Presentation Overview

- Introduction
  - The Big Picture
  - Balance and Aging
- Components Required for Balance
  - Pathologies Affecting Each Component
    - Implications of Pathology
  - Pathologies Affecting Multiple Components
- Additional Factors that Increase Fall Risk
- Implications for Reducing Fall Risk

The Big Picture

- Control of Balance and Prevention of Falls
  - Multiple components
  - Multiple sources for increased fall risk
  - Intrinsic and extrinsic factors
- Elderly More at Risk
  - Combined effects
    - Normal aging
    - Accumulated pathologies
    - Medication effects
  - Higher risk for injurious falls

Balance and Aging

- Balance Declines with Increased Age
  - Reduced balance leads to:
    - Increased fall risk
    - Falls increase morbidity
    - Falls increase mortality
    - Falls decreased quality of life
    - Falls increased expenses
  - health care costs
  - reduced independence
- Role of Health Care Professionals

Components Required for Balance

- Many systems contribute to maintaining balance
  - Sensory systems
  - Vestibular system
  - Musculoskeletal system
  - Cardiovascular system

Components of Balance: Sensory Systems

- Vision
- Touch
- Proprioception
  - location in space
Components of Balance: Sensory Systems

- **Vision**
  - Acuity
  - Contrast Sensitivity
  - Horizon
  - Environment
    - Light
    - Dark
  - Visual Attention
  - Visual Dominance

- **Proprioception**
  - Awareness of Body/Limb Position
  - Ankle Sway
  - Counterbalance
    - head
    - trunk
    - arms

- **Touch**
  - Pressure on soles of feet
    - changes in pressure
  - Arms/Hands
    - Additional Point of Input
    - Comparisons

- **Review**
  - Sensory systems contribute to maintaining balance
    - seeing the environment
    - feeling the body’s position in the environment
    - feeling the body interacting with the environment
      - hands and/or feet
    - Detecting CHANGES between body and environment

Pathology of the Sensory Systems: Consequences

- Reduced visual acuity and/or attention
  - Increases postural instability
  - Self-restricted activity level
    - disuse weakness
  - Increases fall risk
- Reduced proprioceptive/touch/pressure input
  - Reduced postural control
  - Increased sway
  - Delayed reaction time to perturbations

Pathologies Affecting Visual Function

- Cataracts
  - increase postural instability
  - improves following cataract surgery
- Glaucoma
- Macular Degeneration
- Smoking Related Visual Loss
- Medication Effects
Pathologies Affecting Proprioceptive Function

- Peripheral Neuropathy
  - nerve compression
  - ischemia (less oxygen)
- Joint/Nerve Damage
  - Sprained ankles
  - Knee/ankle/foot surgery

Pathologies Affecting Touch/Pressure Sensation

- Peripheral Neuropathy
- Nerve Damage
  - central
  - peripheral

Components of Balance

- Many systems contribute to maintaining balance
  - Sensory systems
  - Vestibular system
  - Musculoskeletal system
  - Cardiovascular system

Components of Balance: Vestibular System

- Inner ear
  - fluid filled chamber
  - responds to changes in movement
    - horizontally
    - vertically
    - angular
- Left and Right Vestibular Systems
  - Nervous System
    - communication
    - integration

Components of Balance: Vestibular System (continued)

- Vestibular System
  - Left and Right Sides
  - Interpret changes in body movement
    - head turning/nodding
    - body moving through space
      - elevator
      - car/plane
  - Reflex connections
    - neck
    - trunk
    - legs

Pathology of the Vestibular System: Consequences

- Unilateral Pathology
  - Flawed integration of left and right sides
    - spinning sensation
    - dizziness
    - nausea
    - imbalance
- Bilateral Pathology
  - Rely exclusively on vision/proptroceptive
    - Initial difficulties with eye control
    - Increased Fall Risk
**Pathologies Affecting the Vestibular System**

- **Unilateral**
  - Benign Positional Vertigo (BPV)
    - OR Benign Paroxysmal Positional Vertigo (BPPV)
    - Object in the fluid-filled cavity (otoconia)
  - Acoustic Neuromas
    - Tumor of the support cells of Cranial Nerve VIII
      - Hearing and vestibular function involved
  - Labyrinthitis
    - Inflammation of the membranous labyrinth
      - Typically viral
      - Elderly
      - May be lack of blood supply
    - Head Trauma

**Components of Balance**

- Many systems contribute to maintaining balance
  - Sensory systems
  - Vestibular system
  - Musculoskeletal system
  - Cardiovascular system

**Components of Balance: Musculoskeletal System**

- **Muscles**
  - Active contraction
    - Hips, knees and/or ankles
  - Timing of contraction
    - Anticipatory
    - Compensatory
  - Static balance
    - Maintain a posture
  - Dynamic balance
    - Changes during movement

- **Bones and Joints**
  - Range of Motion
    - Amount of joint movement available
    - Hips, knees and/or ankles
  - Allow movement
    - Slow and/or fast
    - Flexibility
  - Efficient movements

**Pathology of the Musculoskeletal System: Consequences**

- Reduced range available to respond
  - ankles, hips, knees
  - alters balance strategies available
- Reduced strength to respond to changes
  - alters balance strategies available
  - changes functional task strategies
    - self-restricted activities
    - leads to disuse and further weakness
- Delayed reaction time
  - further from stable base before correcting
- Pain
  - alters reactions
  - alters balance strategies available
  - self-restricted activities
  - Increased Fall Risk

**Pathologies Affecting the Musculoskeletal System**

- Arthritis
  - Reduces joint range of motion
  - less flexibility
  - stiff
  - Joint pain
- Osteoporosis
  - weak bones
  - fracture BEFORE the fall
- Amyotrophic Lateral Sclerosis (ALS)
  - loss of nerve supply to the muscle
  - weakness
- Disuse
  - NOT A DISEASE
    - more sedentary
    - muscle weakness
### Components of Balance

- Many systems contribute to maintaining balance
  - Sensory systems
  - Vestibular system
  - Musculoskeletal system
  - Cardiovascular system

### Pathology of the Cardiovascular System: Consequences

- May not keep brain adequately supplied
  - Changes in position
    - sitting up from laying down
    - sit to stand
    - dizziness
    - unsteady, insecure
  - Syncope
- Peripheral Supply
  - tissue ischemia distally
  - reduced sensation in feet and ankles

### Pathologies Affecting the Cardiovascular System

- Postural Hypotension
  - Changing positions
    - lying down to sitting OR standing
    - Blood pressure drops
    - Dizzy, light headed, or may pass out
    - May be influenced by medications

- Peripheral Vascular Disease
  - Sensory nerves to the feet and ankles
  - Reduced proprioception and pressure sensation

### Components of Balance

- Many systems contribute to maintaining balance
  - Sensory systems
  - Vestibular system
  - Musculoskeletal system
  - Cardiovascular system

- Many elderly people have more than one system affected

### Some Pathologies Affect More than One System

- Diabetes
  - Sensory System
    - damages nerves
      - vision (retinopathy)
      - proprioception
      - pressure on the sole of the foot
      - reduces reaction time
  - Musculoskeletal
    - muscle metabolism
    - weakness
  - Cardiovascular
    - peripheral vascular disease
    - stocking-glove sensory loss
    - hands and feet
### Some Pathologies Affect More than One System (continued)

- **Cancer**
  - Specific to form of cancer
    - Location of the tumor(s)
    - Sensory System
    - Vestibular System
    - Musculoskeletal System
  - Cancer Treatment
    - Radiation and/or Chemotherapy
      - Sensory System
      - Musculoskeletal System

- **Stroke (Cerebrovascular Accident)**
  - Typically one side of the body
    - Sensory System
      - vision
      - lose ½ field of vision
    - double vision
    - touch
    - Musculoskeletal System
      - reduced motor control of arm and leg on affected side
    - Vestibular System
      - Brain Stem location

### Additional Factors that Increase Fall Risk

- **Normal Changes with Aging**
  - Changes within the proprioceptive receptors
  - Fewer touch receptors
  - Slowed nerve conduction velocity

- **Changes in Cognitive Ability**
  - Dementia\textsuperscript{1,13,14}
    - Alzheimer’s Disease
  - Age-associated changes\textsuperscript{15,16}
    - Reduced ability to make safe decisions\textsuperscript{13,17}
    - May not interpret environment adequately

### Implications for Reducing Fall Risk

- Screen to Identify Those at Risk\textsuperscript{16}
- Understand the Pathologies
  - Treat to Restore Losses
    - Medication
    - Flexibility/Strength/Endurance Programs
  - Compensate for Impaired Balance Systems
    - Assistive devices (cane, walker)
- Understand Additional Factors
  - Intrinsic and Extrinsic
- Education to Promote Safe Behavior
  - Who?
    - Elderly People
    - Care Providers
  - What?
    - Fall Prevention
    - Home/Community Safety

### Summary

- Many Body Systems and Factors Influence Balance
- Pathology of One or More Systems May Reduce Balance
- Reduced Balance Increases the Risk for Falls
- Other Factors Also Increase Risk for Falls
- Comprehensive Screening and Intervention Needed
- Further Research is Needed
Cited References


Questions?

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