Considerations for Mobility and Technology needs for Children and Adult with Spinal Cord Injuries

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Objectives

1. Identify key components of the therapy evaluation.
2. Set patient and family centered goals.
3. Recognize functional expectations of patients with different levels of injury.
4. Describe assistive technology interventions.

Neurological Classification of SCIs

Tetraplegia - (AKA quadriplegia) Impairment or loss of motor and/or sensory function in the cervical segments of the spinal cord resulting in impairment of function in the trunk, arms, legs and pelvic organs (ASIA 2000)

Paraplegia - Impairment or loss of motor and/or sensory function in the thoracic, lumbar, or sacral segments of the spinal cord resulting in impairment of function in the trunk, legs and pelvic organs (ASIA 2000)

Neurological Classification of SCIs

Neurologic level - The lowest level at which key muscles are 3/5 and sensation is intact for this level's dermatome + the level above must be of normal strength and sensation. Diagnosed by the physician.

10 key muscles on each side and 28 sensory points on each side of the body

Functional level - the lowest segment at which strength of key muscles are 3+/5 or above and pain sensation is intact.

Key muscles - those which significantly effect functional outcomes.

STANDARD NEUROLOGICAL CLASSIFICATION OF SPINAL CORD INJURY

MOTOR

KEY MUSCLES

	R	L	
C2			
C3			
C4			
C5			Elbow flexors
C6			Wrist extensors
C7			Elbow extensors
C8			Finger flexors (distal phalanx of middle finger)
T1			Finger abductors (little finger)
T2			
T3			
T4			
T5			
T6			
T7			
T8			
T9			
T10			
T11			
T12			
L1			
L2			Hip flexors
L3			Knee extensors
L4			Ankle dorsiflexors
L5			Long toe extensors
S1			Ankle plantar flexors
S2			
S3			
S4-5			

0 = total paralysis
1 = palpable or visible contraction
2 = active movement, gravity eliminated
3 = active movement, against gravity
4 = active movement, against some resistance
5 = active movement, against full resistance
NT = not testable

Voluntary anal contraction (Yes/No)

TOTALS ☐ + ☐ = ☐ MOTOR SCORE

(MAXIMUM) (50) (50) (100)

SENSORY

KEY SENSORY POINTS

	LIGHT TOUCH R	LIGHT TOUCH L	PIN PRICK R	PIN PRICK L
C2				
C3				
C4				
C5				
C6				
C7				
C8				
T1				
T2				
T3				
T4				
T5				
T6				
T7				
T8				
T9				
T10				
T11				
T12				
L1				
L2				
L3				
L4				
L5				
S1				
S2				
S3				
S4-5				

0 = absent
1 = impaired
2 = normal
NT = not testable

Any anal sensation (Yes/No)

TOTALS ☐ + ☐ = ☐ LIGHT TOUCH SCORE (max 112)

☐ + ☐ = ☐ PIN PRICK SCORE (max 112)

MAXIMUM (56) (56) (56) (56)

*Key Sensory Points

NEUROLOGICAL LEVEL
The most caudal segment with normal function

	R	L
SENSORY	☐	☐
MOTOR	☐	☐

COMPLETE OR INCOMPLETE? ☐
Incomplete = Any sensory or motor function in S4-S5

ASIA IMPAIRMENT SCALE ☐

ZONE OF PARTIAL PRESERVATION
Partially innervated segments

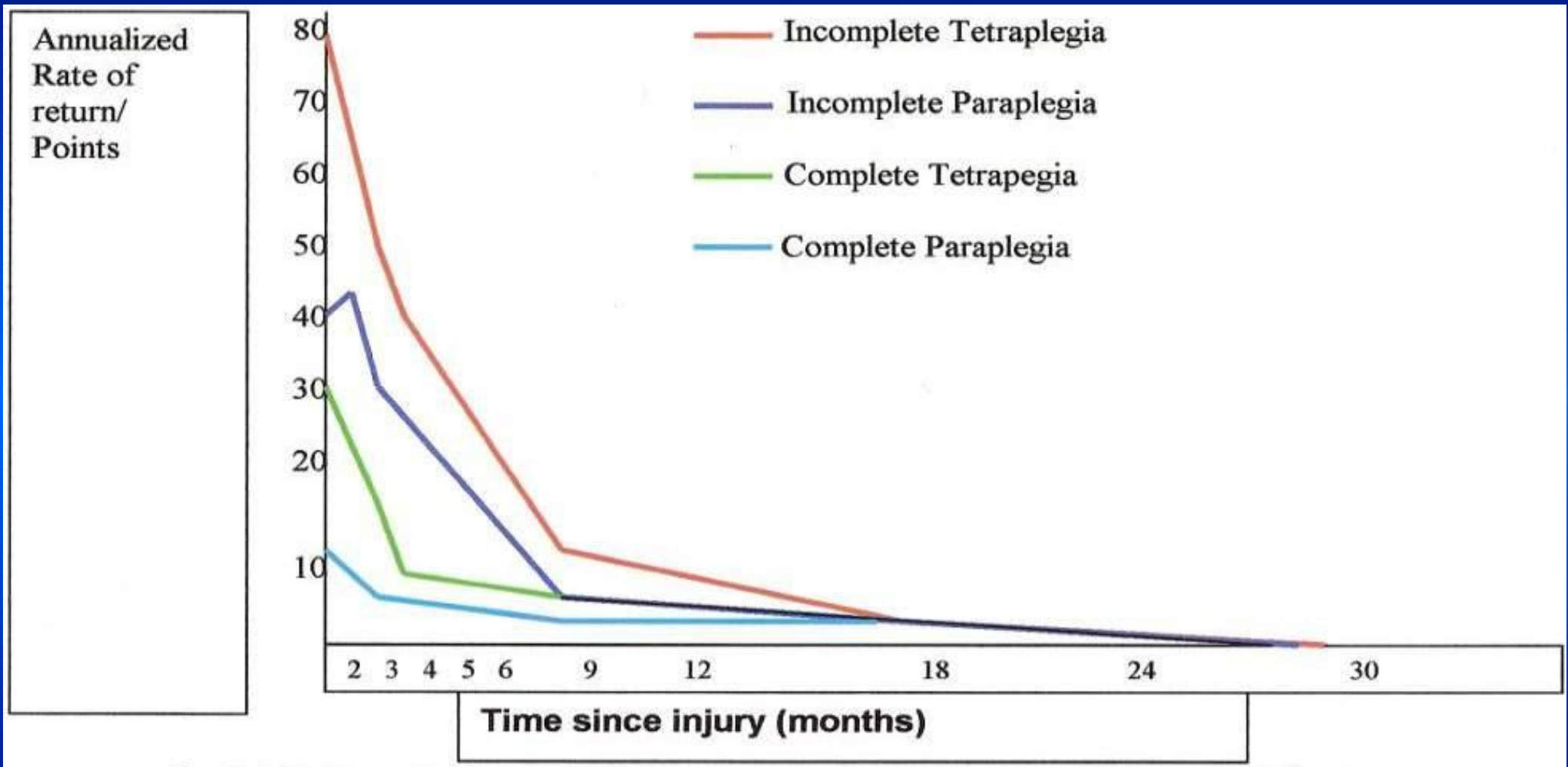
	R	L
SENSORY	☐	☐
MOTOR	☐	☐

ASIA Impairment Scale

- A = Complete
- B = Incomplete: Sensory but no motor + includes S4-S5.
- C = Incomplete: More than 1/2 of key muscles below the neurological level have a muscle grade less than 3. Must include S4-S5 + either voluntary anal sphincter or sparing of motor function more than 3 levels below the motor level.
- D = Incomplete: More than ½ of key muscles equal or greater than 3. Rest same as C.
- E = Normal

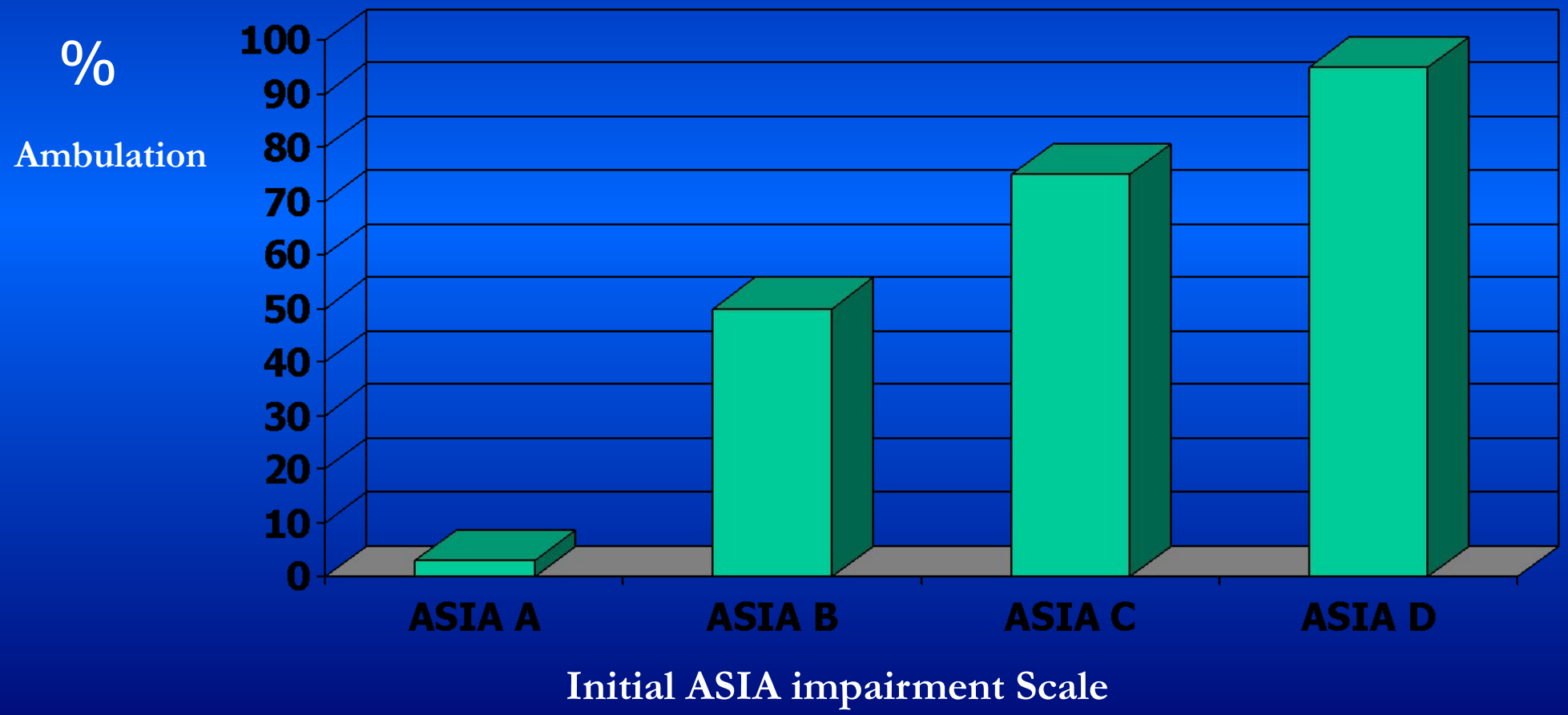
Prognosis

- On the minds of patients, families and staff
- With complete injuries recovery is in the Zone of Partial Preservation (ZPP)
- Patients with incomplete injuries have a better prognosis and recovery is less predictable



Sie, I. & Waters, R. Outcomes Following SCI in Lin V.W. (Ed.) (2003) *Spinal Cord Medicine*. NY, NY: Demos.

Prognosis for ambulation after traumatic SCI (Consortium for SCI, 1999).



Potential for Recovery

Waters, et. Al. Functional and Neurological Recovery Following Acute SCI. Journal of Spinal Cord Medicine, July 1998. Vol. 21. No 3, pp. 195-199.

- Complete Paraplegia
  - 1 month post injury is predictive of future
    - Only 4% convert to incomplete after 1 mo.
    - 0/5 strength ⟹ 3/5 strength: 5%
    - 1/5 strength ⟹ 3/5 strength: 64%
  - Only 5% will become community ambulators
    - One side had 3/5 hip flexor and knee extensor strength

Potential for Recovery

- Incomplete Paraplegia
  - Average change in motor points between one month and one year is 12
  - 76% chance of becoming a community ambulator in one year.
  - 1 month post injury is predictive of future
    - 0/5 strength → 3/5 strength: 26%
    - 1/5 strength → 3/5 strength: 85%

Potential for Recovery

- Complete Tetraplegia
  - 1 month post injury is predictive of future
    - 10% will convert to incomplete
      - 50% will regain control of bowel and/or bladder control
      - The majority will not have sufficient strength to ambulate
    - 0/5 strength → 3/5 strength: 24%
    - 1/5 strength → 3/5 strength: 97%

Potential for Recovery

- Incomplete Tetraplegia
  - 1 month post injury is predictive of future
    - 0/5 UE/LE strength → 3/5 strength: 20%
    - 1/5 UE/LE strength → 3/5 strength: 95%
  - 46% will become community ambulators

Evaluation

- ASIA Impairment Scale
- Medical Precautions
- Physical Evaluation
- Functional Evaluation
- Occupational Profile
- Patient perspective

Adjustment to injury:

- Emotional
- Social
- Economic
- Vocational
- Leisure
- Spiritual

Outcomes Following Traumatic SCI: Clinical Practice Guidelines for Health-Care Professionals.

(Consortium for SC Medicine, Paralyzed Veterans of America 1999).

- To the health care professional
- One year post injury
- Does not include hand function and table top activities.

Potential Functional Status as Correlated with Functional Level of Injury and Expected Functional Outcome Tables

Expected Functional Outcome Tables:

- How are they useful?

  Help as guidelines
- How should they be used?

  Only with ASIA A complete injuries

  With the “average” person

TABLE 6. Expected Functional Outcomes **Level C5**

Functionally relevant muscles innervated: Deltoid, biceps, brachialis, brachioradialis, rhomboids, serratus anterior (partially innervated)
Movement possible: Shoulder flexion, abduction, and extension; elbow flexion and supination; scapular adduction and abduction
Patterns of weakness: Absence of elbow extension, pronation, all wrist and hand movement
Total paralysis of trunk and lower extremities

FIM/Assistance Data: Exp = Expected FIM Score / **Med** = NSCISC Median / **IR** = NSCISC Interquartile Range
NSCISC Sample Size: FIM=41 / Assist=35

	Expected Functional Outcomes	Equipment	FIM/Assistance Data Exp	Med	IR
Respiratory	Low endurance and vital capacity secondary to paralysis of intercostals; may require assist to clear secretions				
Bowel	Total assist	Padded shower/commode chair or padded transfer tub bench with commode cutout	1	1	1
Bladder	Total assist	Adaptive devices may be indicated (electric leg bag emptier)	1	1	1
Bed Mobility	Some assist	• Full electric hospital bed with Trendelenburg feature with patients control • Side rails			
Bed/Wheelchair Transfers	Total assist	• Transfer board • Power or mechanical lift	1	1	1
Pressure Relief/ Positioning	Independent with equipment	• Power recline and/or tilt wheelchair • Wheelchair pressure-relief cushion • Hand splints • Specialty bed or pressure-relief mattress may be indicated • Postural support devices			
Eating	Total assist for setup, then independent eating with equipment	• Long opponens splint • Adaptive devices as indicated	5	5	2.5–5.5
Dressing	Lower extremity: Total assist Upper extremity: Some assist	• Long opponens splint • Adaptive devices as indicated	1	1	1–4
Grooming	Some to total assist	• Long opponens splints • Adaptive devices as indicated	1–3	1	1–5
Bathing	Total assist	• Padded tub transfer bench or shower/commode chair • Handheld shower	1	1	1–3
Wheelchair Propulsion	Power: Independent Manual: Independent to some assist indoors on noncarpet, level surface; some to total assist outdoors	Power: Power recline and/or tilt with arm drive control Manual: Lightweight rigid or folding frame with handrim modifications	6	6	5–6
Standing/ Ambulation	Total assist	Hydraulic standing frame			
Communication	Independent to some assist after setup with equipment	• Long opponens splint • Adaptive devices as needed for page turning, writing, button pushing			
Transportation	Independent with highly specialized equipment; some assist with accessible public transportation; total assist for attendant-operated vehicle	Highly specialized modified van with lift			
Homemaking	Total assist				
Assist Required	• Personal care: 10 hours/day • Homecare: 6 hours/day • Able to instruct in all aspects of care		16*	23*	10–24*

*Hours per day.

High Tetraplegia

C1-C4

No movement below the neck

Expected Outcomes

C1-C3

- Ventilator Dependent
- Total (A) with all ADL's, bowel & bladder, bed mobility, transfers
- 24 hour attendant care
- Communication: may need augmentative device
- Functionally relevant muscles: sternocleidomastoid, cervical paraspinal; neck accessories

Expected Outcomes

C4

- May be able to breathe without a ventilator
- Total (A) with all ADL's, bowel & bladder, bed mobility, transfers
- Initially 24 hour attendant care
- Functionally relevant muscles: upper trapezius, diaphragm, cervical paraspinal muscles

Expected Outcomes

- Areas of Expected Functional Independence
  - Wheelchair Propulsion
    - Power chair with adapted controls
  - Communication
    - Mouthstick, high-tech computer access, environmental control unit (ECU)
  - Respiratory
    - Alternative breathing methods

Alternative Breathing Methods (time off of ventilator)

- Suctioning
- Accidental disconnection
- Transfers

Alternative Breathing Methods

- GBP
- Neck breathing
- Weaning off a ventilator

Therapy Program

- Strengthening muscles for increased independence
  - Mouthstick activities
    - **Writing**
    - **Painting**
    - **Reading**
    - **Games**
    - **Computer access**

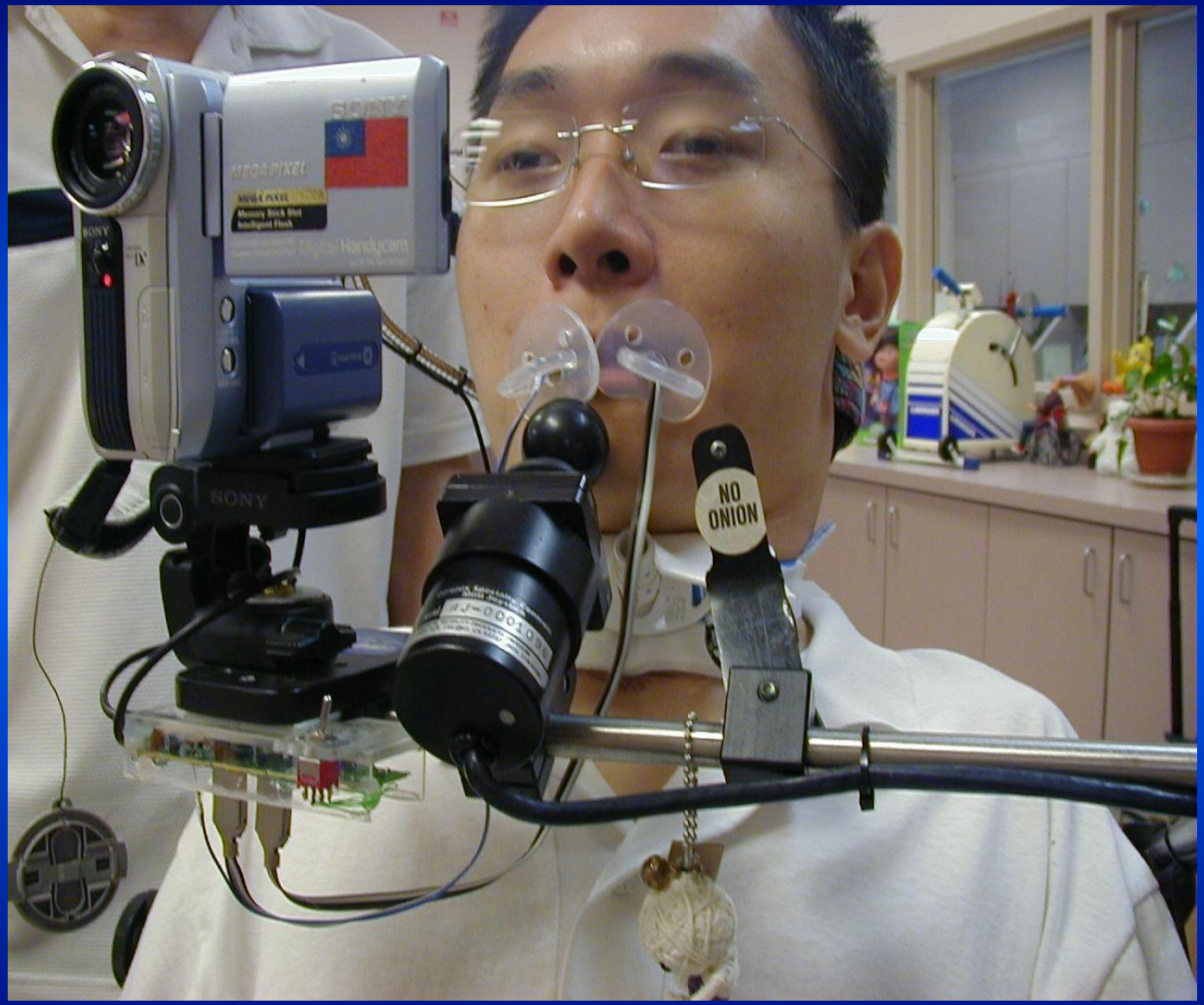
Therapy Program-cont.

Positioning:
Wheelchair level

- Head support
- Self pressure relief
- Female tilt & recline for bladder care
- Integrated ECUs

Therapy Program-cont

- Assistive Technology
  - Emergency call system, telephone access, computer access, TV/lights/radio/DVD
- Community resources
  - Transportation, financial support
- Community reintegration
  - Preparation for an outing (supplies, transportation, medication schedule, bowel & bladder care, etc.)


SONY
NO
ONION

Equipment

- Manual recliner wheelchair
- Power wheelchair with tilt/recline
- Mechanical lift
- Hospital bed
- Bathing equipment
- Mouthstick, book holder, overbed table

C1-4

- Sternocleidomastoids
- Trapezius
- Diaphram

GOALS: Power W/C mobility w/ tilt/recline for pressure relief/bladder management

Types of Controllers:
Sip n'puff, chin joystick minjoystick or MEC, head (RIM), Head array

Types of Power W/c Controllers

Proportional

Head: RIM

Chin: Mini, MEC

Hand joystick: remote for center mount

Foot proportional

Infra red touch pad

Digital

Sip and puff

Head array: proximity switches

Single switches:

Mechanical

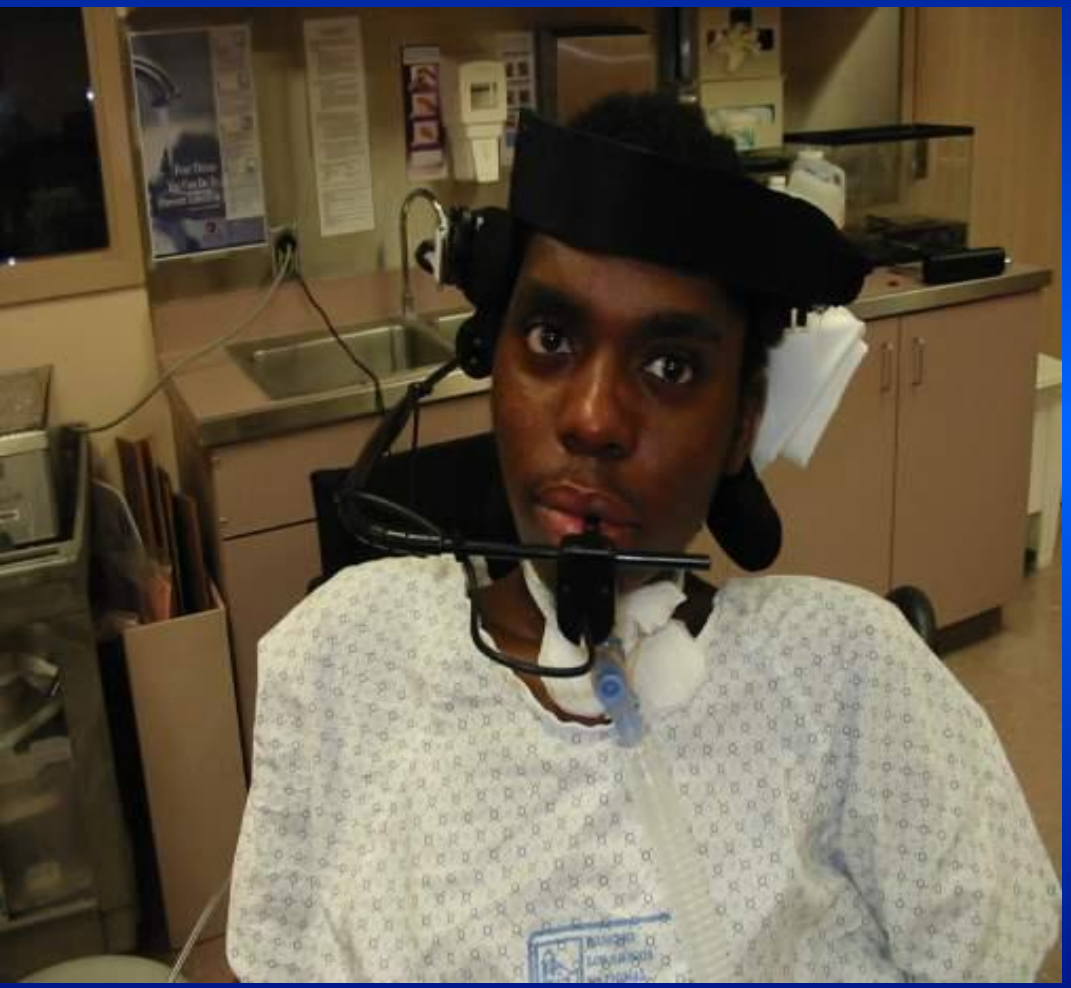
Fiber optic

proximity

Sip and Puff

Proportional chin joystick

Mini/MEC joystick controller



Head supports attached to TLSO

RIM head controller

Ann Ruth
C3

Ann Ruth

Special Considerations for Children

- Strengthening via developmentally appropriate play
- Pediatric powered mobility (PPWST)
  - Problem Solving
  - Spatial relations
  - Guerette et al, 1999

Individuals with C5 injury

Biceps and Deltoids

Functionally relevant muscles innervated

- Functionally relevant muscles: Biceps and Deltoid
- Also innervated:
  - Brachialis, Brachioradialis, Rhomboids, Serratus Anterior (partially innervated), full diaphragm

Movement Possible:

- Shoulder flexion, abduction, and extension
- Elbow flexion and supination
- Scapular adduction and abduction
- Substitutions:
  - shoulder extension for elbow extension
  - Forearm supination & swing arm out to side
  - Test for triceps in gravity eliminated plane

Expected Functional Outcomes

Wheelchair Mobility

- Power recline and/or tilt: Independent W/C driving in home and community
- Pressure relief with power recline: Independent
- Manual w/c
  - Lightweight, limited distance, trunk support, psychological benefit

Expected Functional Outcomes

- Body handling- Full assist
  - Therapy session sitting on mat
    - neck/trunk strengthening
    - psychological
- Bed to WC transfers- Full assist
  - mechanical lift
  - dependent sliding board

Expected Functional Outcomes

- Respiratory
  - Expected vital capacity = 52% of normal
  - Tracheostomy
  - Strengthening
  - Assisted Cough

Equipment

- Manual (recliner) wheelchair
- Power wheelchair with tilt/recline
- mechanical lift
- Sliding board
- Hospital bed
- Bathing equipment (commode, tub slider)
- Equipment for ADL's (u-cuff, mobile arm support, wrist support, scoop dish, etc)

Independent driving

Special Considerations for Children

- Access to play: adapted games, dolls, etc.
- School re-entry (McGinnis, K et al, 2004)
- Hip ROM
- Body jacket
  - Prevention of scoliosis
  - Limits reachable workspace (Sison-Williamson et al, 2007)

C5,6 level of injury

- Biceps
- Brachialis
- Wrist extensors
- Absent intrinsics

GOALS:

C6 Manual w/c: household (plastic handrims, C6 projections C5)

Powered mobility or power assist/Magic wheels

C5 level of injury

Power w/c back with scapular cut out

Early Powered Mobility

- Has positive impact on psychosocial skills
- Reduces learned helplessness and increases confidence, cooperation, and interactions with others
- Improves quality and quantity of play skills with peers and family

Guerette, Furumasu, Tefft

2007 RESNA abstract

Objectives – Project I (1990-95)

- **Develop cognitive assessment battery for children with physical disabilities**
- **Develop powered mobility skills list and objective scoring scale**
- **Document relationship between cognitive skills and powered mobility skills**

Five Piagetian Cognitive Domains

- Cause and effect
- Object permanence
- Problem solving
- Spatial relations
- Symbolic play

Powered Mobility Program Scoring

Score	Amount of Assistance	# Children
0 - <3	Maximal to minimal hands-on assistance	15
3 - <4	Stand-by assistance	2
4 - 5	Verbal cueing to age-appropriate supervision	9

Pediatric Powered Wheelchair Screening Test

- **Basic Skills:**
  - Problems solving = 20 mos
  - Spatial relations = 25 mos
- **Functional skills:**
  - Problem solving = 30 mos
  - Spatial relations = 25 mos

  Cutoffs yield sensitivity = 1.0, specificity = .80

Power Mobility Program (PMP)

Approach: Motivational Learning through Play

17 Basic/Exploratory Skills: starting/stopping, directional, speed control

17 Functional Mobility:

doors, hallways, sidewalks, ramps etc

PEDIATRIC POWERED WHEELCHAIR SCREENING TEST (PPWST)

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RESPONSE FORM

Name:_____ Age:_____Diagnosis:
Date of screening:_____ Examiner._____
Spatial Relations Last Item Correct:_____Problem Solving Last Item Correct:_____

SPATIAL RELATIONS SCALE

YES/NO
(Check if Y/N method used)

1. _____ Nine piece formboard
2. _____Three piece formboard-in order
3. _____**Three piece formboard - reversed order**
4A. _____ Train of blocks - horizontal combination
4B. _____Train of blocks - with chimney
5A. _____ House of blocks - imitation
6. _____ Sequencing toys - two out of three
5B. _____ House of blocks – copy

PROBLEM SOLVING SCALE

1. _____Two supports and a toy
2. _____ One support and a toy
3. _____Stick as a tool
4. _____Broken doll
5A. _____Fixes two toys of four toys - marginal repair
5B. _____Fixes two toys of four toys - approximate repair
5C. _____ Fixes two toys of four toys - exact repair

Thoracic Lumbar Sacral Orthosis (TLSO)

- To prevent/reduce the rate of progression of scoliosis
  - In SCI's prior to skeletal maturity, 98% of children developed scoliosis, with 67% at risk for spinal fusion (Betz and Mulcahey, 2001)
- Improves posture and stability for function

Individuals with C6 injury

C6 Functionally Relevant Muscles

- Serratus Anterior
  - Stabilizes and assists with rotating the Scapula which assists with pushing a wheelchair & overhead reach
- Clavicular Pectoralis Major
  - Allows for shoulder horizontal adduction which assists with crossing midline and rolling in bed
- Extensor carpi radialis longus
  - Wrist extension allows for tenodesis grasp

Tenodesis Grasp

Passive opening of the fingers when the wrist is flexed and closing of the fingers when the wrist is extended (Wilson et al., 1984)

OT's role in Facilitating a Functional Tenodesis Grasp

Assess strength of wrist extensors and strengthen as needed – Must have at least a 3+/5 (Fair+) grade muscle and sufficient endurance to maintain wrist extension throughout functional tasks

Expected Functional Outcomes

- Eating – Independent with or without equipment except cutting which may be total (A)

Expected Functional Outcomes

- Dressing – Independent to assisted - upper body dressing, some (A) to total (A) with lower body dressing
- Grooming – Some (A) to Independent with equipment

Facilitate Function

Wrist Driven Wrist Hand Orthosis for C6, 7

Atkins, M., Clark, D., & Waters, R., 2003

Expected Functional Outcomes
(continued)

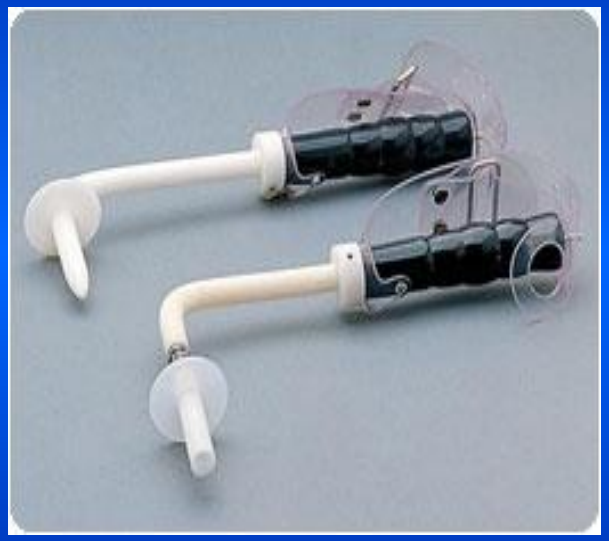
- Bathing – Upper body independent bedbath or bathing on a tub bench or commode chair; Lower body - some to total assist
- Adapted shower hose, bath mitt

Expected Functional Outcomes
(continued)

- Bladder management – Some to total assist; may be able to manage Intermittent Catheterization (IC) with equipment or empty leg bag independently
- Catheter inserter

Expected Functional Outcomes
(continued)

- Bowel management – Some to total assist
- Suppository inserter
- Homemaking – Some assist - light meal preparation; total assist - all other homemaking



Expected Functional Outcomes
(continued)

Sitting balance:

- shoulder external rotation, elbow extension, hand fisted to preserve tenodesis, forward lean, use of pectoralis to "lock out" elbows

Expected Functional Outcomes
(continued)

Body handling:

- Assisted to independent
- Dependent on body type and strength

Transfers:

Sliding board-

- assisted to independent
- momentum from “head and hips” opposition

Expected Functional Outcomes
(continued)

- Wheelchair propulsion – Independent - standard arm-drive power wheelchair; Independent - manual wheelchair indoors; some to total (A) - outdoors

C6 Wheelchair Considerations

- Power vs Manual vs Manual Assist
- (I) pressure relief?
- Rubber grips on pushrims
- Push cuffs
- Specialty back
- Chest strap (able to self remove?)

Special Considerations for Children

- Urinary diversion to promote independence with self catheterization (Merenda et al., 2007)
- Energy conservation/Priorities: i.e. dressing independently each morning or pushing manual wheelchair at school
- Under age 4 lack upper extremity strength to transfer

C7-C8

C7 Functionally Relevant Muscles

- Triceps - elbow extension
  - overhead reach
- Latissimus Dorsi and Triceps
  - Allows for shoulder depression which assists with balance when sitting (i.e. while dressing at bed level)
  - transfers & pressure relief
  - ease with coming to sit
- Flexor carpi radialis – wrist flexion (C7-C8)

Individuals with C8 injury

- Add: Thumb and Finger extrinsics
- Flexor Digitorum Profundus and superficialis
- Flexor/abductor pollicis longus
- Flexor pollicis Brevis

Spinal nerve contributions to hand function:

( )= partial neural contribution

Flexor digitorum sublimis	(C7) C8 T1
Flexor digitorum profundus	(C7) C8 T1
Flexor pollicis longus	(C7) C8 T1
Opponens pollicis	C8 (T1)
Abductor pollicis brevis	C8 (T1)
Flexor pollicis brevis	C8, T1
Palmaris brevis	(C8) T1
Adductor pollicis	(C8) T1
Flexor digiti quinti	(C8) T1
Abductor digiti quinti	(C8) T1
Opponens digiti quinti	(C8) T1
Interossei	(C8) T1
Lumbricals	(C7) C8, T1

Formal & Smith, 1996

Intrinsic Minus Hand

- Weak grasp and release
- Compromised dexterity
- Difficulty with turning a key, holding a pen, turning a screw, manipulating small objects
- Positioning

Expected Functional Outcomes: C7-8

- **Eating**: independent
  - may need adaptive devices for cutting food
  - built up utensil
- **Grooming**: independent
  - may need adaptive equipment (i.e. dycem to open deoderant)
  - built-up utensil

Expected Functional Outcomes: C7-8

- **Bathing**:
  - May need some assist
  - Equipment: padded tub bench or commode chair, shower hose
- **Dressing**:
  - Upper body dressing: independent
  - Lower body dressing: may need some assist or adaptive equipment to independent

Expected Functional Outcomes: C7-8

- **Body Handling**:
  - Min A to independent
- **Transfers**:
  - Min A to independent
  - Sliding board or depression transfer

Expected Functional Outcomes: C7-8

- **Wheelchair**:
  - Manual vs. power vs. power assist
  - Manual independent at household level, limited community

C7,8

- Triceps
- Finger flexors
- Intrinsics

GOALS:

Manual w/c - Home/community

Transfer to car and load w/c or van seat

Front Wheel Drive

Spinal Support:TLSO

Demands of Manual W/C Propulsion

- Manual wheelchair propulsion requires higher O2 consumption than ambulation in a typical child
- Wheelchair weight in proportion to childs size, shorter UE affect ability to propel efficiently
- Age and environmental demands

Meiser,McEwen Pediatric Phys Ther

Energy Cost of Propulsion in Standard and Ultralight Wheelchairs in People with SCI

- Beekman et al 1999 74 clients with SCI
- Compared C6, C7/8, T2-T8, T10-L1
- VO2, distance, velocity in 20 minutes
- Standard Chair vs Ultra light chair

Conclusions
Tetraplegia

. No change in velocity between w/cs

- C6 had highest O2 cost and least velocity
- C6 75% slower than a pt with T10 para
- C7 50% slower than a pt with T10 para
- Earlier fatigue in scapular depressors and external rotators of shoulder in all patients with tetraplegia.

Alternative Manual Wheelchair Assist

Power Assisted

Gear Assisted

Power Assist wheels

Energy Consumption

	Rate of O2 consumption	Oxygen cost	Heart rate
Standard w/c	8.4 ml/kg min	.11 ml/kg m	82
I- Glide	6.9	.11	72
Xtender	6.7	.07	75
e.motion	6.2	,08	78

Paraplegia

Injury at Level T2 and Below

Paraplegia

"Loss or impairment in motor and/or sensory function in the thoracic, lumbar, or sacral segments of the cord resulting in the impairment in the trunk, legs, and pelvic organs and sparing of the arms (ASIA 2000)."

Levels

T2-T7:	Chest muscles
T8-T12:	Abdominal muscles
L1-S1:	Leg muscles
S2-S5:	Bowel, bladder and sex

Trunk Control

Higher Level Paraplegia (T2-T9)
-Weak to no Trunk Control-

- Sitting balance
- Reach
- Bimanual activities
- Fear of falling

Expected Functional Outcomes
(One year post injury)

- Modified Independent to Independent
  - Self care
  - All transfers
  - Wheelchair mobility
  - Transportation

Expected Functional Outcomes
(cont.)

- Assistance and/or Setup.
  - Homemaking activities

Self-Care

- Pt should become independent with self-feeding, hygiene/grooming and upper body dressing
- More focus on lower body dressing, bathing, and toileting

Lower Body Dressing

- Dressing sequence
  - Head of bed raised
  - Flat bed with bed rails
  - Flat bed with bed rails removed
  - Wheel chair dressing
  - Adaptive equipment: dressing stick, reacher, sock aid

Bathing

- Equipment is dependent on two factors:
  - 1. Bathroom setup at discharge destination
  - 2. Trunk stability/control of patient
- Equipment options:

  padded seating, long handled sponge, grab bars, hand held shower hose

Toileting

- Bladder Care
- Bowel Care
- Important to practice in the community as not all bathrooms are accessible

Skin Care

- Persons with *paraplegia* are more prone to skin breakdown/pressure sores than persons with *tetraplegia*.
- Pressure Relief
  - 1 minute for every hour; 1 second for every minute of sitting
- Skin inspection

Pressure Relieving Raise

- Depression (push up)
- Forward flexion (or side to side)
  - Redistribution of pressure provides better recovery of tissue perfusion than just reducing interface pressure

Makhous et al. 2007

Sitting Balance

- Supported
- Unsupported
- Dynamic

- Long sit
- Short sit

Transfers

- Mechanical lift
  - Progress to
- Sliding Board
  - Progress to
- Depression
  - Level surface
  - Up/down surfaces
  - Unstable surfaces

Transfers, cont.

- Common transfers:
  - Bed
  - W/c
  - Toilet
  - Tub
  - Car

Transfers, cont.

- Less common:
  - Furniture
  - Floor
  - Rolling chair
  - Exercise apparatus

  *Children under age 4 lack the UE strength to transfer independently

Community Training

- Reintegration activities
- Public transportation
- Various activities as per patient goals
- Create alternatives if outings not possible

T1-L2:Ultra lightweight rigid wheelchairs

Wheelchair Seating Assessment

- Seat Depth: back post to front edge of seat sling
- Seat Width: outside seat rail
- Front Seat Height (FSH) floor to top of front seat rail
- Rear Seat Height (RSH) floor to top of rear seat rail
- Seat Slope – difference between FSH & RSH
- Foot placement affects knee angle

Seat slope

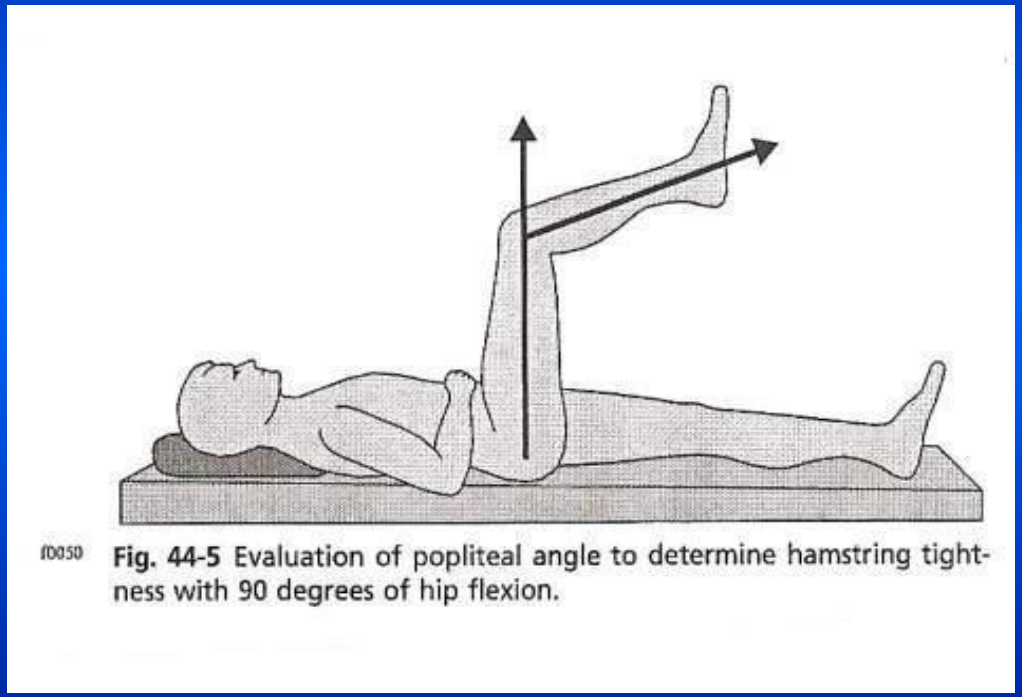
- Bucket, Squeeze, Dump
- Affects posture of tetraplegic and high level para
- Does not affect pressure on ITs

Patient Assessment

- Seat Depth: supine and sitting
- Hip ROM: check for asymmetries
- Tone: hamstring or glut max tone
- Hamstring tone affecting knee angle or foot placement
- Abdominal control (increased bucket)

Hip and knee ROM

- Seat to Back angle: Isolate hip from pelvic ROM (Spasticity in Hip extensors)
- Foot placement: Popliteal angle: Quick stretch knee extension w/hips flexed (hamstring spasticity-hanger angle)

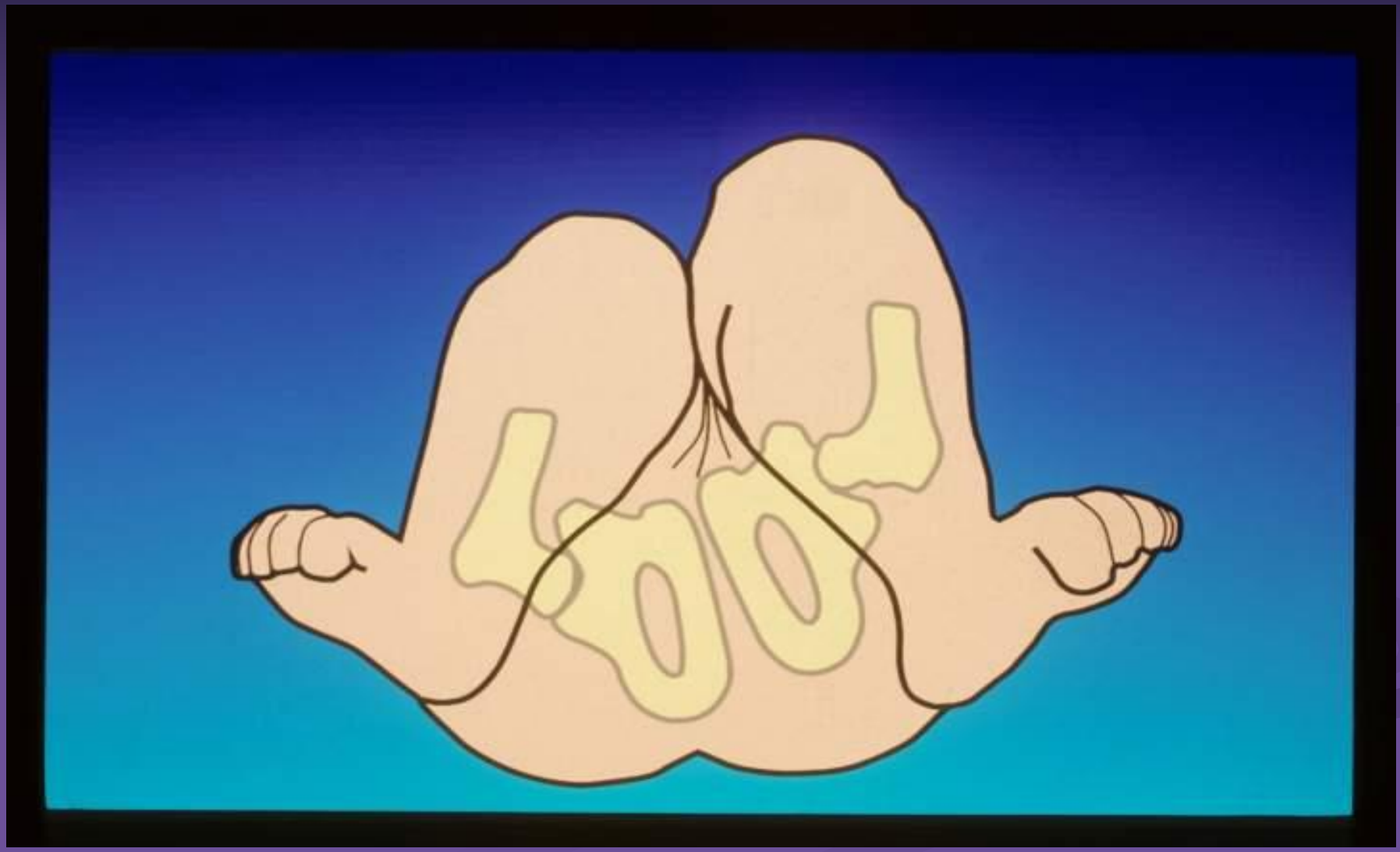


f0050 **Fig. 44-5** Evaluation of popliteal angle to determine hamstring tightness with 90 degrees of hip flexion.

Supine Mat Evaluation

Hip Flexion Asymmetries

Pelvic Deformity: Pelvic rotation



3 Point Control to support Scoliosis

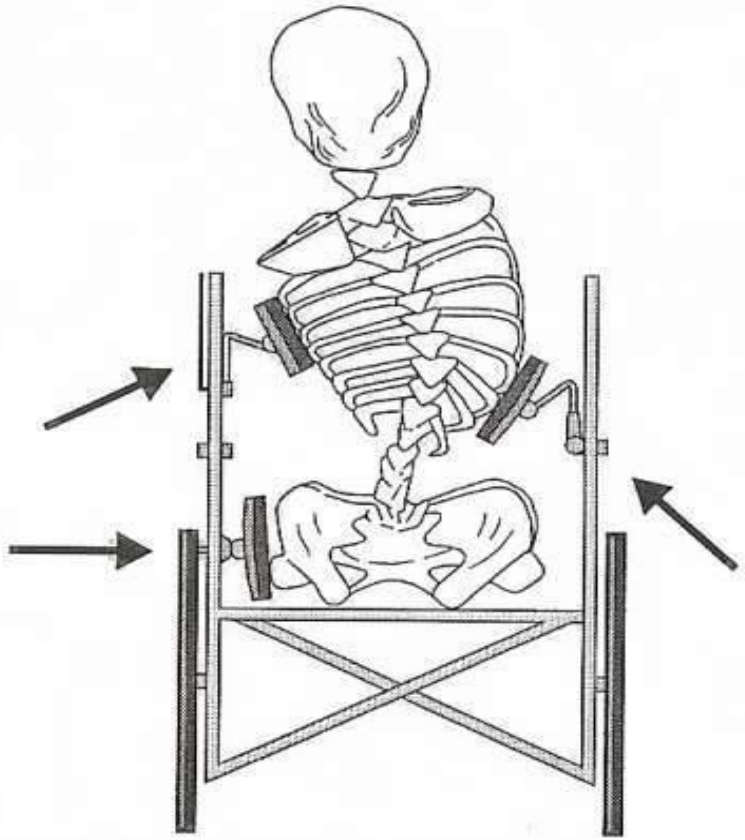


Fig. 44-10 Opposing forces of a three-point control system to control a deformity. f0100

Optimal Wheelchair Configuration

- Backrest: perpendicular to floor
- Adjust the rear axle forward 2”
- The upper arm and forearm angle:100 -120 degrees
- Increase Bucket/Squeeze in the frame with decreased abdominal control

Wheel Axle placement

Wheel axle placement

“Wheelie Test”

- Have patient pop a wheelie. Want the front casters at least 1” off of the ground.
- If front casters are greater than 4” off of the ground, then the axle is too far back.

Wheelchair Skills

- Wheelie
- Thresholds
- Ramps
- Curbs
- Uneven Surfaces
- Stairs/escalators
- Sports (basketball, tennis, snowskiing)

Wheelchair skills

Sports w/cs

- Camber increases lateral stability,
- Quick, powerful turning capabilities

Suspension Wheelchairs

Spine Deformity- Kyphosis

- Flexible – 3 pt. Control
  - anterior chest/ shoulder support
  - mid thoracic, lumbo/sacral support; curved back; tilt in frame; tray for support UEs
- Fixed – grid; foam in place; custom molded back, Jay Care back

Correcting for Fixed Kyphosis

Ideal Access to Push-rims

- Rear wheels are infinitely adjustable to ensure easy access to push-rims
- Adjust rear wheels forward to reduce load on casters – makes the chair very easy to propel

WHEELCHAIRS FOR FUNCTION AND INDEPENDENCE

Spine Deformity- Scoliosis

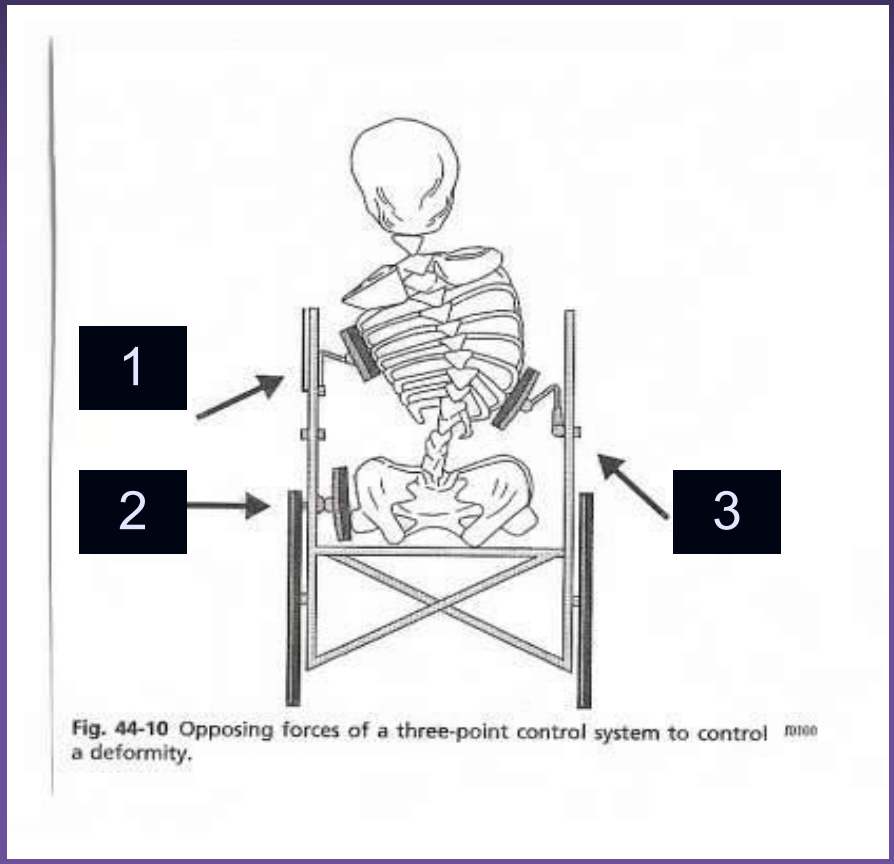
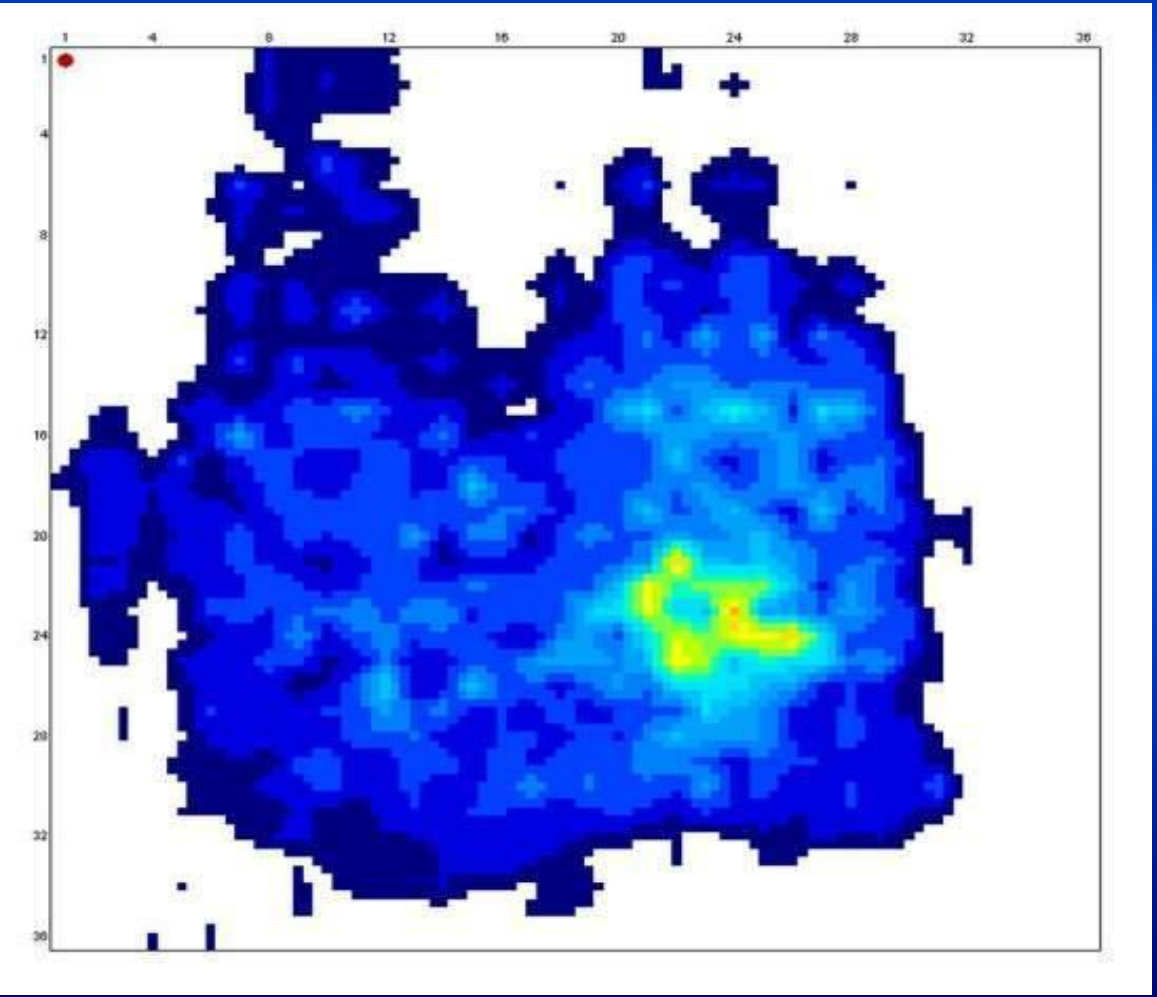


Fig. 44-10 Opposing forces of a three-point control system to control a deformity.

Three points of control are used

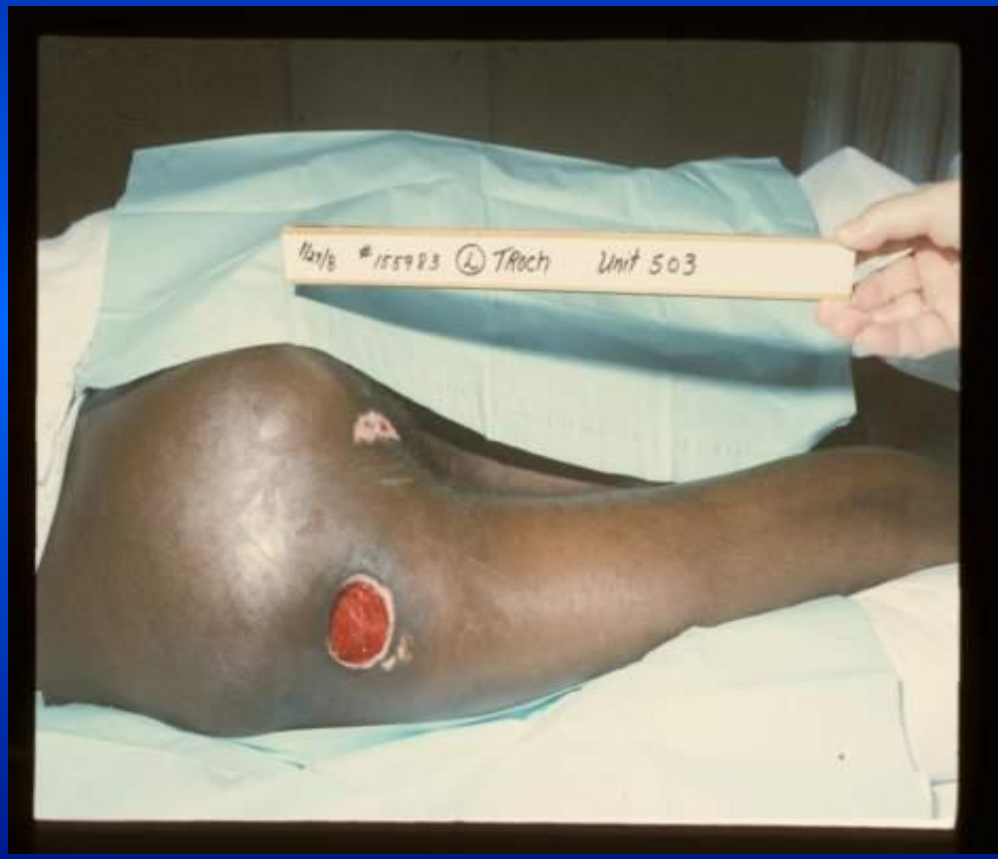
Where are the excess forces?

Incorporating Pressure Relief into Seating systems



Pressure Ulcers

- SCI/Elderly most at risk
- 66% on pelvis
- Costs to heal: 1,000-7,000/ulcer
- Medicare 2.2-3.6 billion/yr
- Ulcers account for ¼ cost of SCI care. Prevention<1/10



Pressure Ulcers

Pressure: Compression Force x Area/Time

Shearing/ Friction: Parallel stress, shear occludes blood vessels at deeper level than friction

Temperature/Heat: 1 degree=10% metabolic increase

Moisture/Humidity: causes skin maceration

Acceptable Pressures

- Ischial Tuberosities 40 mmHg
- Trochanters 60 mm Hg
- Sacrum less than 20 mm Hg
- Coccyx 0 mmHg

Pressure Relief

- Vary the technique no matter what level of paraplegia.

  -Depression lift

  -Forward lean

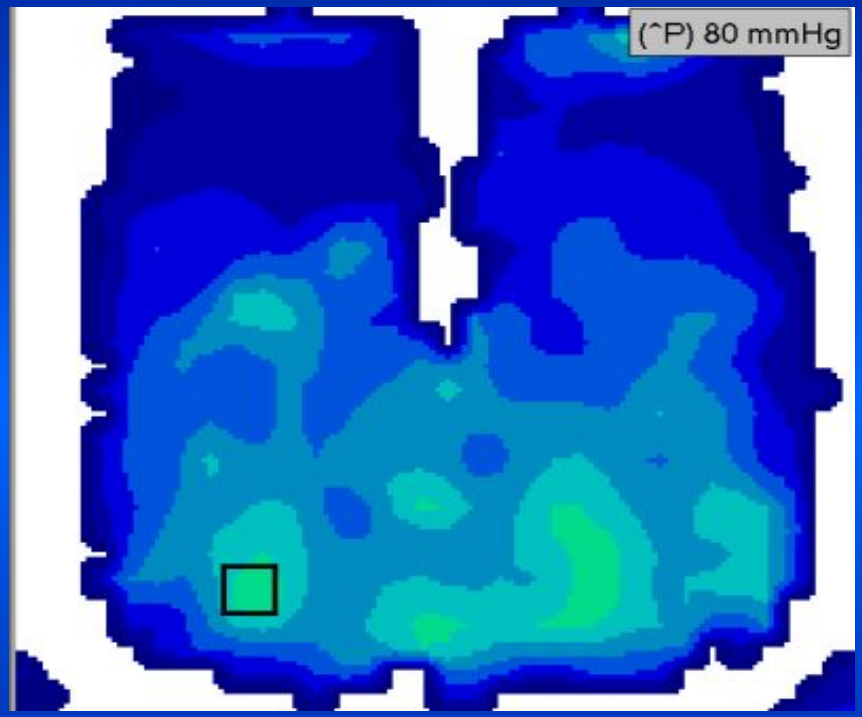
  -Side to side lean

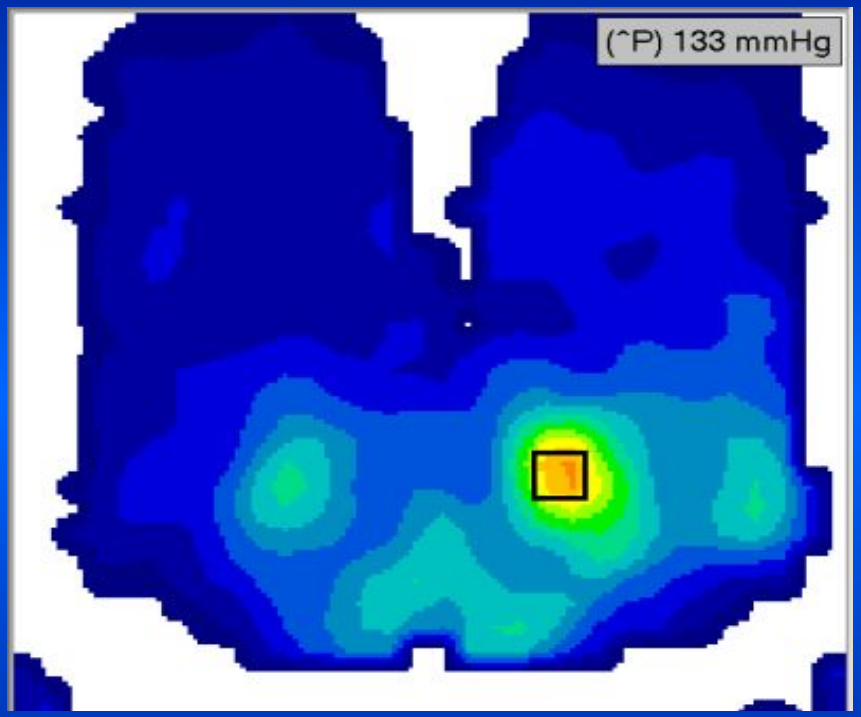
- Buttock tissue needs 3 min to allow the tissue perfusion return to the uncompressed level.

Factors Contributing to Ulcers

- Absent/ impaired sensation
- Loss of body fat/muscle mass
- Impaired circulation
- History of pressure sore
- Infections
- Immoblity
- Fragile Elderly skin
- Poor nutrition
- Cognitive

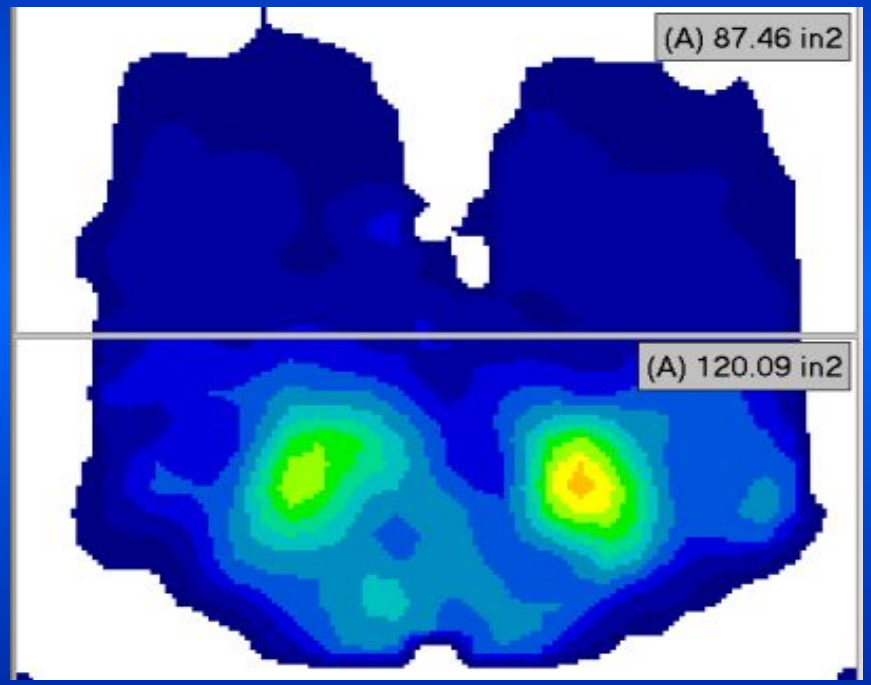
Peak pressure



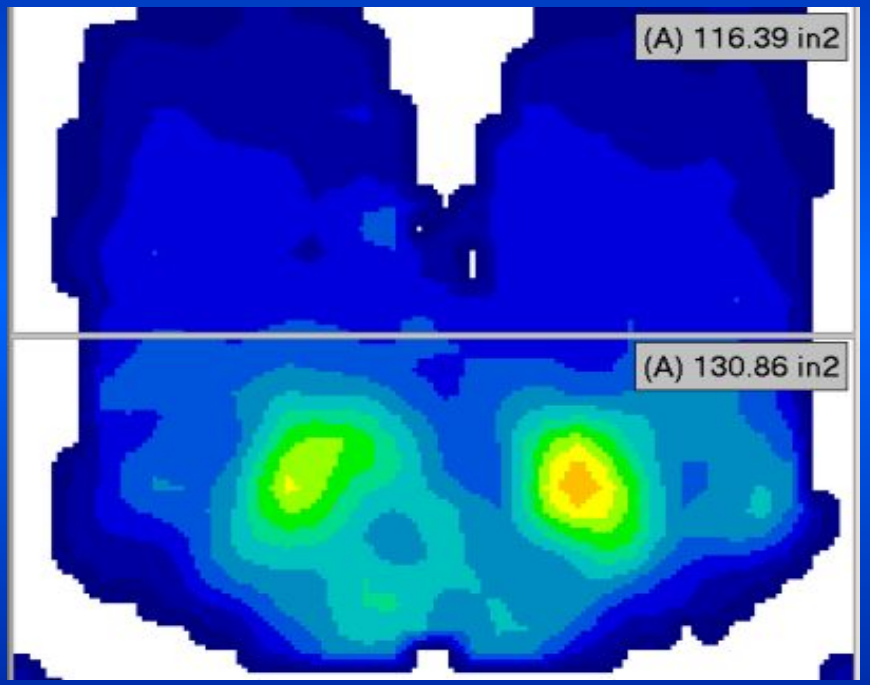


Surface contact area

A



B



Cushion Assessment

Client centered factors:

- Sensation
- Ability to Shift Weight
- Stability Provided by the Cushion
- Areas of Bony Prominence
- Transfer Ability
- Trunk Stability

Cushion centered factors **:**

Stability

Moisture and heat

Cushion height

Durability

Maintenance

Fire retardancy

Types of Cushions

- Comfort/General Use
- Skin Protection
- Positioning
- Skin Protection/Positioning

Principles of pressure relief

Pressure distribution by Immersion

- ROHO
- Jay
- Foam (T foam)

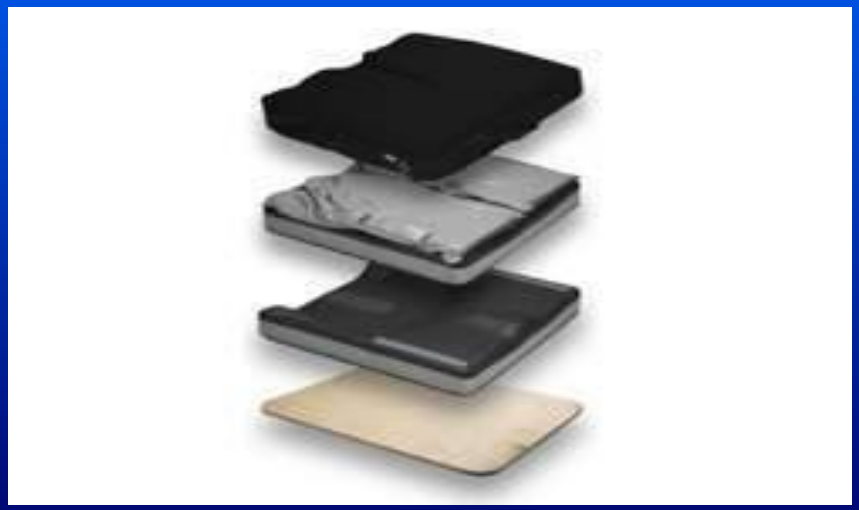
Pressure Redistribution

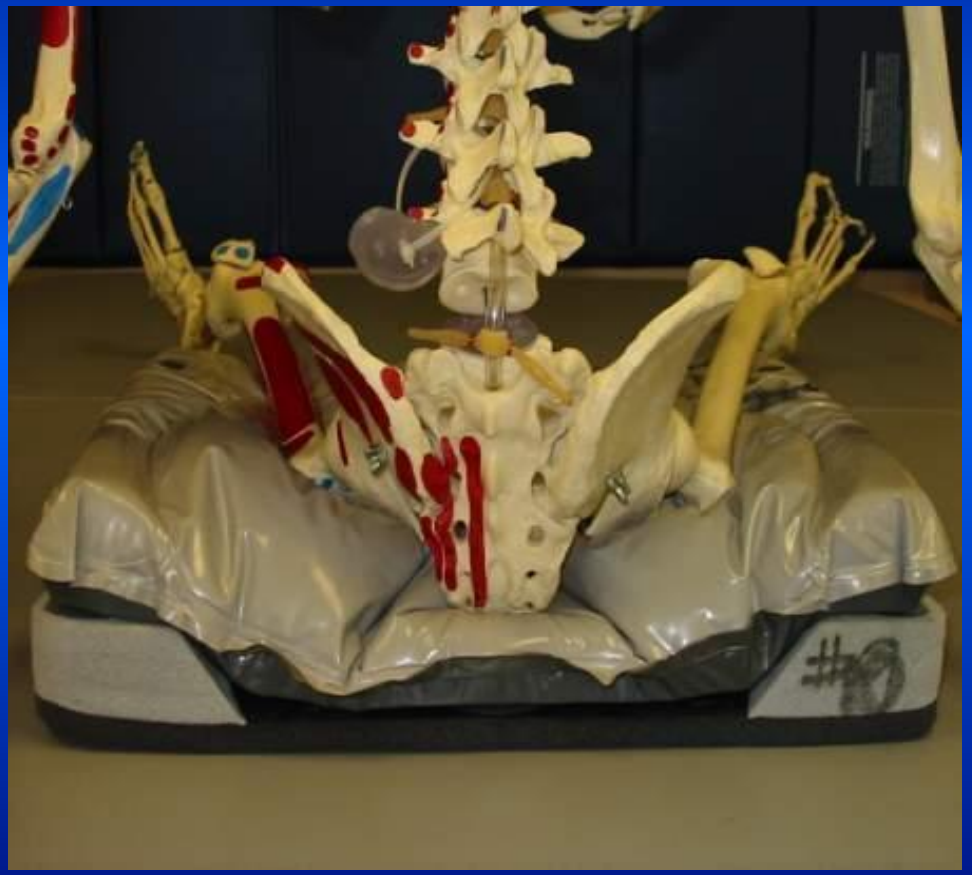
- Ride Designs custom cushions
- Foam with cut outs

Contouring for positioning

Air Cushions

Gel Cushions





Redistributing pressures

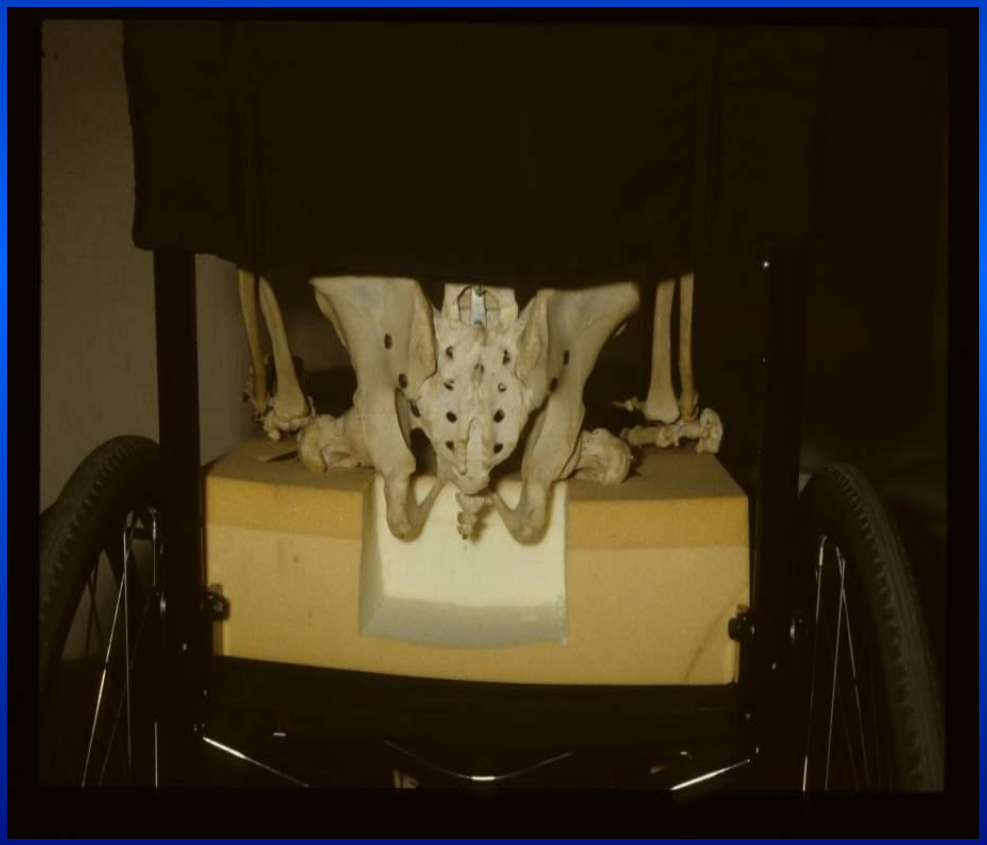
- 4” spring air foam

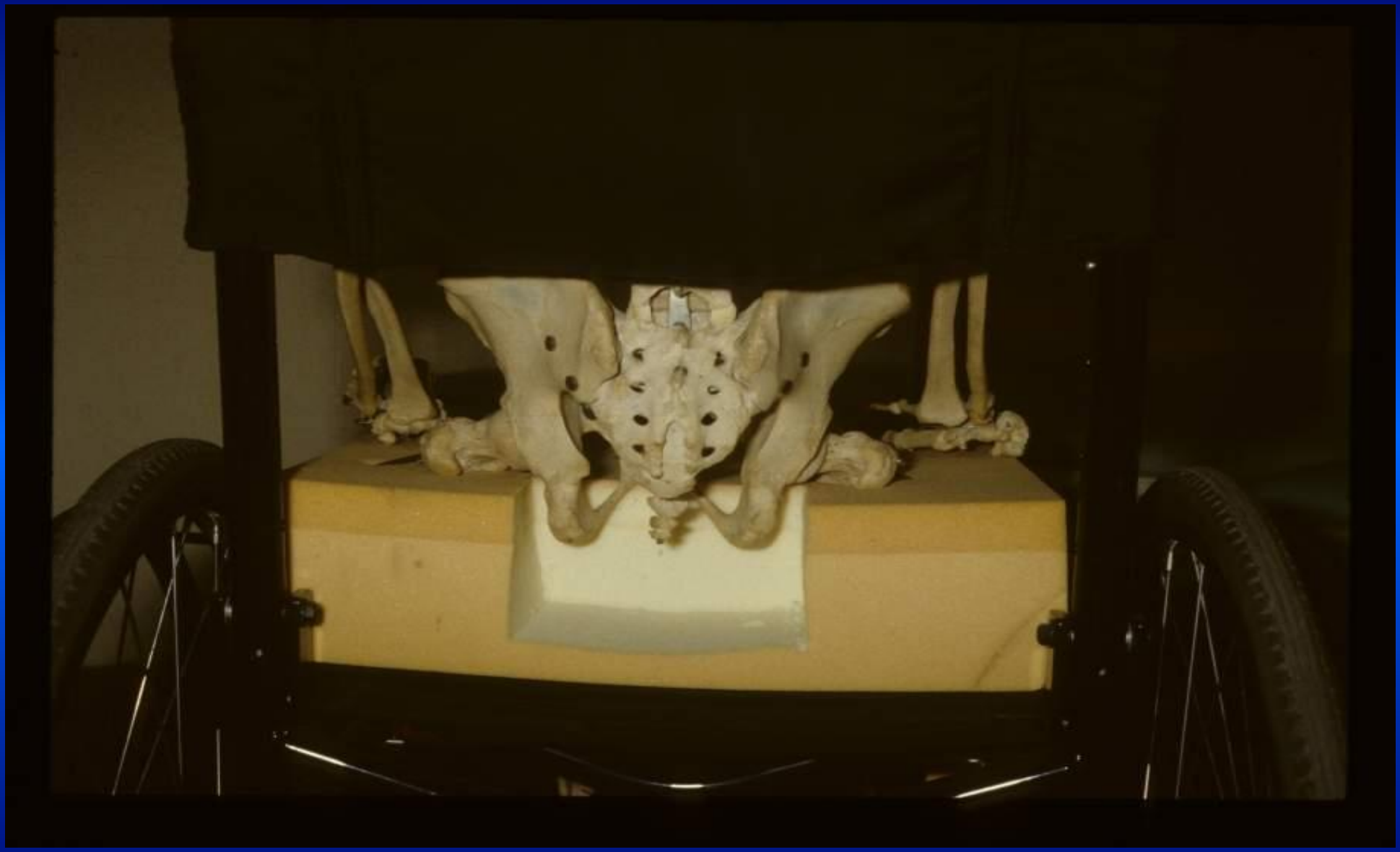
3” 5# foam w/ 1”4# foam laminated on top

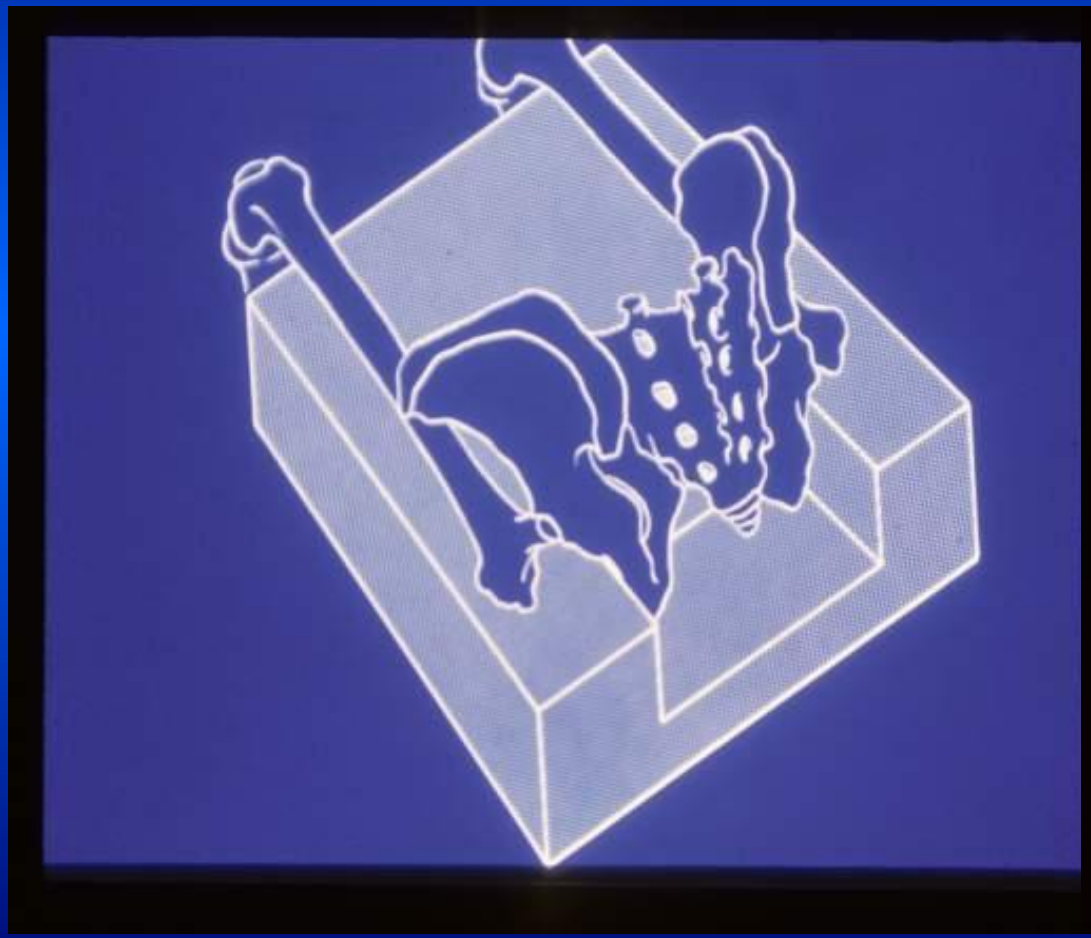
Males: 7” wide x 5” deep

Females: 8” wide x 6” deep

Sunset medical

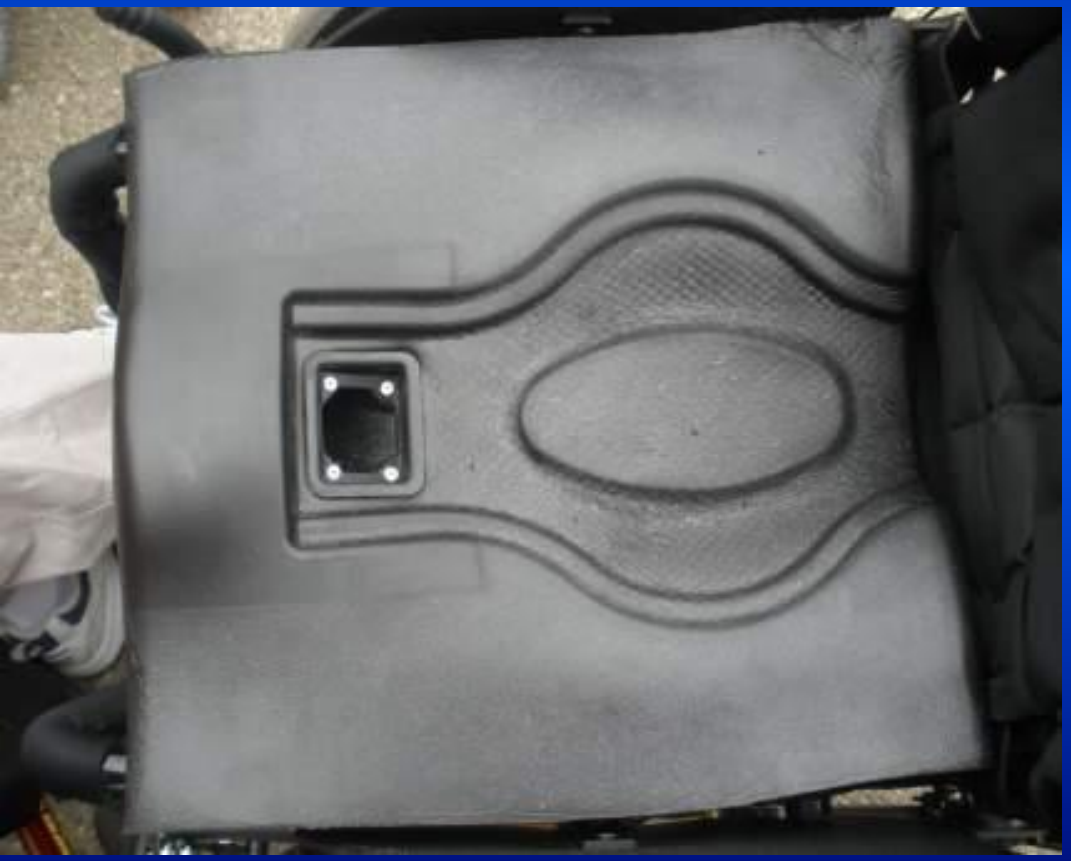




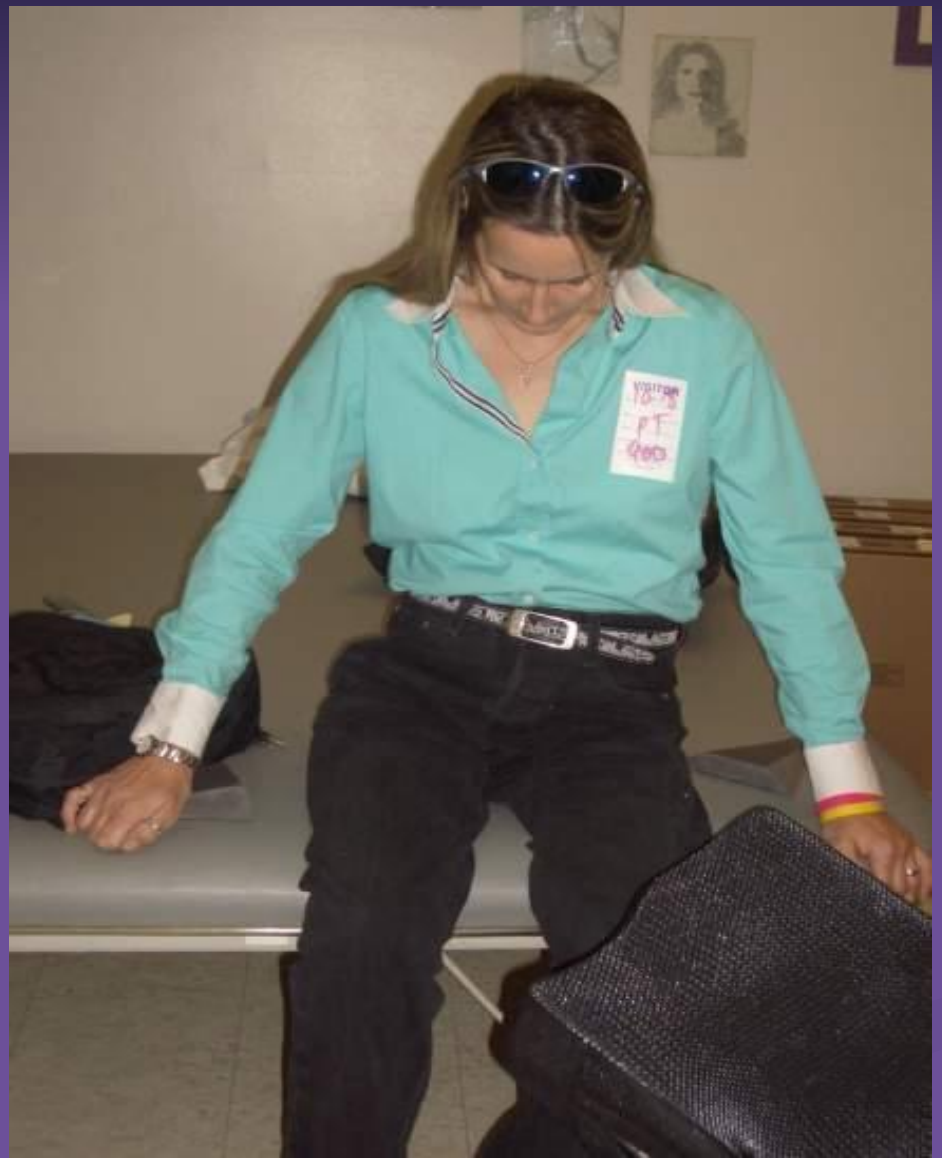


Temperature and Humidity

AireRx

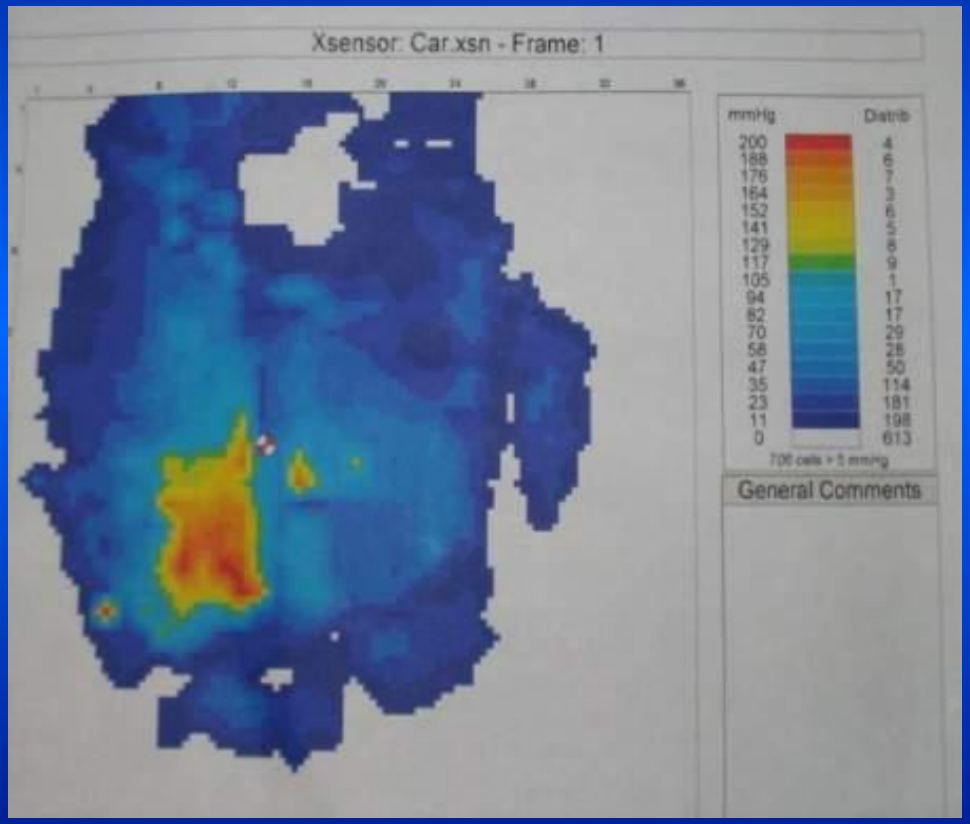


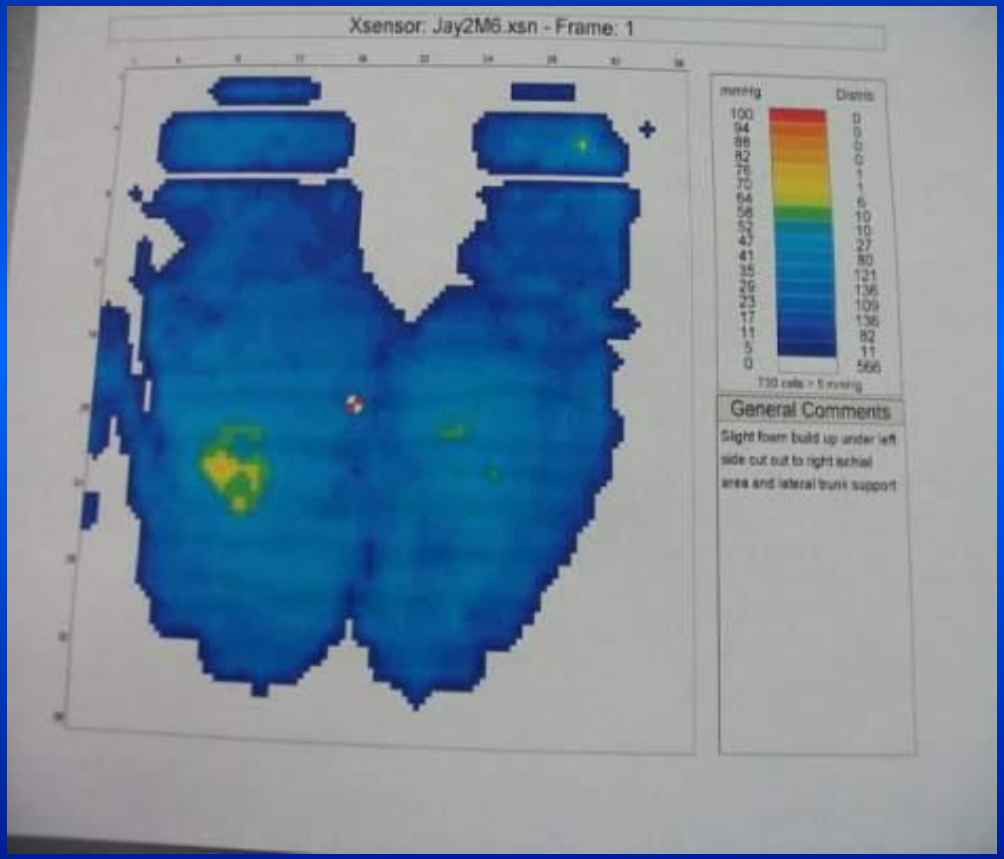
Flexible pelvic obliquity



Accommodation for pelvic obliquity

Accommodation of Pelvic Obliquity





Power Seating: Tilt in Space

- Pressure redistribution without sliding. Seat to back angle is maintained
- Accommodates hip and knee flexion
- Minimizes extensor spasticity and shearing
- Maintains orientation to controls

Justification for Recline

- Bladder management
- Distribute weight bearing surfaces
- Transfers
- Open hip and knee angle manage pain/discomfort
- Dressing to avoid unnecessary transfers
- Hypotension

Justification for Tilt and Recline

- Cannot Weight shift and HIGH risk for pressure sores
- Bladder management, comfort/pain relief, circulation
- To manage spasticity or increased tone

Seat Elevation

- Seat elevate for down hill transfers
- Increase UE reach to decrease shld impingement from overhead reaching

Seat to Floor

Permobil K 450 MX

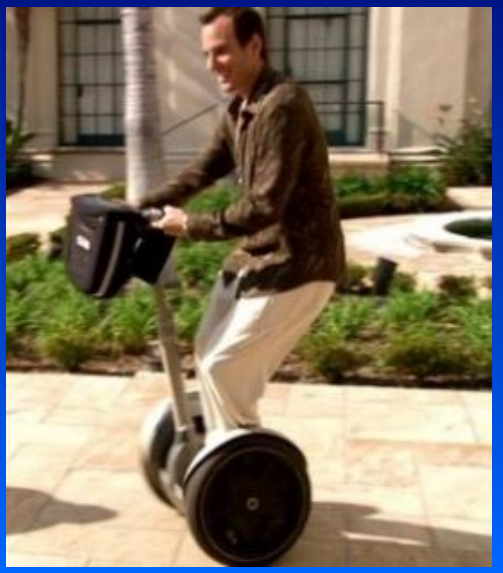
Pediatric Onset-Adult Outcomes

New technologies for Powered Mobility Access

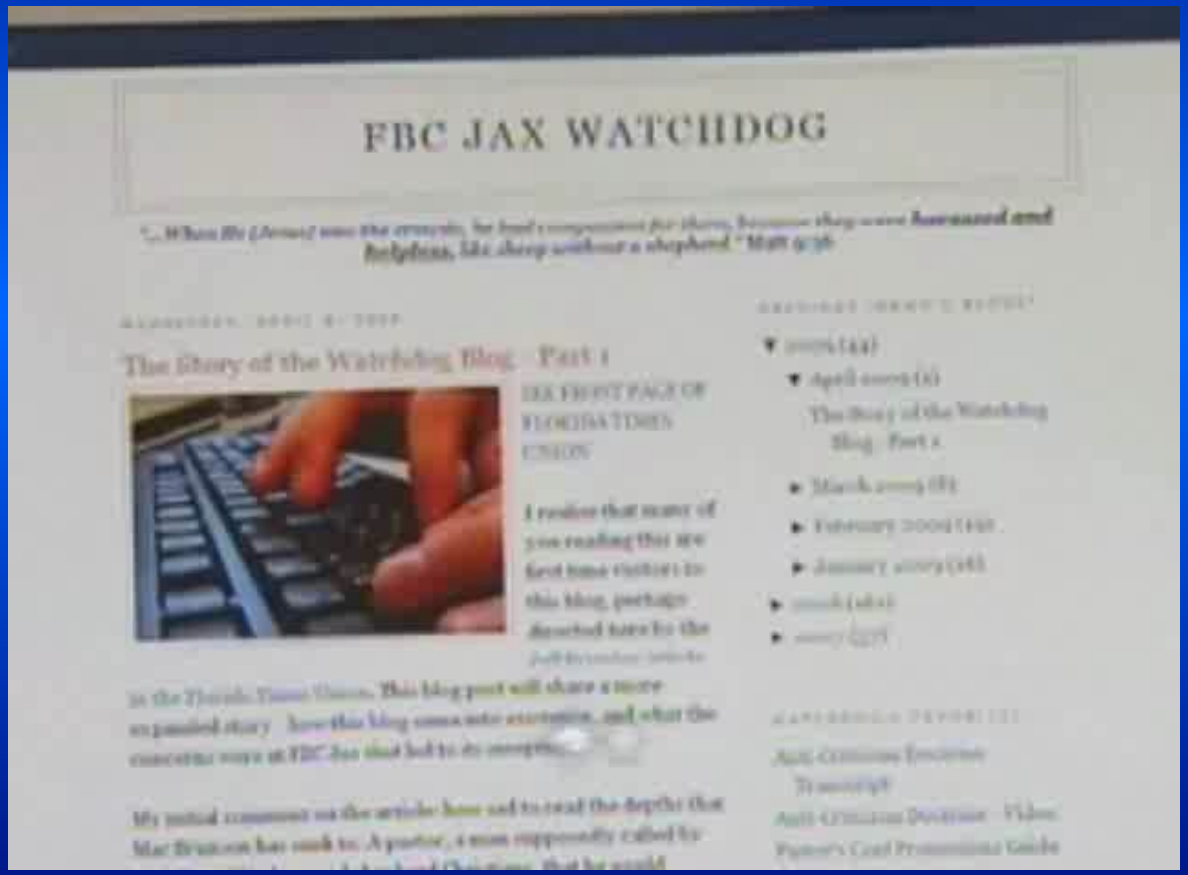
- Brain EMG controlled technology
- Voice technology
- Eye gaze
- Tongue Drive System

Segways

Segs for Vets



Segs for Vets



Body weight support by Honda

Personal powered Mobility by Honda

Thank you!

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