

**American College of Physicians - Internal Medicine Meeting 2024  
Boston, MA**

**Function Focused Gait Assessment**

*Director:*

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## Get to know your local PTs!

### INDICATIONS FOR PHYSICAL THERAPY REFERRAL

- Strengthening
  - ROM
  - Pain of mechanical origin
  - Balance re-training: sitting/standing
  - Functional mobility
  - Vestibular Therapy
  - Gait training
  - Sports injury prevention/recovery
  - DME needs - ambulatory device vs. orthotic
- 

### DURABLE MEDICAL EQUIPMENT (DME)

- Life Expectancy
  - 5 years
    - Unless lost, stolen, or accidentally damaged beyond repair (includes natural disasters)
    - Sooner if change in patient's condition
  - Will pay for repairs if worn out before end of its lifetime
- Eligibility
  - Medically Necessary
  - Needed for home use

### CANES

- Single Point Cane (SPC): Mild balance deficit
- Quad Cane: Narrow or Small Base (NBQC/SBQC), Wide or Large Base (WBQC/LBQC)
  1. Neuropathic gait – s/p CVA or BI
  2. Generally decreased balance
    - Improved stability, but sacrificed mobility/maneuverability vs. SPC
    - Challenging to navigate stairs
- All Terrain Cane: “Hurry Cane”
  1. Provides increased stability compared to single point cane
  2. Provides more maneuverability compared to quad cane
  
- Fit: the handle should reach the crease of wrist when standing with hand relaxed at their side
- Proper hand to use: opposite of involved leg

### WALKING POLES

- Uneven terrain

## Promoting a Functional Gait

Jackie Bentlage-Brown, MSPT (jbentlagebrown@pennstatehealth.psu.edu)  
ACP IM Conference 2023

### WALKERS

- Hemi-Walker: unilateral device, hemiplegia, early gait trainer
- Standard Walker: no wheels, step-to gait pattern (often for orthopedic injuries)
- Rolling Walker (RW or FWW): 2 front wheels, reciprocal gait pattern, ~ 5-7 lbs.
- Rolling Walker with Platform Attachment: useful if NWB of wrist/hand
- Rollator Walker: 4 wheels, seat, brakes, typically 11-21 lbs.
- Upright Walker: rollator walker with platforms, can help with posture, heavier, can be tippy
- Reverse or Posterior Walker: CP/diplegic gait, rear locking brakes
- Knee Scooter: if NWB in ankle/foot, extended time standing/walking

### CRUTCHES

- Axillary Crutch: adjustment - start with tips ~6 inches forward and lateral, top of crutch is 2-3 finger widths between crutch and axilla, handle at height of wrist
- Knee Crutch: can be hands free, requires very good stability/mobility
- Forearm (Lofstrand) Crutch: Less likely to drop

### ORTHOTICS

- Molded Ankle Foot Orthosis (MAFO):
  - Eligibility:
    - Expected need is > 6 months
    - Need to control the knee, ankle, or foot in > 1 plane
    - Could not be fitted with prefabricated orthotic
  - Pros: Custom, modifiable after fabrication, multi-plane control, more stability
  - Cons: Little energy return, doesn't allow for fluctuating edema, less mobility, heavier than carbon fiber AFO
- Carbon Fiber (AFO):
  - Eligibility:
    - Ambulatory
    - Diagnosis of weakness/deformity of foot & ankle – need for stabilization
    - Potential to benefit functionally
    - Condition is permanent or longstanding duration
  - Pros: Stronger, lighter, minimalist design, increased kinetic energy
  - Cons: Less custom, generally less medial/lateral support, generally not modifiable after fabrication
- Bilateral Metal Uprights:
  - Pros: Allows for fluctuating edema, stronger to help with high tone/spasticity
  - Cons: Heavy, bulky, isolated to one pair of shoes
- Functional Electrical Stimulation:
  - Bioness L300 (Go) or Walk Aide

# Pathologic Gait Descriptions

Nicole Osevala MD (nosevala@pennstatehealth.psu.edu) ACP  
IM Conference 2024

<u>Gait</u>	<u>Description</u>	
	<u>Standing</u>	<u>Ambulating</u>
<b>Hemiplegic</b>  “Circumduction”	<ul style="list-style-type: none"> <li>- Affected arm flexed, adducted, internally rotated.</li> <li>- Affected leg extended, plantarflexed</li> </ul>	<ul style="list-style-type: none"> <li>- Affected arm loss of normal arm swing</li> <li>- Weight shifted to the contralateral side.</li> <li>- Unable to flex hip and knee.</li> <li>- Affected leg circumducts and hip hikes to clear ankle dorsiflexion weakness.</li> </ul>
<b>Diplegic</b>  “Scissoring”	<ul style="list-style-type: none"> <li>- Tight hip adductors bilaterally resulting in genu valgum of knees.</li> <li>- Hips and knees are in the flexed position</li> <li>- Ankles are internally rotated</li> </ul>	<ul style="list-style-type: none"> <li>- Forward posture of the upper body with arms in the flexed position.</li> <li>- The lower limbs swing outward and create a scissoring pattern with legs crossing midline.</li> <li>- Both legs will be dragged, toes will be scrapped</li> <li>- Patients will toe walk.</li> </ul>
<b>Neuropathic</b>  “Steppage Gait”	<ul style="list-style-type: none"> <li>- No issues seen</li> </ul>	<ul style="list-style-type: none"> <li>- No dorsiflexion of the ankle.</li> <li>- To clear the toes there will be exaggerated knee and/or hip flexion.</li> </ul>

# Pathologic Gait Descriptions

Neyha Cherin, DO (ncherin@pennstatehealth.psu.edu)  
 ACP IM Conference 2022

		<ul style="list-style-type: none"> <li>- Toes hit first, then heels = double-tap phenomenon.</li> </ul>
<b>Myopathic</b>  “Trendelenburg”  Or  “Waddling Gait”	<ul style="list-style-type: none"> <li>- No deficit.</li> </ul>	<b><u>Unilateral Issue:</u></b> <ul style="list-style-type: none"> <li>- Trendelenburg sign → Contralateral pelvis drop and upper body weight is shifted to the weight-bearing limb.</li> </ul> <b><u>Bilateral Issue:</u></b> <ul style="list-style-type: none"> <li>- Waddling sign → Circumduction of BLE. Truncal lean to the weight-bearing side to allow circumduction of the opposite limb.</li> </ul>
<b>Choreiform Gait</b>  “Hyperkinetic Gait”	<ul style="list-style-type: none"> <li>- Irregular, jerky, involuntary movements in all extremities.</li> <li>- twisting movements of the trunk, head, arms, and legs.</li> </ul>	<ul style="list-style-type: none"> <li>- unpredictable accelerations and decelerations in walking speed.</li> <li>- Walking can worsen the baseline movements.</li> </ul>
<b>Ataxic Gait</b>  “Cerebellar Gait”	<ul style="list-style-type: none"> <li>- Titubation = body swaggers back and forth.</li> </ul>	<ul style="list-style-type: none"> <li>- Clumsy gait, veer laterally.</li> <li>- Lack of coordination, slow walking speed.</li> <li>- Difficulty with stops and turns.</li> <li>- Cannot walk in straight line.</li> </ul>

# Pathologic Gait Descriptions

Neyha Cherin, DO (ncherin@pennstatehealth.psu.edu)  
 ACP IM Conference 2022

		<ul style="list-style-type: none"> <li>- Poor balance, wide base of support.</li> <li>- Inconsistent arm swing.</li> </ul>
<b>Parkinsonian Gait</b> “Hypokinetic Gait”	<ul style="list-style-type: none"> <li>- Stooped forward with head and neck in forward flexion, knees in flexion.</li> <li>- Parkinson’s signs:             <ul style="list-style-type: none"> <li>o Masked faces, tremors.</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>- Slow, small shuffling steps.</li> <li>- Rigidity and bradykinesia.</li> <li>- Decreased arm swing.</li> <li>- Difficulty initiating steps.</li> <li>- Increased number of steps to turn.</li> <li>- Balance abnormality</li> </ul>
<b>Sensory Gait</b> “Stomping Gait”	<ul style="list-style-type: none"> <li>- Decreased proprioception</li> </ul>	<ul style="list-style-type: none"> <li>- Patient looking toward the ground to see where their feet are in space.</li> <li>- The affected foot slams onto the ground to provide sensory feedback.</li> <li>- High leg lift, with excessive knee flexion.</li> <li>- Symptoms exacerbated when patients cannot see their feet (ie. darkness).</li> </ul>

American College of Physicians Annual Meeting, ACP Clinical Skills 2024, April 19-20, Boston, MA  
**Function-Focused Gait Assessment - Objective Measures of Activity Performance**

This handout is a compilation of objective measures that can be employed in any clinical setting and by any trained observer. The point is not to use all of them for each patient encounter, but to incorporate those specific objective measures that can be followed in a serial fashion if warranted. When more detailed objective measures are needed, consider referring the patient to a physical or occupational therapist who is equipped to perform additional objective measures, including those that take longer time to perform than is available in a typical clinic visit.

**Inspection/Observation:**

Gait Pattern?       Normal       Ataxic       Antalgic       Other \_\_\_\_\_

Assistive Device?       None     Rolling walker     Standard walker     Quad Cane     Single Point Cane     Crutches  
 Other \_\_\_\_\_

Orthotics? (circle) Left    Right     Ankle-Foot     Knee-Ankle-Foot     Shoe Insert     Other \_\_\_\_\_

Leg Length Discrepancy?

Leg length measured from anterior iliac spine to medial malleolus in supine position:  
 (Normal < 2 cm side-to-side difference)

Left Leg	Right Leg
cm	cm

**Examination**

**Active Range of Motion**

Left	Flexion	Extension	Abduction	Adduction	Right	Flexion	Extension	Abduction	Adduction
Hip	°	°	°	°	Hip	°	°	°	°
Knee	°			°	Knee	°	°	°	°
Ankle	°	°	°	°	Ankle	°	°	°	°

Isolated Strength	Left	Right	Instructions to patient
Quadriceps	/5	/5	“Stand on one leg and then the other”
Gluteus Medius	/5	/5	“Stand on one leg and swing other leg out from body”
Tibialis Anterior	/5	/5	“Rock back on your heels”
Gastrocnemius	/5	/5	“Stand on your toes”

Sensation (Present / Absent)	Left	Right
Light Touch		
Great Toe Proprioception		
Vibration Perception		

Deep Tendon Reflexes	Left	Right
Patellar		
Achilles		

**Functional**

Standing Time (seconds)	Feet together touching =	One Foot advanced - _	Feet Tandem - -
Normal > 10 seconds	sec	sec	sec

**Timed Up and Go**

Mark a line 3m (10ft) from patient’s chair. Patient sits in chair. “When I say go, stand up and walk to line, turn around and return to your seat. Walk at your usual pace. You may use your (assistive device).”

Time measured from moment patient stands to sitting down:

sec
-----

Age	60-69	70-75	76-80	81-85	86-99
Men	7.3	8.6	9.4	10.3	11.1
Women	8.1	9.8	10.7	12.4	13.2

### Five Times Sit to Stand

Patient sits in armless chair. "When I say go, stand up and sit down 5 times in a row as quickly as you can. Be sure to stand up fully and try not to let your back touch the chair back between each repetition. Do not use or push your legs against the back of the chair." Time measured from moment patient begins to stand to last sitting down:  sec

Age	60-69	70-79	80-89
Time	11.4	12.6	14.8

### 4-Meter Walking Speed Test

Mark a total distance of 6 meters, place markers at end, make internal markers 1 meter in. Patient stands at the 0-meter mark. There are two trials performed measuring time to walk both directions.

Normal Pace: "When I say go, walk at normal pace past the far mark." Patient turns around and stops at the 6-meter mark. "When I say go, walk at normal pace back to the starting mark."

Time is measured from moment patient crosses the 1-meter and stops when crossing the 5-meter marks:  $T_1$   sec

Time is measured in same format coming back:  $T_2$   sec

Take the average of both times.  $(T_1 + T_2)/2 = T_{avg}$   sec

Divide 4 by the average time to get walking speed in m/sec:  $4 \text{ m}/T_{avg} = \text{Walking Speed}$   m/s

Fast Pace: "When I say go, walk at your fastest pace past the far mark." Patient turns around and stops at the 6-meter mark. "When I say go, walk at your fastest pace back to the starting mark."

Time is measured from moment patient crosses the 1-meter and stops when crossing the 5-meter marks:  $T_1$   sec

Time is measured in same format coming back:  $T_2$   sec

Take the average of both times.  $(T_1 + T_2)/2 = T_{avg}$   sec

Divide 4 by the average time to get walking speed in m/sec:  $4 \text{ m}/T_{avg} = \text{Walking Speed}$   m/s

Walking speed is compared over time with each new measurement compared to the previous one. Multiply by 2.24 to convert to mph for patient's understanding:  $\text{Walking Speed (m/s)} \times 2.24 = \text{Walking Speed (miles per hour)}$   mph

Clinically significant decline in walking speed over time  $> 0.10 \text{ m/sec}$

Negligible decline in walking speed over time  $< 0.05 \text{ m/sec}$

### References:

- Oscevala N and Hills E, "Chapter 38-Gait Impairment", in Harper GM, Lyons WL, Poter JF, et al, eds. Geriatric Review Syllabus: A Core Curriculum in Geriatric Medicine. 11<sup>th</sup> Edition. New York: American Geriatrics Society; 2022
- Makizato, H et al, Predictive Cutoff Values of the Five-Times Sit-to-Stand Test and the Timed "Up-and Go" Test for Disability Incidence in Older People Dwelling in the Community, Physical Therapy, vol. 97, No. 4, 2017
- Martinez, BP et al, Accuracy of the Timed Up and Go Test for predicting sarcopenia in elderly hospitalized patients, Cinics (Sao Paulo, Brazil), vol. 70, No. 5, 2015
- Whitney, SL et al, Clinical measurement of sit-to-stand performance in people with balance disorders: validity of data for the Five-Times-Sit-to Stand Test, Physical Therapy, Vol. 85, No. 10, 2005



5. Bohannon, Richard and Andrews, A Williams, Normal Walking Speed: a Descriptive meta-analysis, *Physiotherapy*, Vol. 97, 2011

Comments/Questions/Suggestions:

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## DURABLE MEDICAL EQUIPMENT (DME)

- Life Expectancy
  - 5 years
  - Unless lost, stolen, or accidentally damaged beyond repair (includes natural disasters)
  - Or, change in patient's condition
  - Will pay for repairs if worn out before end of its lifetime
- Eligibility
  - Medically Necessary
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## CANES

- Quad Cane: Narrow Base or Small Base vs. Wide Base or Large Base (NBQC or SBQC vs. WBQC or LBQC)
  - Neuropathic Gait – s/p CVA or BI
  - Improved stability – sacrificed mobility/maneuverability vs. SPC
  - Challenging to navigate stairs
- All Terrain Cane: “Hurry Cane”
  - Provides increased stability compared to single point cane
  - Provides more maneuverability compared to quad cane
- Single Point Cane (SPC): Mild balance deficit, not much of any weight bearing
- Fit: to crease of wrist when standing with hand relaxed at their side
- Which hand? Opposite of involved leg

## WALKERS

- Standard Walker: no wheels, step to gait pattern
- Rolling Walker with Platform Attachment: useful if NWB of wrist/hand or hemiplegia
- Rolling Walker (RW or FWW): 2 front wheels, reciprocal gait pattern, ~ 5-7 lbs.
- Rollator Walker: 4 wheels, seat, brakes, typically 11-21 lbs.
- Hemi-Walker: unilateral device, hemiplegia, early gait trainer

## ORTHOTICS

- Molded Ankle Foot Orthosis (MAFO):
  - Eligibility:
    - Expected need is > 6 months
    - Need to control the knee, ankle, or foot in > 1 plane
    - Could not be fitted with pre-fabricated orthotic
  - Pros: Custom, modifiable after fabrication, multi-plane control, more stability
  - Cons: Little energy return, doesn't allow for fluctuating edema, less mobility
- Carbon Fiber (AFO):
  - Eligibility:
    - Ambulatory

## Promoting a Functional Gait

Jon Lahr PT, DPT ([jlahr@pennstatehealth.psu.edu](mailto:jlahr@pennstatehealth.psu.edu))

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- Diagnosis of weakness/deformity of foot & ankle – need for stabilization
- Potential to benefit functionally
- Condition is permanent or longstanding duration
- Pros: Stronger, lighter, minimalist design, increased kinetic energy
- Cons: Less custom, generally less medial/lateral support, generally not modifiable after fabrication
- Functional Electrical Stimulation:
  - Helps to lift the foot during swing phase if there is drop foot
  - Not covered by Medicare
  - Common Peroneal Nerve needs to be intact
  - Bioness L300 (Go) or Walk Aide

# Pathologic Gait Descriptions

Jonathan Lahr, DO (jlahr@pennstatehealth.psu.edu)

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<u>Gait</u>	<u>Causes</u>	<u>Description</u>	
		<u>Standing</u>	<u>Ambulating</u>
	*Not all-inclusive*		
<b>Hemiplegic</b> “Circumduction”	Lesion in CNS  ie. (Stroke)	<ul style="list-style-type: none"> <li>- Affected arm flexed, adducted, internally rotated.</li> <li>- Affected leg extended, plantarflexed</li> </ul>	<ul style="list-style-type: none"> <li>- Affected arm loss of normal arm swing</li> <li>- Weight shifted to the contralateral side.</li> <li>- Unable to flex hip and knee.</li> <li>- Affected leg circumducts and hip hikes to clear ankle dorsiflexion weakness.</li> </ul>
<b>Diplegic</b> “Scissoring”	Bilateral corticospinal tract dysfunction  ie. (CP, spinal cord injury)	<ul style="list-style-type: none"> <li>- Tight hip adductors bilaterally resulting in genu valgum of knees.</li> <li>- Hips and knees are in the flexed position</li> <li>- Ankles are internally rotated</li> </ul>	<ul style="list-style-type: none"> <li>- Forward posture of the upper body with arms in the flexed position.</li> <li>- The lower limbs swing outward and create a scissoring pattern with legs crossing midline.</li> <li>- Both legs will be dragged, toes will be scrapped</li> <li>- Patients will toe walk.</li> </ul>
<b>Neuropathic</b> “Steppage Gait”	Any damage to pathway of the peroneal nerve  ie. s/p TKA, L5 radic, central problem (CMT, DM, ALS.)	<ul style="list-style-type: none"> <li>- No issues seen</li> </ul>	<ul style="list-style-type: none"> <li>- No dorsiflexion of the ankle.</li> <li>- To clear the toes there will be exaggerated knee and/or hip flexion.</li> <li>- Toes hit first, then heels = double-tap phenomenon.</li> </ul>

# Pathologic Gait Descriptions

Neyha Cherin, DO (ncherin@pennstatehealth.psu.edu)  
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<p><b>Myopathic</b></p> <p>“Trendelenburg”</p> <p>Or</p> <p>“Waddling Gait”</p>	<p>Weak pelvic girdle muscles.</p> <p>ie. (Pregnancy, congenital hip dysplasia, muscular dystrophies, spinal muscular atrophy, myopathies)</p>	<ul style="list-style-type: none"> <li>- No deficit.</li> </ul>	<p><b><u>Unilateral Issue:</u></b></p> <ul style="list-style-type: none"> <li>- Trendelenburg sign → Contralateral pelvis drop and upper body weight is shifted to the weight-bearing limb.</li> </ul> <p><b><u>Bilateral Issue:</u></b></p> <ul style="list-style-type: none"> <li>- Waddling sign → Circumduction of BLE. Truncal lean to the weight-bearing side to allow circumduction of the opposite limb.</li> </ul>
<p><b>Choreiform Gait</b></p> <p>“Hyperkinetic Gait”</p>	<p>Basal ganglia disorders.</p> <p>ie. (Sydenham’s chorea, Huntington’s disease, Athetosis)</p>	<ul style="list-style-type: none"> <li>- Irregular, jerky, involuntary movements in all extremities.</li> <li>- twisting movements of the trunk, head, arms, and legs.</li> </ul>	<ul style="list-style-type: none"> <li>- unpredictable accelerations and decelerations in walking speed.</li> <li>- Walking can worsen the baseline movements.</li> </ul>
<p><b>Ataxic Gait</b></p> <p>“Cerebellar Gait”</p>	<p>Cerebellar disease.</p> <p>ie. Alcohol intoxication, multiple system atrophy.</p>	<ul style="list-style-type: none"> <li>- Titubation = body swaggers back and forth.</li> </ul>	<ul style="list-style-type: none"> <li>- Clumsy gait, veer laterally.</li> <li>- Lack of coordination, slow walking speed.</li> <li>- Difficulty with stops and turns.</li> <li>- Cannot walk in straight line.</li> <li>- Poor balance, wide base of support.</li> <li>- Inconsistent arm swing.</li> </ul>

# Pathologic Gait Descriptions

Neyha Cherin, DO (ncherin@pennstatehealth.psu.edu)

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<p><b>Parkinsonian Gait</b></p> <p>“Hypokinetic Gait”</p>	<p>Basal ganglia dysfunction</p> <p>ie. (Parkinson’s disease, drug effects)</p>	<ul style="list-style-type: none"> <li>- Stooped forward with head and neck in forward flexion, knees in flexion.</li> <li>- Parkinson’s signs:             <ul style="list-style-type: none"> <li>o Masked faces, tremors.</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>- Slow, small shuffling steps.</li> <li>- Rigidity and bradykinesia.</li> <li>- Decreased arm swing.</li> <li>- Difficulty initiating steps.</li> <li>- Increased number of steps to turn.</li> <li>- Balance abnormality</li> </ul>
<p><b>Sensory Gait</b></p> <p>“Stomping Gait”</p>	<p>Dysfunction of dorsal columns.</p> <p>ie (infectious, auto-immune, metabolic, toxic, hereditary, vascular)</p>	<ul style="list-style-type: none"> <li>- Decreased proprioception</li> </ul>	<ul style="list-style-type: none"> <li>- Patient looking toward the ground to see where their feet are in space.</li> <li>- The affected foot slams onto the ground to provide sensory feedback.</li> <li>- High leg lift, with excessive knee flexion.</li> <li>- Symptoms exacerbated when patients cannot see their feet (ie. darkness).</li> </ul>



## Function-Focused Gait Assessment

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Jonathan Lahr, DPT, Physical Therapy, Department of Orthopaedics and Rehabilitation, Penn State Milton S. Hershey Medical Center

Everett Hills, MD, MS, Function Focused PMR Care+, LLC (Course Director)



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## Disclosure of Financial Relationships

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## Learning Objectives

### Didactics:

Understand basic gait concepts

Create framework for observing key features of gait abnormalities on clinic presentation

Optimize physical therapy services referrals and mobility assessment needs

### Hands-on Practicum:

Practice function-focused gait assessments

Practice using mobility aids and orthotics



3

## What is Function-Focused Gait Assessment All About?



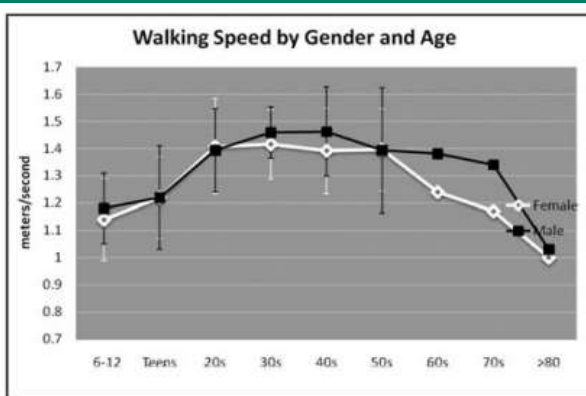
Universal activity generally taken for granted until altered or impaired



Walking falters for many reasons



Falls and predicting life expectancy



Fritz and Lusardi, Journal of Geriatric Physical Therapy, 2009  
"Gait Speed and Survival in Older Adults" Studenski et al, JAMA 2011



4



## Walking speed: the “6<sup>th</sup> vital sign”

> **1.0 m/sec (2.2 mph)**  
Cross streets safely

< **0.8 m/sec (1.8 mph)**  
Household ambulatory  
Need assistive device  
High risk for  
hospitalization

< **0.2 m/sec (0.4 mph)**  
Discharge to SNF  
Extremely frail



Fritz and Lusardi, Journal of Geriatric Physical Therapy, 2009  
Rasmussen et al. JAMA Network Open, Oct. 11, 2019



5

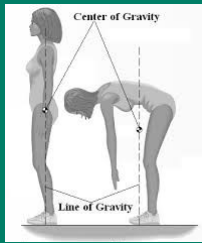
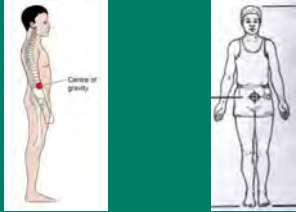
## Important Gait Concepts

Center of Gravity (Mass)  
Step vs Stride  
Gait Cycle  
Primary Muscle Involvement  
Joint Range of Motion



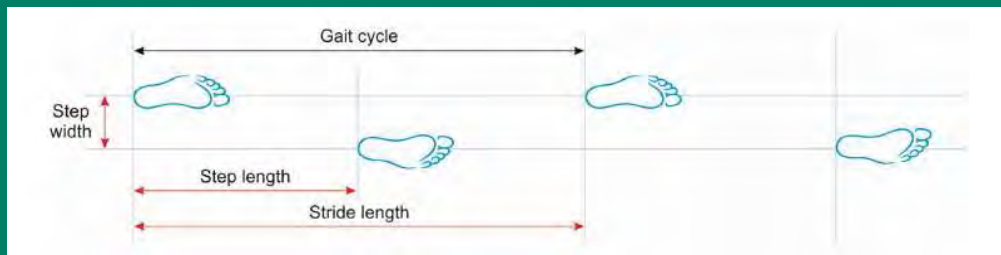
6

## Center of Gravity



7

## Step versus Stride

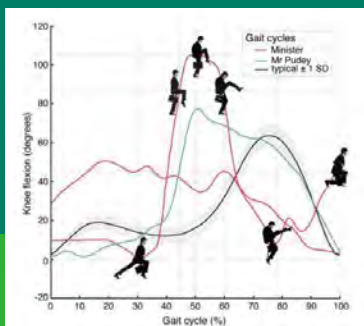
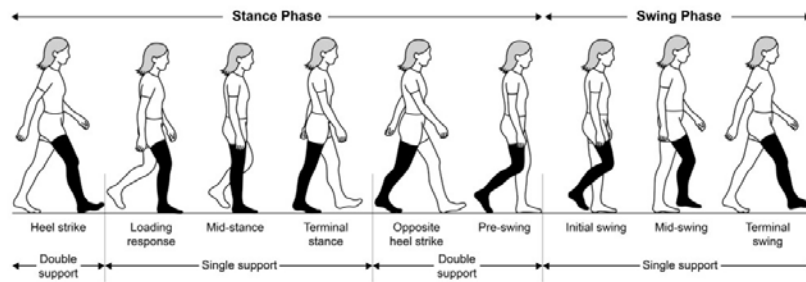


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# “Unequal Step and Stride”



9



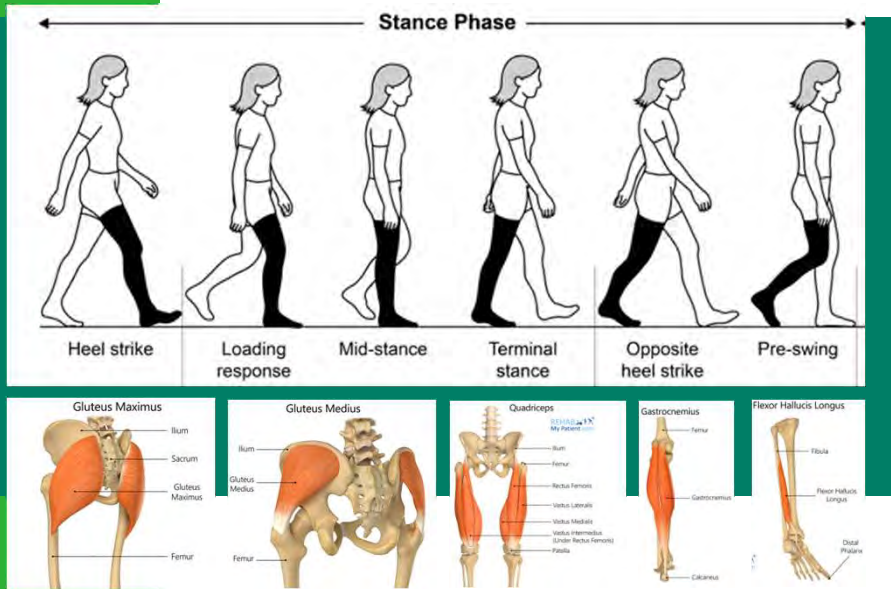
# Gait Cycle

Osevala and Hills, Geriatric Review Syllabus, 11<sup>th</sup> Ed. 2022  
 Erin E Butler et al. Peer review at the Ministry of Silly Walks, *Gait & Posture* (2020)



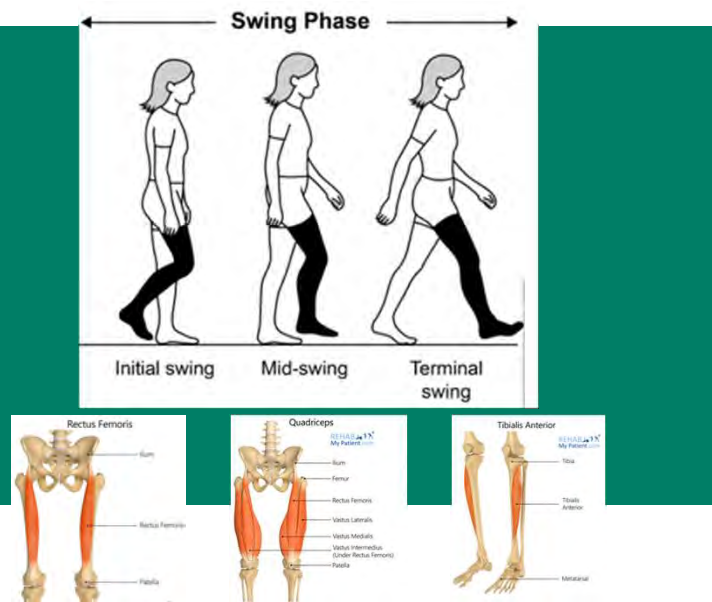
10

## Gait Cycle: Primary Muscles in Stance Phase



11

## Gait Cycle: Primary Muscles in Swing Phase



12

## Trendelenberg Gait



13

## "Compass" Gait



14

## Foot drop



15

## Circumduction Gait



16

## “Swing Gait”



17

## Wide-based Gait



18

# Spastic Diplegic Gait



19



20



## End of Part 1



21

## Function-Focused Gait Assessment

Clinical Gait Assessment



22

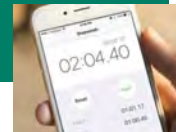
# Parameters for the clinical gait evaluation

Sitting unaided
Standing up from a sitting position (unaided and with/without use of upper limbs)
Posture (trunk, neck and head, upright, bent or asymmetrical)
Stance (narrow/wide base)
Gait initiation (blockage)
Walking (smooth, stiff, insecure, symmetrical, limping)
Step length, lifting of feet, contact with ground, wide/narrow base
Speed
Arm swing
Freezing
Turning
Postural reflexes (pull or push test)
Sitting down ("motor recklessness")
<b>Complex tests of stance and gait</b>
Tandem stance
Tandem gait
Romberg's test (standing with eyes closed and narrow base)
Blind gait
Walking backwards
Walking fast
Walking slowly (in a deliberate manner)
Running
Turning quickly
Turning on the spot
Unterberger's test (walking on the spot with eyes closed)
Standing and walking on heels
Standing and walking on toes
Hopping on one foot
Dual task maneuver (walking while talking or carrying objects)
Functional reach

Gait disorders in adults and the elderly, 2017

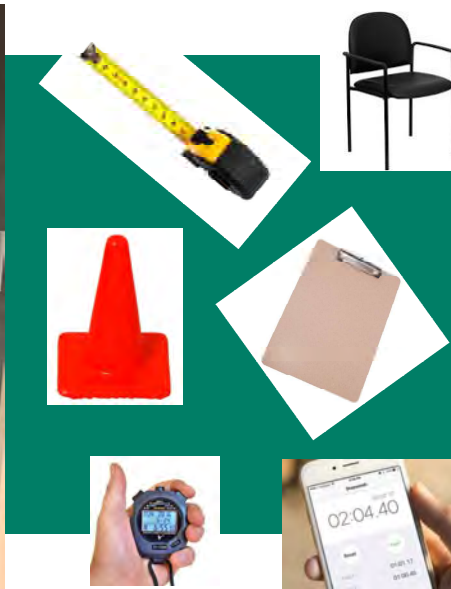
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### Requirements to perform a focus-functioned gait assessment



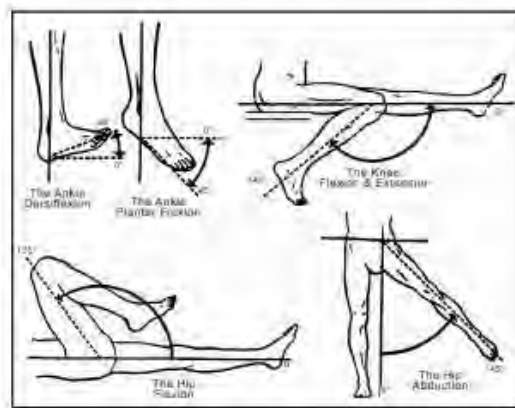
25

### Range of Motion

Hip Flexion 120 - 125°  
 Extension 10 - 20°  
 Abduction 35 - 45°  
 IR/ER 45°

Knee Flexion 135 - 145°  
 Extension 0 - 5°

Ankle Plantarflexion 45 - 55°  
 Dorsiflexion 15 - 25°



Merck Manual; NCBI  
[www.physio-pedia.com/Gait](http://www.physio-pedia.com/Gait)



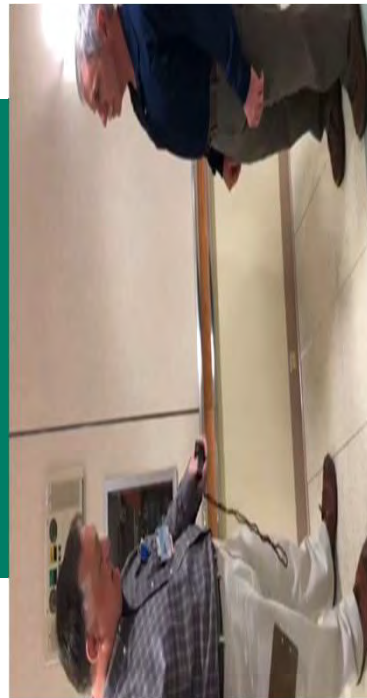
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## Balance



27

## Tests of Balance



28

## Five Times Sit to Stand Test



29

## Five Times Sit-to-Stand Test

Assessment  
Time to perform  
Instructions

Lower limb strength  
~30 seconds  
"Sit in a chair with arms across chest, stand up, then return to sitting position. Repeat 5 times.

Measurement  
Normative values

Time to complete

Age	Male/Female
60-69	11.4 seconds
70-79	12.6 seconds
80-89	14.8 seconds

Whitney, Physical Therapy, 2005



30

## Timed Up and Go Test



31

## Timed Up-and-Go Test

Assessment Fall risk and predictor of sarcopenia  
 Time to perform ~12 seconds  
 Instructions Sit in a chair. Mark a line 3 meters from patient. Instruct patient to stand up, walk to line at normal pace, turn around and return to seat.  
 Measurement Time to complete

Normative values

Age	Male	Female
60-69	7.3 seconds	8.1 seconds
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Pondel & del Ser, *Journal of Geriatric Physical Therapy*, 2001



32

## 4 Meter Walking Speed Test



33

## 4 meter walking speed test

Assessment  
Time to perform  
Instructions  
(beyond marks)  
Measurement

Indicator of functional limitations  
~60 seconds  
"Walk at normal pace from 1<sup>st</sup> to 2<sup>nd</sup> mark. Walk at fastest pace past both marks."  
Time to walk 4 meters, both directions @ normal and fast pace

Performance Measure	Meaningful Change	Criterion
4-meter gait speed	Small	0.05 m/sec
	Substantial	0.10 m/sec

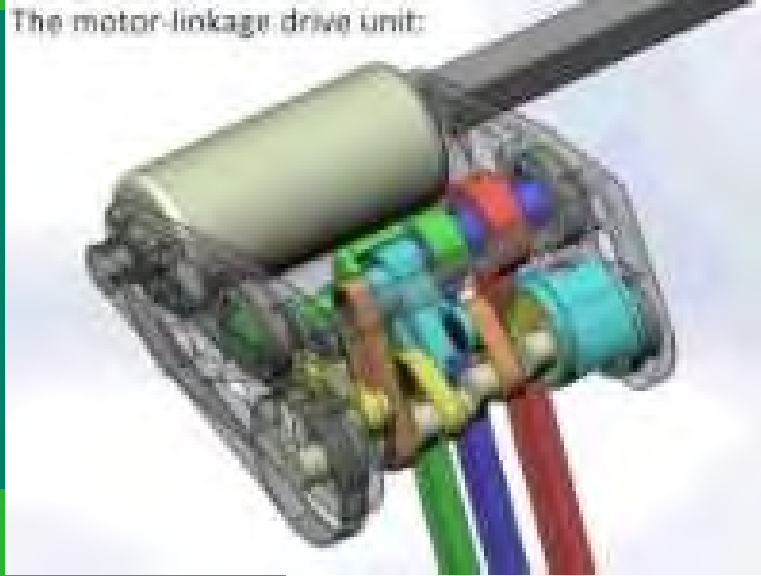


Gill TM J Am Geriatric Soc. 2010;Oct;58:S308-S321

34

## Questions?

The motor-linkage-drive unit:



Video courtesy of Dr. Mark Plecnik  
Department of Mechanical Engineering  
University of Notre Dame, IN



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## Thanks!

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# Promoting a Functional Gait

Jonathan Lahr, PT, DPT  
jlahr@pennstatehealth.psu.edu  
Penn State Health therapy services, Hershey, PA  
April 19-20, 2024



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## Disclosure of Financial Relationships

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## Objectives

- Learn when to refer a patient to your local PT for gait evaluation
- Learn how to choose an ambulatory device or orthotic for a pathologic gait pattern in order to promote an improved functional gait
- Learn importance of getting to know your local PT

3

3

## Falls in adults 65 and over

- 800,000+ patients/year hospitalized for fall injury
- 3 million ED visits/year
- \$50 billion in medical costs of which 75% paid by Medicare/Medicaid in 2015



Image: thestar.com

Centers for Disease Control and Prevention

4

4

## Questions to Ask

- Have you fallen this past year?
- Do you use furniture, walls, or other people to help you walk?



Image: pixabay.com

5

## Indications for Physical Therapy Referral

- Strengthening
- ROM
- Pain (musculoskeletal)
- Balance training
- Functional mobility
- Vestibular therapy
- Neuromuscular re-education
- Gait training/fall prevention
- **DME needs – ambulatory device vs. orthotic**

6

# Durable Medical Equipment (DME)

Medicare Guidelines



7

## DME Life Expectancy

- 5 years
- Unless lost, stolen, or accidentally damaged beyond repair (includes natural disasters)
- Or, change in patient's condition

[www.medicare.gov](http://www.medicare.gov)  
[www.medicareinteractive.org](http://www.medicareinteractive.org)

8

## Hemiplegic Gait



Image: Researchgate.net, Pinterest

- One sided deficit due to paresis
- Impaired natural swing at the hip and knee with leg circumduction

9

## Hemiplegic Gait Devices



Platform Rolling Walker



Hemi-walker

10

## Hemiplegic Gait Devices cont...



Quad Cane



HurryCane



Single Point Cane

11

## Molded Ankle Foot Orthosis (MAFO)

### Eligibility:

- Expected need is to be > 6 months
- Need for control > 1 plane of movement at the knee, ankle, or foot
- Could not be fitted with pre-fabricated orthotic



Image: researchgate.com

12

## MAFO continued



Image: IndiaMART.com

### Pros:

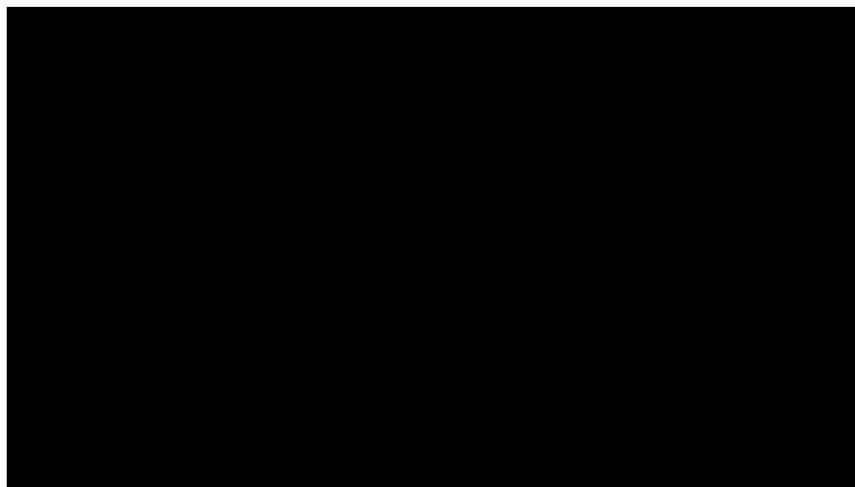
- Customized
- Modifiable after fabrication
- Controls multiple planes of movement
- More stability

### Cons:

- Little energy return
- Doesn't allow for fluctuating edema
- Less mobility

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## Hemiplegic Orthotic



Video: [https://www.youtube.com/watch?v=rStEEx\\_xXFc](https://www.youtube.com/watch?v=rStEEx_xXFc)

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## Neuropathic Gait

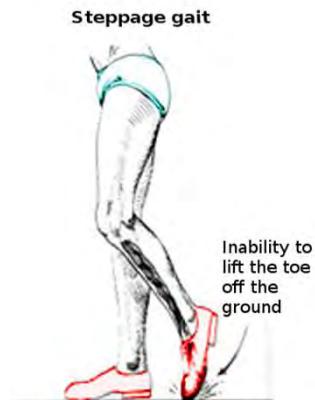


Image: ncbi.nlm.nih.gov

- Foot drop/Steppage Gait
- Weakness of muscles in the distal limb, typically dorsiflexors due to nerve damage
- AFO, MAFO, Functional Electrical Stimulation

15

## Ankle Foot Orthosis (AFO)

Eligibility:

- Ambulatory
- Diagnosis of weakness/deformity of foot & ankle – need for stabilization
- Potential to benefit functionally
- Condition is permanent or longstanding duration



Image: restorahealthcare.com

16



## AFO continued

Carbon Fiber



### Pros:

- Stronger
- Lighter
- Minimalist design
- Increased kinetic energy

### Cons:

- Less customized
- Less medial/lateral stability
- Minimal to no modification after fabrication

17

## Functional Electrical Stimulation (FES)

- Orthotic used in the treatment of foot drop
- Stimulates the common peroneal nerve
- Muscle contraction produced that lifts the foot during the swing phase of gait
- Indicated for LMN or UMN injury/disease?

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## Functional Electrical Stimulation



Stimulation Off



Stimulation On

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## Ataxic Gait



Image: quizlet.com

- Wide base of support
- Truncal sway
- Inaccuracy of limb movements – sometimes scissoring



Standard Cane

20

## Ataxic Gait Devices cont...



Image: failrehab.com



Image: failrehab.com

Full set (12lbs) \$280  
Half set (6lbs) \$150



## Weighted Walkers

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## Myopathic Gait

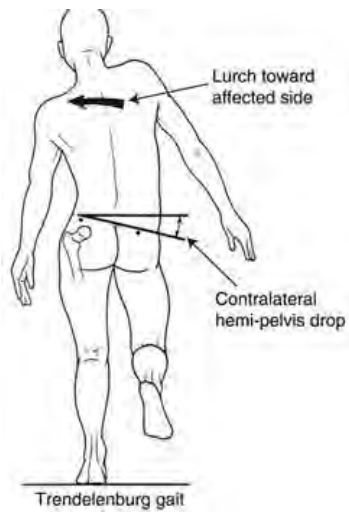


Image: BMJ, pemaplaybook.org

- Waddling gait or Trendelenburg gait
- Due to hip weakness

22

## Myopathic Gait Devices



Rolling walker

- 5-7 lbs.
- Typical max capacity: 300 lbs.
- Typical wheel size: 5" diameter



Rollator

- 11-21 lbs.
- Typical wheel size: 6-8" diameter



Offset Cane

- Allows for mild weight bearing

23

## In Summary: Things to Consider When Ordering DME

- Lifting restrictions?
- Live alone?
- Stairs?
- Cognitive impairment?
- Be specific with your prescription:
  - Rollator walker with 4 wheels and a seat
  - Bariatric
  - Pediatric
  - Narrow based vs. wide based quad canes



When in doubt, consult your local PT:

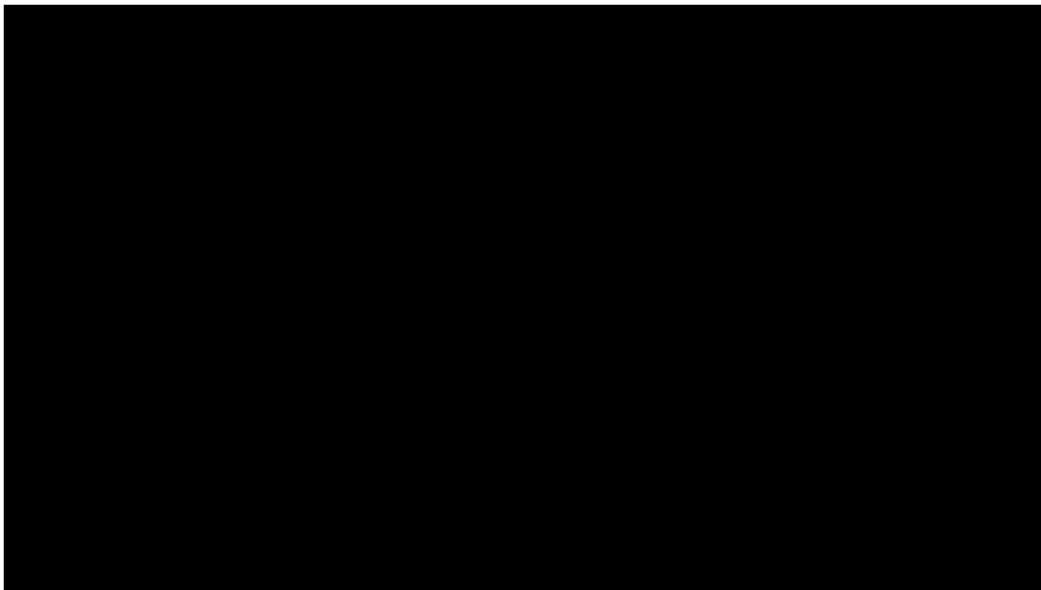
“PT Eval for ambulatory device or PT eval and treat gait/balance/fall prevention”

24

## Physical Therapy Referral

- According to Jennifer Joyce, M.D., “primary care physicians will refer more patients to physical therapists when they have more knowledge about physical therapy, recognize physical therapists’ capabilities to diagnose, and believe in the ... effectiveness of physical therapy intervention.” - *Am Fam Physician*. 2005 Oct 1; 72(7): 1183-1184.

25



Video: <https://www.youtube.com/watch?v=IV2VINJFZC8>

26

**Thank You!**





# The Why, When, and What of Gait Assessment

Nicole Osevala MD, FACP  
Chief, Geriatric Medicine  
Associate Professor of Medicine Penn State College of Medicine  
Medical Director Post-Acute Care Service



1

## Disclosure of Financial Relationships

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## Framing your perspective on gait assessment

- Like most diseases, risk of gait impairment increases with age and is associated with increased morbidity and mortality
- Slowed walking speed (along with weakness, low physical activity, low energy and weight loss) is one of the 5 phenotypic components manifest in frailty syndrome (physiologic state of heightened vulnerability for older adults)
- Identification of gait impairment creates an opportunity for further gait and functional assessment, education, and management of contributing conditions



3

## Why perform a gait assessment?

- Gait and balance disorders increase with age from 10% at age 60-69 to more than 60% in those >80 years old
- Community-dwelling older adults with gait disorders, especially neurologically abnormal gait disorders, are at highest risk for institutionalization and death
- Gait impairment negatively impacts quality of life, threatens preservation of functional independence, and is associated with falls
- Complications from falls are the leading cause of death from injury in adults  $\geq 65$  years old



4



## When to inquire about and assess gait?



- The “Welcome to Medicare” visit
- Annual visit
- After a surgery (elective or urgent)
- After hospitalization
- During and following an acute illness

5

5

## What questions can indicate current or impending gait disturbances?

- Do you limit leaving your home due to difficulty walking?
  - Do you hold onto furniture or walls when moving around your home?
  - Do you use an assistive device?
  - If you use an assistive device, was it prescribed by a physical therapist?
  - Are you fearful of falling or have you fallen?
  - Is it difficult to rise from a chair or walk across a room?
- A “yes” to any of these questions should prompt a formal gait assessment



6

6



## Function-Focused Gait Assessment

Nicole Osevala, MD, FACP, Harry Albertman Chair in Geriatric Medicine, Associate Professor, Department of Medicine; Chief, Division of Geriatric Medicine, Penn State University College of Medicine and Milton S. Hershey Medical Center

Jonathan Lahr, DPT, Physical Therapy, Department of Orthopaedics and Rehabilitation, Penn State Milton S. Hershey Medical Center

Everett Hills, MD, MS, Function Focused PMR Care+, LLC (Course Director)



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2

## Learning Objectives

### Didactics:

Understand basic gait concepts

Create framework for observing key features of gait abnormalities on clinic presentation

Optimize physical therapy services referrals and mobility assessment needs

### Hands-on Practicum:

Practice function-focused gait assessments

Practice using mobility aids and orthotics



3

## What is Function-Focused Gait Assessment All About?



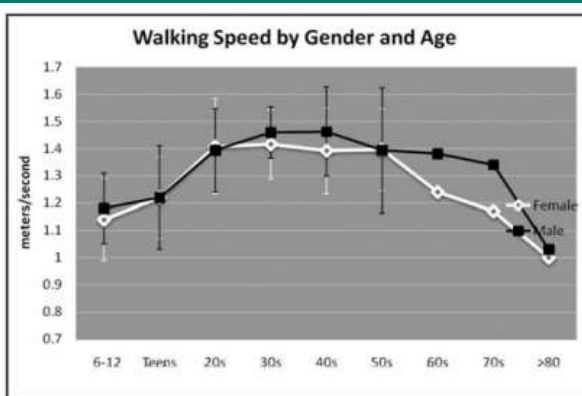
Universal activity generally taken for granted until altered or impaired



Walking falters for many reasons



Falls and predicting life expectancy



Fritz and Lusardi, Journal of Geriatric Physical Therapy, 2009  
"Gait Speed and Survival in Older Adults" Studenski et al, JAMA 2011



4

## Walking speed: the “6<sup>th</sup> vital sign”

> **1.0 m/sec (2.2 mph)**  
Cross streets safely

< **0.8 m/sec (1.8 mph)**  
Household ambulatory  
Need assistive device  
High risk for  
hospitalization

< **0.2 m/sec (0.4 mph)**  
Discharge to SNF  
Extremely frail



Fritz and Lusardi, Journal of Geriatric Physical Therapy, 2009  
Rasmussen et al. JAMA Network Open, Oct. 11, 2019



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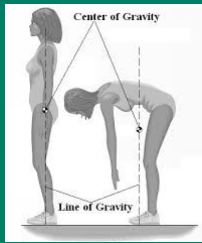
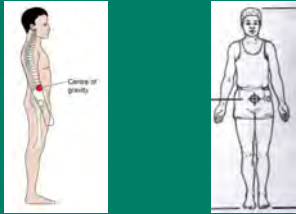
## Important Gait Concepts

Center of Gravity (Mass)  
Step vs Stride  
Gait Cycle  
Primary Muscle Involvement  
Joint Range of Motion



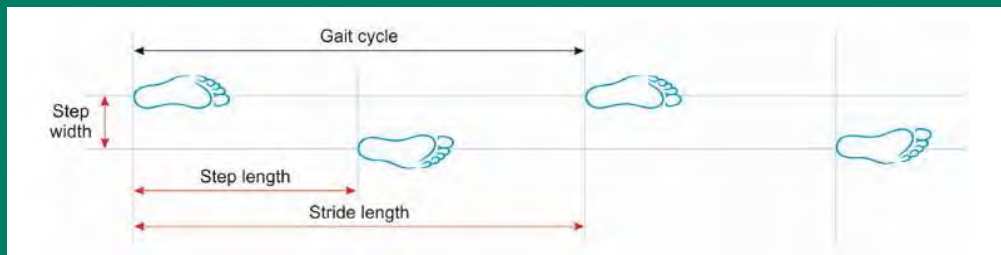
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## Center of Gravity



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## Step versus Stride

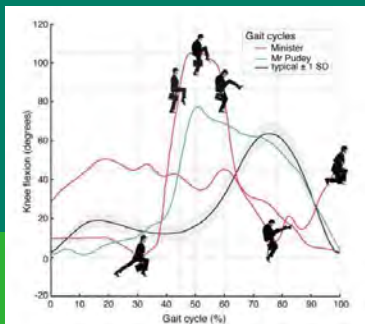
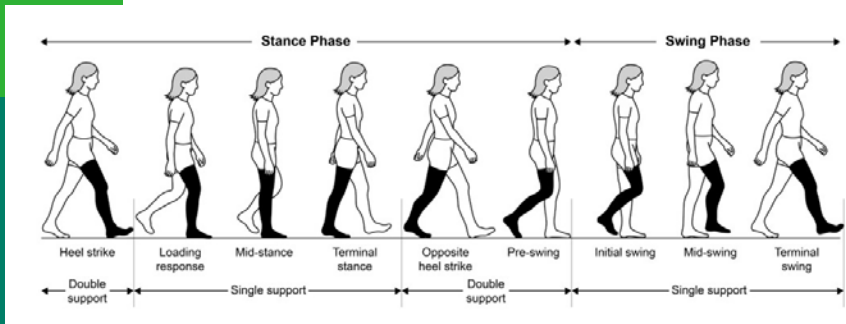


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# “Unequal Step and Stride”



9



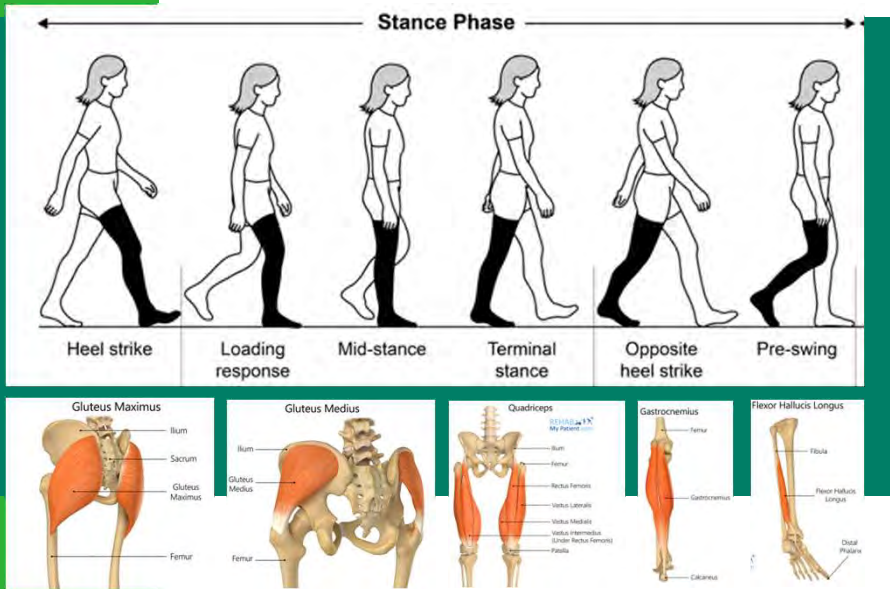
# Gait Cycle

Osevala and Hills, Geriatric Review Syllabus, 11<sup>th</sup> Ed. 2022  
 Erin E Butler et al. Peer review at the Ministry of Silly Walks, *Gait & Posture* (2020)



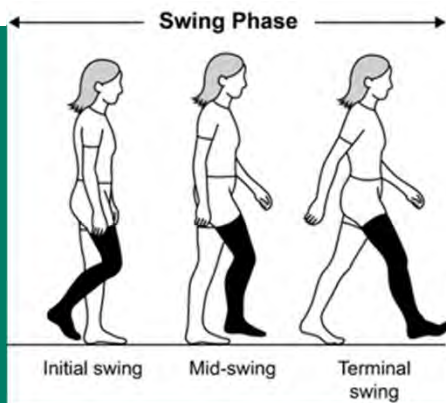
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## Gait Cycle: Primary Muscles in Stance Phase



11

## Gait Cycle: Primary Muscles in Swing Phase



12

## Trendelenberg Gait



13

## "Compass" Gait



14



## Foot drop



15

## Circumduction Gait



16

## “Swing Gait”



17

## Wide-based Gait



18

# Spastic Diplegic Gait



19



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## End of Part 1



21

## Function-Focused Gait Assessment

Clinical Gait Assessment



22

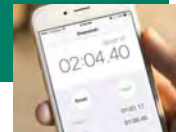
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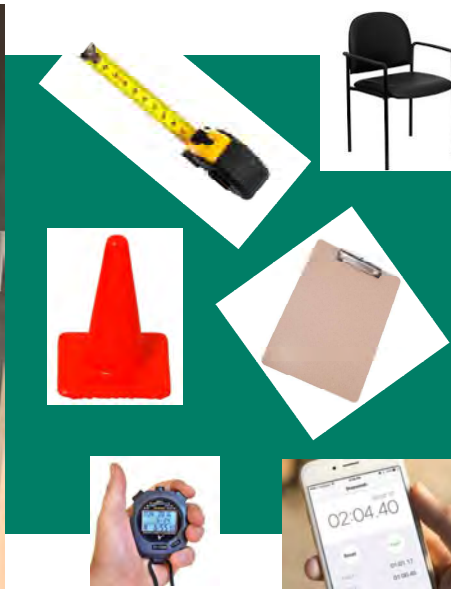
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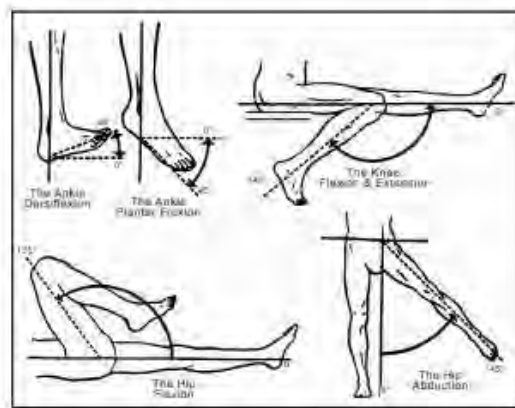
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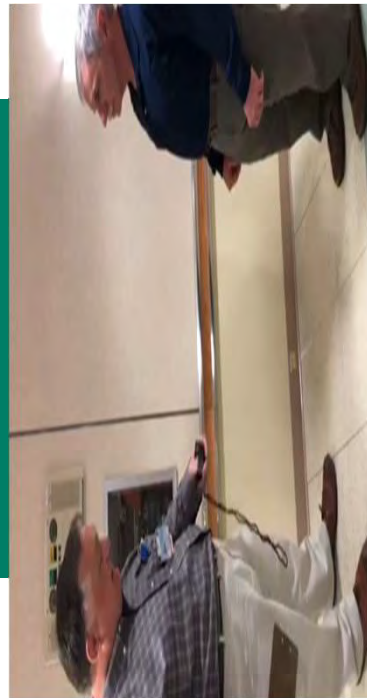
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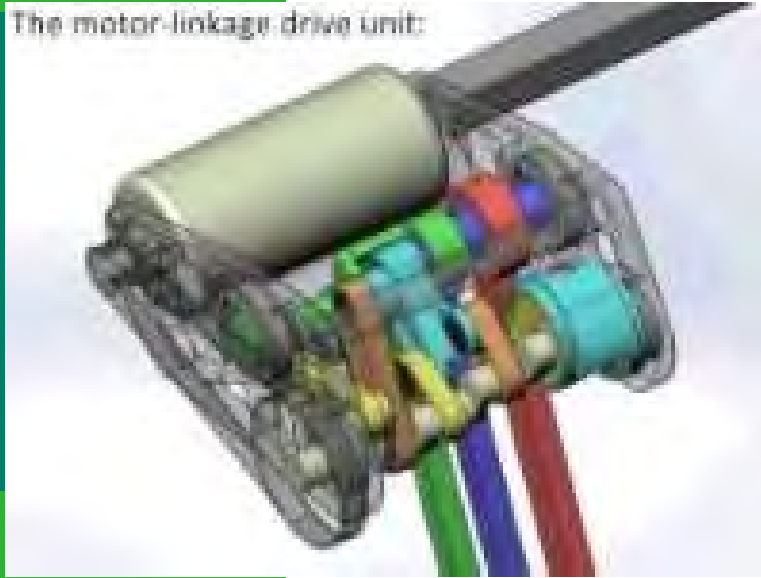


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