State of Art Pressure Relieving Technology
Improving Quality of Life of Young & Active Paraplegic Clients
By Seating Team in PWH

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Clearly, assistive technology does not and will not answer all problems associated with disabling conditions. Nevertheless, when assistive technology is well designed, taught in appropriate context, made affordable, and accepted by the consumer, the lives of individuals with disabilities are enhanced.

Spencer et al 1995
Pressure Ulcer

- Secondary complication of Spinal Cord Injury (SCI)
- Preventable
- Severe $\Rightarrow$ further disability, ↓mobility, loss of independence, fatal infections $^{2-4}$
Pressure Ulcer

- **Cost of Rx**
  - **Canada**
    - cost of 3 months accelerated wound Rx for stage III ulcer = $27,632 by Allen & Houghton 200321
  - **US**
    - cost of care $1.2-1.3 billion annually,
    - prevention about 1/10 by Byrne & Salzberg in 199622
  - **Hong Kong**
    - Length of Stay???
    - Rough estimate of 5-10 active paraplegic patients FU in O&T OP clinic in NTEC
    - Spina Bifida-more congenital deformity over spine with progressive ↑ structural deformity, eg. Hip dislocation=>scoliosis=>↑pelvic obliquity
Definition & Aetiology

- A lesion on any skin surface that result from pressure or pressure in combination with shear force and/or friction.\textsuperscript{5-8}

- Collapsing blood capillaries and lymph vessels, drainage of interstitial fluid and reduction in the functioning of nerve fibres\textsuperscript{9-10}; leads to ischemia of overlying soft tissues, ultimately lead to necrosis\textsuperscript{6,11-12}
Aetiology

- Common sites: bony prominences, i.e. sacrum and ischial tuberosity (IT)
- Hydrostatic pressure and shear stress are high, so that blood capillaries, lymph vessels and nerve fibres are compressed
- Drainage of interstitial fluid:
  - high > low pressure
  - “dried out” tissue & cell and capillary damage
  - Inhibited blood flow, lack of oxygen supply
- Finally, tissue starvation (necrosis) and pressure sores (decubitus)\textsuperscript{13-14}
Pressure distribution

The posture and the nature of supporting surfaces have a significant influence on the pressure distribution parameters\textsuperscript{19}.
Pressure prevention

- Pressure relief practice ~2 min every 15-30 min
  - Manual vertical lift is not practical and sustainable
  - By manual reclining or tilting wheelchair to 65° with 47% ↓max pressure
  - Forward-leaning position - 78% ↓max pressure
  - Side to side pressure relief is less effective with Roho air cushion than plain Polyurethane (PU) foam cushion after Spinal Cord Injury (SCI) because of greater pelvic obliquity than normal subject
Pressure prevention

Wheelchair cushions selection

- Roho cushion with large no. of air sacs with interconnected tubes to allow free air flow in between
- Roho-better for SCI with slump posture\textsuperscript{19}
- Roho-relatively unstable compared to PU foam\textsuperscript{19}
- (Air Cushion with separate pyramidal air sacs is not effective for pressure relief)
- Gel with hard foam cushion-higher pressure at IT than Roho in upright sitting posture\textsuperscript{26}
- Temperature-lower for gel, water & air cushion, higher for foam\textsuperscript{27}
- High risk subjects-choice of cushion not alleviate problem\textsuperscript{19}
Pressure prevention

- **Lumber support of 7.5cm**
  - Reduce 90% seated pressure with change in anterior pelvic tilt in normal subjects\(^{16}\)
  - Minimal effect (2%) on Ischial pressure of SCI with >3y post injury\(^{16}\)
    - high variability of pelvic obliquity 12.7° (normal subject 4.2°)
      - due to muscle dysfunction & prolonged poor sitting posture in W/C\(^{19}\)
- **Early attendance at specialized seating clinics**\(^{23-25}\)
  - Level 2 evidence showing early attendance increase skin management ability of post SCI
  - Emphasis on **personal responsibility** through personal care, inspection of skin, pressure relief, correct use of prescribed equipment
Pressure prevention

- **Prolonged standing programme**
  - Standing with average 40 min, 4 day/week by standing frame or combination of braces with walker
  - **Cost of equipment** for standing prevent continuation of standing at home
  - Lack of knowledge of potential perceived benefits
  - **Simple intervention with diverse benefits for all systems of body**
Integrated wheelchair Standing System

Rehabilitation Engineering & Assistive Technology Society of North America (RESNA) in 2009

Position on the Application of Wheelchair Standing Devices

- often medically necessary
  - Reduce the occurrence of pressure sores, skeletal deformities, passive range of motion
  - Reduce abnormal muscle tone and spasticity
  - Maintain vital organ capacity (anterior tilt), bone mineral density
  - Improve circulation
  - Reduce the occurrence of urinary tract infections
  - Improve functional reach to enable participation in ADL & Recreation
  - Enhance independence and productivity, psychological well-being
  - Especially important for children for healthy skeletal alignment, especially to promote proper development of acetabulum socket as head of femur is better seated in acetabulum
Integrated wheelchair Standing System

Definition of Integrated w/c standing system

- Mechanical / electric mechanical
- Seat surface from horizontal to vertical or anteriorly sloping position with vertical backrest & leg rest, with hip & knee extend through gradual angle changes
- Full vertical or partial vertical
- On manual or power w/c base
Benefits of integrating stander into w/c

- Without need to transfer from w/c to standing device
- Reduce attendant care, ↓back pain & risk of injury $$$
- Dynamic loading is more effective than static loading to prevent Bone Mineral Density loss
- Total pressure relief off IT =>↓pressure ulcer
- More effective to delay skeletal deformities for people with long period of sitting in w/c
- More effective as not dependent on circumstances to continue standing
- ↓fatigue especially in ULs to delay shoulder overused syndrome in active w/c user
- Male user can use public urinal independently
- Partial standing possible=>↑Lx Lordosis=>↑alertness & UL function
- For school children, ↓need of separate device in school & home
- Psychosocially enhance confidence & equality, better integration, self-esteem=>reduce depression $$$
Contraindications & Precautions

- Existing contractures: need mechanical / electronic limitation for amount of extension
- Significant skeletal deformities: special accommodations needed with careful observation on skeletal alignment while standing
- Postural hypotension esp. for new clients: check BP & dizziness
- Lack of standing tolerance: assessment & X-ray / bone density
- Osteoporosis: well-designed progressive standing programme
- Sacral shearing: check skin integrity in sacral region
- Adaptive / custom seating: not for 1-piece seating system or highly contoured seating system due to shear
Integrated wheelchair Standing System

- Frequency of Standing
  - Recommended on individual basis
  - Varied by tolerance, fatigue, level of current BMD & functional goals
  - As long & as often as user can tolerate comfortably
Common Seating cushions used in PWH for paraplegic clients

- **Roho and Polyurethane (PU) foam cushions**
- **With paraplegic group, the maximum ischial pressure**:
  - on Roho cushion, ranged from 88mmHg for trunk-bent-forward (PF) posture to 146mmHg for trunk-bent-right (PR) posture
  - On PU foam, ranged from 106mmHg for PF posture to 221mmHg for PR posture
  - Sitting with trunk bent laterally, more prominent pressure difference over IT on PU foam
  - Roho cushion was significantly more efficient in compensating the adverse effects of sitting posture on pressure distribution
Pressure Analysis

- Hip ext/int rotation
Pressure Analysis

- Trunk stability
Pressure Analysis

- Sit-to-Stand
Common Seating cushions used in PWH

Causes of Sore

- Poor and Fixed trunk & pelvis alignment => uneven pressure distribution
- Shear forces especially for active young adult with recreational or competitive sports
CADCAM Technology

Application in Molded Seating

• Match the exact pressure area with pressure mapping
• Relieve pressure
• Increase support from intact area
CADCAM Technology

- **Computer Aided Design**
  - Assist the design process
  - Comparing the pressure mapping data and 3D image
  - Modify the interface to relieve pressure and increase support
  - May be applicable to other client groups
Seating and mobility technologies, like all other assistive technologies, are tools that are available to people with SCIs to allow exploration of options to reframe their “core sense of value and place in the world”

lezsoni29
Cost & Effectiveness

- New products mostly not available & affordable in HK
- Clinicians have limited choices for recommendation
- Clinicians should<sup>20</sup>:
  - Document outcome measures not only on impact, function & QOL; also on cost of providing assessment, products & training.
  - Incorporate pressure mapping systems, using clinical practice backed by evidence, & document actual long-term outcomes to meet seating & mobility needs of person with SCI.
Reference list

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