THE SCIENCE OF SITTING IN EVERYDAY LIFE

Mary Ellen Buning The Myositis Conference October 18, 2013 in Louisville, KY





Learning Objectives

- Recognize good seated posture and its role in preventing postural collapse
- Travel with mobility devices and Wheelchair Transportation Safety
- Share changes in Centers for Medicare and Medicaid Services (CMS) reimbursement and attitude toward durable medical equipment (DME)
- Review of some wheelchair technologies
- Complex Rehab Technology and the role of the Assistive Technology Professional





Seated posture is NOT passive

- Since the human body is designed for standing, sitting all the time creates concerns
 - The pelvis, femurs and spine are no longer at end range... so muscle strength is needed for postural control
 - When the lumbar curve is reduced or eliminated, it leads to kyphosis, chin forward, diminished reach, etc.
 - Functional sitting requires "active posture"







Sitting reduces typical spinal curves



- In sitting...
- The lumbar curve is reduced or eliminated
- Reach and range of motion are more restricted





The goal? Support a neutral pelvis



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- It's a challenge even with a typical neuromuscular system!
- Why is it a challenge?
 - Ischial Tuberosities (ITs) are shaped like "rockers"
 - Hamstrings are under stretched and under tension
 - Pelvis can rotate in three planes



Seated posture needs external support

- A stable pelvis is a basis for movement & control!
 But, it requires muscle activity!
 - Dealing with weakness of core musculature?
 - Diagnosis-related deconditioning?
 - Gravity is relentless and the body seeks stability

• So...

- Do your best to maintain strength and flexibility!
- Get good external postural support!
- Work with a therapist with skills in ergonomics and seating





Posterior tilt: The pelvis wants stability



- Adds a third point of contact
- More stability than
 2 points of contact
- Increases the contact area
- Increases pressure ulcer (PU) risk





Posterior Tilt: The pelvis looses ability

Posterior Pelvic Tilt



- What happens to the seated posture?
 - A cascade of changes
- What functional limitations?
 - Breathing
 - Swallowing
 - Reaching & lifting
 - Pushing & pulling





How do you stabilize a seated pelvis?







Rigid Contoured Back Support

- Fits into the body's lumbar curve and adds additional lumbar support
- Prevents loss of lumbar arch
- Increases spinal lengthening
- Helps to orient the pelvis so it can maintain neutral
- Prevents secondary disability and pain







What supports good seated posture?

- The same features found in a high end or "ergonomic" office chair:
 - Solid foot contact with the floor
 - Seat width and depth that matches your body
 - Adjustable arm rest height
 - Optimal pressure distribution
 - The right amount of back support for a range of tasks
 - Temperature distribution

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What is right about this picture?









Work Surface Heights



.....



Sitting reduces typical spinal curves



- Once the lumbar curve is lost or reduced a cascade of issues follow:
- Kyphosis
- Ribcage collapses onto the diaphragm and lungs
- Neck flexion
- Reach and range of motion are more restricted





When does seated posture need skin protection?

- Loss of "protective sensation" is a big complication
 - When no sensory feedback -> no urge to shift position
- Lost or limited motor control makes it hard to move
- Cognitive impairment or depression can also be complicating factor
- ADL limitations can further complicate:
 - Poor nutrition
 - Bowel & bladder issues





Seated posture requires skin protection



- Trouble spots:
- Coccyx
- Ischial tuberosities
- Greater trochanters

 Sacral wounds are usually related to lying in bed





Capillary Blood Pressure

- What we know as normal BP of 120/90 is greatly reduced at the level of capillary blood vessels
 - Via cell walls, nutrition is delivered & waste is removed
- We use 32mmHg as an estimate of capillary blood pressure at the arteriole
- Remember... other health factors affect BP too
- Key issue: the force/pressure created by the bony prominences that vertically load muscle/soft tissue is *much greater* than capillary blood pressure of 32mmHg





Pressure Mapping Technology

- Piezo-resistive polymer sensors are imbedded in a flexible mat connected to a computer with software to interpret data.
- The scale is 0mmHg to 200mmHg and it measures force/pressure at the interface between the body and the sitting surface or cushion
- Mat is filled with sensors and so the greater the pressure the greater the resistance
- Allows use of force data for comparisons though NOT empirical data





Pressure Mapping Technology

- Enables a "real time" view of interface pressures
- Essential for seating individuals without sensation
- Effective tool for teaching weight shift and pressure relief



BHIJKLN





Pressure Mapping: As a teaching tool

- Train for pressure relief: 1 minute every 30
 - Wheelchair push ups
 - Also...





Leaning to right buttock





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Elbow on thighs

How does Pressure Mapping work?

- Several companies make this technology
 - Force Sensing Array by Vista Medical
 - Tek Scan
 - X-Sensor
 - Capture both momentary and motion data
 - Uses a laptop computer... it portable
 - Teaching tool for new patients
 - Allows comparison of seating support surfaces
 - Adds value to the cushion selection process
 - Supports the role of power seating for weight shifts & repositioning





Another issue:

Standard manual & power wheelchairs

- Only standard sizes, limited features
- Minimal adjustability
- Heavy: 30-40 lbs.
- Fixed axle position



- Captain or van-style seating
- No power seating
- No upgradable electronics





Standard wheelchairs = lack support

- Pelvis goes into posterior tilt
- Lumbar curve is lost
- Hamstrings shorten
- Kyphosis increases
- Head/neck fall into cervical lordosis
- Ribs collapse and lungs compress

Posterior Pelvic Tilt promotes Kyphosis





Catch scoliosis & pelvic obliquity early!



- The larger the divergence of the angle from vertical, the greater the force on the lever arm
- Result: more rapid progression
- Pelvic obliquity creates peak pressures which can lead to pressure ulcers and increased pain
- Imbalance in muscle strength



Pressure: There are only two options

- Distribute the load as broadly as possible
 - Create maximum surface contact to spread the force
- Transfer the load to places that are more pressure tolerant
- Accomplished through cushion design and material properties





Load distribution is the most common approach

- User/therapist preference/habit leads to routine use of air flotation & viscous fluid
- Theory: use load averaging to reduce ischemia from loading of the ischial tuberosities
- Pressure mapping can display interface pressures & guide cushion choices





There's NO recipe for cushion selection

- Cushion properties affect the user through:
 - Pressure distribution
 - Stability
 - Interface temperature
 - Reliability
- Yet, a cushion must be:
 - Comfortable
 - Functional
 - Easy to use
 - Clinically safe





Cushion Materials Properties

- Density mass over area (kg/m3)
- Stiffness resistance to indentation
 - Rated or measured in indentation load displacement (ILD)
- Thermal characteristics
 - insulates (holds heat)
 - conducts (draws heat away)
- Friction resistance to shear or sliding





Solid base

- Good stability and reliability
- Essential for manual wheelchairs with a sling seat
- Job is NOT to distribute pressure; but to allow the cushion to do a better job



Applewood Insert





General Purpose Cushion: Flat foam

- Good stability
- Variable indentation -> pressure distribution
- Poor resilience over time
- Insulator of heat
- Reliable
- High shear (moderated by choice of cover)
- Lightweight
- Inexpensive







One of my favorites... Varilite Evolution



- Combination of foam & air
- Base is closed cell foam
- Sealed within a nylon cover
- Valve is easy to manage
- Resilient
- Customized fit
- Other options for asymmetrical posture





Sitting reduces typical spinal curves



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- Reach and range of motion are more restricted





Pressure Relieving: Gel or Viscous Fluid

- Good load distribution
- Low shear, i.e., slippery
- Poor resilience = may bottom out
- Reliability: Need to contain or restrict flow of fluid
- Good thermal properties (neutral)
- Protect from freezing
- Can be heavy







Air-filled cushions

- Excellent immersion, max load distribution
- Good dynamic properties
- Absorbs impact & vibration
- Reliability may be a problem: burns, punctures, user error
- No margin for safety
- Requires patient education and compliant or vigilant user



ROHO cushion





Hybrid air flotation with rigid foam base

- Greater density from dense foam in the front makes transfers easier
- Air cells located in region of the sitting bones or ITs
- Duals zones in the IT area help adjust for obliquity
- Neutral insulation
- Excellent immersion





Another approach: Offloading pressure

- Orthotic cushion
 - Transfers load off of bony prominences
 - Placing load on more tolerant areas
 - Cantles create support for a neutral pelvis
- Important new technology
 - Previously only possible with in-house orthotist service
- Ride Designs Custom Contour Cushion by Aspen Seating in Denver






Off-loading is an orthotic approach

- Eliminate load from bony prominences, e.g., ischial tuberosities
- Transfer load to more tolerant areas, e.g., posterior ilium & inferior femur/ trochanter



Ride Design Cushion: Aspen Seating





Clinical indications: Orthotic approach

- Pelvic obliquity with pressure ulcers
- Pelvic obliquity with developing scoliosis
- Anterior collapse of trunk (rib cage is resting on abdominal soft tissue)
- Lumbar, thoracic or cervical pain or unexplained autonomic dysreflexia
- Must be able to justify need for a custom cushion
- Need certification for fitting







Starts with capturing a mold of the buttocks



Simulator foam for custom impression





Load distribution versus off-loading

- Maximize surface contact through envelopment
- Load averaging to offset ischial tuberosity loading
- Examples: ROHO air flotation, JAY viscous fluid

- Remove load from bony prominences: ischial tuberosities
- Load tolerant areas, e.g., posterior ilium, femurs & inferior trochanter
- Example: Ride Designs





Factors Affecting Cushion Selection

- Use of wheelchair for > 4 hours/day
- Poor sitting balance
- Fixed vs. Flexible deformities
- Sensation
- Ability to perform weight shifts
- Current or past history of skin breakdown
- Awareness
- Activity level





Factors Affecting Cushion Fit

- Body weight distribution
- Mechanical properties of cushion
- Mechanical properties of the buttocks
- Shape of the buttocks
- Shape of the cushion





Goals of therapeutic seating

Wheelchair seating needs to:

- Optimize skin protection
- Prevent abnormal posture
- Creating a stable base of support to optimize function with head and hands
- Allow access to desired activities
- Maximize attention and concentration
- Prevent repetitive strain injuries





Let's change the seating focus to...

Wheelchair Transportation Safety

- Who needs this info?
- Anyone who uses a wheelchair as a seat during travel
- Too weak, unsteady, painful to transfer to a vehicle seat
- Many transportation options for consumers who use wheelchairs:
 - Personally owned sedan, minivan, van or pickup truck
 - School bus
 - City transit bus
 - Paratransit bus
 - Accessible taxi









A little review... Vehicle Mass

Large mass vehicles:

- The larger the vehicle, the safer the trip for its passengers
 - Greater mass also makes acceleration and deceleration slower
 - The vehicle mass absorbs more of the force of an impact and less impact force is experienced by passengers



Force = Mass x Acceleration





A little review... Vehicle Mass

- More about large mass vehicles:
 - The ADA requires that large mass public transit vehicles be accessible to persons with disabilities
 - If there is fixed route public transit then there is also typically paratransit for those unable to use fixed route buses
 - If there is no public transit in small or rural community
 - Then it is likely that there is NO paratransit
 - Small communities may rely on non-profits for paratransit
 - City dwellers and lower income folks are often public transit riders
 - Many new consumers have no experience with public transit
 - Riding in a large mass vehicle while seated in a wheelchair is safest when the wheelchair is secured and occupant restraint belts are used





A little more review... Vehicle Mass

Force = Mass x Acceleration

Small mass vehicles:

- The smaller the vehicle, the faster it accelerates and decelerates
- There is less vehicle mass to absorb the force of an impact so the force is quickly transferred to passengers
- Small mass vehicles typically travel at higher speeds, which also increases the passenger's risk of injury







A little review... Vehicle Mass

- More about small mass vehicles:
 - The National Highway Transit and Safety Administration (NHTSA) regulates the occupant safety features of cars, trucks, and vans to improve passenger safety and survivability
 - Millions of \$ are spent on R&D to increase the passenger safety: seat design, head rests, airbags, etc.
 - Effectiveness varies by manufacturer but higher safety scores are used as a selling point
 - The safest seat is in the OEM seat using a 3-point lap/shoulder belt and an airbag





Transit Options Compared

Public transit vehicles

- Vehicles are already modified for wheelchair transportation
- Our taxes cover costs of a driver, vehicle purchase, maintenance, fuel & insurance = No capital outlay + low fares
- Functions on predictable routes and time schedules
- Door-to-door service is available if not near a fixedroute bus stop

Personally-owned vehicles

- High level of convenience
- A vehicle specially customized for the consumer's needs
- It allows living in a small town or a rural settings, i.e., anywhere
- There are high costs for purchase, vehicle modification, maintenance, fuel & insurance plus high costs for trade-in





So what about the wheelchair?

- Individuals who use a wheelchair during travel need education, product information, guidance and best practice from therapists and suppliers because:
- NHTSA does NOT regulate the safety of wheelchairs when used as seats in motor vehicles
- The Food & Drug Administration (FDA) which enforces standards for wheelchairs does NOT require meeting standards for transportation safety
- All we have is... best practice in the selection and use of aftermarket safety products that meet *voluntary* industry standards





A wheelchair designed for transportation!

- Since 2000, a voluntary industry standard for a transit wheelchair
- Designed with:
 - Same 30ph/20g as all automotive components
 - 4 crash-tested securement points mounted to improve crash response and wheelchair stability
 - Adaptable to most wheelchair types
 - Allows proper routing and placement of 3-point lap shoulder belt
 - No additional wheelchair hardware required





Here is the concept:

- Anchor the wheelchair to the floor of the vehicle
- Secure the passenger in the wheelchair



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Best practices for occupant restraints

Upper torso belt comes from the vehicle wall above and behind the passenger





Lap portion low and snug at pelvis!

Postural belts on wheelchair frames are generally NOT designed for safety during transportation!!!





A Crashworthy Wheelchair

Labeling requirements:

 Wheelchair frame, primary seating, and crashworthy pelvic belt labeled with the symbol ==>



 Securement points-marked by hook symbol







The benefits of a WC19 Wheelchair

- Improved structural design and materials for crashworthiness in frontal impact
- Provides four labeled easy to reach securement points located at proper height
- Provides clear paths for tiedowns
- Tested with a wheelchair-anchored pelvic safety belt
- Reports level of accommodation and fit of vehicleanchored belt-restraints
- Reports wheelchair stability during normal travel
- Reduces sharp edges and hard points
- Improves battery retention and increases use of gelcell batteries







A work around for standard wheelchairs

- Standard wheelchairs are designed for someone who requires a wheelchair in the home, therefore NOT crash tested
- Recommendation for action:
- If the consumer is *not* able to transfer to a vehicle seat and *must* ride in their wheelchair:
 - Attach the 4-point, strap type, tiedowns to symmetrical *welded* joints on the wheelchair frame
 - Never attach straps to wheels, axles, or removable armrests, leg and foot rests







Standard Manual and Power: Actions & Recommendations for Transit

- If the consumer is *not* able to transfer to a vehicle seat and must ride in their wheelchair:
 - Consider adding 4 crash-tested web loops or securement straps to the best locations on a wheelchair frame
 - This assists the driver and eliminates guess work about proper securement location









Riding in a Passenger Seat in a Sedan or SUV

Wheelchair Considerations:

- Select a manual wheelchair that can be stowed
 - Lightweight manual or a transport style wheelchair
 - Cross brace or rigid frame ultralight weight manual
- If there is potential for driving from the drivers seat focus on one of these ultralight frame types:
 - Rigid frame ultralight weight manual
 - Cross brace frame ultralight weight manual
 - Ultralight weight manual with power wheels
- Or, consider a power chair that can be lifted into rear with a power chair lift or carried outside on a bumper lift





Riding in a Passenger Seat in a Sedan/SUV

- A small power chair can be stowed in the back but will always require assist or limited walking
- A swivel seat lift and vehicle wheelchair lifts can greatly increase ease of transfer and safety





Riding as a Wheelchair-seated Passenger in an *Accessible Van or Minivan*

- If transfers are NOT feasible, use a crash-tested docking station or 4-point, strap-type tiedowns along with a crash tested wheelchair
 - A docking system works great for a specific wheelchair and can be placed mid-vehicle or in the front right passenger position
 - Four point strap-type tiedowns need more space and work best in the mid-vehicle position to achieve correct strap angle







A crash-tested docking system

- Add hardware to the frame of a manual or power wheelchair
- Not all wheelchairs can be docked
- Anchor the dock plate to the floor of the vehicle
- Locate the dock so the vehicle's occupant restraints fit properly
- Work with a NMEDA van modifier.

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Riding as a Wheelchair-seated Passenger in an *Accessible Van or Minivan*

- Not ALL vans or minivans are suitable for use as a wheelchair accessible van for a wheelchair seated passenger. Consult a NMEDA van modifier
- To help make this decision:
 - Decide if the consumer can transfer to the van's OEM seat; if they CAN there is no problem
 - With a manual wheelchair; just stow the chair and go
 - With a powered chair; use an aluminum suitcase ramp to drive the unoccupied chair into the vehicle where it will be dry inside the vehicle
 - Secure an unoccupied wheelchair to the vehicle floor





Riding as a Wheelchair-seated Passenger in an *Accessible Van or Minivan*

- If the individual can NOT transfer into the van or mini-van seat, determine if this is a temporary situation.
 - Will the problem be eliminated with recovery?
 - If yes, reconsider using Medicaid, paratransit, city bus taxi or a wheelchair accessible vehicle temporarily
- If the need is permanent, talk to a van modifier to determine if the vehicle can be modified for a wheelchairseated passenger (or potentially a driver)
- If the van is NOT suitable for conversion:
 - Consider van purchase/trade-in, a second hand van, occasional van rental, or use of other options





Riding as a Wheelchair-seated Driver in an Accessible Van or Minivan

- If an accessible van is possible, work with a NMEDA van modifier for safety and quality installation
- Ensure that the wheelchair selected will fit within the van's height & space limitations
- Coordinate wheelchair features with van specifications
- Ensure that the vehicle's lapshoulder safety belt is modified so it properly fits the wheelchairseated passenger or driver





Centers for Medicare and Medicaid

- CMS has a huge influence on policy with all health insurance
- Due to unscrupulous practices they have a high suspicion for "fraud and abuse."
- Due to high utilization Medicare budget is groaning
- New cost saving strategies
 - 13 month rental prior to ownership
 - Competitive bidding to control pricing
 - Limits the number of sellers which reduces competition
 - Severely hinders the service components of DME businesses
 - Physician "Face to Face" visit and documentation of equipment need





Centers for Medicare and Medicaid

- All this restriction is leading to:
- A "carve out" for Complex Rehab Technology
 - Legislation is working its way through Congress
 - NCART a coalition of therapists, rehab technology suppliers and disability organizations
- Rely on therapists and suppliers with a current RESNA ATP or SMS credential
- New products innovations outside of Medicare Coding and insurance
 - Designed to appeal to the consumer with personal \$ resources and the desire for control of a more limited mobility solution





Invacare Pronto Air – less than \$4K







- Invacare Pronto Air
- Performs nicely indoors & outdoors
- Comfortable contouring
- Breaks down for stowage











My Smart Wheelchair - <\$ 2K <u>http://www.mysmartchair.com</u> Folding light weight power





My Smart Wheelchair <u>http://www.mysmartchair.com</u>







My Smart Wheelchair <u>http://www.mysmartchair.com</u>







Smart Drive by Max Mobility

- An option within health insurance
- A power add on for manual wheelchairs
- <u>http://www.youtube.com/w</u> <u>atch?v=a-_hgHJdnu4</u>






Smart Drive by Max Mobility

http://www.youtube.com/watch?v=a-_hgHJdnu4







Component skills for wheelchair evals

- Qualified OT or PT who teams with a Certified Rehab Technology Supplier: knowledgeable, ethical, committed to good service
- Tools: pressure map, evaluation mat table, demo equipment, the ability to educate/explain and trial use!





The RESNA Assistive Technology Professional



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Review of the Learning Objectives

- Recognize good seated posture and its role in preventing postural collapse
- Travel with mobility devices and Wheelchair Transportation Safety
- Share changes in Centers for Medicare and Medicaid Services (CMS) reimbursement and attitude toward durable medical equipment (DME)
- Review of some wheelchair technologies
- Complex Rehab Technology and the role of the Assistive Technology Professional





Get a seating evaluation!

- Goal: Understand the individual as a whole person, i.e., health conditions & risks, ADLs, environments & transportation needs
- A collaboration between therapist and supplier
- Therapist: assesses posture & determine missing components
- Develops a plan and justifies med necessity







How to find: A Certified therapist or supplier

http://RESNA.org/Certification/

- The Rehabilitation Engineering and Assistive Technology Society of North America Certification Directory
- Narrow the ATP search by selecting your state or city
- Click the ATP name for contact information. Let your fingers do the walking!
- New certification now available:
 - RESNA Seating and Mobility Specialist for providers with specific expertise in wheelchairs and seating
 - Search for SMS
- http://www.NRRTS.org/Registrants/
 - The National Registry of Rehabilitation Technology Suppliers
 - Find a NRRTS registrant in your community

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Questions? Your experiences?

Mary Ellen Buning, PhD, OTR/L, ATP/SMS

Frazier Rehab Institute Wheelchair Seating and Mobility Clinic 220 Abraham Flexner Way, 11th Floor

Phone: 502.407.3272 Email: <u>MaryBuning@KentuckyOneHealth.org</u> For Appointments: 502.582.7660



