Principles of Pressure Management

Douglas A. Hobson, Ph.D.

RERC on Wheeled Mobility*
Department of Rehabilitation Science and Technology
University of Pittsburgh

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This presentation is intended to provide an overview of the basic principles of pressure sore causation and the procedures used for clinical management, as viewed from the assistive technology perspective.

Pressure Sore Incidence and Costs

- 40% occur in hospital- (lying ulcers-sacrum, heels, elbows)
- 30% occur post discharge (sitting ulcers - sacrum, ischium)
- Cause of mortality in about 4% of SCI people
- Repair costs-$15-60k/ incident
- Social/psychological costs immeasurable!!

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Pressure sores or decubitus ulcers is still a costly, unresolved problem.

Populations at Risk

- Spinal Cord Injured
- Immobile Elderly
- Diabetics
- ALS, MS, MD
- Immobility is greatest risk factor
- Risk assessment scales have been developed (e.g., Braden scale, Norton scale)

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It still can not be predicted with a high degree of certainty which individuals are most likely to develop pressure sores.

The Etiology of Pressure Ulcers (prime factors)

- Local pressure above capillary (32 mmHg) reduces or occludes blood flow and oxygen to tissues (ischemia).
- Higher pressures usually occur over bony areas: ischial tuberosities, trochanters, and sacrum.
- If pressure sustained over pressure/time threshold, normal recovery will not occur.

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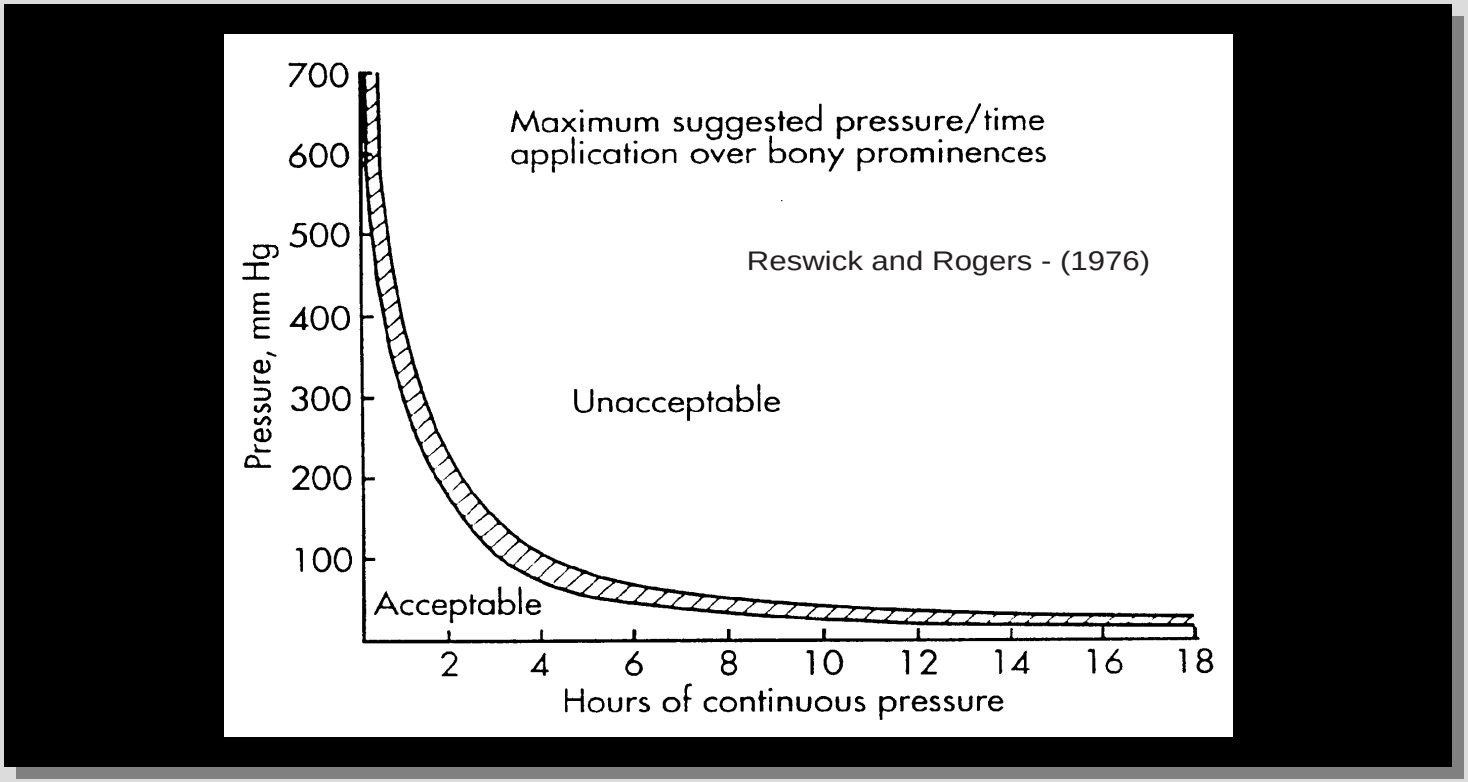
Pressure Tolerance Guidelines



Rewick and Rogers demonstrated that there seemed to be a relationship between the maximum pressure being experienced by the supporting tissues and the time over which that maximum pressure was applied. If the pressure/time index fell above the curve, subjects exhibited pressure sore histories. If it fell in the acceptable zone, they did not shoe pressure problems. This classic study has served as the basis for clinical management practices until this day.

The Etiology of Pressure Ulcers (prime factors)

- If repeated assault occurs, the breakdown process will begin.
- Deep tissue distortion due to shear forces also major contributing factor.
- Surface sores can result from repeated surface friction/abrasion.

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The exact effects of shear forces and resulting distortion of deeper tissues remains largely unknown and subject of current research studies.

Other Contributing Factors

- Immobility- close correlation between onset and frequency of movement.
- Loss of sensation-evidence that denervated tissue has reduced nutrition and oxygen perfusion.
- Body Type- does not seem to be any relationship between body-type and deep ulcers. Surface friction may increase with heavier people.

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Other Contributing Factors

- Nutrition-inadequate dietary intake can result in muscle atrophy, anemia, low protein levels and vitamin C deficiency– reducing skin integrity.
- Infection-increased metabolic rate, higher oxygen demand endangers ischemic tissue.

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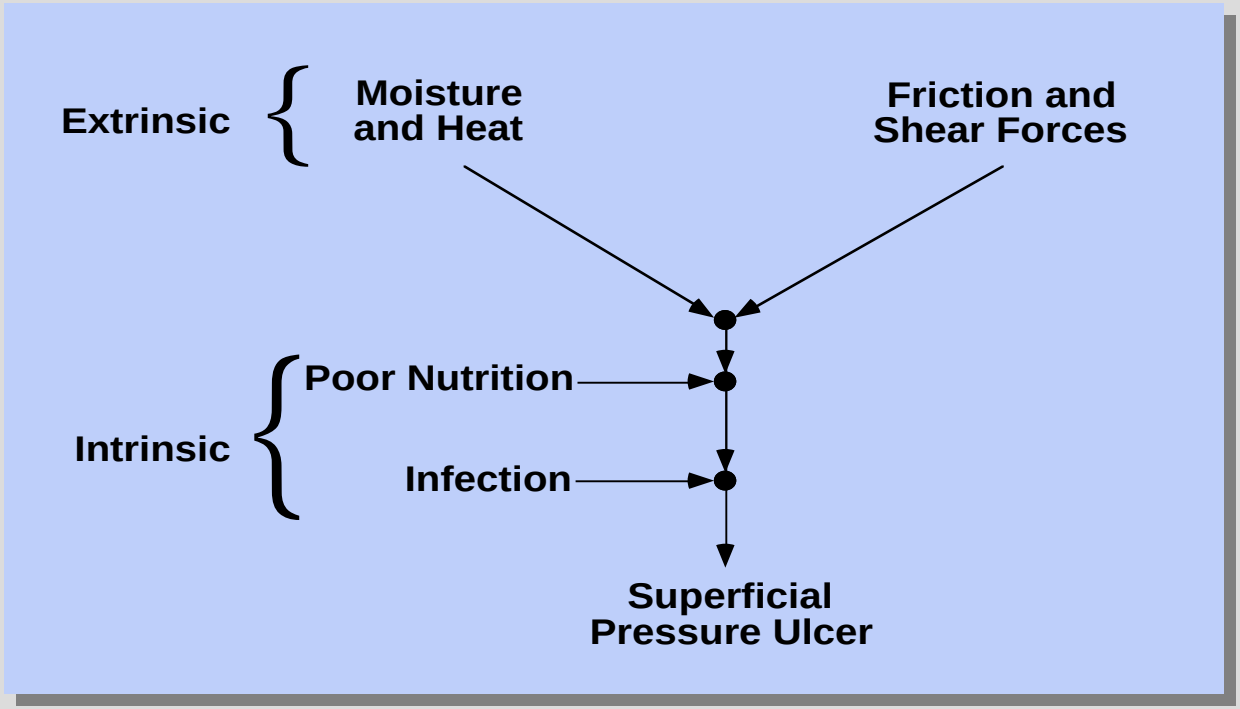
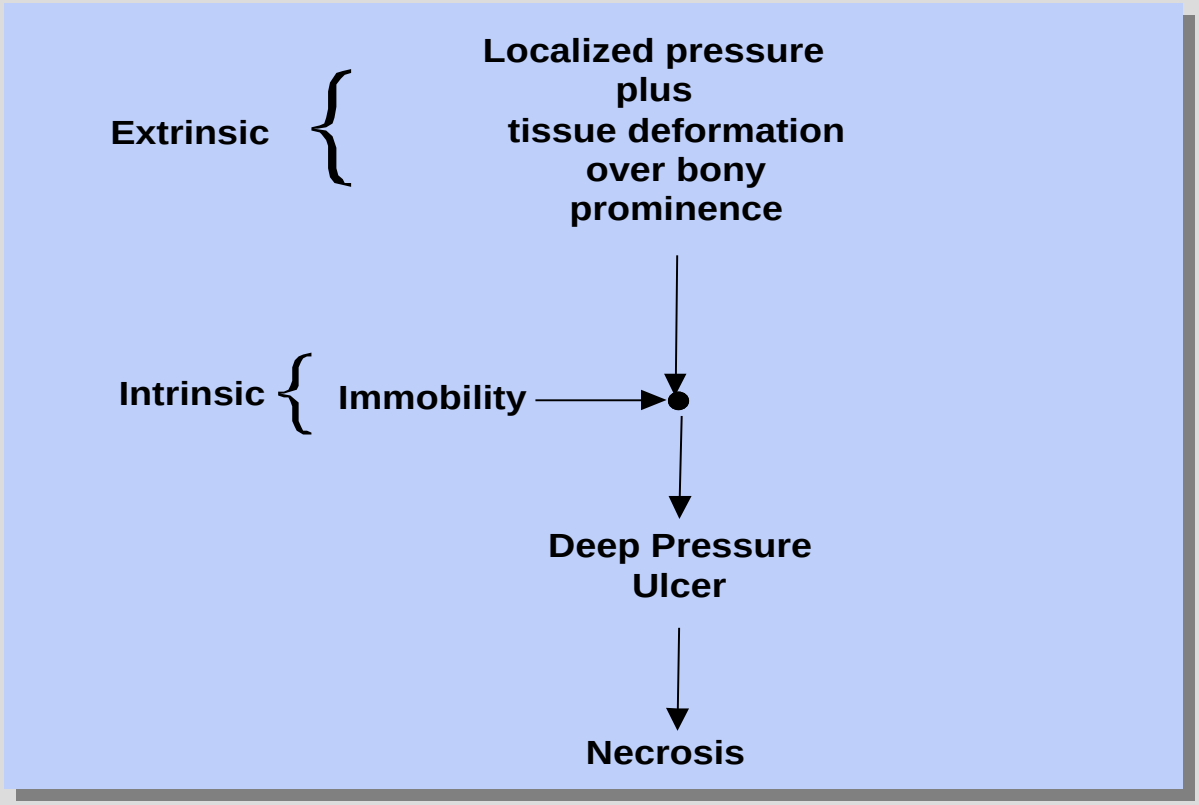
Other Contributing Factors

- Age-normal loss of elasticity, muscle atrophy, & reduced tone increases vulnerability.
- Posture-pelvic/spinal deformity will cause localized pressure increases.
- Microclimate- at the skin/seat interface
  - temperature, moisture, incontinence
- Impact injuries/abrasions.

Typical Superficial Ulcer Development



Development of Typical Deep Ulcer



Necrosis, or destruction of deep tissues, can be a serious threat to a persons survival. Necrotic tissue usually must be removed surgically and recovery will often take months of bed rest. The primary focus of clinical management is to prevent the formation of either deep or superficial ulcers.

Five Clinical Stages of Pressure Sore Development

- Stage I - blanching of reddened area experiencing reactive hyperemia
  - circulation intact, redness disappears in reasonable time (1-2 hrs)
- Stage II - blanching does not occur, redness remains
- Stage III - ulceration progresses beyond the dermis to subcutaneous tissue
  - redness remains around edges, hardening of tissue occurs

Five Clinical Stages of Pressure Development (cont'd)

- Stage IV - ulceration progresses to fat layer and muscle becomes swollen.
- Stage V - necrosis (dying tissue) penetrates deep fascia, muscle and sometimes bone. Surgical repair necessary, requires 2-6 months of inactivity.

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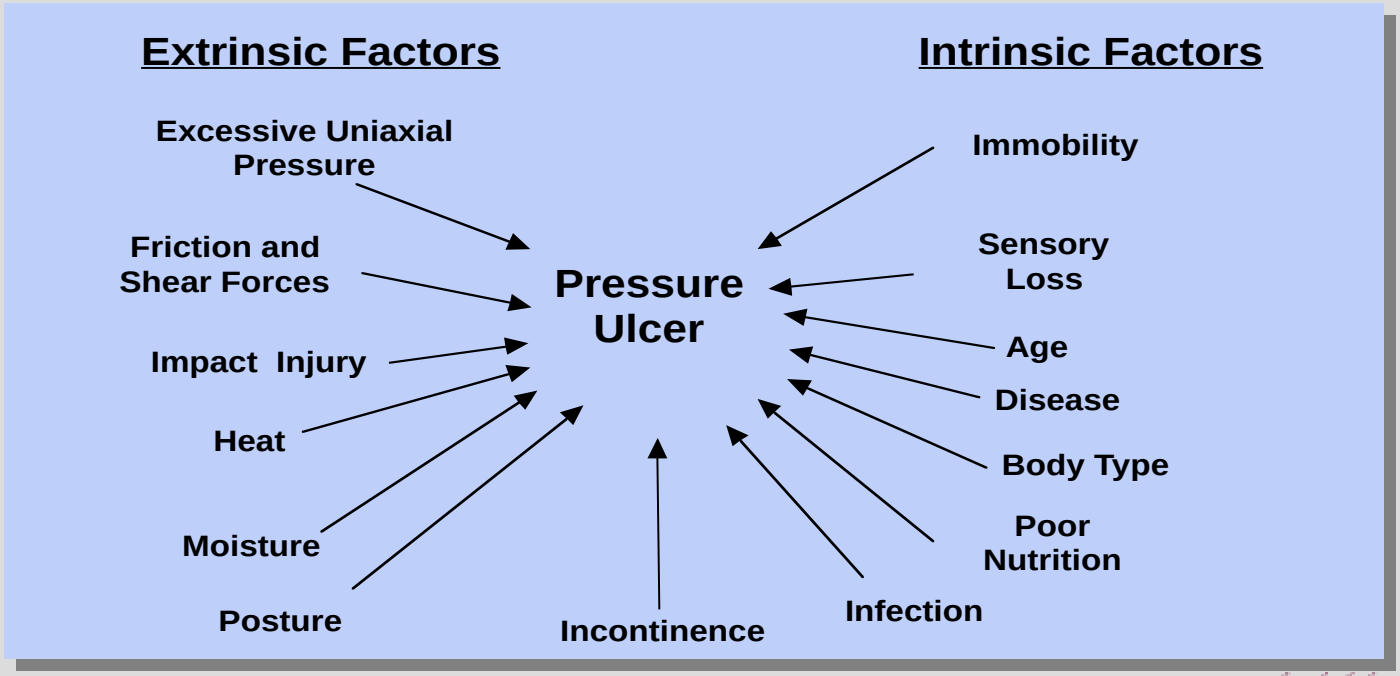
Pressure Ulcer Risk Factors



This diagram presents a summary of the multiple factors that are thought to contribute to pressure ulcer formation.

Principles of Clinical Pressure Management

- Maximize the surface area: decrease the pressure on any one location (peak pressures)
- Redistribute body weight: use support surface shape and materials with required properties.
- Minimize asymmetries: i.e., unequal loading of pelvic structures and tissues.
- Training for pressure relief: i.e., regular weight relieving movements

The first three above are goals that can be achieved by the selection or design of an appropriate body support surface (wheelchair seat cushion).

Principles of Clinical Pressure Management (cont'd)

- Dietary instruction: critical to both good health and skin integrity
- Instruction for lifting/ transferring: whenever possible person should instruct care-givers
- Personal hygiene and skin care: very important!

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Clearly the person themselves must be prepared to play a leading role in the prevention of pressure ulcers through strict adherence to several basics of self-care.

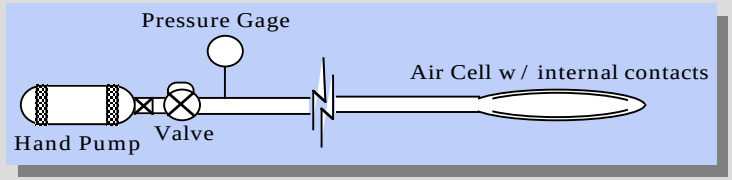
Skin Viability Measurement Techniques

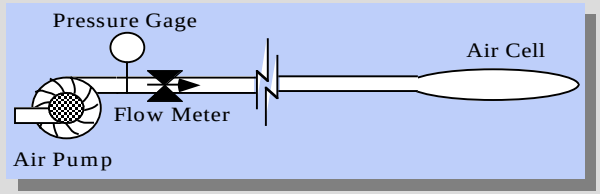
- Skin blanching
- Measurement of interface pressure (single site and mapping)
- Thermography
- Oxygenation of blood flow
- Measurement of tissue deformation - Brienza
- Measurement tissue stiffness - Brienza

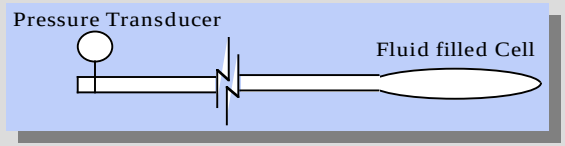
Multiple approaches to assessing skin viability have been studied. Observance of skin coloration (blanching) and measurement of seat interface pressures have proven to be the most clinically viable to date. Research studies are being conducted currently on several techniques, especially on the last three listed above.

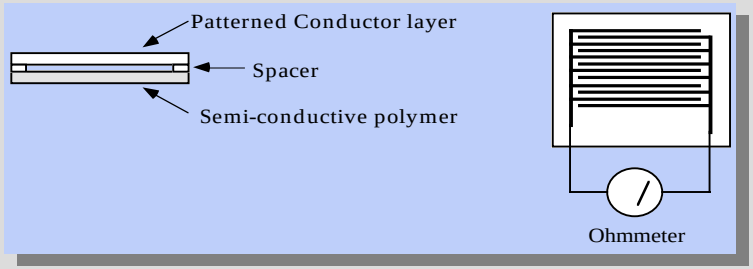
Pressure Measurement Technologies

- Electropneumatic bladder
- Pneumatic bladder
- Fluid filled bladder
- Thick film resist. element
- Capacitive element









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These are the electro-mechanical technologies that have and are being used to measure the pressure between the person and their support surface, usually a wheelchair cushion.

Single Cell vs. Mapping Devices

- Single bladder type devices are:
  - more accurate and repeatable
  - more difficult to use
  - provide limited information
  - allow single or continuous measurements

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One approach is to have the measurement device built into a single cell or measuring sensor. The other approach to to combine many single cells into measuring mat, called a pressure mapping device.

Continuous measurements means that the device will take sequential measurements and keep track of each one. Continuous measures allow one to see what happens, for example, when the person changes position

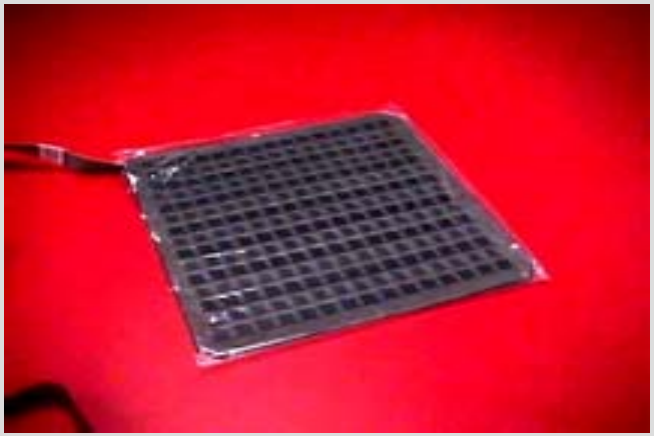
Single Cell vs. Mapping Devices (cont'd)

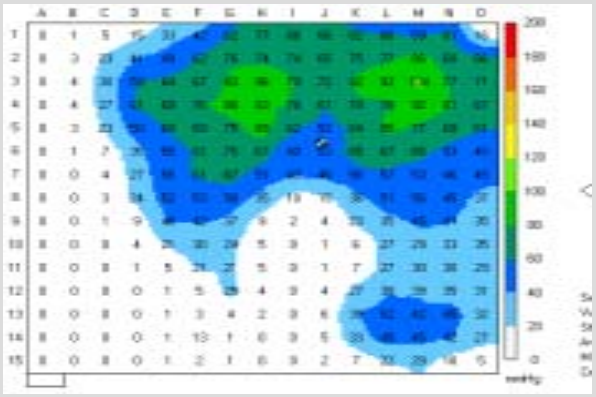
- Mapping devices:
  - provide posture and relative pressure information
  - allow graphical displays
  - are quicker to use and provide much more information
  - are more expensive
  - allow single or continuous measurements

Clinical Applications (Lipka, 1997)

- Objective representation of peak pressure
- Differential comparison of support surfaces
- Effectiveness of weight shifting interventions
- Wheelchair configuration set-up
- Clinical validation

Pressure Mapping Systems





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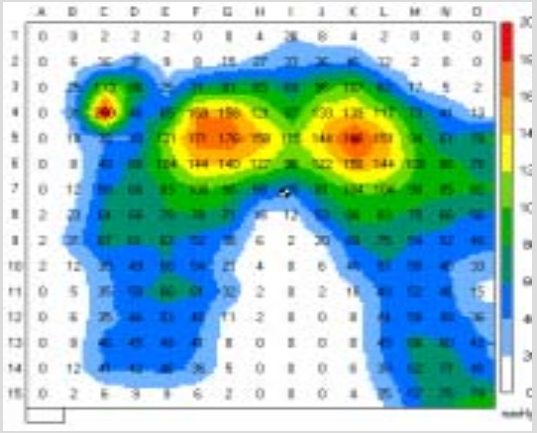
One clear advantage of pressuring mapping devices is that they provide a visual image of the pressure profile (map) of a person's interface pressure distribution. The left diagram shows a pressure mat which has more than 200 individual measurement cells. The right diagram shows the read out on the computer screen of the pressure map from the individual cells. The dark green areas are the maximum pressure areas which normally fall under the ischial tuberosities (the sitting bones). Cushion selection attempts to minimize these high pressure areas.

Pressure Mapping as Biofeedback



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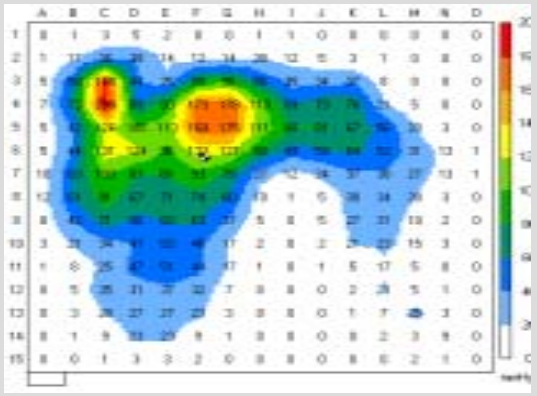
Pressure maps can give the wheelchair user an idea of what upper body movements are required in order to provide significant pressure relief to buttock tissues.

Shifting to One Side



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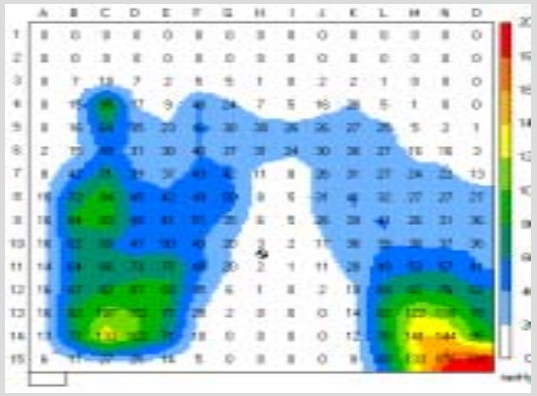
This example shows the change in the support pressure pattern as the person shifts their upper body mass to their right side.

Shifting Forward



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This computer map shows the pattern change when the person leans forward.

Comparative Study

Ferguson-Pell & Cardi (1992)

- Three computer-based devices.
- Four different cushion types.
- Results, comparisons of readings between different cushions, same subject, may produce errors as much as 10mmHg.

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This important study provides an indication of the accuracy that can be expected from mapping devices.

Interpretation of Pressure Data: A Few Precautions

- Comparison of absolute pressure values can be misleading.
- Measurement device may be altering the distribution of surface forces (e.g, hammocking).
- Relative pressure comparisons are probably most useful.

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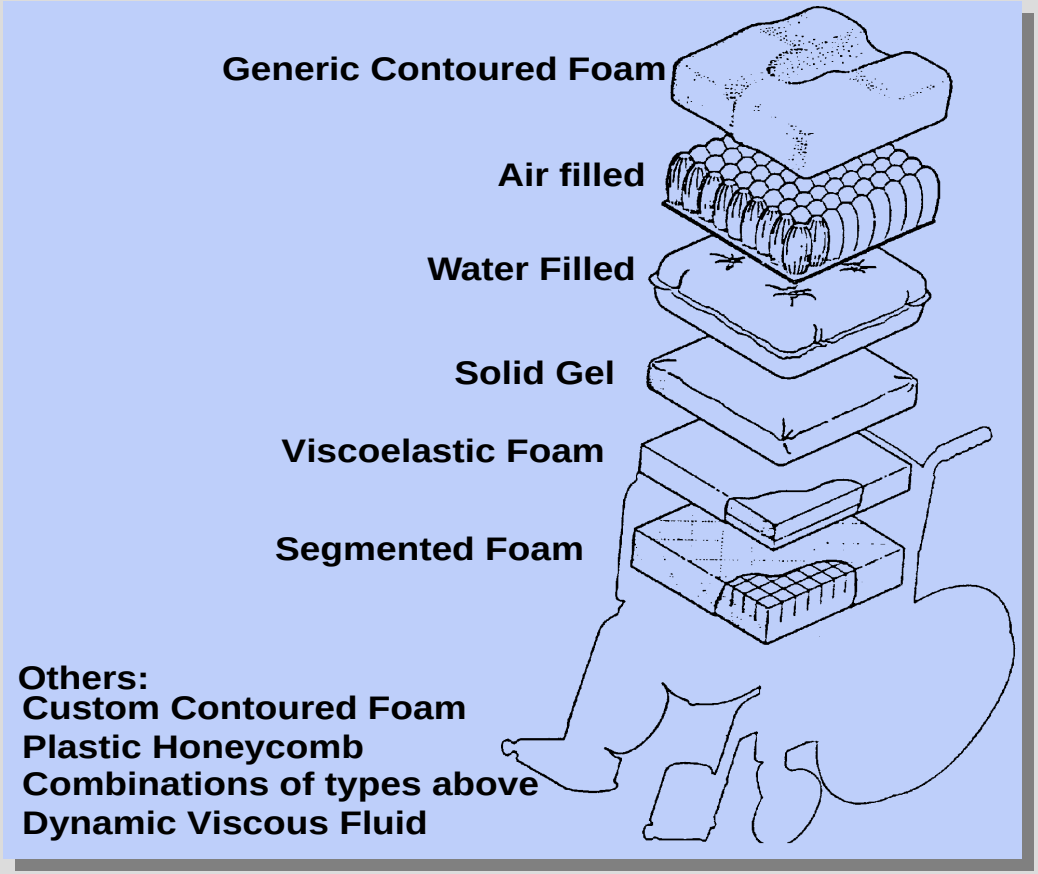
Cushion Types



Key Properties of Cushion Materials

(Sprigle, 1992)

- Density - weight/volume ratio.
- Stiffness - measure of softness.
- Resilience - ability to recover shape.
- Dampening - absorb impact loads.
- Envelopment - surface area covered.

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Positioning for Pressure and Postural Management

- planer vs. sling seat surface
- provide appropriate pressure relieving cushion
- incline seat (5-10°)
- firm contoured back, reclined 10-20°
- match backrest height to user needs.

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Positioning for Pressure and Postural Management (cont'd)

- add lumbar pad (optional).
- adjust arm and foot rests for optimal weight distribution.
- provide weight relief accessories to wheelchair (recline/tilt) as necessary.
- provide training on weight relief and use of seating and/or wheelchair system.

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