Cerebral Palsy

Introduction

- The term cerebral palsy (CP) is an umbrella term for a group of permanent disorders of the development of movement and posture that cause activity limitations attributed to nonprogressive disturbances in the developing fetal or immature infant brain. The motor disorders of cerebral palsy are often accompanied by disturbances of sensation, perception, cognition, communication, and behaviour, caused by epilepsy and by secondary musculoskeletal problems

- Associated damage to one of more areas of the brain may lead to paralysis, spasticity, or abnormal control of movement or posture. Although the injury to the brain is considered static, the pattern of motor impairment changes over time, often affecting development in all daily occupations of childhood. The lesion or damage in the brain may cause impairment in muscle activity in all or part of the body.
- Cerebral palsy typically affects the development of sensory, perceptual, and motor areas of the central nervous system. As a result, the child has difficulty integrating the information that the brain needs to correctly plan and direct movements in the trunk and extremities that are used in everyday interactions with the environment. The muscles are activated in uncoordinated and inefficient ways and are unable to work together to create smooth, effective motion

Prevalence and Etiology of Cerebral Palsy

- Cerebral palsy is the most prevalent cause of persistent motor dysfunction in children, with a prevalence of 1.4–2.1 per 1000 live births.
- The diagnosis of CP is approximately 1.5 times more common in males and is higher among non-Hispanic, African American children and children from low-to middle-income families. Approximately, 1 in 323 children have cerebral palsy in the United States.

- CP can result from the interaction of multiple factors, and in many cases, a single cause cannot be identified.
- Prenatal maternal infection, premature birth, low birth weight, and multiple pregnancies have been associated with cerebral palsy. Prenatal factors may include genetic abnormalities or maternal health factors such as stress, malnutrition, exposure to damaging drugs, and pregnancy-induced hypertension. Some gestational conditions of the mother, such as diabetes, may cause perinatal risks to the developing infant; prematurity and low birth weight significantly increase an infant's chance of acquiring a cerebral palsy diagnosis

- The origin of brain injury may occur during the prenatal, perinatal, or postnatal period, but evidence suggests that 70% to 80% is prenatal in origin The nervous system damage that causes CP can occur before or during birth or before a child's second year, the time when myelination of the child's sensory and motor tracts and central nervous system (CNS) structures occurs rapidly.
- Medical problems associated with premature birth may directly or indirectly damage the developing sensorimotor areas of the CNS. In particular, respiratory disorders can cause the premature newborn to experience hypoxemia, which deprives brain cells of the oxygen needed to function and survive.

Risk Factors Associated With the Development of Cerebral Palsy Prenatal

Prenatal

- Genetic disorders
- Maternal health factors (e.g., chronic stress, malnutrition)
- Teratogenic agents (e.g., drugs, chemical exposure, radiation)
- Placental disruption (inability of the placenta to provide the developing fetus with oxygen and nutrients)
- Lack of growth factors affecting fetal growth in utero (e.g., hormones, insulin, proteins)
- RH blood type incompatibility between mother and infant

Perinatal

- Prenatal conditions (e.g., toxemia secondary to maternal diabetes)
- Medical problems associated with prematurity (e.g., compromised respiratory and cardiovascular systems, intraventricular hemorrhage [IVH], periventricular leukomalacia [PVL])
- Multiple births
- Low birth weight

Postnatal

- Severe and untreated jaundice shortly after birth
- Infections (e.g., meningitis, encephalitis, chorioamnionitis)
- Alcohol or drug intoxication transferred during breastfeeding
- Hypoxic ischemic encephalopathy (HIE): prolonged loss of oxygen during the birthing process
- Trauma during birth or shortly after

Diagnosis

- A diagnosis of CP is made by a medical professional (e.g., general practitioner, paediatrician, paediatric neurologist). Best practice for diagnosis of CP involves a combination of assessments such as:

1. Medical history concerning risk factors
2. Neurological examination
3. Standardized motor assessment
4. Prechtl's General Movement for infants <4 months corrected (assesses quality of spontaneous movements)
5. Developmental Assessment of Young Children for infants 6–12 months of age (parental questionnaire of volitional movements)
6. Neuroimaging
7. Ruling out of alternative diagnoses, including progressive disorders.

Societal and Familial Costs

- Societal costs for persons diagnosed with CP are substantial, and estimates of total lifetime expenditures are estimated as high as $11.5 billion.
- Average lifetime expenditure per child could exceed $900,000 above the ordinary costs of raising a child. These costs can be due to several factors as families and specialists try to manage the secondary impairments that occur over the child's lifespan.

Common Symptoms in Children With Cerebral Palsy

- Occupational therapists working with children with CP provide a variety of interventions to address children's participation in their desired occupations. Children with CP exhibit muscle tone abnormalities which present differently among but interfere with movement and occupational performance. Abnormal muscle tone affects posture, postural control and movement, and hand and upper extremity function. Secondary impairments develop over time and interfere with a child's performance in everyday activities. Children with CP may have difficulties with cognition and language, sensory functions, and feeding, eating, and swallowing.

Common Symptoms in Children With Cerebral Palsy

1.Posture, Postural Control, and Movement

Atypical movement patterns

- Children who have CP demonstrate difficulty achieving and maintaining stable posture while lying down, sitting, and standing because of impaired patterns of muscle activation. Poor postural alignment and stability result from the CNS' decreased ability to control coactivation and reciprocal innervation of select muscle groups. Coactivation of muscle, or simultaneous contraction of agonist and antagonist muscle groups, provides stability around a joint and stability of body posture. Reciprocal innervation in muscle groups occurs when excitatory input directs the agonist muscle to contract while inhibitory input directs the antagonist muscle to remain inactive

Common Symptoms in Children With Cerebral Palsy

1.Posture, Postural Control, and Movement

The term posture describes the alignment of the body's parts in relation to each other and the environment. The ability to develop a large repertoire of postures and change them easily during an activity depends on the integration of automatic, involuntary movement actions referred to as the postural mechanism. The postural mechanism includes several strategic components:

- Muscle and postural tone
- Emergence of righting, equilibrium, and protective extension reactions.
- Developmental integration of early, primitive reflex movement patterns.
- Intentional, voluntary movements against the forces of gravity.
- The ability to combine movement patterns in the performance of functional activities.

- Righting reactions and equilibrium reactions allow individuals to maintain upright posture with dynamic stability. When the head is out of alignment with the body, righting reactions realign the head with the body. An individual uses equilibrium reactions or balance reactions when the body's centre of gravity is moved over the base of support. Equilibrium reactions are coordinated responses of trunk, neck, and extremities as the individual moves in and out of different postures. When righting and equilibrium reactions are not sufficient to regain an upright posture, individuals use a protective extension reaction (i.e., they automatically reach outward from their bodies to catch themselves or prevent a fall). A protective response requires the motor ability to quickly extend an extremity (i.e., arm or leg)

- Children who have CP may develop abnormal movement compensations and body postures as they try to overcome these motor deficits to function within their environments.
- Over time, movement compensations and atypical motor patterns create barriers to ongoing motor skill development. Instead of freely moving and exploring the world, as children with a normally developing sensorimotor system do, children who have CP may rely on primitive and automatic reflex movement patterns as their primary means of mobility.

- Muscle tone is the force with which a muscle resists being lengthened; it can also be defined as the muscle's resting stiffness. It is tested by an occupational therapist's passive stretch of the muscle from the shortened to the lengthened state as the occupational therapist feels the resistance offered by the muscle to the stretch. A child's ability to perform sequential movements is supported by muscle tension (stiffness) and elasticity during the movements. Muscles must have enough tone to move against gravity in a smooth, coordinated motion. Emotions and mental state, including levels of alertness, fatigue, and excitement, can also influence muscle tone.

- Normal muscle tone develops along a continuum, with some variability among members of the typical population. The muscle's qualities of contractility and elasticity are necessary for immediate, consistent responses to the elongation and contraction experienced during movement, such as during coactivation. Muscle tone allows muscles to adapt readily to the changing sensory stimuli during functional activities. Decreased muscle tone, or hypotonia, can make a child appear relaxed and even "floppy." Increased muscle tone, or hypertonia, can make a child appear stiff or rigid. In some cases of CP, an infant may initially appear hypotonic, but the muscle tone may change to hypertonia at 6 or 7 months.

- Sensorimotor Problems in Children With Cerebral Palsy

1. Abnormal muscle tone
    - Hypertonicity: increase in resting state of muscle
    - Spasticity: velocity-dependent increase in muscle tone (occurs with active or passive movement)
    - Hypotonicity: decrease in resting state of muscle
    - Fluctuating: muscle tone changes between hypertonic and hypotonic
2. Persistence of atypical and abnormal primitive reflexes
3. Atypical righting, equilibrium, and protective responses

4. Poor sensory processing
    - Decreased processing of vestibular, visual, and proprioceptive information
    - Limited body awareness and body scheme
5. Joint hypermobility or joint stiffness
    - Reduced limb stability and poor cocontraction across joints
    - Reduced joint movement
6. Muscle weakness and poor muscle coactivation
7. Delays in typical progressing of motor movement and motor skills affecting adaptive function

Common Symptoms in Children With Cerebral Palsy

1.Posture, Postural Control, and Movement

Distribution and classification of muscle tone

- Monoplegia refers to the involvement of one extremity.
- Hemiplegia refers to involvement of upper and lower extremities on one side of the body.
- Paraplegia means that both lower extremities experience atypical tone, and quadriplegia refers to the involvement of all limbs.
- If all limbs and the head/neck experience atypical tone, this is referred to as tetraplegia.

- CP is also classified by the nature of the movement disorder according to four main types: (1) spastic, (2) dyskinetic, (3) ataxic, and (4) mixed.
- Children with spastic CP demonstrate hypertonia and muscle spasticity. Spasticity is defined as a velocity-dependent resistance to stretch. It is characterized by an excessive stiffness in the muscles when the child attempts to move or maintain a posture against gravity. Resistance to range of motion will either increase with speed of force or will increase with quick movement. The effects of spasticity are often associated with clonus, an extensor plantar response, and persistent primitive reflexes.

- As a child with spastic CP attempts to move, muscle tone increases and then rapidly releases, triggering a hyperactive stretch reflex in the muscle. Spasticity can vary according to the child's state of alertness, emotions, activity, posture, or presence of pain. Spasticity is associated with poor control of voluntary movement and limited ability to regulate force of movement. Distribution of spasticity can be monoplegia (rare), diplegia, hemiplegia, quadriplegia, or tetraplegia.
- In dyskinetic CP, movement patterns are classified as athetoid, choreoathetoid, and dystonic, which generally affect the entire body. A child with dyskinesia exhibits excessive and abnormal movement, and often when initiating movement in one extremity, atypical and unintentional movements in other extremities result. The child with athetosis exhibits slow, writhing, involuntary motor movements in combination with abrupt, irregular, and jerky movements.

- Athetosis is made worse by attempts to move; however, it may also be present at rest and is distinguished from dystonia by the lack of sustained postures, and from chorea by the lack of identifiable movement fragments. Children with pure athetosis demonstrate a fluctuation of muscle tone from low to normal with little or no spasticity and poor coactivation of muscle flexors and extensors.

Classification of Cerebral Palsy

Type of Movement Disorder	Area of Body Involved	Prevalence
Spastic	Diplegic: legs > arms	32%
	Quadriplegic: all four extremities	24%
	Hemiplegic: one-sided involvement, arm > leg	29%
	Double hemiplegic: both sides; one greater than other, arms > legs	24%
Dyskinetic	Choreoathetoid	14%
	Dystonic Athetosis	
Ataxic		<1%
Mixed (percentages included above)		

- Children with choreoathetosis have constant fluctuations from low to high with jerky involuntary movement that may be seen more proximal to distal. These movements are sustained twisted postures that are absent at rest and triggered by movement (action). Chorea is distinguished from dystonia by the apparently random, unpredictable, and continuously ongoing nature of the movements, compared with the more predictable and stereotyped movements or postures of dystonia. The movements of chorea often appear more rapid than those associated with dystonia. Although chorea may be worsened by movement, attempts at movement, or stress, specific movements are not triggered by voluntary attempts with the same degree of temporal specificity as in dystonia

- The third type of CP, ataxia, is characterized by poor balance and coordination. Children who have ataxia may show shifts in muscle tone, with quadriplegic distribution, but to a lesser degree than those with dyskinesia. Children with ataxic type CP are more successful in directing voluntary movements but appear clumsy and show involuntary tremor. They have considerable difficulty with balance, coordination, and maintenance of stable alignment of the head, trunk, shoulders, and pelvis. These children may have poorly developed equilibrium responses and lack proximal stability in the trunk to assist with control of hand and leg movements.

- Children with CP who often show combinations of high and low muscle tone problems are classified as the mixed type. When children have a diagnosis of CP where than is more than one motor type (i.e., spasticity and dystonia), usually one motor type will appear dominant. The distribution for mixed type CP is typically quadriplegic.

Common Symptoms in Children With Cerebral Palsy
2.Hand Skills and Upper Extremity Function

- Children with CP demonstrate problems with upper limb function resulting from abnormal muscle tone and decreased ability to maintain a stable posture when attempting functional tasks.
- Efficient performance of the arm and hand depends on proximal control and dynamic stability of the trunk and shoulder girdle. Children with CP demonstrate weakness in the shoulder girdle, may have contractures in their elbow, forearm, wrist, fingers, and thumb caused by hypertonicity, or may move the arm and hand in synergistic patterns, lacking the ability to isolate single joint movements.

- Postural instability can affect upper extremity movement also, as children with CP may need to use their upper extremity to support upright postures against gravity. When the upper extremity is fixed and used to help stabilize and compensate for trunk weakness, the arm and hand cannot be used for functional tasks (e.g., functional mobility such as pulling self from sitting to standing or playing with toys at the midline of the body while challenged to sit unsupported).

3. Secondary Impairments

- Children with CP manifest primary impairments that are the direct result of the lesion in the CNS. Primary impairments are those that are an immediate and a direct result of the cortical lesion in the brain. Because the lesion occurs in immature brain structures, the progression of the child's motor development may appear to change, causing secondary impairments (see Box). The motor impairments of CP are almost always accompanied by one or more secondary impairments.

Primary Impairments	Secondary Impairments
Muscle weakness or hypotonicity **Muscle tightness or hypertonicity** **Spasticity** **Involuntary movement** **Weakness of eye muscles** **Abnormal muscle tone in facial musculature** **Impaired sensation in affected limbs** **Possible seizure disorder**	Contracture in a joint (e.g., elbow, wrist, hip, knee, ankle) Poor or unsteady gait or mobility Impairment of visual processing, hearing, or speech Difficulty with bladder and bowel control Intellectual disability, learning disabilities Problems with breathing because of postural difficulties and weakness in trunk muscles Skin integrity: increased risk of pressure sores Difficulty in feeding, eating, and swallowing

- For many children, these secondary conditions are more disabling than their physical impairment:
- Three in four will experience chronic pain
- One in two will have an intellectual impairment
- One in three will be unable to walk
- One in three will experience hip displacement
- One in four will be unable to talk
- One in four will have epilepsy
- One in four will have a behavior disorder
- One in four will have bladder incontinence
- One in five will have a sleep disorder
- One in 10 will have a vision impairment
- One in 15 will be unable to eat orally
- One in 25 will have a hearing impairment

- Children with CP may develop secondary impairments in systems or organs over time because of the effects of one or more of the primary impairments.
- Although the initial brain injury is unchanging, the results or the secondary impairments are not static and change over time with body growth and attempts to move against gravity.
- When playing or in functional activities, children with CP move in atypical patterns that may become repetitive and fixed.

- The repetition of the atypical movement patterns prevents children with CP from gaining full voluntary control of their movements and can lead to diminished strength and musculoskeletal problems. The combination of impaired muscle coactivation and the use of reflexively controlled postures may lead to future contractures in the muscle, tendon, and ligamentous tissues, causing the tissues to become permanently shortened. Soft tissue changes can lead to contractures and possibly bone deformities; they can also cause spinal and joint misalignment.

- In addition to the risk for joint contractures and deformities and spinal or joint misalignment, children with CP are at risk for skin breakdown and decreased bone density. Children in wheelchairs, who maintain sitting or lying for extended periods or who cannot independently shift their weight, risk skin breakdown. Children who are most vulnerable may sit with their body weight pressure on body prominences for prolonged time periods.
- Children in wheelchairs also experience limited time standing or ambulating, negatively influencing the strength of the individual's bones. Children diagnosed with CP may have reduced bone mineral density and are vulnerable to pathologic fractures

- Children with CP may experience additional problems such as seizures and other medical conditions not directly related to the child's movement disorder. When postural muscles are weak, breathing can be compromised. Abnormal posture and weak muscle activity may compromise cardiac and respiratory functions and prevent these systems from working efficiently. The resulting low endurance and fatigue can influence the child's capacity for activity. The occupational therapy practitioner monitors each child's physical endurance and plans therapeutic goals to increase strength and endurance.

4. Cognition and Language

- Because CP is caused by a focal brain lesion, language and cognition may or may not be affected, depending on which areas of the brain are affected (e.g., frontal lobe, temporal lobe). Lesions affecting the frontal lobe may affect the child's cognitive abilities, including attention, organization, problem-solving, inhibition, and judgment. Lesions affecting both the primary motor and temporal lobes may affect language and speech development.

- Because speech requires complex movements of oral/facial structure and requires control of breathing, children and adults diagnosed with CP may have various problems with speech and language.
- These potential problems include decreased speech production, poor articulation, and decreased speech intelligibility. Dysarthria is the term used to describe a disorder of speech production secondary to decreased muscle coordination, paralysis, or weakness.

- In addition to speech production disorders, children who have CP may have changes in the quality of their voice resulting from limited strength or control of respiratory and postural muscles. Because CP has the potential to affect areas of the brain outside of the motor system, children who have CP can have impaired expressive and receptive language skills. This means they have difficulty processing language-based information or producing responses.

- All of these potential impairments can have a significant impact on the child's participation in age-appropriate activities with peers, understanding of and response to directions, making his or her needs known, and managing his or her own care. A child's cognitive and linguistic skill level is considered when developing goals and potential outcomes.

5. Sensory Functions

- Children with CP may have significant deficits in one or more sensory systems and should be routinely tested for visual and hearing impairments. Children who have more severe CP are more likely to have visual impairment and regardless of the functional level of a child, vision should always be taken into consideration during fine motor tasks, play, and activities of daily living (ADL) completion. Vision plays an important role in timing of grasp and release, manipulating objects, orienting materials, making eye contact, and finding needed items.

- Children with visual impairments may use postural adaptations, such as a head tilt or changes to the angle of gaze, to compensate for visual deficits. These deficits may be oculomotor in nature, meaning their eye muscles do not move smoothly or in sync or may move involuntarily. The term strabismus refers to the eyes not being aligned because of muscle imbalance. Functionally, strabismus may cause difficulty with attending to visual tasks. The child may have limited convergence or divergence, decreased depth perception, or double vision.

- Other terms describing misalignment of the eyes include exotropia (one eye drifts temporally), esotropia (one eye drifts nasally), hypertropia (one eye drifts upward), and hypotropia (one eye drifts downward).
- Nystagmus refers to the eyes constantly moving in a repetitive and uncontrolled way. Functional issues associated with nystagmus include reduced acuity, difficulty fixating on a target to maintain balance, reduced target accuracy when reaching or grasping, compensatory head movements, or posturing to compensate for visual deficit.

- The causes of visual impairment in children with CP may include, but are not limited to, retinopathy of prematurity, congenital cataract, and cortical/cerebral visual impairment (CVI). Other visual impairments included refractive errors, myopia, hypermetropia, astigmatism, and strabismus, or “functional blindness”
- Children with CP can also have a visual processing disorder, which is a reduced ability to interpret information registered through the visual system. Without proper processing, a child may not understand the spatial relationships among objects, be missing part of the visual field, or not identify a partially hidden item, such as his or her coat in a closet.

Clinical signs of visual dysfunction include:

- ❖Complaints of severe, sudden eye pain
- ❖Complaints of blurred or double vision
- ❖Deconjugate eye gaze and poor eye teaming
- ❖Limited attention to tasks requiring sustained vision
- ❖Distraction in busy visual environments at home and school
- ❖Delays in the development of skills requiring vision (i.e., letter recognition, reading, writing)
- ❖Clumsiness and frequent bumping into people and objects.

- Auditory reception and processing deficits have an impact on 25% of individuals with CP. One in twenty-five children with CP will have a hearing impairment. The exact pathophysiological mechanisms for hearing loss remain unclear, but it is likely that hyperbilirubinemia, hypoxia, infection, and use of ototoxic drugs may all play a role.
- Sensorineural hearing loss is due to damage to the neural receptors of the inner ear, the nervous pathways to the brain, or the area of the brain that receives auditory stimuli. Hearing loss of this type can be congenital or acquired. Higher pitched or faint noises are often difficult to hear and children can also present with poor balance and reports of dizziness

- Conductive hearing loss affects the structures of the outer and middle ear. Conduction of sound through the outer and middle ear is disrupted, affecting hearing before the sound reaches the cochlea and the nerve receptors of the inner ear. Severe cases can be caused by malformation of the ear canal in utero.
- Mixed hearing loss occurs when symptoms of both types of hearing loss are present. Hearing impairment can have a profound impact on a child with CP and can lead to delays in language, speech, and social development.

Signs of a hearing impairment include:

- Minimal startle at loud noises or waking to noises
- Limited calming with parent's voice
- Paying closer attention to a person's face while listening or speaking to others (e.g., looking for facial cues)
- Frequently requiring parent to repeat directions
- Lack of consistency in response to name being called following verbal directions
- Poor attention to music, singing, or being read a story.

- Children with CP may have difficulty processing other sensory information including tactile and proprioceptive stimuli (e.g., fingertip force regulation during object manipulation). Children with CP may also demonstrate hypersensitivities (e.g., overreacting to touch, textures, and changes in head position), causing some children to become visibly upset when handled or moved by others.
- When children have multiple sensory processing problems, they may have difficulty understanding and responding to the social and physical elements of their environment.

- Oral tactile sensitivity may be associated with abnormal oral movement patterns. Children may have an aversion to certain food textures, causing disorganized oral motor control and problems coordinating chewing, sucking, and swallowing.
- Those with severe problems in this area may be surgically fi ed with a percutaneous endoscopic gastrostomy (PEG) tube for feeding. Occupational therapists must consider a child's sensory limitations and strengths when setting intervention goals. The therapist considers which sensory experiences are likely to improve occupational performance.

6. Feeding, Eating, and Swallowing

- One in 5 children with CP have difficulty controlling saliva and secretions, and 1 in 15 children with CP will require alternative methods for nutrition (nonoral feeders). Dysphagia is the term used to describe difficulty with swallowing which may impact a child's ability to eat.

Common signs and symptoms of dysphagia include:

❖Inability to swallow and/or pain when trying to swallow

❖Regurgitation

❖Heartburn

❖Unusual weight loss

❖Hoarse voice

- Gagging, choking, and/or coughing when a empting to swallow
- Excessive drooling or inability to manage secretions
- Delayed (or sometimes absent) swallowing reflex
- Change in color while eating or drinking
- Recurrent chest infection/aspiration pneumonia
- Families report that mealtimes are stressful or distressing for the child
- Prolonged meal duration.

Evaluation Process and Methods

- Therapists typically begin an occupational therapy evaluation by completing an occupational profile, which is a summary of a client's occupational history and experiences, patterns of daily living, interests, values, and needs.
- The information is typically obtained from the client's or family's perspective through both formal interview techniques and casual conversation and leads to an individualized, client-centered approach to intervention.

- Structured clinical observation of the child's occupational performance provides the occupational therapist with data on factors influencing the child's muscle tone, reflex activity, gross and fine motor skills, sensory systems, cognition, perception, and psychosocial development. This clinical assessment data create a "picture" of the child's functioning and indicate his or her strengths and challenges.
- It is important to observe the child completing everyday tasks such as putting on a shirt, transitioning from a chair to the floor, opening containers, or playing with age-appropriate toys, as it helps the occupational therapist identify atypical postures and movements that may be limiting functional abilities.

- Observation and task analysis are common methods of assessment. Therapists will also evaluate functional cognition during the child's completion of daily activities. Functional cognition refers to the thinking and processing skills that are used to accomplish everyday activities in clinical, home, and community environments. A therapist performs a task analysis of specific activities to divide complex tasks into a sequence of smaller steps or actions (i.e., steps required to put on a shirt or pair of pants).
- The therapist then teaches or trains the child to complete the smaller steps to reach the goal of completing the full task independently.

- Task/activity analysis addresses the typical demands of an activity, the range of skills involved in its performance, and the various cultural meanings that might be ascribed to it. Occupation-based activity analysis places the person in the foreground. It considers the person's interests, goals, abilities, and contexts, as well as the demands of the activity itself.
- These considerations shape the practitioner's efforts to help the person reach his/her goals through carefully designed evaluation and intervention.

- Selection of assessment measures may be based on several factors, including the child's age, setting (e.g., home health, school system, community), and the caregiver's and child's specific concerns about functional limitations.

Selected Upper Limb Assessments for Body Structure, Function, and Activity for Children With Cerebral Palsy

Assessment	Age	Domain and Activities
Melbourne Assessment of Unilateral Upper Limb Function (MUUL) (Cusick, Vasquez et al., 2005; Randall, Johnson, & Reddihough, 1999)	5–15 years	Assessment of impairment and activity limitations in the upper extremity. Examiner administers 16 items that involve reach, grasp, release, and manipulation. Each item is scored according to specific criteria to rate quality of range of motion, accuracy, fluency, and dexterity, yielding a maximum possible raw score of 122.
Quality of Upper Extremity Skills Test (QUEST) (DeMatteo, Law, & Russell, 1992; Thorley, Lannin et al. (2012)	2–13 years	A criterion-referenced observational assessment measuring 34 items in four domains (dissociated movement, grasp, weight-bearing, and protective extension). Scores from each domain are summed and converted to a percentage score.
Jebsen-Taylor Test of Hand Function (JTTHF) (Davis Sears & Chung, 2010)	6–17 years	A clinical evaluation of speed and dexterity of upper limb tasks. The seven timed subtests vary in complexity and use everyday objects to assess how a child uses grasp and release in daily tasks.
Pediatric Motor Activity Log (PMAL) (Uswatter, Taub, Griffin, Vogtle, Rowe, & Barman, 2012)	2–8 years	A parent-report questionnaire measuring real-world use of impaired upper limb in common daily activities, capturing both perceived amount of use and quality of use. It is completed through a semistructured interview with the parent. The parent is asked specific questions about the way the child uses his/her upper limbs from a list of 22 real-world activities.
Assessment of ability to manage routine tasks requiring both upper extremities – (ABILHAND-Kids) (Arnould, Penta,	6–15 years	A parent completed questionnaire that assesses manual abilities of children who have impaired upper limb functions. The assessment consists of 21 items covering both unimanual and bimanual self-care activities. Each item is rated as 0 impossible, 1 difficult, 2 easy, yielding a score range of 0 to 42. The parent is asked to estimate the child's ease or difficulty in performing each activity without assistance, irrespective of using right or left upper limb, and using whatever means necessary (compensation is allowed).

Selected Participation and Quality-of-Life Measures for Children With Cerebral Palsy

Outcome Measure	Age	Domains and Relevant Items
Cerebral Palsy Quality of Life (CP QOL)—Child (Waters et al., 2013)	4–12 years Parent report; Child report 9–12 years	66 items 1. Social well-being and acceptance 2. Participation and physical health 3. Functioning 4. Emotional well-being 5. Pain and impact of disability 6. Access to services 7. Family Self-report: 53 items
Cerebral Palsy Quality of Life (CP QOL)—Teen (Waters et al., 2013)	12–18 years Child report	72 items 1. Well-being and participation 2. Communication and physical health 3. School well-being 4. Social well-being 5. Access to services 6. Family health 7. Feelings about functioning

- The Hammersmith Infant Neurological Examination (HINE)
- The HINE is a neurological assessment for infants between 2 and 24 months of age that includes items for cranial nerve function, posture, movements, tone, and reflexes. It can be reliably used to assess infants at neurological risk, both preterm and term born. The HINE identifies early signs of CP in infants with neonatal brain lesions.
- Infants with global scores ≤56 at 3 months and ≤65 at 12 months showed a high (~90%) sensitivity and specificity for the development of CP
- Scores <40 are associated with non independently ambulatory CP Gross Motor Function Classification System (GMFCS III-V)
- Scores between 40–60 are associated with independently ambulatory CP (GMFCS I-II)

- Developmental Assessment of Young Children (DAYC)
- The DAYC is a simple questionnaire that does not require training, personnel, or equipment. It is an individually administered, norm-referenced measure of early childhood development for children from birth through age 5 years, 11 months. Developmental domains addressed include cognition, communication, social-emotional development, physical development, and adaptive behavior. A drop of two standard deviations in DAYC motor scores between 6–12 months of age is 83% predictive of CP

Classification Systems

- There are four functional classification systems including (1) the Gross Motor Function Classification System (GMFCS), (2) the Manual Ability Classification System for Children (MACS and mini-MACS for children one to 4 years of age), (3) the Eating and Drinking Ability Classification System (EDACS), and (4) the Communication Function Classification System (CFCS).
- Classification systems help identify the functional abilities of children diagnosed with CP over several domains including functional mobility, manual ability with two hands, receptive and expressive communication, and safe and efficient feeding and eating. Practitioners use the classification systems to provide a common understanding of a child's functional abilities and deficits. In addition, researchers use classification systems to help identify children who may be best responders for specific type of interventions

**Gross Motor Function Classification System
The Gross Motor Function Classification System (GMFCS) is a five-level classification that describes the gross motor function of children with cerebral palsy on the basis of their self-initiated movement with particular emphasis on sitting, walking, and wheeled mobility. Distinctions between levels are based on functional abilities, the need for assistive technology, including handheld mobility devices (walkers, crutches, or canes) or wheeled mobility, and to a much lesser extent, their quality of movement.
The focus is on determining which level best represents the child's present abilities and limitations in gross motor function. Emphasis is on usual performance in home, school, and community settings (i.e., what they do), rather than what they are known to be able to do at their best (capability). It is therefore important to classify current performance in gross motor function and not to include judgments about the quality of movement or prognosis for improvement. GMFCS level should be determined in conjunction with the child and family, not solely by a professional.**

Level	Description of Functional Abilities
Level I	Walks without limitations. Performs gross motor skills like running and jumping but speed, balance, and coordination may be impaired.
Level II	Walks with limitations. This includes on uneven surface, inclines, stairs, long distances, or in crowds or confined spaces.
Level III	Walks using a handheld mobility device. Walks on even surfaces, indoors, and outdoors with an assistive device. Children may use manual wheelchair for long distances.
Level IV	Self-mobility with limitations. Child may use powered mobility or require assistance from a caregiver. May walk short distances with a mobility device but relies primarily on wheeled mobility.
Level V	Transported in a manual wheelchair. Child has no means of independent mobility and relies on caregiver for all transportation needs.

The occupational therapy practitioner uses the occupational profile, parental concerns and priorities, and information from standardized assessments and classification systems to collaborate with families and clients to formulate goals that match the child's needs, developmental performance, and potential outcomes.

Box 29.4 Sample Occupational Therapy Goals

Self-care	Child will don pullover shirt with minimal assistance, 100% trials. Child will use adaptive spoon to eat soft solid foods with modified independence.
Play	Child will show improved postural control to engage in 15-minute play activity while sitting unsupported at table with minimal physical support from occupational therapist.
Recreation	Child will successfully participate on an adaptive community sports team with same-aged peers, per parent's report.
Fine motor	Child will write first name from memory with no errors, 80% of trials. Child will isolate right index finger to successfully access games on iPad, four out of five trials.

Medical-Based Interventions

- Children and adolescents with CP may require medical-based interventions (e.g., Botox, medications) to address the muscle spasticity. Physicians may prescribe pharmaceutics, recommend surgeries, or apply specific medical interventions for children and youth with CP. Medical interventions are often used in conjunction with occupational therapy to maximize the effect. Children with spasticity may benefit from medications that reduce muscle tone. Baclofen is a medication that may be dosed orally or injected into a pump that delivers the medication directly into the cerebrospinal fluid. Baclofen reduces muscle tone throughout the person's body.

- Over time and with growth, children with moderate to severe spasticity may experience increasing muscle and tendon tightness, contractures, joint dislocation (particularly at hips), and other joint problems. Orthopedic surgeries can help ameliorate these issues when more conservative treatment such as orthotics is not effective. Surgeries include tendon transfers, muscle releases, and osteotomies. In tendon transfer surgery, the insertion of a muscle is moved to change the action the muscle produces.

- For example, a child with weak or paralyzed hand musculature may have a wrist muscle moved to the finger flexors to assist with grasp. Other types of soft tissue surgery include muscle releases or lengthening. These procedures lengthen or release tight muscle tissue to allow increased movement of a joint. Often done in conjunction with soft tissue surgery, osteotomies are procedures in which the bone is lengthened or shortened to improve its alignment. All of these surgeries involve a period of immobilization initially, followed by early movement and occupational therapy to strengthen and promote the function made possible by the structural changes

Occupation-Focused Intervention for Children with Cerebral Palsy

- Occupational therapists working with children who have cerebral palsy use occupation-based models, such as (MOHO), (PEOP), or (CMOP-E) to structure their thinking and address the multitude of factors influencing occupational performance.
- These models all follow current dynamic systems theory and address the interactions between person, environment, and occupation (and tasks). They allow occupational therapists to consider a child's interests, motivations, and abilities within his/her environment (e.g., home, school, community) in relation to those things the child wants to do (occupations). Using therapeutic reasoning skills, occupational therapists address areas to better understand how to intervene so the child can engage in those things that are important to him or her. Occupational therapists review current evidence to create intervention that best addresses occupational performance.

- Dynamic systems theory poses that movement is complex and multidimensional systems work in coordination to influence functional movement.
- Several strategic principles of dynamic systems theory include a child's ability to self-organize motor actions through repetition and practice, thus creating new pa erns from refinement of motor actions. The child's physical characteristics, activity demands, and environmental factors can influence the child's functional movement.

Motor Control and Motor Learning

- Because children diagnosed with CP have difficulty with postural control and movement against gravity, therapists frequently use motor control and motor learning concepts to guide intervention of children with movement disorders. The ability to regulate movement is complex and emerges from the interaction of the child, the task, and the environment. A child generates movement to meet the demands of the task performed in a specific environment. For example, a child selects specific movements to use a spoon to eat a bowl of soup while si ing at the kitchen table with family.

- The selected movements are influenced by the child's ability to feel, hold, and manipulate a spoon; the task (e.g., type of soup, size of bowl, type of spoon); and the environment (e.g., how the child is sitting, who is present at the table, environmental sounds). In everyday life, a child performs a variety of functional tasks requiring simple to complex movements. Motor control and motor learning research finds that intervention focusing on meaningful whole tasks (i.e., occupation) in the natural context are most effective.

Occupational Therapy Intervention Approaches

- After gathering information on the child (e.g., strengths, challenges, goals, interests), environment (e.g., supports, barriers), and the desired occupations (e.g., academics, feeding, dressing, play), the occupational therapist plans and implements interventions to promote participation in meaningful activities (i.e., occupations). Occupational therapists may work one-on-one with the child, lead groups of children with similar goals, or take a consultative role in assisting caregivers with problem-solving adaptive tools and strategies to encourage the child's independence.

- They can work with children in a variety of se ings, including school, home, and the community.
- A recent comprehensive review of interventions used with children with CP (Novak et al., 2013) found the research evidence supported the following interventions: adaptive equipment training, casting and orthotics, CIMT, functional and goal-directed therapy, and bimanual training.
- Overall, intervention approaches that provide high dose (intensity, frequency, time, and type) are found to be more effective. Interventions that promote meaningful activities that are chosen by the child and performed in the natural environment (requiring that the child problem-solve and move in flexible ways) produce better outcomes.

Adaptive Equipment

- A variety of adaptive devices and equipment can assist a child with CP to complete ADLs, instrumental activities of daily living (IADLs), play, and educational tasks. These devices serve to modify or control some of the degrees of freedom required for children to engage in daily activities. The occupational therapist selects a device that matches the child's motor needs while simultaneously considering his or her sensory functioning (including vision, auditory, and sensation), the environment in which it will be used, and the child's position when using it (standing, siittng, or in his or her wheelchair or bed). Other considerations are the child or family's ability to transport the adaptive equipment, the set up needed to use it, and the ease of cleaning the device.

- The occupational therapist may work with interdisciplinary team members when determining the child's needs. For example, when selecting a communication device for a child with quadriplegic CP and cortical visual impairment, an occupational therapist may work with a low vision therapist and speech-language pathologist to select the most appropriate device and determine the most efficient way to access the device and the optimal position to mount the device for ease of visual scanning.

- The occupational therapist may recommend adaptive utensils during mealtime to compensate for limited grasping patterns or nonskid material to control the child's plate on the table top. Dressing tasks can also be modified to optimize the child's safety, efficiency, and independence.
- A large zipper pull on jeans or pants may be recommended for a child with diplegic CP and limited fine motor coordination. The occupational therapist practitioner should become familiar with a diverse group of assistive devices so that equipment recommendations consider all occupational performance concerns and the family's financial resources. It is also common for occupational therapists to fabricate assistive devices from common household materials or orthotic materials.

Case Example

- Brian is an 11-year-old boy who was born at 35 weeks' gestation by emergency caesarean section. He had global developmental delays with hypotonia and was diagnosed with quadriplegic cerebral palsy and neurodevelopmental disability.
- He quickly becomes fatigued during self-feeding and requires assistance with spoon-feeding to obtain adequate nutrition. His mother reports that she often feeds him at home, so he is able to eat much more quickly. She reports that he is easily distracted when eating.

- During an occupational therapy assessment, Brian grasped a toddler spoon with large handle as well as a bent-handled spoon with large handle. He switched hand dominance but performed best when using his left hand. He required moderate to maximum assistance to scoop thick foods from a scoop bowl and minimal assist to transport foods to his mouth without spilling.

- Brian required repeated tactile and verbal cues to close his lips around the spoon and use his top lip to clear the spoon. He prefers to “dump” food into his mouth. He exhibited tongue thrust movements to move food laterally and posteriorly for swallowing. No coughing or choking was observed.
- Brian used a straw to drink thin liquids from a juice box, but he had difficulty creating a tight seal with his lips and lost small amounts of liquid when drinking. The occupational therapist suggested an adapted straw with a larger opening to make it easier for him to drink.
- Brian made gains in his ability to clear the spoon with his top lip when he was given assistance to stabilize his lower jaw and verbal cues to use his top lip to clear the spoon. He made improvements in his ability to move food from the bowl to his mouth without spilling.

Case Example

- Nathan is a 14-year-old boy with spastic quadriplegic cerebral palsy and normal cognition. He uses a power wheelchair. His posture is poor, and he has impaired righting equilibrium and protective responses. He requires a chest strap and lateral supports on his wheelchair to assist with postural alignment and upright seating in his chair. His dynamic unsupported sitting balance is poor and his static sitting balance on the edge of his bed is fair but requires close supervision. Fine motor skills are significantly impaired with limited grip strength; his left hand is more affected than his right. Nathan has not received occupational therapy services since he was 10-years-old when he and his family decided to take a break from services and explore adaptive recreational activities and aquatic therapy.

- Recently he requested to return to services to become more independent in self-care. His family also recently purchased a computer tablet for him and he is interested in finding applications that will help him control his environment. At his initial evaluation, the occupational therapist conducted the Canadian Occupational Performance Measure (COPM) with Nathan. He identified his most important occupational performance problems as doffing his shoes, completing simple meal preparation, turning on his bedroom lights, and completing written work for school assignments. During the evaluation the occupational therapist determined that his power wheelchair was the safest place for him to complete activities of daily living (ADLs) since it offered him the best postural support.

Occupational Therapy Goals

1. While sitting with trunk supported and using adapted equipment, Nathan will successfully doff shoes within 1 minute.

2. Nathan will follow four-step instructions to prepare a simple meal with intermittent verbal cueing by the therapist.

3. Using a tablet programmed for environmental control placed on his power wheelchair, Nathan will successfully turn lights on in rooms at home, 100% of trials.

4. Nathan will dictate all appropriate school reports using adaptive word processing program with supervision and set up only.

- Over the course of his 12-week admission, the occupational therapist tried and evaluated various adaptive equipment training. To increase independence in lower extremity dressing, Nathan attempted to use a reacher and long-handled shoe horn with good success. By the end of the 12 weeks, Nathan successfully unstrapped his foot supports, untied his shoes, and, using a long-handled shoe horn, doffed them. He continued to require assistance with doffing his ankle foot orthoses (AFOs) but was making progress toward independence with the strategies and adaptive equipment provided by his therapist.

- To address simple meal preparation activities, the occupational therapist suggested use of an adapted cutting board that secured food and use of a rocker knife. Positioning his chair to the side of the counter to retrieve materials with his stronger arm was also beneficial. With a consult from an assistive technology specialist, Nathan and the occupational therapist explored tablet applications for environmental control and found one that controlled the lights, his television, and his DVD player. The occupational therapist fabricated a mount with a Loc-Line modular hose system that allowed him to easily reposition his computer tablet or push it out of the way when not in use.

- The assistive technology specialist also recommended textto-speech software and agreed that the most effective position for him to dictate school reports was in his chair, where he had the best breath support. Nathan worked with the occupational therapist to learn how to use the software and his speech-language pathologist was consulted for strategies to improve his articulation. At the end of the 12 weeks the occupational therapist reassessed his progress through structured observation and readministered the COPM. Nathan reported improved performance and satisfaction with his performance on all the performance goals identified at admission, with the greatest change noted on meal preparation tasks. Because of his progress the occupational therapist reduced visits to one-time monthly consultative sessions for the next 6 months.

Orthotics or Casting

- Orthotics (previously referred to as splinting), or casting can be used to improve hand function, prevent joint contracture, relieve pain in a specific joint, improve functional use of the arm and hand, and improve position of the hand/thumb for hygiene and/or outward appearance. Using an orthotic may also be used to reduce unsafe behaviours in a child with self-injurious behaviours. Orthotics can support the arm in a functional position to improve performance in ADLs.

- Serial static orthoses and casts are designed to lengthen tissues and correct deformity through application of gentle forces sustained for extended periods of time with the goal of reducing tightness or spasticity in a selected muscle group. Orthotics are remolded and casts replaced at intervals that allow for the muscle tissue to respond to the lengthened position. The biomechanical effects of orthoses and casting relate to changes in the length of muscle and connective tissues, which can reverse the effects that occur when a muscle is maintained in a shortened position. Using orthoses to lengthen tight and contracted muscles in children with CP is best if applied continuously for periods greater than 6 hours.

- Casting has additional biomechanical and neurophysiologic effects, although the exact neurophysiologic effects of casting on spasticity are not well defined at this time. It is theorized that inhibition of muscle contractions allowing lengthening of muscle tissue results from decreased cutaneous sensory input from muscle receptors during the period of immobilization. The effects of neutral warmth and circumferential contact also are believed to contribute to modification of spasticity

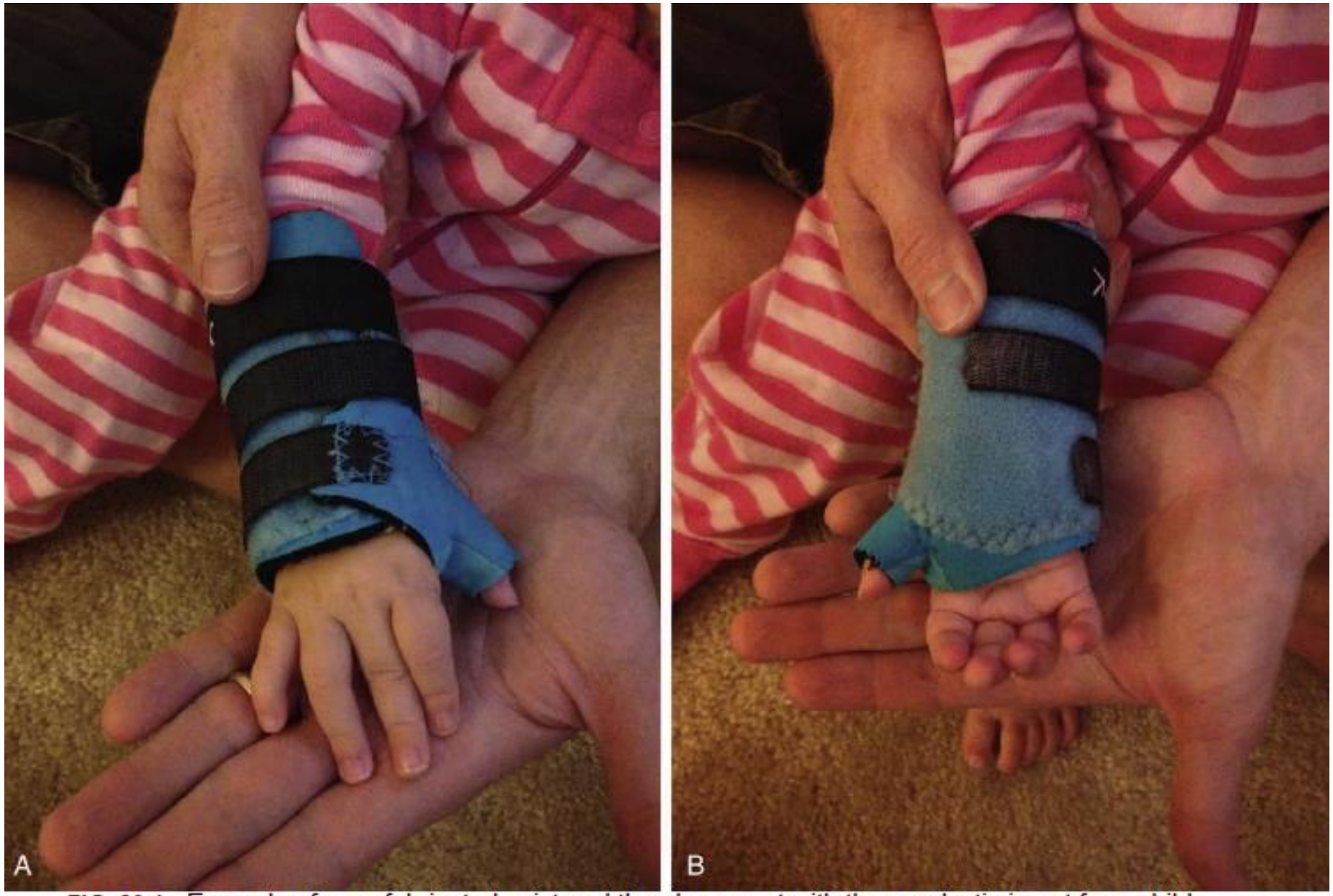

FIG. 29.1 Example of a prefabricated wrist and thumb support with thermoplastic insert for a child with hemiplegia.

- Orthoses can also be used to meet the goals of the child or parent. For example, an orthosis may be fabricated to isolate a child's index finger to access a touch screen device or communication system. Orthosis have been used to compensate for hand deformities preventing the ability to grasp eating or writing utensils.
- Orthotics may also be used to aid in the ability to drive a power wheelchair such as a wrist support that allows a child to access the joystick control. Temporary orthotics are also fabricated by therapists to prevent movement from the hand to the mouth when children exhibit self-injurious behaviours or attempt to pull out feeding tubes, intravenous lines, or tracheostomy tubing.

- A systematic review of orthotic use in children with CP reported that when the use of an orthotic was combined with an active therapy program, it had positive effects on function. The use of orthoses and serial casting to reduce spasticity may be most effective when used in conjunction with botulinum toxin A injections.
- When an occupational therapist determines that a child would benefit from wearing an orthosis or cast, he or she needs to educate parents as to the purpose and goals for the orthotic, provide instructions for donning, doffing, and cleaning, and determine an optimal wearing schedule that fits the family’s routines.

Constraint-Induced Movement Therapy

- CIMT is an evidence-based intervention for children with hemiplegia that targets the functional use of the child's affected upper extremity through engagement in intensive practice, shaping and grading of targeted movements, and restricting use of the unaffected, stronger upper extremity.
- Children with hemiplegia often show "developmental disregard", that is, they learn to ignore the involved arm because it is inefficient. Therefore use of the involved arm is negatively reinforced despite the function that may be available. The goal of CIMT is to reverse this effect.

FIG. 29.2 An example of sensory exploration during modified CIMT.

- CIMT was initially used in the rehabilitation of patients post stroke and then developed as an intervention for children. Multiple case reports, cohort studies, and randomized control trials have reported the effectiveness of this intervention technique both in the lab and the clinic.

- Current implementation of CIMT varies, but all programs have three essential features: (1) some method of constraint of use of the unimpaired upper extremity; (2) intensive, repetitive practice of motor activities, for up to 6 hours per day, for 2 to 4 weeks; and (3) shaping of more complex, functional motor acts by identifying the component movements of a targeted task and rewarding actions that are successive approximations to the task. The literature reports a variety of constraining devices and wearing schedules, including mitts, casts, orthotics, and slings.

- Use of constraining devices may be intermittent and they may be removed at certain times of the day or after massed practice trials are completed, or they may be applied continuously, allowing for practice and generalization of skills throughout the child’s day for a set period of time.

- CIIMT can be defined as either a signature CIMT or modified CIMT (m-CIMT). A signature CIMT approach has five essential components, including (1) constraint of the unaffected upper limb, (2) a high dosage of repetitive task practice (3 to 6 hours of therapy per day over several consecutive days), (3) the use of shaping techniques, (4) therapy provided in a natural setting, and (5) a transition or post-CIMT program to maintain gains acquired during the CIMT program

- A typical signature approach provides massed practice and shaping of more mature motor movement for at least 2 consecutive weeks (14 to 21 days, dosage equal to 42 to 128 hours) by a professional with an understanding of rehabilitation techniques to improve motor function.
- m-CIMT is defined as constraint of the stronger or less affected upper limb combined with less than 3 hours per day of therapy. Most of the five essential elements of the signature approach are provided, but with modifications, including variation in where the therapy is provided (e.g., clinic or camp versus individual treatment at home) or a variation in the dosage of therapy (e.g., less concentrated, may be more distributed over several days or weeks)
- Repetition of this intervention has also shown positive clinical changes.

FIG. 29.3 Example of motor-based activities during modified CIMT. (A) The child holds onto the swing with her affected hand. (B) The child plays a game using her affected hand.

Bimanual Therapy

- Bimanual therapy retains the intensive structure and task practice of CIMT, but the focus is improving the ability to perform bimanual activities. Bimanual therapy uses carefully planned, repeated practice of twohanded, or bimanual, games and activities to improve a child's ability to use their hands together in daily activities. It involves intensive, massed practice, similar to the dosage required for CIMT (>30 hours) and can be provided during individual or group therapy formats. Structured practice and skill progression are important elements of bimanual and intensive therapy approaches.

- There is emerging evidence to indicate that when compared to unstructured bimanual task practice, structured bimanual training demonstrates not only positive outcomes on clinical measures but also changes to cortical motor maps. Structured skilled progression of activity also leads to better trunk stability and greater dissociated movement patterns of the affected upper extremity.
- Using bimanual therapy, object properties can be adapted to trigger goal-related perceptual and cognitive processes required for children to learn to recognize when two hands are required for task completion.

- The therapist encourages the child to use both hands during bimanual tasks and discourages unimanual skills using only the stronger, nonaffected upper limb.
- Therapy activities target bimanual movements such as those required to play with toys with two hands, transfer items between hands, remove or put on clothing, or carry or move toys.

Physical Agent Modalities

- Various modalities target increasing muscle length and strength and reducing spasticity in children with CP to improve a child's functioning in play, ADLs, IADLs, and academics. These intervention modalities include electrical stimulation and hot/cold therapy. Heat may be used in conjunction with a stretching program to improve muscle length and reduce pain. Electrical stimulation can strengthen antagonist muscles, reeducate muscles, target pain reduction, improve coordination, increase range of motion, and reduce spasticity

- Electrical stimulation is most effective when used with a functional activity, such as combing hair when stimulating the biceps or releasing toys into a container while stimulating wrist extensors. Use of neuromuscular electrical stimulation when applied with intensity can improve upper limb range of motion and strength, especially when paired with dynamic orthotics or static orthotics.
- Risk for burns is an important consideration, especially on the affected limb where sensation may be decreased or absent. In addition, contraindications such as cancer apply. Therapists should complete advanced training in PAM application before use.

Therapeutic Taping and Strapping

- Two types of therapeutic tape are used in rehabilitation. Therapists use rigid tape to limit movement around a joint or to protect a joint during functional movement, while flexible, elastic kinesiology tape is used to facilitate improved movement patterns.

- Kinesiology tape is applied directly to a child's skin and works by increasing stimulation to cutaneous mechanoreceptors that facilitate muscle contraction or inhibition. The elastic properties of the tape can also be used to reposition joints to a more appropriate alignment. Four major functions of kinesiology tape are to (1) support a weakened muscle, (2) improve circulation, (3) reduce pain, and (4) improve joint alignment

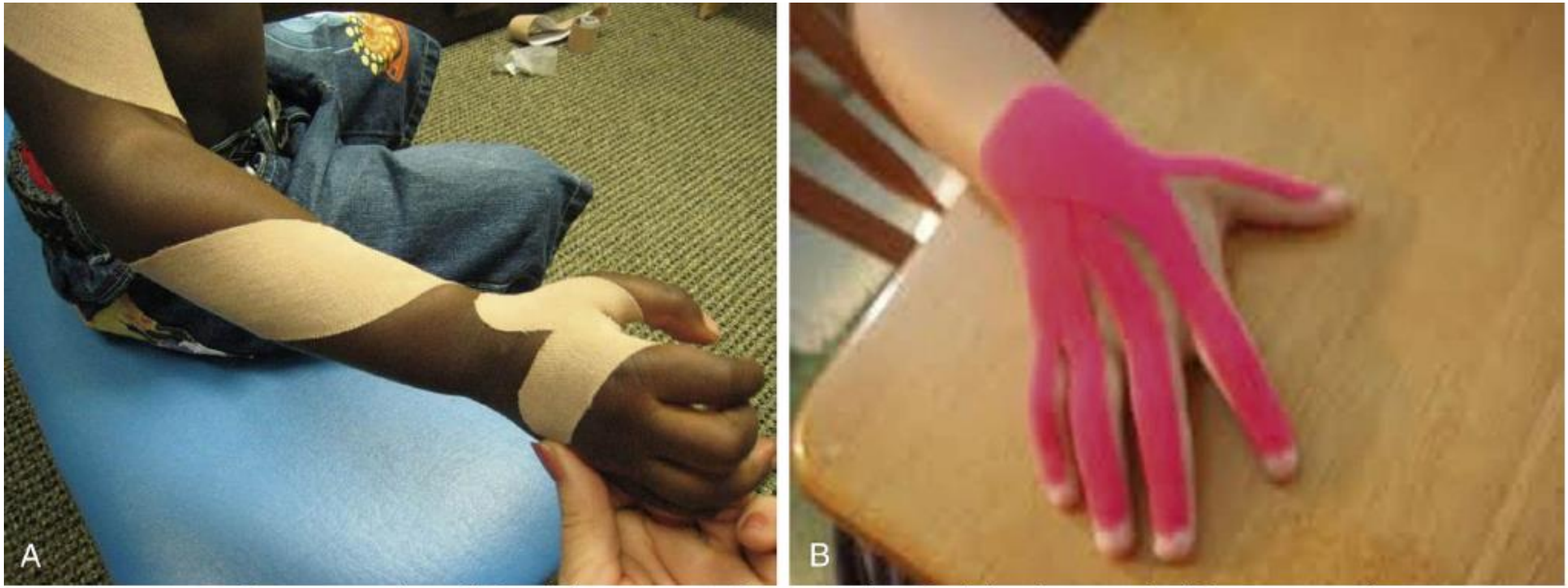

FIG. 29.4 Two examples of kinesiology tape to improve thumb abduction needed for grasp and release.

- Because of potential skin sensitivities in children, it is always important, before taping a full joint, to apply a small “test” strip to the child’s skin to check for negative reactions to the properties of the tape. Advanced training in kinesiology and rigid taping applications is available through continuing education courses.
- Published evidence to support or refute the use of taping interventions is small but growing. Studies report improvements in postural control, muscle balance, gross motor skills, functional daily living skills, and motor control of both lower and upper extremities.

Positioning, Handling, and Neurodevelopmental Treatment

- Occupational therapy practitioners often employ neurodevelopmental treatment (NDT) techniques of therapeutic positioning and handling to assist children with CP to optimize their independence with functional tasks. Occupational therapists determine the safest and most efficient positioning and handling techniques to facilitate completion of ADLs and IADLs. They recommend and select wheelchairs, standers, activity chairs, commode or bath chairs, and side-lyers to aid in completing play and ADL tasks.

- The occupational therapist makes recommendations for positioning, seating, and mobility in collaboration with interdisciplinary team members from rehabilitation engineering, speech-language pathology, and physical therapy depending on the complexity of the child and his or her needs. For example, an occupational therapist may suggest a reclined bath chair with a seat belt to support a child with quadriplegic CP and poor head control during bathing. A school therapist may suggest a slant board and foot support to improve posture during writing tasks for a child with hemiplegic CP.

- In addition to positioning in preparation for tasks, therapeutic handling can affect a child's tone throughout the body to assist with efficient muscle activation for movement. As a preparatory technique, handling techniques such as imposed rotational movement pa erns, slow rocking, and bouncing facilitate or inhibit the child's muscle tone and enhance arousal level. Often children with CP have poor body awareness and a limited ability to anticipate postural changes required for movement or anticipatory control

- Facilitated weight-bearing and weight-shifting can build strength, improve co-contraction, and improve postural symmetry and alignment in children with CP. For example, an occupational therapist working with a child who tends to move in an extensor pattern may facilitate sustained flexion of the trunk and slow trunk rotation in sitting and knee flexion in quadruped in preparation for si ing in a chair for mealtime.

- A practitioner may also train a parent to complete these activities with the child before dressing. If the child has high tone and his or her muscles are stiff, positioning and handling techniques may facilitate movements required for dressing and self-care tasks. Improved passive knee flexion reduces the burden of care on the caregiver while donning a child's pants.
- Evidence to support this intervention is mixed as recent studies have not been able to isolate the effect of treatment to this intervention.

Community Recreation

- Children and teens with disabilities are at risk for limited participation in recreational and leisure activities and youths with physical disabilities experience two to three times the activity limitations that are experienced by children with other chronic conditions.
- In addition, children with disabilities are more restricted in their participation compared with their peers. Their leisure activities tend to be limited; they attend fewer social engagements and spend less time in quiet recreation than their typically developing peers. Children with disabilities tend to be involved with more informal versus formal recreation activities and participate less in physical and skill-based activities

- Occupational therapists can assist children with CP in accessing adaptive recreation options. Children's recreation and leisure participation can be divided into formal activities (e.g., structured activities with rules and often a leader) and informal activities (e.g., child-initiated, unstructured activities).
- Occupational therapists can assist in identifying preferred formal and informal leisure and recreational activities for children with CP and also can assist in the modification of specific activities to meet the needs of the child both at home and in the community.

- For example, an occupational therapist may suggest the use of a tee stand for a child with hemiplegia to participate on a softball team with his or her peers or may provide a universal cuff to allow a child to participate in playing a video game at home. Occupational therapists may also guide families to appropriate community organizations that provide recreational activities for children with disabilities.

Robotics and Commercially Available Gaming Systems

- The field of paediatric neurorehabilitation has rapidly evolved with the introduction of robotics, computer-assisted systems, and virtual reality, which may complement conventional occupational therapies. These systems appear promising, especially the exciting and challenging virtual reality scenarios which can increase motivation to train intensely in a playful therapeutic environment.

- Despite promising experiences and a large acceptance by the patients and parents, so far, few robotic, computer-assisted systems, and virtual reality programs have been rigorously evaluated in children with CP and well-designed, randomized controlled studies in this field are lacking. It is unclear which systems are effective for specific types of CP and the best application for this technology (e.g., duration, frequency, and intensity) to generate the best results.

- Rehabilitation robotics is the use of robotic devices to restore or improve function for a person with a disability. Robotics can be part of a prosthetic, used as an assistive device for some functional task, or used therapeutically to achieve a high level of repetition of movement patterns.
- Therapeutic robotics may be used to achieve massed practice during a therapy program. Because most devices have settings that progress and challenge movement patterns and strength, the occupational therapist can select the level of challenge most appropriate for the child.

- Robotic devices range from large, stationary devices with both gross and fine motor components to glove-based systems with small sensors. Most robotic devices are connected to a computer so that the child can receive feedback from the game graphics on a screen or monitor. Fig. shows adaptations that allow children with limited hand function to use a robot arm or access gaming technology. Research on the effectiveness of robotics for children with CP is limited. One study reported that use of robotic training with children with hemiplegia demonstrated improved range of motion and coordination of the upper limb.

FIG. 29.5 A screenshot of robotic device software.

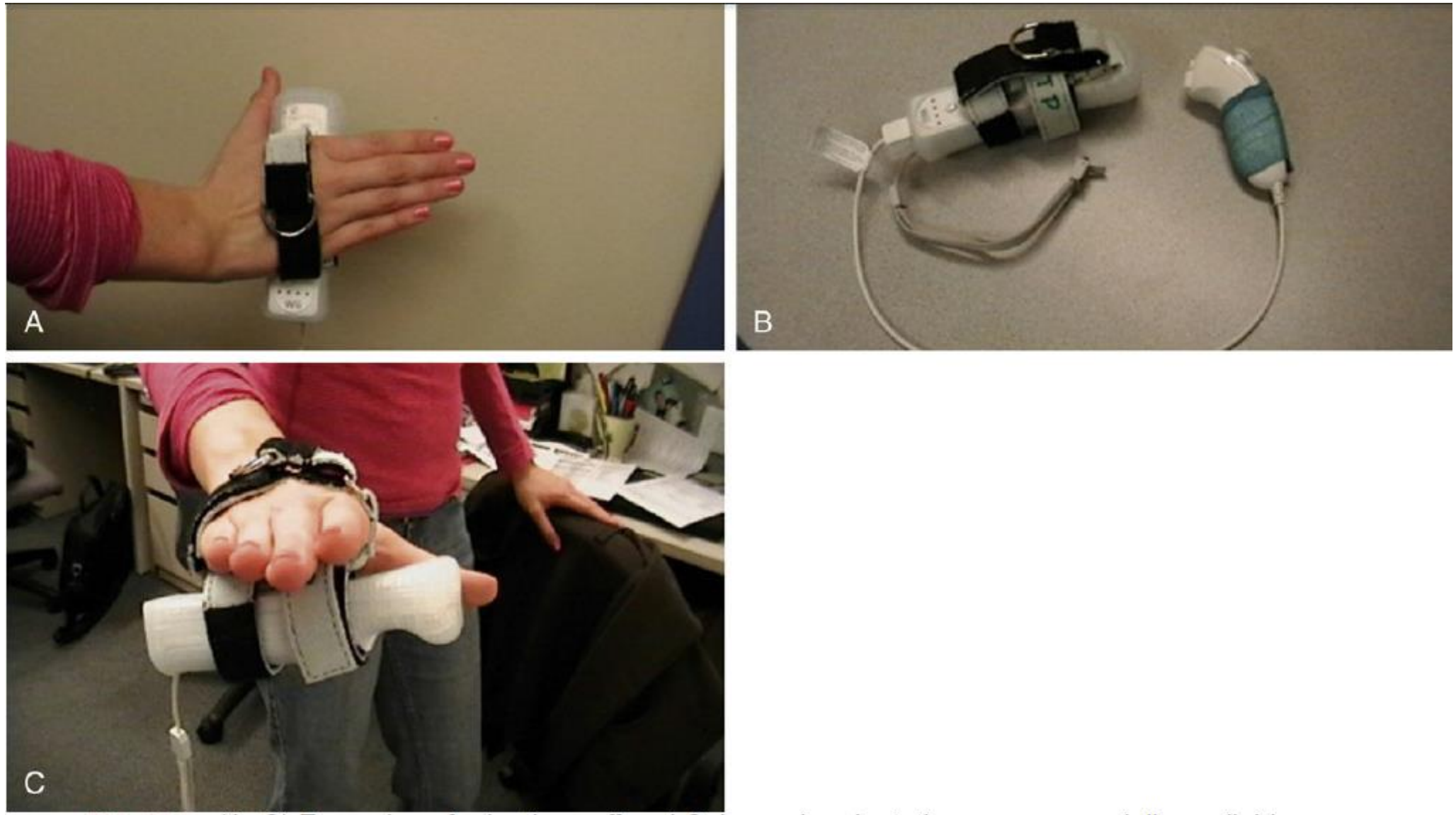

FIG. 29.6 (A–C) Examples of adaptive cuff and Coban grip adaptation on commercially available gaming technology.

FIG. 29.7 (A) Armeo Spring Exoskeleton with integrated spring mechanism.
Photo A Hocoma, Switzerland.) (B–D) Handtutor by Meditouch. (Photo courtesy of Meditouch, Netanya, Israel.

- Gaming technology refers to the use of commercially available video game systems in the clinical environment in ways that are integrated with planned therapy. In recent years, a number of gaming devices that require gross motor activity to successfully operate have become commercially available and are quickly being incorporated into clinical rehabilitation programs. Research on use of these devices in rehabilitation is limited to case reports.

- Use of robotics and gaming technology should be selected with caution. When choosing a device or gaming system, an occupational therapist considers multiple factors. The child’s age and cognitive ability suggest his or her capacity to follow directions and play games associated with the device. The size of the child’s arm and hand may prohibit his or her use of a robotic device that was created for adult use. Baseline level of motor function helps determine the level of additional support or adaptations a device may require for the participant to hold the device.

- Visual perceptual capacities may pose a challenge or add additional frustration to game play. Games with high contrast or solid backgrounds may be easier for the child to see. During intervention, occupational therapists monitor for compensatory movements that could cause repetitive use injuries, provide breaks at regular intervals, and monitor for muscle fatigue, providing the appropriate challenge based on the child's performance. Robotics, virtual reality, and commercially available gaming systems may complement an occupational therapy plan of care because they motivate the child and provide additional opportunities for massed practice.