

THE
2ND DECADE



MYOTONIC
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MYOTONIC
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Care and a Cure

ORTHOTICS AND MOBILITY

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Stanford
MEDICINE

Department
of Medicine

Outline

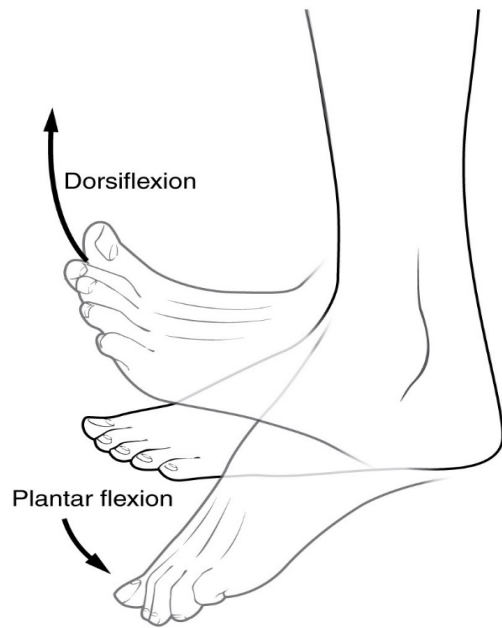
- Leg Anatomy
 - Muscle Imbalances
- Biomechanics
 - Clinical symptoms
 - Muscle Imbalances: Ankle tightness/contractures
 - Gait/Walking
 - Stability or Balance
 - Energy Expenditure
- Treatment options for lower leg weakness
 - Exercise, Stretching, Orthosis
- Orthosis
 - Ground Reaction Forces
 - Choosing the right orthosis

Quick Fire: Mobility options

- Transfer Devices
- Upper Extremity Supports
- Power and Manual Mobility Devices

Lets get on the same page...

Side View



Front View



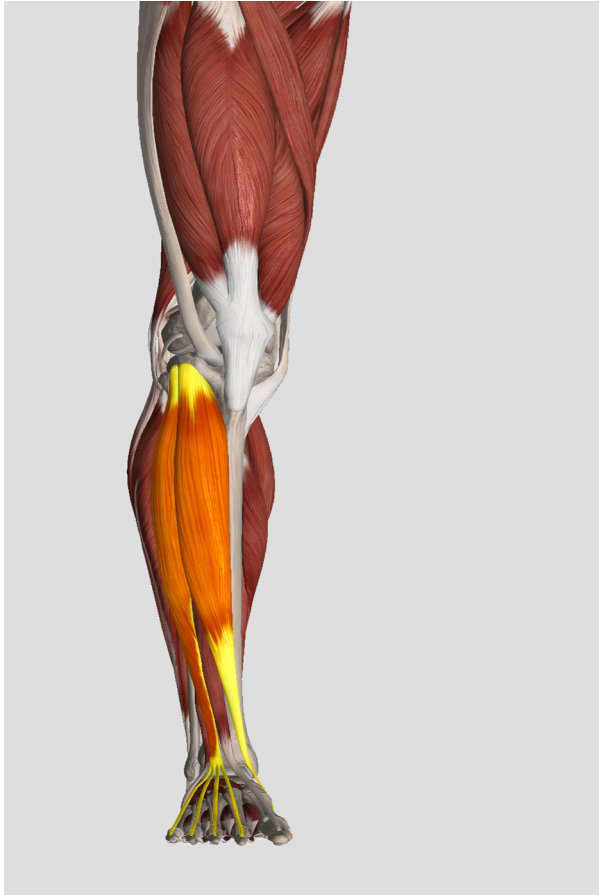
Hind View



Leg Anatomy

Dorsiflexors:

Tibialis Anterior, Extensor hallucis longus, Extensor Digitorum Longus

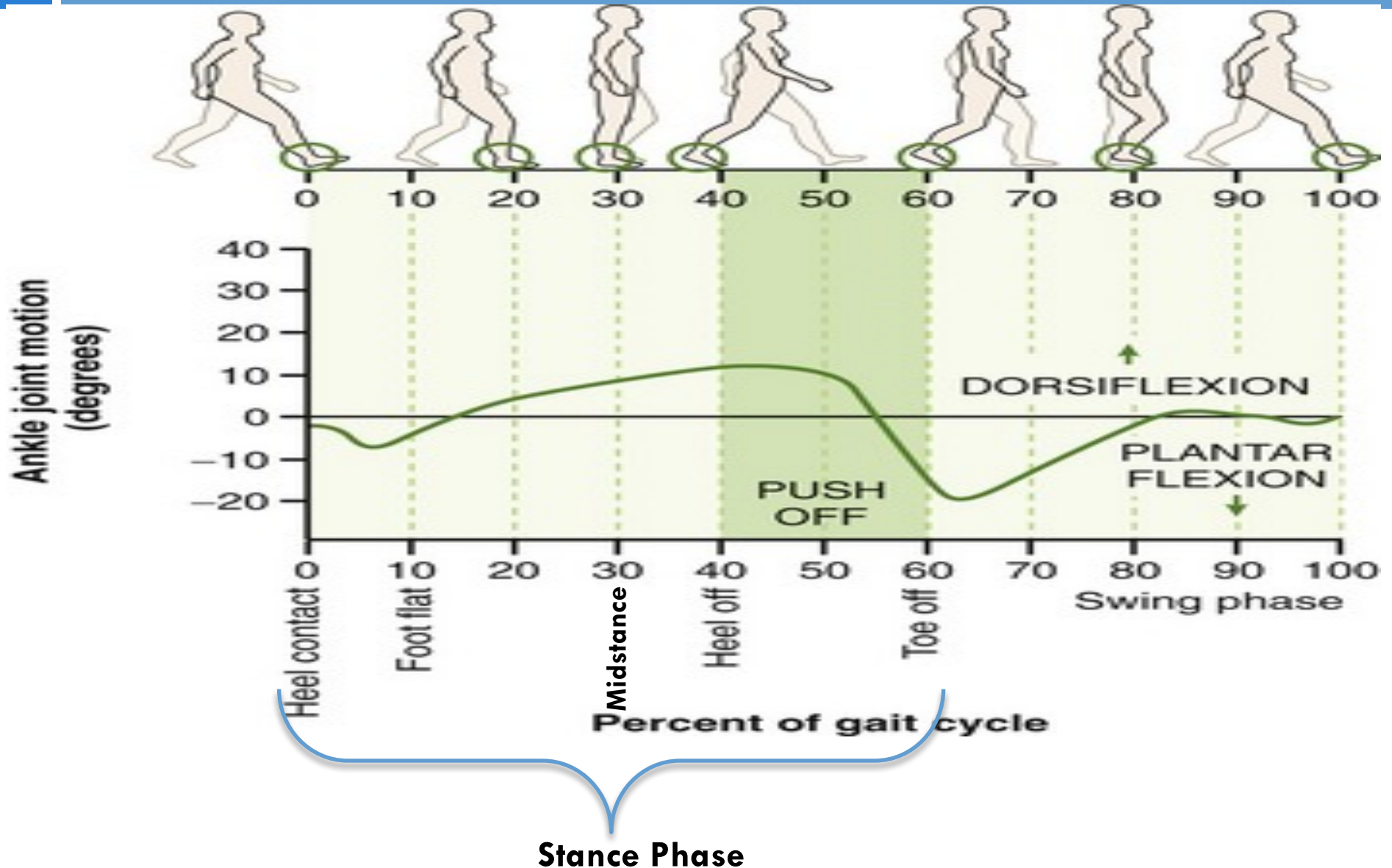


Plantarflexors:

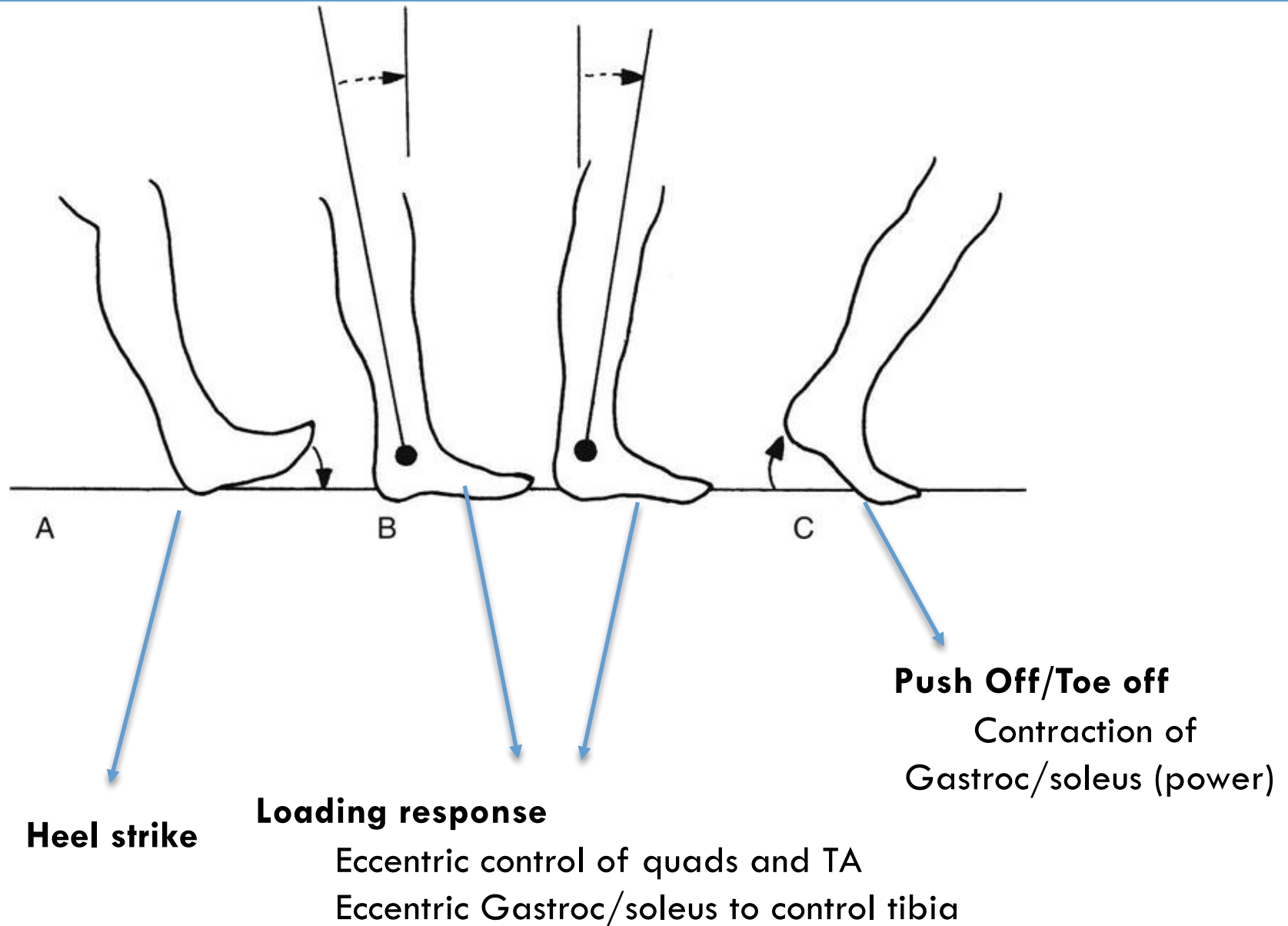
Gastrocnemius and Soleus



2 Phases of Gait (walking)



Stance Phase: Rocker Phases



Objectives in Gait

- Move from one place to another safely
- Use the least amount of energy to move
 - ▣ Forward motion
 - Rigid foot lever arm to propel body forward
 - Muscles to control movement
 - ▣ Limit vertical motion
- Limit Pain/discomfort

Management of ankle foot muscle weakness

Sackley et al 2009

- No intervention
- Physical therapy
 - ▣ Stretching:
 - Maintenance of range of motion (ROM)---tight Achilles tendon
 - ▣ Strengthening to improve active muscle movement
 - ▣ Balance
- Orthotics
 - ▣ Static
 - ▣ Dynamic

Stretching and Orthotics in ROM

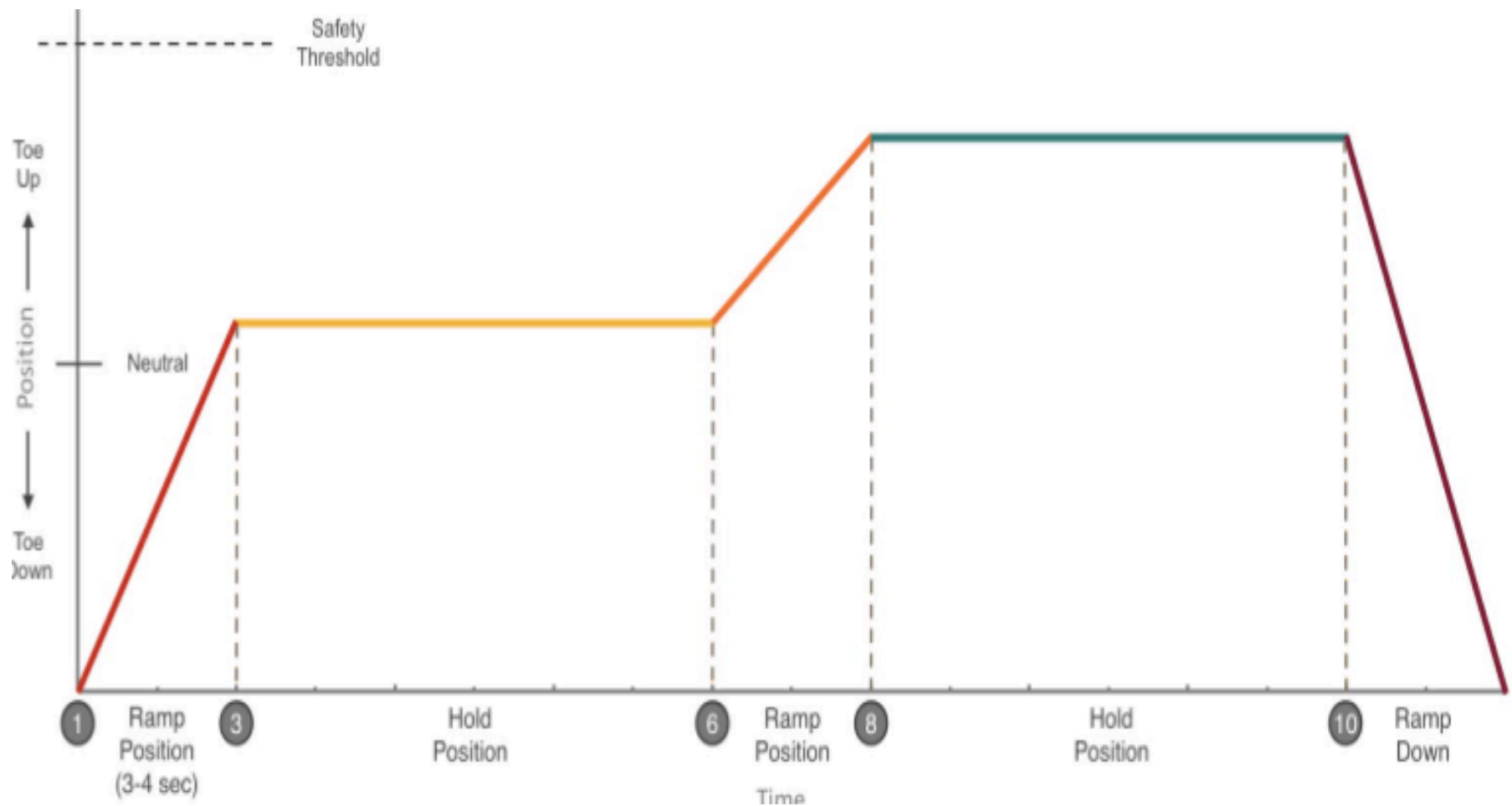
- DMD Cohort
- Solid AFO or stretching orthosis used daily significant effect on ankle range of motion

	RIGHT ANGLE DORSIFLEXION			
Characteristic	N	Mean ± SD	Median (range)	P-value*
STRETCHING				
Have used	43	-6.0 ± 13.10	0 (-35 – 15)	0.008
Daily use	89	1.0 ± 10.7	0 (-45 – 20)	
NIGHT SPLINTS				
Have used	33	-7.7 ± 15.0	-5 (-45 – 15)	0.006
Daily use	83	0.4 ± 9.7	0 (-30 – 15)	

*p-value from non-parametric comparison using Wilcoxon rank sum test
(Duong, Unpublished 2016)

Physiology of Stretch

- Slow Sustained pressure = most effective stretch



Strengthening: DM

- ▣ 24 week strength training program (RCT)

Lindeman et al 1995

- No effect on walking speed or stairs
- Reported improvements on ADLs
- No negative effects

- ▣ 12 Week aerobic training (Orngreen et al 2005)

- Improvement oxygen uptake by 14%
- Muscle fiber size increased

Benefits of Exercise

Healthy Individuals

- Aerobic Endurance
 - ▣ 30 minutes VO₂max 50-85%
 - ▣ Improved circulation, oxygen usage, oxidative phosphorylation (Timmons et al, 2010)
 - ▣ 30min of moderate exercise, 5/week decreased mortality rates (Whitehead et al, 1995)
- Strength training
 - ▣ Increased muscle strength and power, increase lean body mass

Individuals with NMD

- Adaptations to exercise in NMD similar to sedentary population (McDonald et al, 2002, Fowler 2002)
- Goals:
 - ▣ Improve/maximize function
 - ▣ Fall prevention/balance
 - Weakness/sensory impairments
 - ▣ Minimize Pain
 - ▣ Improve sleep
 - ▣ Minimize development of contractures



Back to orthotics...

You may need a brace if...

- Steppage gait
- Dragging of the foot and toes
- Scraping of the toes across the ground
- Uncontrolled slapping of the toes against the ground
- Unable to walk normally in heel-to-toe fashion
- The inability to raise the foot at the ankle
- The inability to point the toes upward at the body (dorsiflexion)



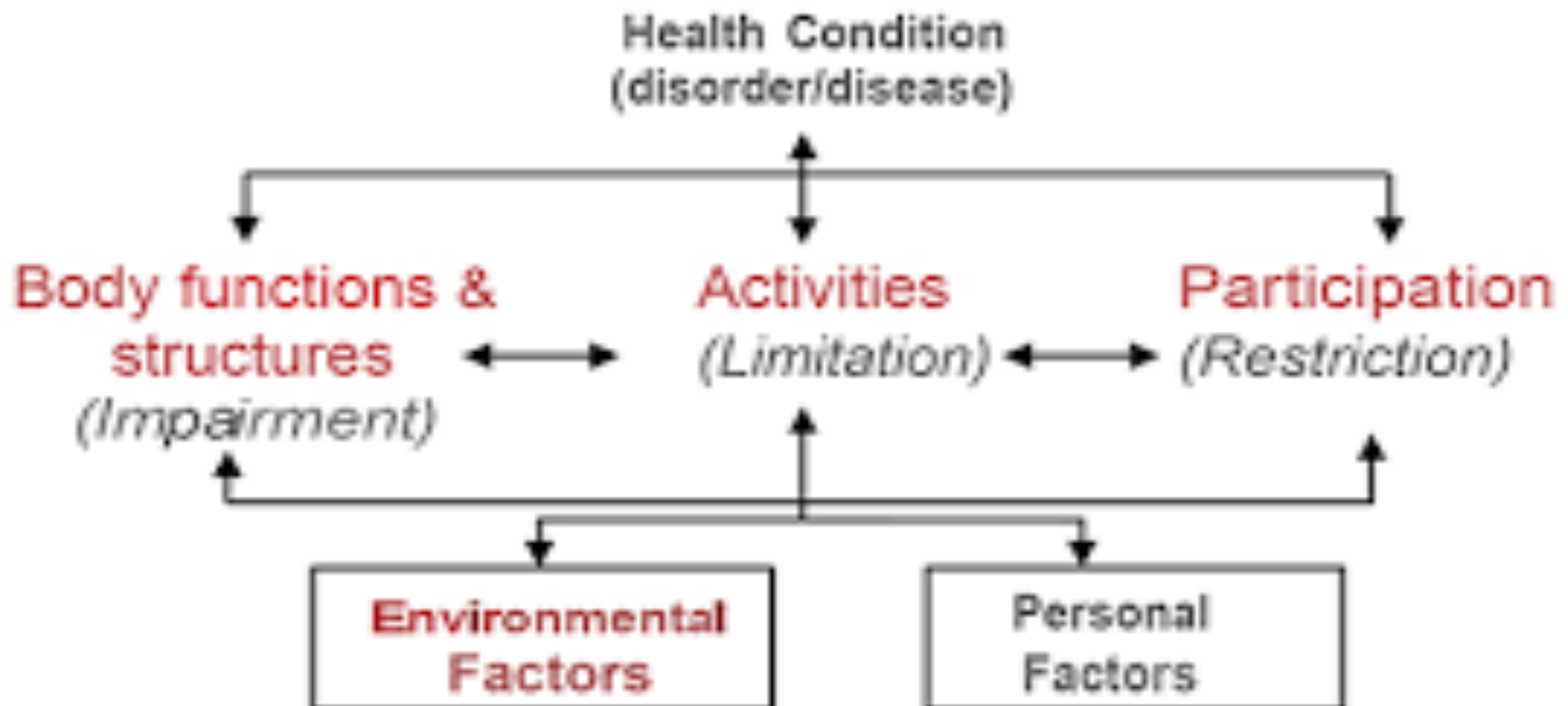
Goal of Orthotics or Bracing

- Improve walking efficiency
 - ▣ Use less energy
- Foot clearance during walking
- Walking speed
- Maintain range of motion
- Improved stability

What type of orthosis works for me?

Considerations

ICF: Interaction of Concepts



Body Structure/Function (impairment)

Domain	Concerns
Joint integrity and stability	Ligamentous instability, joint deformity
Range of motion	Soft tissue contracture, joint deformity
Muscle length	Fixed versus modifiable contracture
Overall flexibility	Ability to don/doff; impact of orthosis on trunk, back
Muscle performance	Strength, power, endurance
Involuntary movement	Impact on tolerance of orthosis
Coordination	Ability to don/doff
Upper extremity function	Ability to don/doff
Postural control, balance	Ability to don/doff
Visual function	Ability to perform skin checks, donning/doffing
Cognitive function	Understanding of how to use orthosis
Cardiovascular endurance	Ability to functionally use orthosis





Activity Level

Domain	Concerns
Gait analysis	Primary gait problems and compensations
	Impact of orthosis on physical work of walking
	Safe function with orthosis and assistive device
	Impact of resistance, unstable surface on gait
Activities of Daily Living	Don/doff orthosis
	Self care
	Orthosis management with clothes ie: shoes

Participation Level

Domain	Concerns
Home	Roles and participation in family tasks
School	Impact of classroom, walking through hallways, play areas
Work	Entering in buildings, workspace, common areas
Leisure	Hobbies
Transportation	Drive, public transportation

Takes a team

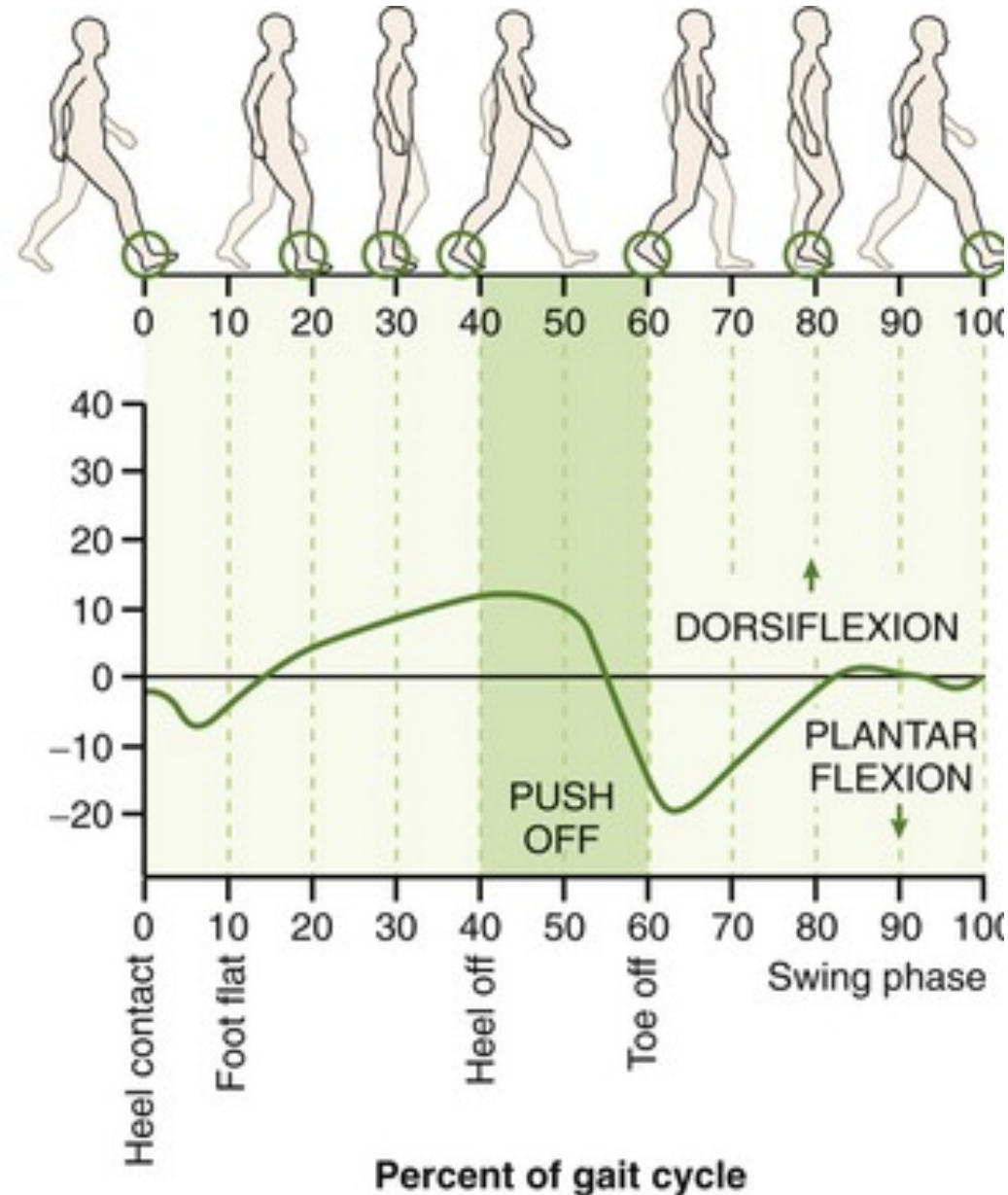
- Patient/Caregiver  Where will you wear it?
How do you put it on? Take it off?
- Physician  Understanding of disease mechanisms and progression
- Physical Therapist  Strength and function
Biomechanics of movement
- Orthotist  Materials
Biomechanics

Orthotic Considerations

- **What is the objective of the orthosis?**
 - **Support/stability**
 - Control movement
 - **Correct deformities**
 - Minimize mal-alignment
 - **Compensate for weakness**
 - Improve gait, safety
 - Endurance (energy efficient gait)
- **Comfort and Cosmesis**
 - Short vs. long term
 - Low profile
 - Custom molded vs. off the shelf
- **Cost** (fabrication and maintenance)
 - Insurance or out of pocket

What do AFOs do?

- Usually prescribed for
 - ▣ Ankle dorsiflexion weakness through swing phase
 - ▣ Ankle Plantar flexion weakness during stance phase
- How?
 - ▣ Supports forefoot from dropping into plantarflexion during swing
 - Energy efficient, Safety



Options

- Fixed
- Articulated/hinged
- Energy storing: Carbon fiber
- Neuroprosthetics
 - Functional Electrical Stimulation
 - Walkaide, Ness 300 foot drop system, Odstock
 - Stimulates peroneal nerve to initiate dorsiflexion
 - Initiated through EMG sensors, IMU sensors



- **Materials**
 - Leather, thermoplastic, carbon fiber
- **Biomechanics**
 - Ankle in neutral
 - In Plantarflexion
 - Extensor moment
 - In Dorsiflexion
 - Flexor moment
- **Other types of orthoses**
 - Shoe inserts
 - SuperMalleolar Orthosis (SMO)
 - Knee ankle foot orthosis (KAFO)
 - Hip Knee ankle foot orthosis (HKAFO)

Minimal AFOs

□ Foot ups

- Supports foot into dorsiflexion
- Low profile



□ Fixed short leg AFOs

- Flat foot
- Keeps foot at 90 degrees
- Not recommended for tall individuals 6'
- Keeps foot at 90 degrees so gait abnormal



□ Dorsiflexion Assist short leg AFOs

- Spring like hinge to help with dorsiflexion
- recommended for tall individuals 6' or 225 lbs.



Long AFOs

- **AFO with plantarflexion stop**
 - Allows normal dorsiflexion
 - Has stop to not allow plantarflexion
- **Solid AFO (traditional)**
 - For dropfoot and knee weakness
 - Keeps foot in fixed position
 - Stability during stance phase
- **Anterior shelf**
 - Prevents knee collapse
 - Need good hip extension strength



Carbon Fiber AFO



- **Energy return AFOs**
 - Carbon fiber
 - Light
 - Energy return at toe off (push off)
 - Lack lateral stability support
 - Normal Heel biomechanics



- Not optimal for
 - Achilles tendon contractures
- Decrease energy expenditure & Improve Gait speed
 - Danielson et al 2004
 - Danielsson et al 2010
 - Bartonek et al 2007
- NM Clinic Pilot study indicates patient satisfaction
 - Mnatsakanian et al 2017

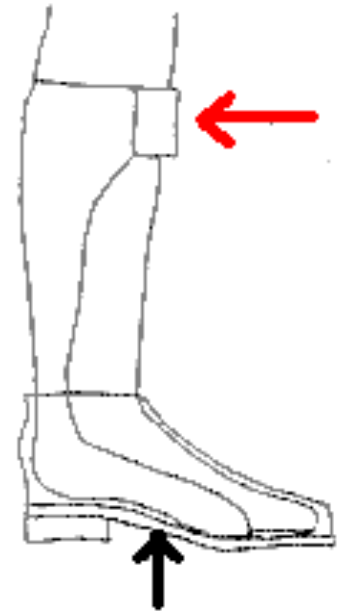
Ground Reaction Force: How it affects your ankle and knees

□ Ground Reaction Force (GRF)

- Force exerted by the ground on the body
- Newton's 3rd law
 - F on ground exerts = and opposite reaction

□ Mid stance and toe off

- Plantarflexors active to counter dorsiflexion moment produced by ground reaction force
 - Weak plantarflexors = knee flexion = decrease stability
- Solid AFO: Translates GRF from the ground to front of tibial
 - Plantarflexion moment

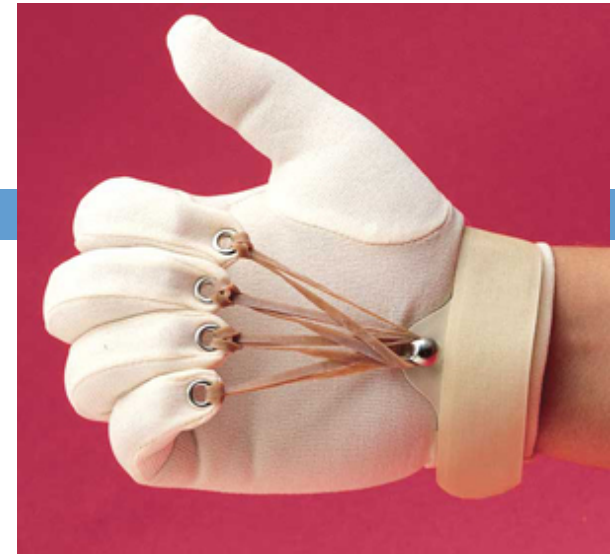


Upper Extremity Supports, Mobility Devices, Transfer Devices

Thank you to Leslie Vogel, Claudia Senesac and Laura Case for contributions to the Equipment slides

Hand splints

- To stretch wrist/finger flexors
- To stretch finger extensors
- To prevent PIP hyperextension



Benik splints



Figure 8 oval splints

Functional Arm Supports

Mechanical- require some strength to elevate

□ **WREX** (rubber band tension)

- <http://jaecoorthopedic.com>



□ **X-Ar exoskeletal arm** (springs and tensioning hardware)

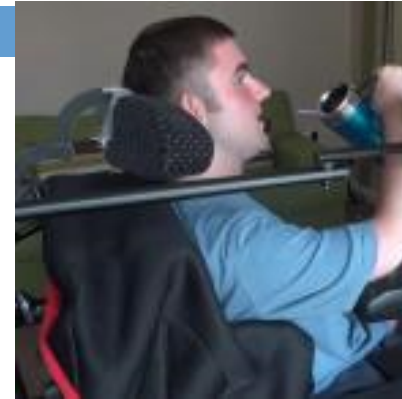
- Not currently on the market



Powered Arm Supports: Requires some strength

- Neater Arm with Assist

- <http://www.neater.co.uk/neater-arm-support>



- Go Wing Arm Support

- <http://www.innovationshealth.com/gowing>



Robotic Arms: No strength requirement

JACO Robotic Arm

<http://www.kinovarobotics.com/about-us>

<https://www.youtube.com/watch?v=IB-ZluvrQqk#t=106>



Early Mobility Devices



Go-Go® Elite Traveler Plus

Go-Go Scooter

- More portable than w/c
- Negatives
 - Poor seating support
 - Large turning radius
 - UE fatigue
- Mobility not Seating device

<http://www.pridemobility.com/gogo/>

Alternative motorized systems

EZ Lite Cruiser



<http://www.ezlitecruiser.com/>

Alternative motorized systems



Zappy

- more portable than w/c
- can stand or stand
- ~13 mph



<http://www.zapworld.com/vehicles/zappy-pro-flex-500>

Alternative motorized systems



EV Stand & Ride

- more portable than w/c
- can sit or stand
- ~15 mph

<http://evrider.com>

Portable power assist wheelchairs



<http://www.alber-usa.com>



Efix



E motion power assist
or twion power assist



Smart Drive

Additional power adaptations



Firefly

- Attaches to manual wheelchair
- **Difficult to transfer into chair with device**
- ~12 mph

Power Wheelchair purchase

- Drive Mechanism
 - ▣ Front wheel
 - ▣ Mid-wheel
 - ▣ Rear wheel
- Power Options
 - ▣ Power standing feature
 - ▣ Power tilt and/or recline
 - ▣ Power seat elevation
 - ▣ Separately elevating power elevating leg rest



Supported Standing

Stand & Drive chairs



Permobil F5 stand & drive
www.permobilus.com/f5vs.php



Other retailers



Redman standing powerchairs
www.redmanpowerchair.com



Levo C3 Standing Chair
levousa.com

Standing frames



EasyStand stander
EasyStand.com



Hydraulic Patient Lifts



Drive Deluxe Silver Vein Patient Lift



Hoyer Hydraulic Patient Lifter

Powered Patient Lifts



Drive Medical Power Patient Lift



Invacare Reliant 450 Battery

Standing Transfer Aids



Easy Pivot



Rifton-Tram

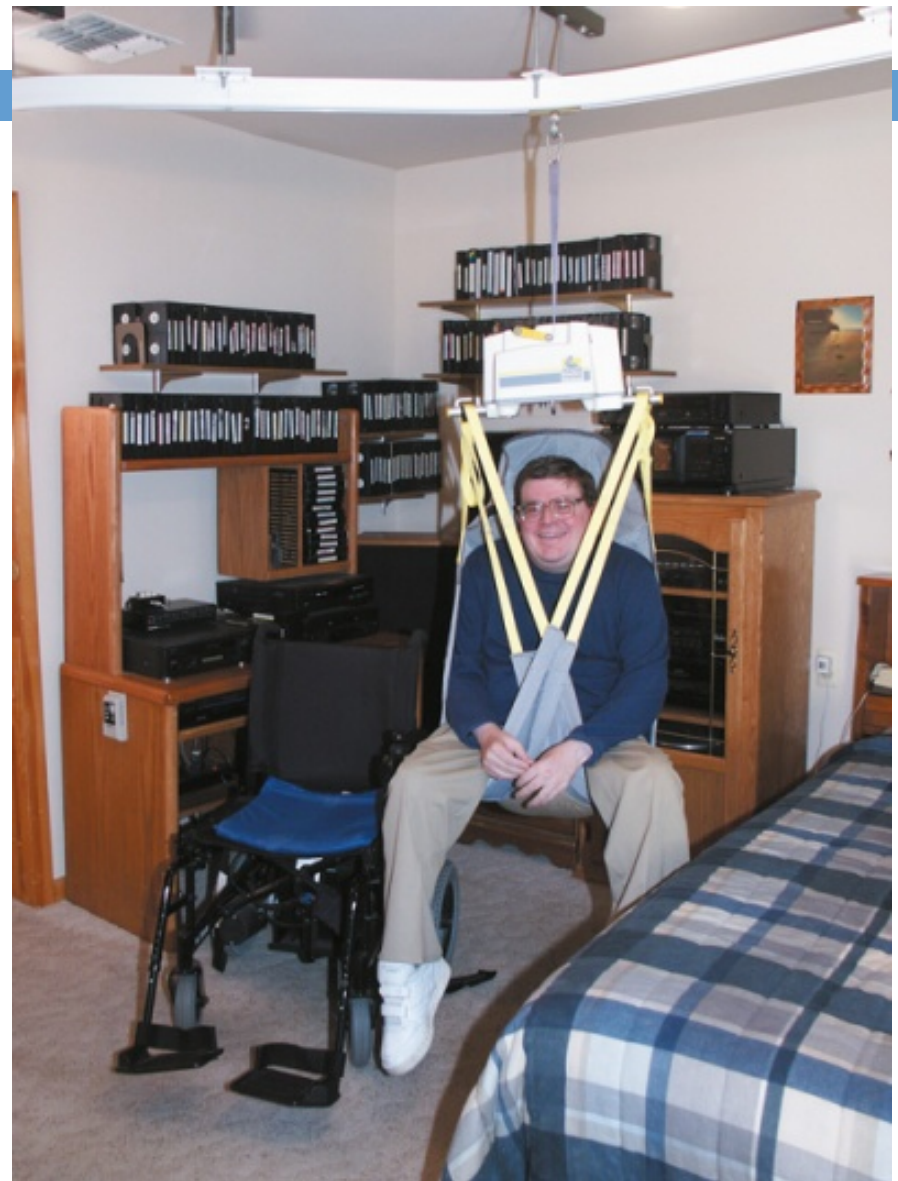


Ceiling Lifts

Barrier Free



Surehands



Joerns Voyager Portable Track



Ceiling Mounted



Bath bracket

Joerns Voyager Portable Track



Post-mounted

Free Standing Tract Lifts

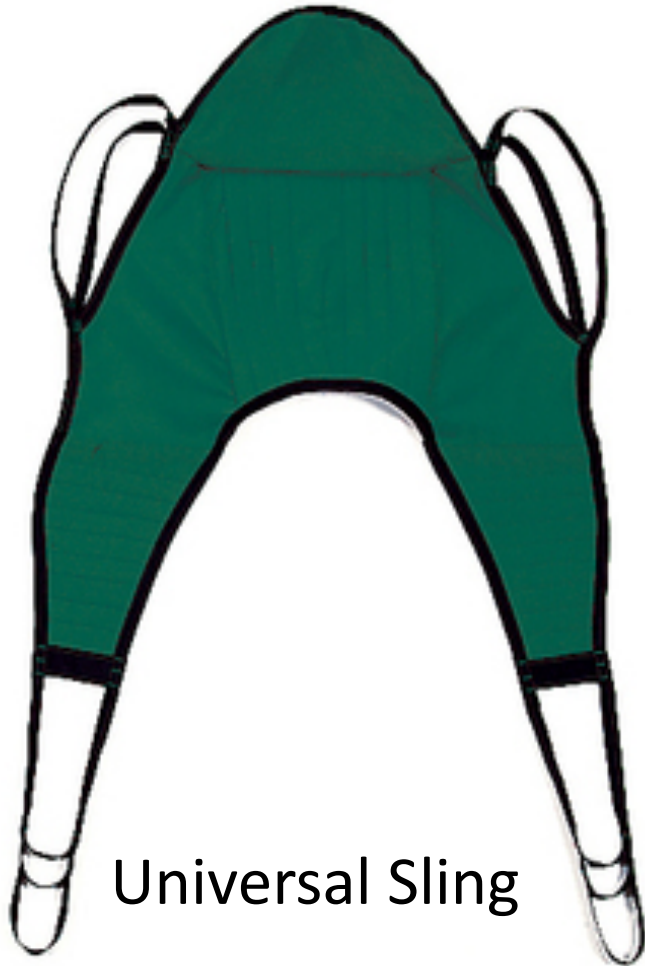


Norco-Inc.



Prism Medical

Slings



Universal Sling

Full Body Sling



- Solid or Mesh
- Head Support

Transfer sheets



Alpha-Modalities



Arjo MaxiSlide



ErgoSlide
Prismmedicalinc.com

Toilet Adaptations



Toilet Arm Rests



Bathroom Transfers



Walmart/Amazon \$50- \$90



Slider systems

Tub Baths



AquaTech

AquaLift



Marlin Lift

Bathroom Transfers



Columbia Ultima Access

<http://www.inspiredbydrive.com>

Tubbuddy with tilt



www.myshowerbuddy.com

Bathroom Transfers- Rifton



Rifton Bath-Commode Chair



Rifton Blue Wave Tub Transfer Base- 2017

Rolling Shower/Commode



ActiveAid 285TR
www.activeaid.com



RAZ-AT (Attendant Tilt)
<http://razdesigninc.com>



Adapt Environment as Necessary

Enjoy LIFE...Don't struggle when you may not have to



QUESTIONS?

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