

Fundamentals in Assistive Technology

Clinical Applications of Assistive Technology

Introductions!

Welcome to the RESNA Fundamentals Course!



Fundamentals in Assistive Technology

How this course is set-up

This course includes 10 modules that cover AT service provision in general and in a variety of AT specialty areas.

At the beginning of each module will be a list of two to three learning outcomes. (Note: you'll be tested on these learning outcomes later!)

At the end of each module will be 2 to 3 review questions, one question based on each learning outcome. You'll have time to answer the questions on your own and then discuss them with your neighbors before the answers are revealed. This is how we'll give you feedback on your learning progress throughout the course.

Ask questions at any time!



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Fundamentals in Assistive Technology After the course – requirements for receiving CEUs

To receive the 1.4 CEUs, you must be present for the entire course. After the course, you must also complete the following steps:

- You must successfully pass a quiz based on the course's learning outcomes. The quiz has 28 multiple-choice questions; you must answer 20 questions correctly to pass. If you do not pass the quiz, you must wait two days before reattempting the quiz.
- You must complete an evaluation survey to give us feedback about the course content and the instructors. Your feedback will help us continue to improve the course.

On the second day of the course, RESNA staff will email attendees a link to the quiz and the evaluation survey.

Within 2 weeks of your passing the quiz and completing the evaluation survey, RESNA will email your CEU transcript for the course.



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Learning Outcomes

- Recognize the major disabilities that use Assistive Technology (AT)
- Identify particular features of AT that can help certain impairments
- Identify etiologies and pathologies involved in disabilities that can benefit from assistive technology



Warning!

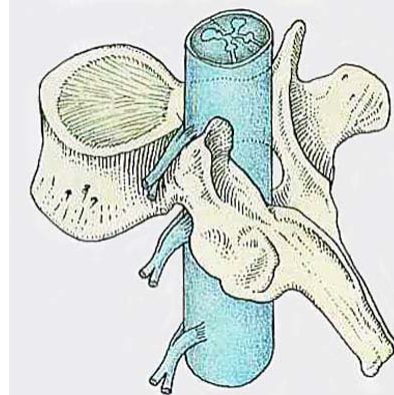
Each individual is unique.
The following generalizations
may not apply to your client.



Diagnoses

Neurological Disorders

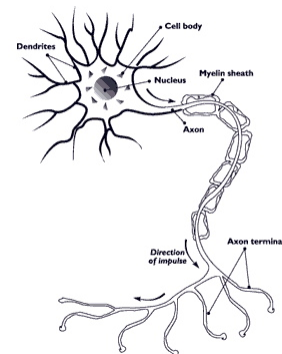
- Neural Canal
- Spinal Cord Injury
- Spina Bifida
- Brain Lesions
- Stroke
- Brain Injury
- Cerebral Palsy



Diagnoses

Neurological Disorders

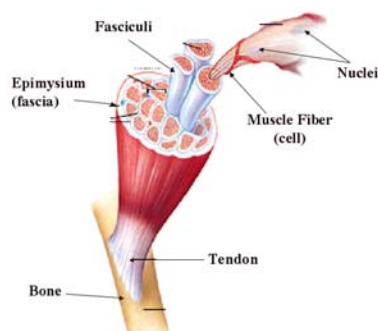
- Degenerative, Adult Onset
- MS
- ALS
- Degenerative, hereditary
- Spinal Muscular Atrophy



Diagnoses

Muscular Disorders

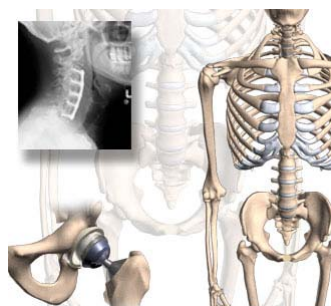
- Duchenne Muscular Dystrophy



Diagnoses

Orthopedic Disorders

- Arthritis
- Amputation
- Arthrogyposis
- Osteogenesis Imperfecta



Spinal Cord Injury

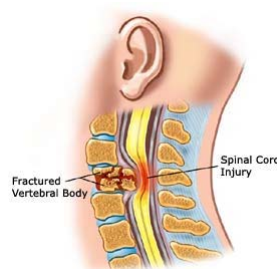


Definition:

Partial or complete severing of the spinal cord



Photo courtesy of robertkreisman.com



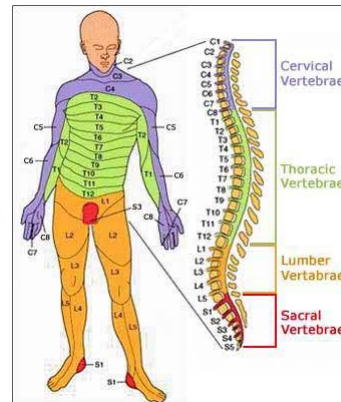
Etiology

- Usually due to trauma
 - Most common causes are auto accidents, sport injuries and gun shot wounds
- Can also be due to tumor
- Young men, risk takers



Etiology

- Quadriplegic
 - All four extremities, often incomplete injury
- Paraplegia
 - Only the legs, usually a complete injury
- Central Cord Syndrome
 - Occurs in cervical area following hyper-extension. Weakness in UEs > LEs. Bowel, bladder and sexual dysfunction may occur



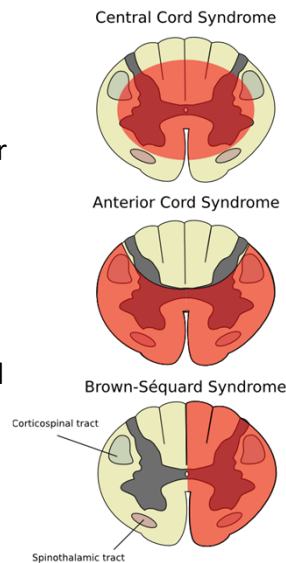
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Etiology

- Brown Sequard
 - Lesion in the midsection of the spinal cord. Proprioceptive and motor loss ipsilaterally (same side). Sensation for pin prick and temperature lost contralaterally (opposite side). Bowel and bladder remain intact.
- Anterior Cord Syndrome
 - Flexion injury causing trauma to the anterior cord. Loss of motor skills and variable sensation. Proprioception, bowel and bladder remain intact.

Incomplete lesions of the spinal cord



Pathology

- Paralysis
- Osteoporosis
- Hypercalcemia (increased calcium)
- Deep vein thrombosis
- Pulmonary embolism
- Spasticity
- Heterotopic ossification
- Neurogenic bladder

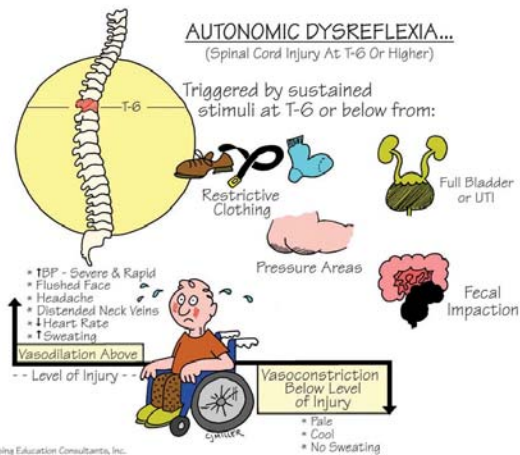


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Pathology

- Autonomic Dysreflexia
 - Aka Autonomic Hyperreflexia
 - Most common above T6
 - Reaction of autonomic system to overstimulation
 - Constipation
 - Full bladder or UTI
 - High blood pressure, sweating, redness, headaches, blurred vision
- Treatment: sit up, remove trigger



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Pathology

- Orthostatic Hypotension
 - Aka Postural Hypotension
 - Blood pressure suddenly drops
 - Light headed, dizzy
 - Difficulty maintaining normal blood pressure and blood flow to upper body
- Treatment
 - Lay down
 - Justification for recline

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Pathology, cont.

- Non-progressive
- Some recovery may occur after initial spinal shock
- Complete lesions: permanent paralysis and loss of sensation below lesion
- If etiology is traumatic, client may have other orthopedic complications and/or a head injury
- Children are at high risk for scoliosis



Spina Bifida



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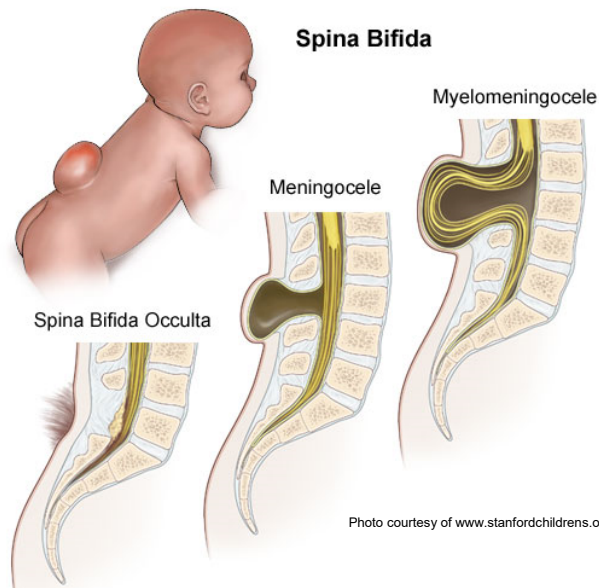
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Definition

- Born with defect in spine and cord due to incomplete fusion during development
- May be due to genetic, environmental or nutritional reasons
- Common causes: exposure to heat, decreased folic acid intake or drug abuse
- Meningocele
 - Spinal cord herniates into the vertebral opening, skin remains intact, often no damage occurs to cord
- Myelomeningocele
 - Spinal cord is exposed and paralysis occurs below this level



Meningocele and Meningomyelocele



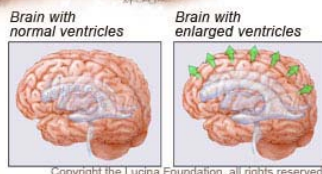
Definitions

Often seen with Spina Bifida:

- Hydrocephalus
 - Build up of spinal fluid in the ventricles, leading to possible skull distortion and brain damage
- Arnold-Chiari malformation
 - Part of the cerebellum protrudes into spinal canal



Hydrocephalus



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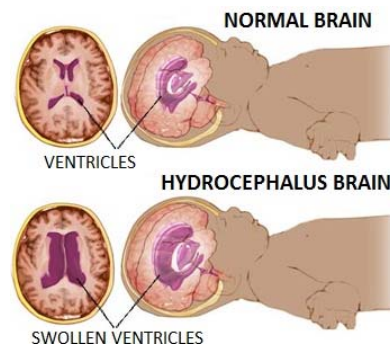


Photo courtesy of robertkreisman.com



Pathology

- Paralysis and lack of sensation below area of neural involvement
- Muscle weakness may occur above lesion
- Decreased muscle tone
- Poor trunk control and balance
- Spinal asymmetries
- Decreased motor planning, coordination and midline skills



Pathology

Visual impairments, including:

- Weak ocular motor control
- Poor fixation
- Impaired tracking
- Impaired scanning
- Impaired perception



Pathology

Cognitive impairments, including:

- Normal to severe cognitive impairment
- Learning disabilities
- Language difficulties
- Attention deficits
- Problems with memory



Assistive Technology Applications

Positioning

- Provide support, particularly below the level of injury
- Children are particularly prone to scoliosis as they grow
- Pressure relief!
- Stability for function
- Change of position for pressure relief and re-distribution, for ADLs and for medical reasons (i.e. autonomic dysreflexia)



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Pressure

Contributing factors:

- Lack of sensation to tell body to shift weight
- Moisture (urine, sweat)
- Heat (cushion materials, cover)
- Hygiene
- Bony Prominences
- Nutrition
- Skin integrity
 - Prior pressure sore



AT Applications

Mobility

- Manual wheelchair
- Power wheelchair
- Actuators
- Drive control
- Interfacing
- Accessories: ventilator

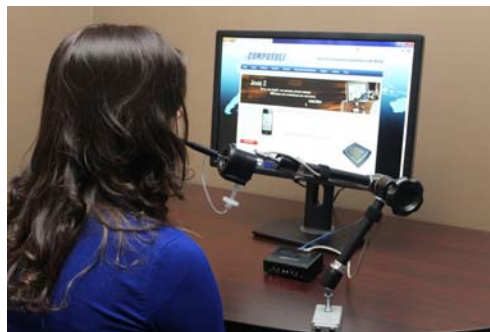


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AT Applications

- ADL equipment to replace/enhance hand grip & reach
- Electronic Aids to Daily Living (EADL)
- Computer with alternative access
- Architectural modifications
- Recreational technology
- Vehicle mobility



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Stroke

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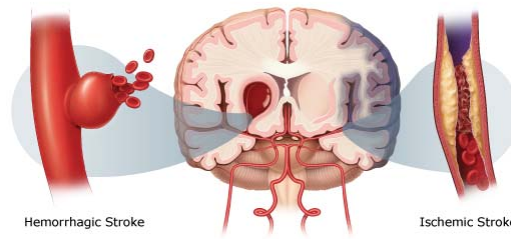
Definition

- Cerebral Vascular Accident (CVA)
- A non-traumatic brain injury resulting from a temporary or permanent occlusion of cerebral blood vessels
- Rupture (aneurism) can have similar result
- Stroke before, during or shortly after birth is typically defined as cerebral palsy



Etiology

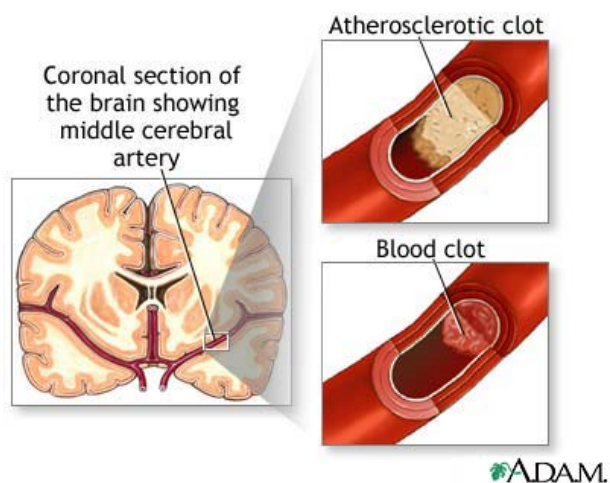
- The brain tissue supplied by the occluded vessels does not receive oxygen and dies.
- Cerebral/cortical strokes:
 - Ischemic: compromise of blood flow
 - Hemorrhagic: bleeding in the brain or dural space around the brain
- Brainstem stroke
 - Affects cranial nerves, bulbar nuclei, tracts and medulla



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Stroke



Etiology

Locked-in Syndrome

- Stroke in pontine area
- Severe physical disability



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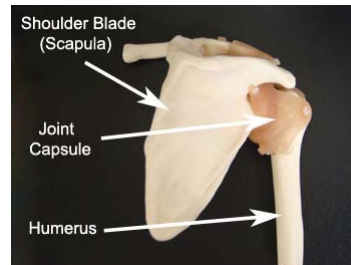
Pathology

- Non-progressive, unless subsequent strokes occur
- 80% survive a stroke
- Recovery depends on the individual and degree of brain damage
- Geriatric population may have complications from other diagnoses
- Recovery most significant in first 6 months



Pathology

- Paralysis
- Decreased motor control
- Weakness
- Decreased balance and coordination
- Decreased sensation
- Changes in muscle tone (flaccid or spastic)
- Contractures
- Shoulder subluxation or pain

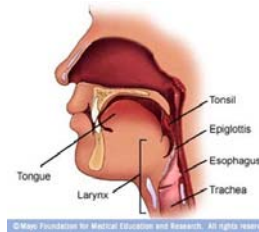


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Pathology

- Impaired purposeful movement and motor planning
- Decreased bowel and bladder control
- Decreased language skills (expressive and receptive)
- Decreased swallowing
- Behavioral issues
- One sided neglect



Pathology

Cognitive deficits

- Various levels of consciousness
- Memory loss
- Short attention span
- Disorientation
- Decreased judgment
- Difficulty learning new tasks



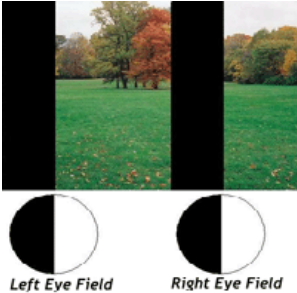
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Pathology

Visual deficits

- Decreased visual field
- Double vision
- Decreased acuity
- Homonymous hemianopsia
- Perceptual deficits




Left Eye Field Right Eye Field



View of Paris for someone with Homonymous Hemianopsia

View of Paris for someone with normal vision.




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Left Stroke

- Right hemiplegia
- Aphasia
- Poor motor planning
- Poor math
- Slow at tasks

Right Stroke

- Left hemiplegia
- Visual field cuts
- Perceptual problems
- Left neglect, denial
- Impulsivity
- Emotional lability



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AT Applications

Positioning

- Postural support to reduce lean to affected side
- Support affected arm
- Comfort



AT Applications

Mobility

- Quad cane
- Walker
- Manual wheelchair with
 - one arm drive
 - one hand and one foot propulsion
- Power wheelchair



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AT Applications

- ADL equipment
 - reacher
 - shower chair
 - raised toilet seat
- EADLs



AT Applications

- Cognitive aids, reminders, alerts
- Augmentative Communication devices
- Computer with one handed access, small keyboard
- Recreational aids
- Architectural modifications



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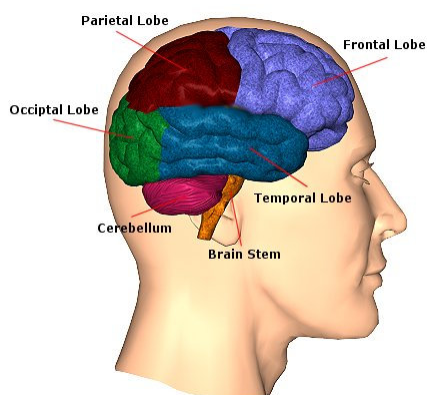


Traumatic Brain Injury



Traumatic Brain Injury (TBI)

Definition: damage to brain due to sudden injury



Etiology

- Injury to the brain resulting in loss of function, dependent on what area is damaged and how extensive the damage is
- 1.4 million people a year
- Higher in males
- Higher in late teens and early 20s



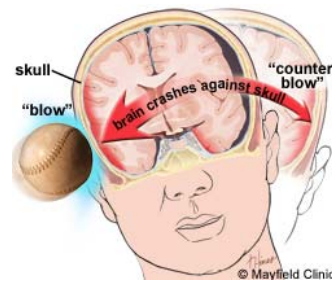
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Etiology

Causes include:

- Closed Head Injury
 - Impact between the head and a blunt object, dura remains intact
- Open Head Injury
 - Same as above, dura being opened
- Penetrating Head Injury
 - A foreign object penetrates the dura and enters the brain



Etiology

- Causes include:
 - Anoxic or hypoxic brain injury
 - e.g. near drowning, attempted hanging, difficult birth
 - Anoxic encephalopathy
 - Toxic/metabolic brain injury
- Specific causes include alcohol abuse, MVAs, falls and assaults (including gunshot wounds and shaken baby syndrome)



Pathology

- Initial loss of consciousness
- Sometimes coma
- Loss of function
- Classifications range from mild to severe depending on standard test scores based on:
 - Eye opening
 - Motor responses
 - Verbal responses



Pathology

- Largest recovery occurs within the first 2 years
- Improvement can occur years after injury
- If an area is partially damaged, the remaining area may be able to control function
- If an area controlling a specific function is completely destroyed, the function is permanently lost.



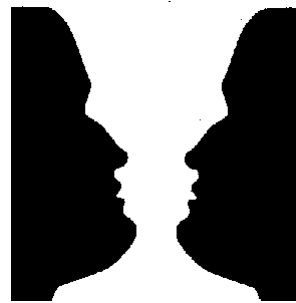
Pathology

- Abnormal muscle tone, rigidity, spasticity, paralysis, high risk for contractures
- Poor motor control, motor planning (apraxia), coordination (ataxia), balance
- Vision, hearing, speech problems, aphasia, language problems
- Emotional & behavioral problems, poor attention, frustration, lack of motivation/initiation, lack of social inhibition



Brain Injury

- Cognitive, memory, attention, and perceptual problems
- Seizures possible



AT Applications

Positioning

- Reduce tone
- Prevent deformity
- Tilt or recline



AT Applications

Mobility

- Walker
- Manual wheelchair
- Power wheelchair
- Judgment



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Clinical Applications of Assistive Technology

AT Applications

- ADL equipment
- Computer
- EADLs
- Sensory and vision aids
- Augmentative Communication devices
- Cognitive aids, reminders, alerts



Cerebral Palsy



Cerebral Palsy (CP)

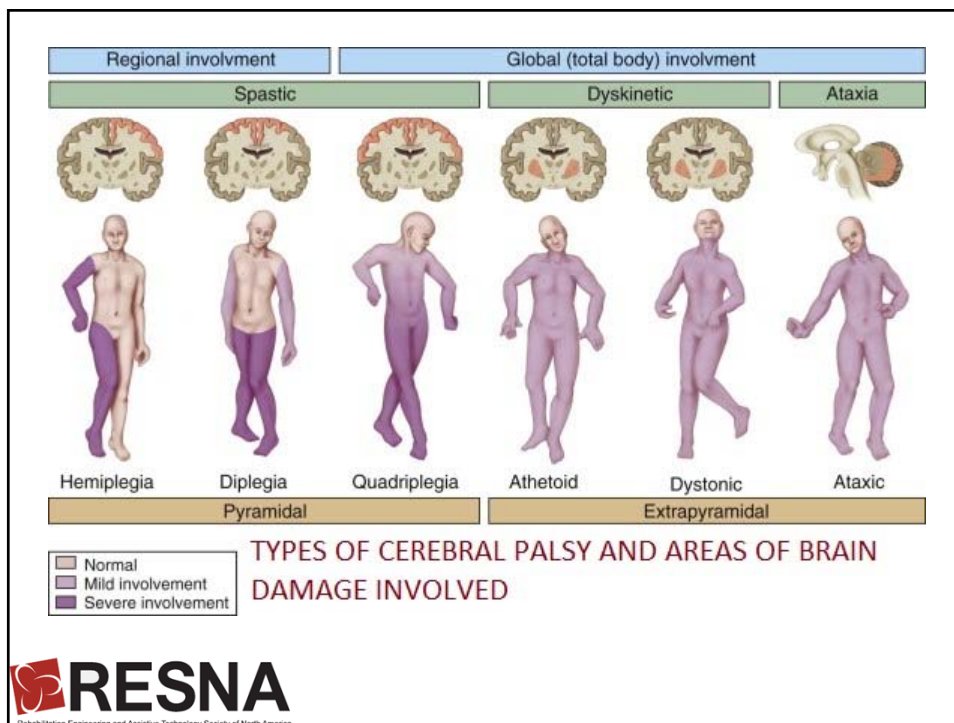
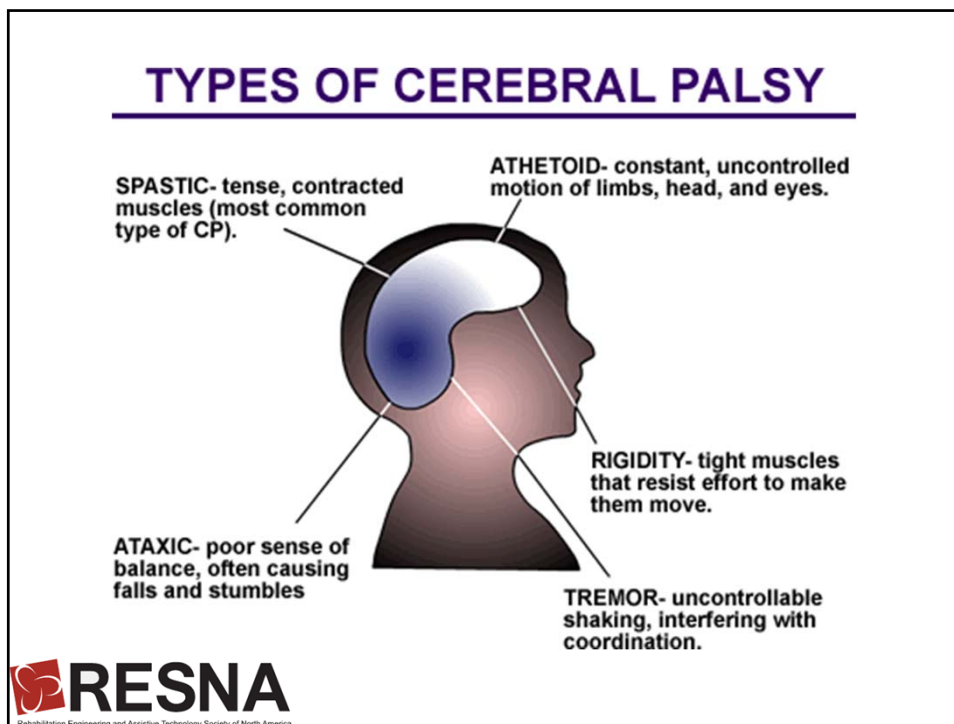
Definition:

- A non-progressive disorder resulting from a lesion to the brain occurring anytime from fetal development to 2 years of age.
- 70% of cases are believed to be caused before birth
- 20% of cases are believed to be caused during birth
- 10% of cases are believed to be caused after birth



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Etiology

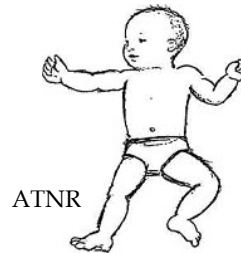
CP can occur prenatally, perinatally or postnatally due to:

- Malformation of the fetus
- Maternal dysfunction
- Premature separation of the placenta
- Bleeding in the baby's brain
- Anoxia in utero or during birth
- Injury to the brain due to swelling
- Post-natal causes include meningitis and injury



Pathology

- Minimal to severe involvement
- Decreased neuromuscular control
- Decreased kinesthesia
 - Ability to perceive position and movement in space
- Primitive reflexes
- Abnormal muscle tone
- Extraneous movement
- Seizure disorders
- Oral motor problems



Pathology

- Oculomotor problems
- Decreased swallowing
- Asymmetry in linear growth
- Orthopedic involvement
- GI problems
- Decreased bowel and bladder control
- Perceptual deficits
- Cognitive deficits



Pathology

Classified by Motor/Tonal involvement:

- Spastic
 - Hypertonia, increased stretch reflex and muscle tone that is velocity dependent
- Dyskinetic movement disorders
 - Athetoid: extraneous, non-volitional movement, often with fluctuating tone
 - Ataxic: uncoordinated movements
- Hypotonic Tone
 - Decreased stretch reflex and muscle tone



Pathology

Classified by Motor/Tonal involvement:

- Mixed
 - Combination of hypertonia and hypotonia



Pathology

Classified by area of body involvement

- Monoplegic: one limb
- Paraplegic: lower limbs
- Diplegic: more involvement in lower limbs
- Hemiplegic: one side of body
- Quadriplegic: all four limbs
- Triplegic: both lower limbs, one upper limb



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AT Applications

Positioning

- to reduce tone
- prevent deformity



AT Applications

Mobility

- Crutches
- Gait trainers
- Walkers
- Manual wheelchairs
- Power wheelchairs



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AT Applications

- ADL equipment
- Alternative computer access
- EADLs
- Sensory and vision aids
- Augmentative communication devices
- Toys, recreational & developmental aids
- Classroom and architectural modifications



PowerLink 4



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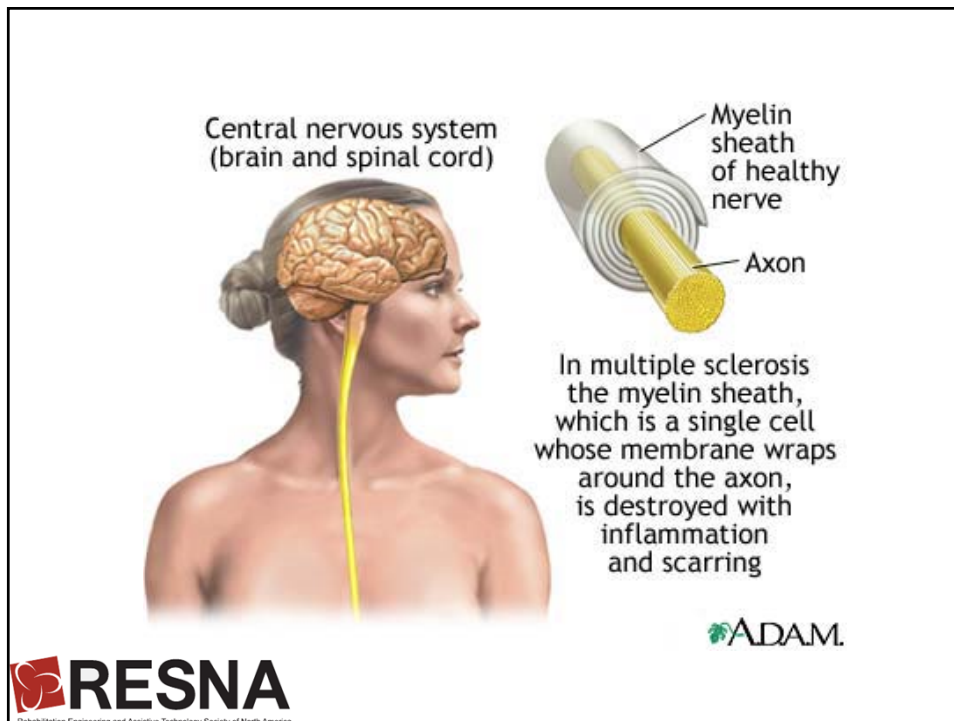
Multiple Sclerosis

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Multiple Sclerosis (MS)

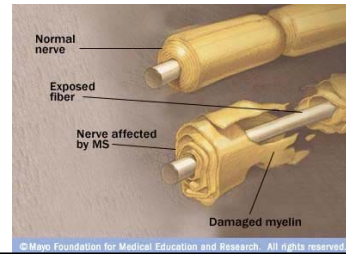
Definition:

- An inflammatory disease of the central nervous system
- Demyelination along the CNS nerves (brain, spinal cord, optic nerves) with the axons being preserved. Myelin is lost, leaving scar tissue called sclerosis. The damaged areas are called lesions or plaques.
- About 400,000 people have MS



Etiology

- Unknown antigen (target that the immune cells are sensitized to attack)
- Immune-mediated process
- More common in females
- Most people diagnosed between age 20 and 50 years



Etiology

Types of MS

- Relapsing-remitting (RRMS) – most common
- Secondary-progressive (SPMS)
- Primary-progressive (PPMS)
- Progressive-relapsing (PRMS)



Pathology

- Remissions and exacerbations
 - Newer medications help
- Unique in every individual
- Fatigue and heat can lead to an exacerbation and loss of function
- Usually typical life span



Pathology

- Weakness
- Impaired gait
- Ataxia
- Pain
- Spasticity
- Paralysis
- Contractures
- Uncoordination
- Tremors
- Fatigue
- Respiratory problems
- Dysarthria
- Dysphagia
- Bowel and Bladder dysfunction
- Impaired sensory response
- Vertigo/Dizziness
- Visual Problems



Pathology

Cognitive changes may include:

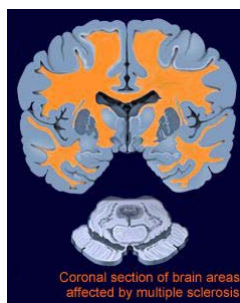
- Difficulty learning
- Short attention span
- Short-term memory problems
- Problem-solving deficits



Pathology

Psychological changes may include:

- Euphoria
- Poor judgment
- Denial
- Depression



Multiple Sclerosis AT use

- Acceptance of AT may be an issue
- Use versatile and adaptable equipment due to unstable and unpredictable nature of MS



Multiple Sclerosis AT use

Seating

- Stability
- Pressure relief
- Comfort



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Multiple Sclerosis AT use

- Mobility
 - orthotics
 - Cane
 - walker
 - Manual wheelchair
 - Power wheelchair
 - Actuators
 - Interfacing
 - Access method
- Important to prevent excessive fatigue



Multiple Sclerosis AT use

- ADL devices
- EADLs
- Sensory & vision adaptations
- Vehicle adaptations
- Computer access
- Augmentative communication aids
- Worksite and architectural modifications



Case Study

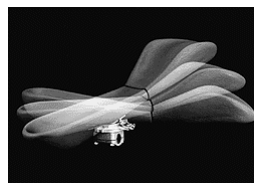
Marjorie, age 60, diagnosed 5 years ago



Case Study

Positioning

- Initially, presented leaning to left side with arms crossed in front of her due to range limitations. Pain in upper back.
- Provided support at left side of trunk and swivel armtroughs to support upper extremities



Case Study

Mobility

- Initially, no longer able to use head array due to left leaning
- After intervention, able to use head array again with Mode switch in left palm to access power tilt



Case Study

Computer

- Voice input
- Head mouse



Case Study

Communication

- verbal



Case Study



EADLs

- Voice input system for control of Audiovisual equipment and lights.
- Door opener operated through wireless transmitter interfaced through power wheelchair electronics.
- Switch operated phone transmitter also interfaced



Case Study

Accessibility

- Home: ramp at garage door entrance
- Work: not working
- Transportation: uses accessible public transportation for medical appointments

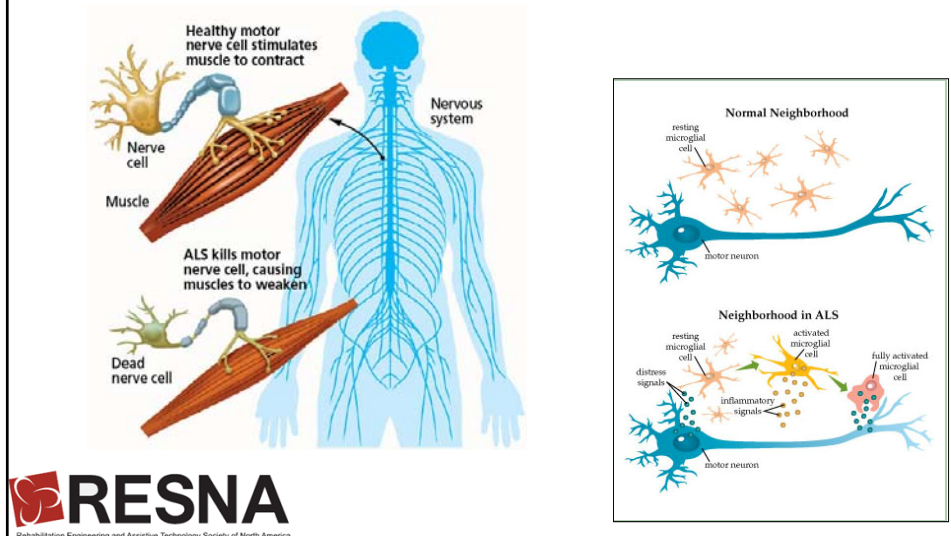


Amyotrophic Lateral Sclerosis



Amyotrophic Lateral Sclerosis (ALS)

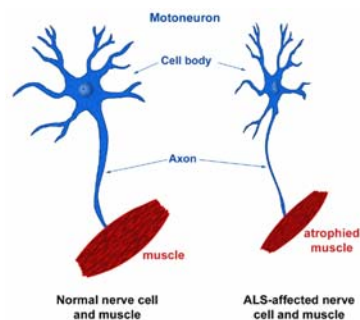
- Also known as Lou Gehrig's disease



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Etiology

- Degeneration or complete loss of motor neurons in the brainstem and spinal cord
- Three types of ALS
- Sporadic ALS
 - Emerging theories
- Familial ALS
 - Hereditary
 - 5 – 10% of cases
- ALS/Dementia



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Etiology

- 2011 Northwestern Medicine study in Chicago found common cause of all forms of ALS
- Broken down protein recycling system in the neurons in the spinal cord and brain. The recycling system removes damaged proteins. The cell can't repair or maintain itself and becomes severely damaged.



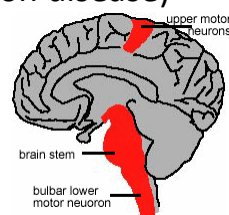
Pathology

- Weakness begins in muscles most used
- Stiffness of joints
- Spasticity and clonus of the hands
- Weakness in trunk, extremities, head, lip, tongue and respiratory
- Swallow and breathing affected
- Sensation intact
- Cognition usually intact



Pathology

- Progressive
- Typically fatal 2 – 5 years after diagnosis
- Clients who present with initial bulbar symptoms have a much more rapid decline
- Affects the corticospinal system from the cortex to the periphery (upper and lower motor neuron disease)
- Progressive bulbar palsy
- Progressive muscular atrophy



AT Applications

Allow for rapid progression, changing needs



AT Applications

Seating

- Support
- Pressure relief
- Comfort



AT Applications

Mobility

- Manual wheelchair
- Power wheelchair
 - Access method
 - Lease programs
 - Actuators
 - Ventilation
 - Interfacing



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AT Applications

- ADL equipment
- EADLs
- Computer access
- Augmentative Communication



Rehabilitation Engineering and Assistive Technology Society of North America



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Fundamentals in Assistive Technology
Clinical Applications of Assistive Technology



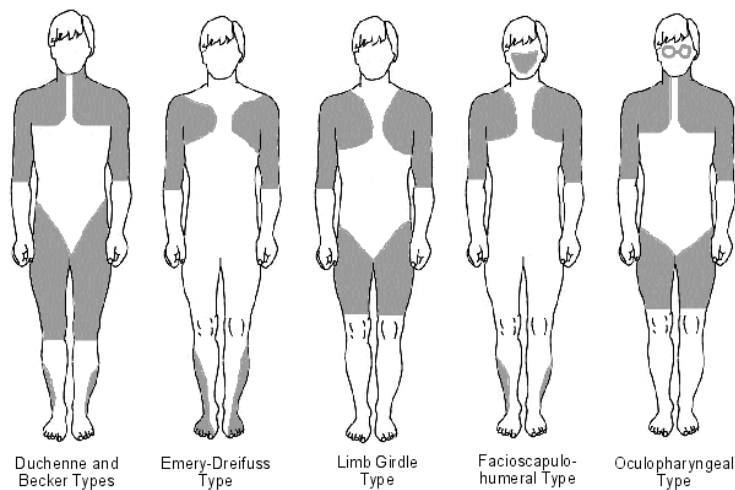
Muscular Dystrophy



Muscular Dystrophy (MD)

Many forms

- Most common is Duchenne MD
- Spinal Muscular Atrophy (SMA)



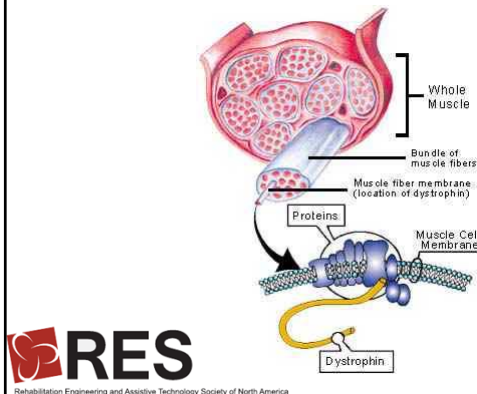
Main areas of muscle weakness in different types of dystrophy



Duchenne Muscular Dystrophy

Definition:

- Pseudohypertrophic muscular dystrophy



Etiology

- Hereditary
 - X-linked recessive
 - May be due to spontaneous mutation, absence or abnormality of the protein dystrophin
- Usually boys
- Usually diagnosed at age 3-7 years
- Muscle fibers destroyed and replaced by fat



Pathology

- Proximal musculature is first affected
- Progresses to distal muscles, respiratory muscles and heart
- Calf pseudohypertrophy occurs in 80% of clients
- Progressive, shortens life span
- Non-ambulatory by about age 12
- Average lifespan is 20 years



Pathology

- Osteoporosis
- Scoliosis
- Lordosis
- Contractures
- Obesity →
- Cognition impaired in 70% of clients
- Discomfort
- Resistance to change



Spinal Muscular Atrophy (SMA)

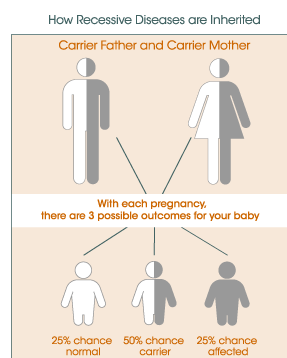
Definition:

- There are four types of SMA
- Affects 1/6000 births



Etiology

Hereditary disease caused by an autosomal recessive gene



Pathology

- Severe muscle atrophy in trunk and upper extremities
- Hypotonia
- Decreased reflexes
- Muscle fasciculations
- Decrease in motor neurons in the brainstem and spinal cord
- Type I: death occurring 6 months to 3 years after birth
- Type II: median age of death 12 years



AT Applications

Positioning

- Support hypotonia
- Spinal asymmetries common
- Tilt to reduce affects of gravity
- pressure relieving surfaces
- comfort
- independent method of pressure relief



AT Applications

Mobility

- Independence
- Plan for future needs
 - Access
 - Actuators
 - Ventilation



AT Applications

- ADL equipment
- EADLs
- Computer Access



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Arthritis



Arthritis

- Rheumatoid arthritis
 - Chemical imbalance
 - Auto-immune?
- Osteo-arthritis
 - Degenerative
 - Traumatic
- Inflammation of the joints
- Exacerbation and remission



Arthritis

- Joint pain, contractures, deformities
- Weakness due to disuse
- Rapid muscle fatigue
- May resist increasing need for technology
- Avoid stress on joints
- Avoid fatigue which can worsen symptoms



Arthritis AT use

- Devices to reduce stress on the joints
- ADL equipment
- EADLs
- Computer access
- Mobility aids
- Positioning -- normalize alignment within the limits of pain, accommodate deformities

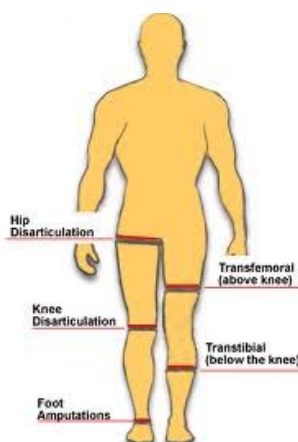


Amputation



Amputations

- Upper or lower extremities
- Hemipelvectomy
- Congenital or acquired



Amputations AT Use

- Adjust wheelchair center of gravity for stability (LE amputation)
- Upper & lower extremity prosthetics
- EADLs (particularly for UE amputation)
- Computer access (UE amputation)



Arthrogryposis multiplex congenita



Arthrogryposis multiplex congenita

- one or more joints become fused together before birth and cannot bend
- associated muscles atrophy
- cognition, sensation intact



Arthrogryposis multiplex congenita AT Use

- accommodate limited range of motion
- find alternative access sites
- AT required depends on which joints are involved



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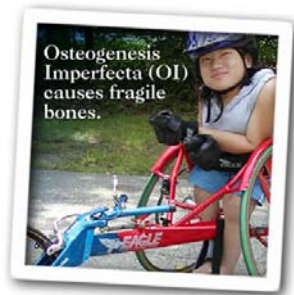


Osteogenesis Imperfecta



Osteogenesis Imperfecta

- fragile bones
- multiple fractures lead to orthopedic distortions and short stature



Osteogenesis Imperfecta AT Use

- protective positioning
- power mobility usually required
- ADL equipment
- AT required depends on range of motion limitations and muscle strength
- think low impact!



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Review Questions (feel free to discuss with your neighbors)

1. Aphasia is common when the stroke occurs in which side of the brain?
 - a. Right
 - b. Left
 - c. Either side
 - d. Both sides
2. A client has experienced a stroke that affected his left side. Why might molded cushion be on the left armrest of his wheelchair?
 - a. To support his left arm
 - b. To encourage him to lean towards his left side
 - c. To protect the surface of the wheelchair
 - d. To reduce proprioception for the left arm
3. Spinal Cord Injury and Spina Bifida both fall under which Neurological Disorders category?
 - a. Neural Canal
 - b. Hereditary, degenerative
 - c. Brain Lesions
 - d. Genetic, degenerative



Review Questions (Here are the answers. How did you do?)

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Questions ?

