]
2	Moves without gravity loading over the full ROM[b]
2+	Moves against gravity less than one-half ROM[b]
3–	Moves against gravity greater than one-half ROM[b]
3	Moves against gravity less over the full ROM[b]
3+	Moves against gravity and moderate resistance less than one-half ROM[b]
4–	Moves against gravity and moderate resistance more than one-half ROM[b]
4	Moves against gravity and moderate resistance over the full ROM[b]
5	Moves against gravity and maximal resistance over the full ROM[b]

[a]Adapted from Ref. 2
[b]ROM = range of motion.

https://pbrainmd.wordpress.com/2017/03/16/manual-muscle-testing/

Range of Motion Measurements

The range of motion in joints is measured just the same in children as in adults. This section will discuss normal values based on age ranges for a range of motion. Techniques

for measuring range of motion are available here: https://musculoskeletalkey.com/pediatric-range-of-motion/.

At birth, the glenohumeral joint is generally more lax than when a growing infant reaches the end of their teenage years. Glenohumeral flexion is around 176 at birth and 168 degrees at age 19. Extension goes from 85 degrees to 65 degrees, abduction is in the 180s at birth and through adolescence, internal rotation decreases from up to 90 degrees down to 70, and external rotation decreases from 123 degrees to 108 degrees. The elbow at birth has 150 degrees of flexion and two degrees of hyperextension and in adolescence 145 degrees of flexion and neutral extension. Adolescents can pronate their forearm by 13 fewer degrees than infants, and wrist flexion and extension decrease from around 90 degrees to 76 degrees. For the lower extremity, hip, knee, and ankle measurements vary as a child ages as well. In infants, hip flexion is 136, extension is lacking a degree, abduction is 57 degrees, adduction is 17 degrees, internal rotation is 38 degrees and external rotation at 70 degrees. At the end of adolescence, hip flexion is 123 degrees, extension seven degrees, abduction 52 degrees, adduction 28 degrees, internal rotation 50 degrees, and external rotation 50 degrees. At the knee, infants have 152 degrees of flexion and four degrees of hyperextension and in adolescence, flexion decreases to 144 degrees and extension to neutral. At the ankle, infants have 50 degrees of dorsiflexion, 55 of plantar flexion, 100 degrees of inversion, and 80 degrees of eversion. In adolescence, dorsiflexion reaches around thirteen degrees, plantarflexion remains about 55 degrees, inversion decreases to 40 degrees, and eversion decreases to about 20 degrees.

Outcome Measures in Pediatric Physical Therapy [44]

Outcome measures are an important way to obtain objective measures throughout pediatric physical therapy. This resource has a list of common measures, how to perform them, and reasons to implement them in care. The Pediatric chapters of the APTA also is a great resource for how to complete outcome measures in pediatric PT. Common measures and categories are listed below.

https://www.physio-pedia.com/Category:Paediatrics_-_Outcome_Measures

Quality of Life Measures

Child Health Index of Life with Disabilities

Pediatric Outcomes Data Collection Instrument

Health Measures

Child Health and Illness Profile – Adolescent Edition

Child Health Questionnaire

Multifaceted Measures

Participation and Environment Measure – Children and Youth (PEM-CY)

Children's Assessment of Participation and Enjoyment

Gross Motor

Alberta Infant Motor Scales

Gross Motor Function Measure

Fine Motor

Bruininks-Oseretsky Test of Motor Proficiency (BOTP-2)

Peabody Developmental Motor Scales Second (PDMS)

Gait

Functional Mobility Assessment

Observational Gait Scale

Play

Preschool Play Scale

Test of Playfulness Developmental Screening

Other

Ages and Stages Questionnaire

Motor Skills Acquisition in the First Year and checklist

Developmental Milestones in Childhood [45,46]

To understand physical therapy goals for infants to adolescents, therapists must have an in-depth grasp of developmental sequencing and milestones for pediatric patients. This section will go through each stage of childhood and normal developmental milestones.

By 3 Months

By three months, infants should begin developing in many ways. Infants will see best from about one foot away and be able to watch objects in front of them. They should be able to lay prone on the floor (tummy time) and lift their head from the ground. This will begin the development of neck extensors, shoulders, and arm strength. Time playing supine will work on reaching and kicking, which will strengthen the upper and lower extremities as well as the abdominals. Infants By three months of age should be able to push into their extended knees with feet on the floor with their weight supported.

3-6 Months

By six months, infants should be able to roll completely from supine to prone and back. They should have the coordination to put their hands in front of them while playing and have increasingly coordinated motor planning with an increased number of kicks and reaches. While prone, babies by six months should support themselves on elbows and have the strength to raise their chest from the ground by extending elbows and using their arms to help with rolling from prone to supine. While supine, infants should achieve hands to knees and feet to mouth, and hold their chin to the chest while an adult pulls them to sit. With sitting, infants by six months should be able to sit without support for around sixty seconds and easily sit with self arm support.

6-9 Months

By six to nine months of age, a baby should be able to sit by themselves unsupported and attain a sitting position by themselves. In prone, they should be able to raise their arms and legs into the air independently, able to crawl alternating upper and lower extremity movement, turn their head and body fully, and attain the quadruped position.

10 months – 1 year

This period is marked by emerging independence with mobility. Babies should be able to crawl with equal movements bilaterally, attain quadruped and pull to standing, and cruise with support (walking with full upper extremity support). Babies should also begin to take a few steps without support with their arms up in the air (high guard position), stand unsupported, and squat without falling over.

1-2 Years

The most important milestone of this stage is being able to walk without support by 18 months of age. By two years, children should be able to ascend and descend stairs with a railing, begin to run and jump, throw and kick balls. From one to two years, babies will

begin climbing on furniture and staying in a squat position while playing with toys. Babies who are on track with developmental milestones should have fewer tumbles due to emerging balance and body control.

3 Years

By three years of age, a child should be pedaling three-wheeled bicycles, walking with a step-through pattern on stairs, running, and climbing things easily. They should be able to use a fork and put a jacket or loosely fitting pants on.

4 Years

By four years of age, a child should be able to hold a pencil or crayon with fingers and thumb, should have the dexterity to unbutton buttons, and catch balls easily.

5 Years

By five years old, a child should hop on one foot and succeed in buttoning shirts.

Middle Childhood (6-8 Years Old)

Children in middle childhood will seek confidence development through social support from friends and physical development and coordination through sports and activities. They should be able to dress independently, tie shoes, and catch a ball very easily.

Middle Childhood (9-11 Years Old)

Children at this stage should achieve full development physically in terms of motor skills. They may begin puberty at this stage (girls especially). Children may feel intense peer pressure and the need to fit into social groups at this stage.

Young Teen (12-14 Years Old)

This stage is marked by puberty changes such as growing facial and pubic hair and voice changes for boys. Girls will typically grow breasts and pubic hair as well as start their period. Teenagers are especially vulnerable to emotional and mental health conditions such as depression, eating disorders, and substance abuse by peer pressure (drugs, alcohol, tobacco).

Teenagers (15-17)

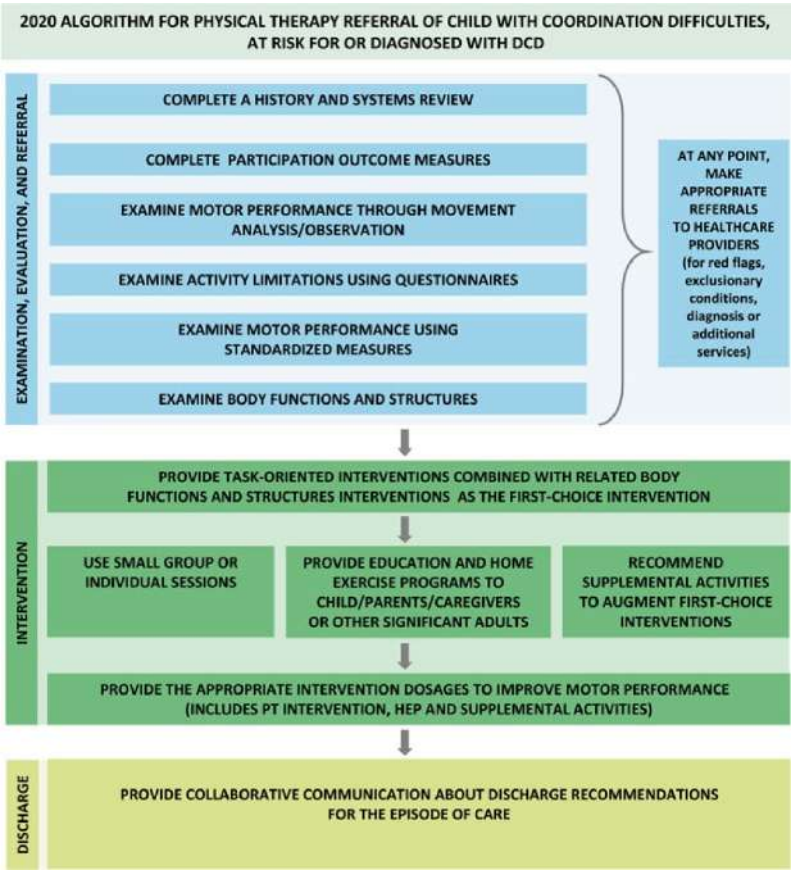
Girls are typically through puberty at this time and boys are still changing physically. This period allows personality development, independence, and a sense of responsibility.

Teenagers begin driving, working, and thinking about living independently after high school at this stage.

EBP to Establish a Goal-Directed Plan of Care [47]

A few clinical practice guidelines exist in the field of pediatric physical therapy, including one to assess and treat children with developmental delay and poor coordination. This is quite common as an association with many of the disorders mentioned in this course including cerebral palsy, muscular dystrophy, autism, spina bifida, and many orthopedic conditions (developmental dysplasia of the hip, genu varum/valgum, pes planus, etc.).

Evidence suggests that therapists should conduct a stepwise focus on their evaluation and follow this with specific interventions and a discharge plan to ensure the most comprehensive care of children with developmental delay. An algorithm on the care sequencing and considerations is available in this section. It highlights examining activity limitations, participation, history, systems review, standardized measures, and body structures. The plan of care should be directed at improving functional measures from the examination and evaluation section to help improve the child's quality of life, motor skills, and strength and achieve developmental milestones.



Section 2 Key Words

Outcome Measure – Objective measurement to document progress in physical therapy care

Developmental Delay – Refers to a child who is behind their peers in the developmental sequence

Section 2 Summary

Evaluation of pediatric patients should be based on developmental sequencing and the ability of children to reach appropriate milestones. This means a shift away from traditional manual muscle testing in favor of describing strength grading in terms of weakness based on the inability to perform tasks. There are many outcome measures in the world of pediatric physical therapy and it is the responsibility of the therapist to use appropriate ones to document progress.

Intervention

Intervention in pediatrics should be focused on helping children achieve milestones, catch up to their peers, and engage in play to progress through developmental sequencing. This section will discuss clinical intervention strategies for the common disorders of each system. As mentioned in this section, physical therapists and assistants must train caregivers on techniques to optimize movement as the child progresses.

Cardiovascular

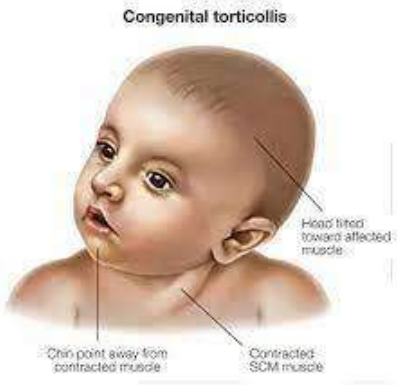
Tetralogy of Fallot [47]

Children with Tetralogy of Fallot usually need a surgical procedure to correct the poorly functioning heart where the gap between the ventricles is closed. Babies typically have this surgery when they are three to six months old. Tetralogy of Fallot is associated with Down Syndrome as around half of people with Down Syndrome have a heart defect. Physical therapy intervention before surgery should be educating the family on what to expect after the operation. Pulmonary rehabilitation should be completed after surgery, where physical therapists and assistants would work on secretion management and airway clearance. The goal of this therapy is to prevent atelectasis by promoting position changes out of supine and improving breathing techniques. Therapists should use segmental expansion techniques and help their patients breathe more deeply into the therapist's hands at the base of the lungs. Percussion and vibration may also be used to clear the airway of mucus, involving tapping and oscillation with breathing out. The baby should be in varied positions for these airway clearing techniques to get the most benefit. Therapists should also introduce a range of motion in the upper extremities and neck soon after surgery to prevent long-term stiffness in muscles and connective tissue resulting from the chest incision. Therapists should educate caregivers on inspiratory

and expiratory techniques they think caregivers could perform safely and encourage activity as this will also help to clear mucus. Older children should be encouraged to walk as much as they can to rehabilitate from the surgery.

Orthopedic and Injuries

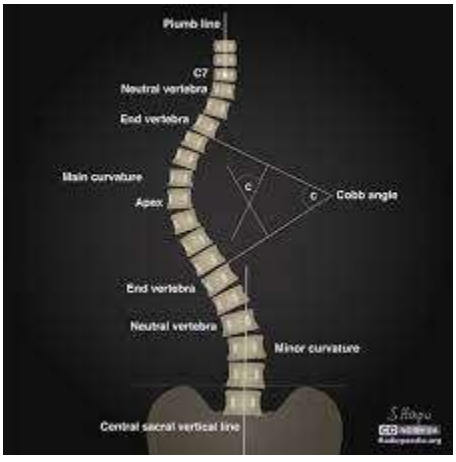
Congenital Muscular Torticollis (CMT) [8]



CMT management should begin at birth for children displaying a contracture in one sternocleidomastoid (SCM) muscle. CMT treatment relies on therapy rather than surgery to normalize the muscle balance in the neck. With CMT, the head will rotate away from and laterally flex toward the contracted SCM. A manual stretching program is the best approach to conservative management with CMT, which should be performed by the therapist and taught to caregivers for follow-up. The neck should be rotated opposite to the contracted SCM, so rotated toward the contracted muscle and laterally flexed away. Stretches should be held for sixty seconds and repeated five times throughout the day. The stretch should be mild and parents/caregivers instructed to stop the stretch when a slight resistance is felt. Education also includes frequent position changes to avoid plagiocephaly, which is the flattening of the skull.

Parents and caregivers may experience a challenge with plagiocephaly, which may require a specialized helmet to reduce the flattening of the skull. Another challenge that may arise is the decision to get surgery for SCM lengthening or not. Evidence supports that surgery should not be considered until nearly five years of age due to the risk of nerve injury and scarring over the SCM.

Pediatric Scoliosis [48]



https://radiopaedia.org/articles/cobb-angle

Pediatric idiopathic scoliosis typically improves with postural, strengthening, and stretching muscles surrounding the spine to achieve balance. For severe scoliosis, when the lateral curvature is greater than 40 degrees based on the Cobb angle (pictured below), corrective surgery is the best course of action. Moderate scoliosis curvatures are between 30 and 50 degrees, which can be improved by a thoracolumbar

spinal orthotic (TLSO). For curvature under 30 degrees, exercises should be able to improve the symptoms. The Schroth method is a progressive exercise program that can improve the curvature, rotation, and stability of the spine of patients with 10 to 30 degrees of curvature. The role of the therapist is to educate the patient and caregiver on how to perform exercises independently by implementing breathing strategies and being aware of posture. Specific details of how to perform the Schroth method are available here:

https://www.google.com/search?client=firefox-b-1-d&q=ehnert-Schroth%2C+Christa.+%22Introduction+to+the+three-dimensional+scoliosis+treatment+according+to+Schroth.%22+Physiotherapy+78.11+%281992%29%3A+810-815.

Pulmonary

Cystic Fibrosis (CF) [49]

Children with CF have collections of mucus in their airway that also causes inflammation and progressive lung damage. It is crucial for people with CF to be competent in some sort of airway clearance techniques. Some babies will not show symptoms of CF until they are a few years old and the severity depends on how extensively their CFTR gene is mutated. The lungs and digestive system are affected the most by the CF disease process. Therapists should be aware that patients with CF will likely be on antibiotics to prevent infection, supplements, bronchodilators to open the airway, and medication to make their mucus mobilize more easily.

Chest physical therapy with airway techniques involves massage to mobilize mucus, drainage positions with posture to help the mucus leave the body and get more air to the lungs, percussion, vibration, and oxygen monitoring. Percussion involves using a cup-shaped hand to strike the chest with good force while the patient is in a postural drainage position to mobilize mucus out of the airways. Vibration involves the therapist using both hands to oscillate around the chest with the patient breathing out. The therapist should always monitor oxygen with a pulse oximeter to ensure adequate oxygenation during the procedure. The active cycle of breathing (ACBT) technique involves breathing control (belly/diaphragmatic breathing), thoracic expansion exercises (deep breathing for improved lung expansion), and forced expiration techniques (huffing, coughing). Positive expiratory pressure can be achieved with a PEP device which also helps to create an open airway.

As far as education to caregivers, postural drainage, percussion, vibration, and breathing techniques should be taught and performed at least twice per day. Therapists should also educate patients and caregivers that aerobic and strength exercises at any intensity are important and safe for general health and further mobilization of mucus. Education about lifespan and prognosis should be implemented by the therapist and the team (physician, pulmonologist, etc.) so the family and patient are prepared in adolescence and early adulthood.

Bronchopulmonary Dysplasia (BPD) [50]

Bronchopulmonary dysplasia occurs as a result of mechanical ventilation from infant respiratory distress syndrome and other breathing complications at birth. Caregivers, therapists, and other practitioners should monitor for signs of respiratory distress including the use of accessory muscles of respiration (scalenes, sternocleidomastoid), grunting, chest, and abdominals moving opposite and visible ribs. Many babies with BPD will be on surfactant replacement therapy, bronchodilators, vasodilators, antibiotics, steroids, and diuretics. The therapist's role in treating BPD in infancy and early childhood is to educate on frequent position changes, vibration, and percussion. Clearing the airway of secretions will prevent further lung damage while the lungs heal. Caregivers should be educated on carrying out positional changes, signs of respiratory distress, and supporting the developmental sequence (prone laying for neck and upper extremity development, progressing to rolling, etc.)

Connective Tissue

Ehlers-Danlos Syndrome (EDS) [51]

For hypermobile EDS (the most common type), physical therapy is crucial in the management of symptoms and injury prevention. Children will be diagnosed by the Beighton scale (joint and skin mobility grading) and genetic testing. Exercise is crucial in people with hypermobile EDS and should include progressive exercise in core strength, endurance, balance, and lower extremity strength. Research suggests that patients can complete strengthening exercises through the range of their joints to the hypermobile phase but be educated on when movements would be harmful to tissues. Orthotics should be recommended when pes planus is severe or if patients have pain in their feet. Bracing around the ankles, knees, or other joints can help recover from sprains or strains in the area. Therapists should educate caregivers and patients in childhood and adolescence to not fear exercise, but to avoid injury by avoiding the extremes of their

hypermobility when loading with impact (sports). Children with EDS should generally not compete in contact sports as their injury rate is quite high.

Osteogenesis Imperfecta (OI) [52]

OI is managed with a team approach including family, therapists, and specialist physicians. The goal of treatment is based on severity and aims to reduce the amount of and possibility of fractures as the child develops. This occurs through stabilization surgeries, medications to stimulate growth, the use of walkers and wheelchairs, and exercises. Beneficial exercise includes aquatic therapy, postural and positional education following the developmental sequence (to promote bone growth and muscle strength), and safe protected weight-bearing exercise. Therapists are integral in recommending wheelchairs and walkers and should always suggest the least restrictive assistive device. Therapists should intervene post-surgery and fracture with a range of motion, stretching, gentle strengthening, and education on positioning the child if they are old enough and the caregiver. Therapists should assist caregivers in techniques to carefully handle their infant, the use of pillows for comfort and low injury risk, and skill acquisition following the developmental sequence.

Neurologic

Cerebral Palsy [53]

Cerebral Palsy (CP) affects each child differently depending on the severity of the initial injury depriving the brain of oxygen. Children with cerebral palsy often have spasticity/ hypertonicity in one or more limbs (spastic CP) and poor balance and coordination (ataxic and dyskinetic CP). Physical therapists should be involved in the care of children with CP at each age of childhood. From the early age of newborns until four years old, the objective of physical therapy is to support the developmental sequence and achieve things like sitting, standing, and walking. Physical therapists should suggest modifying activities at home and working on games that support the child's development. There are a couple of recent pieces of high-quality evidence regarding the efficacy of common physical therapy interventions for cerebral palsy. The best evidence supports therapy focused on specific activities and goals, constraint-induced movement therapy, and gait training. Little evidence exists for neurodevelopmental therapy, electrical stimulation, and manual stretching for spasticity management. Physical therapists may also suggest durable medical equipment such as ankle-foot orthoses (AFO) and assistive devices to improve ambulation potential. Nonambulatory children with severe CP will need

physical therapy intervention to support appropriate positioning in their chairs and to manage contractures through splints and bracing.

Exercise

Evidence supports exercise in the management of CP, which is best combined with botulinum toxin to reduce spasticity. Exercise for specific muscle groups to help with achieving milestones used to have support, but now lacks the quality of evidence. Generally, specific strengthening exercises alone do not help increase strength or improve gait mechanics in children with CP. Manual stretching is not helpful in contracture management and contractures should instead be treated with splinting and casting. Neurodevelopmental therapy, or specific training of muscle groups to support upper and lower extremity functional strength is limited in evidence.

Gait Training

Gait training has high-quality evidence in helping children with CP who are ambulatory walk more efficiently. Supportive braces such as AFOs will improve gastrocnemius contractures which affect the loading response and push-off phases of gait. Children may need a walker or crutches to ambulate safely. Physical therapists should recommend devices that give the highest level of independence to their patients. This means that if a child is safe with crutches and a walker, the therapist should recommend crutches as it is the least restrictive assistive device. The picture below illustrates a posterior walker with forearm support that would be suitable for a child who lacks postural control to stand independently and is unable to use the hands and wrists to push up (forearm support is necessary). The other picture shows a child standing with Lofstrand/forearm crutches which would act as two extra balance points. These should not be used in children with moderate to severe postural and balance challenges.

https://www.shopwheelchair.com/p-drive-forearm-platforms-for-trekker-gait-trainer.html?gclid=CjwKCAjwquWVBhBrEiwAt1KmwhMksZw4kEGCqLm1NczzpHGTE89POVTvxc3ukhqoJOfNnEWQxsqABBoCcPcQAvD_BwE

Activity-Based Therapy

The best evidence in pediatric PT for cerebral palsy management, which improves gait, coordination, and participation in developmental tasks is activity-based, goal-oriented training. This means letting the child start a task they are interested in and creating a therapeutic experience from it. An example is setting out a few activities around the child, such as blocks, balls, and puzzles, and working on positioning and promoting the use of appropriate muscles throughout the activity. If a six-month-old child with CP is struggling to sit without support for any duration, the therapist could focus on helping the child sit with postural support and challenge this by safely taking support away to stimulate core strength.

Constraint-induced Movement Therapy (CIMT)

CIMT involves restricting the use of an upper extremity to encourage the use of the affected limb which is hypertonic in children with CP. This would be appropriate in a child with hemiplegic CP where one upper extremity is affected and not the other. The therapist would constrain the normally functioning upper extremity in a sling and engage the child in activities to work on coordination, strength, and tasks with the weak arm.

Electrical Stimulation

E-stim for use in children with cerebral palsy has moderate to limited evidence in improving strength, range of motion, and functional use of extremities in children with CP. E-stim with dynamic splinting combined was more effective than e-stim alone in improving posture and function. Dynamic splinting puts the joint at the end range rather than mid-range to prevent it from stiffening. Dynamic splits move a bit, whereas static splits stay stationary, to help encourage fluid to enter the joint. The picture below is a dynamic splint for the extensors of the fingers to the common extensor tendon at the elbow.

https://www.vitalitymedical.com/rolyan-dynamic-high-profile-outrigger-hand-splint.html?gclid=CjwKCAjwquWVBhBrEiwAt1Kmwiao0FMaaBXfqj7zCk9MVSUOL95BETGXTyKqzJqCcBEUos7eDxf_0xoCycQQAvD_BwE

Spina Bifida [54,55]

Children with spina bifida need physical therapy at all stages of their life, depending on the severity. Physical therapists should intervene in the neonatal intensive care unit for positioning and educate the family on techniques. It is important if the baby is born prematurely to simulate the tight quarters of the uterus with a tight blanket wrap with the limbs in flexion. The baby should be rotated in short intervals from supine to side-lying to prone to support development. Many infants will have surgery to close the spine, with the types spina bifida myelomeningocele and occulta. Physical therapists should perform a range of motion to all joints to prevent contractures after surgery and educate these methods to caregivers to be completed three times per day. Therapists will see children with spina bifida in early intervention at their homes and in school-based PT. Once the child is old enough to begin moving on their own, muscle strengthening is important. This should be accomplished with activity-based therapy, which is goal-directed and aimed at improving lower and upper extremity strength. Once the baby is around one year old, ambulation will be the goal. Ambulation for children with thoracic level spina bifida and with neurologic involvement will be a challenge. Therapists should instruct caregivers to avoid using any assistive devices for a couple of years to avoid reliance on them and stunting developmental growth. Therapists should follow the developmental sequence suggesting tummy time/prone laying for upper extremity and neck strength development, sitting around six months for core strength, and pulling to stand before one year for lower extremity strength. Following these steps will give a child the best chance to ambulate earlier rather than later. Therapists should give the child as little support as possible to train standing and walking and teach these techniques to parents. Once children are around age three to four they can be fitted for braces and splints to help them move more efficiently. Examples are hip-knee-ankle-foot orthoses, knee-ankle-foot-orthoses, and ankle-foot orthoses. Children with thoracic level spina bifida would likely need the higher support, from the hip to the ankle to help them ambulate as independently as possible. Children may need posterior walkers, forearm crutches, or no assistive device to walk. Physical therapists should recommend the least restrictive assistive device at all times to avoid dependence on the device and encourage development.

Parawalking frame used for children with thoracic level spina bifida.

Muscular Dystrophy (MD) [56]

Muscular dystrophy is a progressive disease, meaning the focus of therapy is to slow the progression and support the needs of the child and caregiver throughout the disease process. Physical therapists work within the healthcare team to help children move effectively, such as suggesting specific walkers, bracing, and eventually wheelchairs to optimize mobility. Children with muscular dystrophy should have therapy that follows the developmental sequence, work on preventing contractures, exercises to maintain muscular strength, breathing exercises, and maintaining physical activity as long as possible. A stretching program should be initiated for all upper and lower extremity limbs starting at diagnosis and completed one to two times daily. Strengthening exercises should never strain a child with MD too much as this can accelerate muscle degeneration. Exercises that are helpful for strength maintenance are swimming, activity-based therapy with child initiation (playing a game like following the leader with jumping, squatting, etc.), and gentle lower extremity activation such as riding a bicycle. Therapists will teach children and parents diaphragmatic breathing and other deep breathing strategies to optimize the function of the diaphragm (respiratory failure is the most common cause of death). Therapists should recommend the least restrictive assistive device at all times, including when muscles degenerate enough to make the patient nonambulatory. Wheelchairs should be professionally fit and avoid skin breakdown. Therapists should educate parents during every interaction to help them support gentle stretching and strengthening of muscles to prevent faster progression.

Down Syndrome [25,57]

Physical therapists are crucial in the management of musculoskeletal problems and developmental skill acquisition for people with Down Syndrome. Because Down Syndrome is a neurodevelopmental disorder, pediatric physical therapy will focus on helping the child reach developmental milestones. Babies with Down Syndrome have difficulties with lax joints, weakness, posture, balance, the use of the hand, and eating. Children benefit the most from physical therapy if they start it as a newborn. Physical therapists should design an intervention plan that works to strengthen weaknesses throughout the body, improve balance and posture, help the child develop motor skills, and help to correct positions that may harm developing muscles and joints. Strengthening should be completed as a part of a game to increase participation from the child. Evidence-based practice supports physical therapists in helping children achieve developmental milestones such as crawling, rolling, and walking. Physical therapists should give cues to the lower extremities and abdominals. For walking, children with Down Syndrome may need cues at the hip flexors, knee extensors, and

paraspinals for postural control. Balance and coordination training should also be a part of the treatment plan. Ankle braces such as short ankle braces are supported by evidence to give stability at the ankle and help to improve balance. It is crucial that the physical therapist or assistant treating a child with Down Syndrome educates caregivers on how to cue the child to give postural support to help achieve goals outside of PT sessions for the best carryover.

Therapists should educate parents/caregivers on position throughout care, including avoiding W sitting. W sitting occurs when a child sits with their lower legs out to the side, as shown in this picture. This is common in children with Down Syndrome and laxity in their hips (developmental hip dysplasia). Parents should be educated to assist their child to sit another way (criss-cross, long sit) and that children that continue to sit like this over time will be delayed from ambulating and standing due to the muscular imbalance that occurs at the hips (short hip flexors, weak glutes, etc.)

https://babysparks.com/2019/03/07/what-is-w-sitting-why-to-discourage-it/

The Pediatric Team and Obstacles

The care of a child with any disease-causing developmental delay needs to be addressed by a team. The team includes pediatricians, specialist physicians, therapists (PT, OT, SLP), the child, and caregivers.

Physicians

The role of physicians in pediatric care is medical management, medication prescription, and surgeries if necessary. They should educate the rest of the team on positions and precautions to avoid after surgery, medication scheduling, any resources that may help the family, as well as optimal nutrition. Families and children may also work with Registered Dietitians to make sure they receive optimal nutrition during development. This includes breast milk into toddler years, protein, fat, carbohydrates, and all of the vitamins and minerals necessary to maintain health. This is especially important in children with digestive problems from their condition. Some children may require tube feeding during the first few months of life, and physicians and dietitians will work to wean children off of these measures while absorbing enough nutrition.

Family/Caregivers [58]

The child's family and caregivers arguably have the largest role in the management of their child's condition. They should be educated on all interventions, how to perform them by the medical and therapy team, and on resources that exist about their child's condition. The family may face the obstacle of difficulty coping with physical and mental limitations of their child's condition, time management obstacles, and finding sufficient childcare. Some groups for support are Parent to Parent USA, the M.O.R.G.A.N. Project, and the Federation for Children with Special Needs. Parents can research these sites for support, community, and ideas to engage their children. Caregivers should be educated to avoid supportive jumpers, have children early on, lay prone, and follow the rest of the developmental sequence in this course.

Therapists (Physical, occupational, speech therapy) [59]

The primary role of therapies for children with disabilities, injuries, and developmental delay is to support the developmental sequence, educate caregivers on these techniques, and help children become as mobile as possible. Many obstacles can arise with these tasks, including children not having caregivers with the time or financial resources to carry out recommendations, discovering cases of child abuse or neglect, and not having adequate time for appropriate interventions. If a therapist finds a child in a situation where they suspect abuse or neglect, they must report this according to the mandatory reporting law for children and elders. Therapists should call 911 if there is suspicion of immediate danger and call the National Child Abuse Hotline to report incidents and discover local resources for children. The abuse hotline number is 1.800.422.4453.

Section 3 Key Words

Constraint-Induced Movement Therapy (CIMT) – Refers to restricting the use of one extremity to strengthen the weaker limb

W Sitting – Refers to children sitting with extreme hip internal rotation with their lower legs laterally

Section 3 Summary

Children with developmental delays and conditions in this section need supportive care from an interdisciplinary team including physicians, therapists, dietitians, and caregivers.

Therapists should always base therapy on the developmental sequence and focus on activities the child chooses to engage them in interventions. Obstacles can and will arise during therapy and this section gives resources that therapists and caregivers can follow to mitigate the challenges.

Case Studies

Case Study 1

Bobby is a three-year-old boy with Down Syndrome who is being evaluated for the first time by a physical therapist. His guardian reports that Bobby has stood supported, sat unsupported, and is great at crawling. At the evaluation, the PT notices that Bobby sits in the W position, is engaged in television, and doesn't have many toys around.

Reflection Questions

1. What developmental tasks should the therapist work on with this child?
2. What immediate interventions should be completed during the very first visit?
3. What is the ultimate goal in working with a child with Down Syndrome?

Responses

1. The therapist should facilitate standing unsupported, cruising, and walking activities. Pre-gait activities could include balancing challenges with standing and taking support away, providing hand support only to stimulate the core and lower extremity strength and control.
2. The most important first intervention is education. The therapist should educate the guardian to help the child avoid the W position as it can delay development by creating tension in the hips (external rotators). Education should also include avoiding television time and instead of engaging the child with toys that encourage development like puzzles and balls.
3. The ultimate goal is to achieve developmental tasks like walking, jumping, standing, etc. to allow the child to catch up with their peers early on so they can live their life to the highest potential.

Case Study 2

You are a physical therapist assistant in a neonatal intensive care unit (NICU). You need to see a premature newborn (8 weeks premature) who has bronchopulmonary dysplasia due to oxygen use. His parents have been very involved and only leave the NICU to sleep and eat.

Reflection Questions

1. What interventions should the PTA perform and why?
2. What would the PTA do if the baby turned cyanotic during treatment?
3. When this baby reaches three months old and has a developmental delay, what are important interventions?

Responses

1. Bronchopulmonary dysplasia causes difficulty with airway clearance due to mucus secretions. This baby is also premature, meaning he missed out on time developing in the womb. The therapist should perform gentle vibrations in positions such as prone and side-lying to help clear the secretions. They should also perform position changes and educate caregivers and nurses/aides to rotate the baby from supine, side-lying, and prone. The baby should have his limbs tucked in flexion in a tight blanket.
2. The PTA should check the oxygen of the baby, which is often on a monitor, and look for signs of respiratory distress. If the oxygenation is dropping below 90% on a SpO2 monitor and/or the baby appears in distress (use of accessory muscles of respiration), the PTA should call for help from the medical team immediately.
3. The baby needs to work on rolling independently, lifting his head and upper body in prone, and work on visual tracking and reaching tasks.

Conclusion

As is evident in this course material, pediatric physical therapy is complex and involves many different factors. Physical therapists and assistants should focus on the recognition of patterns that children with disabilities have and help them navigate the

developmental sequence. Education to guardians is arguably the most important part of pediatric physical therapy as interventions will be carried out every day with guardian involvement. Therapists should always refer to resources for the best evidence on interventions and rules and regulations on the pediatric American Physical Therapy Association page.

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