

Properties of Seat Cushions

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This is the second slide lecture in a series of eight lectures that are intended to provide an overview of the wheelchair mobility and seating evaluation process. The lecture series contains:

- Seating Biomechanics
- Wheelchair Seat Cushions
- Pressure Mapping
- Wheelchair Backs
- Manual Wheelchair Set-up and Propulsion Biomechanics
- Rehabilitation Technology Suppliers & Clinicians
- Wheelchair Service Delivery
- Documentation

Presenter Bio-sketch

Mark Schmeler is the Director of Clinical Services at the Center for Assistive Technology. He has many years of front-line clinical experience in seating and mobility with individuals with complex seating needs.

Mary Ellen Buning is a research associate in the Rehabilitation Science and Technology Department with interest in AT education, service delivery and functional outcomes that result from AT devices and services.

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Learning Objectives

- Understand the importance of taking a holistic view of the the seated client.
- See the relationship between seated posture and supporting surfaces and comfort, function, prevention of orthopedic deformities and prevention pressure sores.

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Performance Objectives

- The learner will understand basic information about the properties of various kinds of wheelchair cushions.
- Understand how various types of cushions are applied to various seating needs.

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Presentation Outline

- This lecture will cover:
 - Pressure ulcer etiology
 - Material properties
 - Types of cushions
 - Pressure mapping

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We have a baseline for understanding the biomechanics of the human body from the previous lecture on Seating Biomechanics.

Now, we want to begin to understand the characteristics of various kinds of cushions. Understanding these characteristics will help explain how they support the seated posture. This lecture has to do with material properties.

Pressure Ulcer Etiology Extrinsic Factors

- Excessive uniaxial pressure
- Friction and shear forces
- Heat
- Moisture

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What are the causes of pressure ulcers that are external to the body?

1. High pressure in one direction; downward. The measurement of uniaxial pressure is the one that is used in marketing pressure relieving cushions. This force is thought to contribute significantly to pressure ulcer development.
2. Friction - a coefficient of friction results when two surfaces come together. Friction is not always bad because it it also what keeps us from slipping. Shear is the force created when two surfaces attempt to slide past each other. For persons with reduced sensation, shear can be more destructive than uniaxial pressure.
3. Heat - combined with other factors causes breakdown.
4. Moisture - the body is 70% WATER. We expel this water by perspiration or urine. Urine is very toxic and contributes heavily to skin breakdown. Perspiration that results from retaining body heat can promote skin problems too.

Pressure Ulcer Etiology Intrinsic Factors

- Immobility
- Sensory loss
- Age
- Poor nutrition
- Incontinence

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What are the causes of pressure ulcers that are internal to the client?

1. Inability to shift weight the body and redistribute body weight. The capillary pressure of blood is not sufficient to overcome the resistance to blood flow created by pressure on soft tissue by bony parts of skeleton.
2. Lack of sensation which causes the body to not be aware that a shift t position is needed.
3. As the body ages and systems begin to change in function. Skin and connective tissue are often a first site for noticing these changes. Skin becomes more fragile, less elastic.
4. Blood doesn't carry sufficient nutrients to all parts of the body. 40% of long term care residents have poor nutrition. Some impairments can affect circulation and absorption of nutrients with the outcome that the body doesn't get enough nutrients.
5. Urine and poor hygiene can predispose to pressure problems.

Incidence Statistics

- SCI - all that require hospitalization.
 - 30% of people with paraplegia.
 - 50% of people with quadriplegia.
- Elderly in long-term care facilities as high as 25%.
- 9% of all hospitalized patients.
- Estimated cost of \$30K to \$80K per incidence.

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The number of pressure sores that will require hospitalization is surprisingly high. The costs for treating and healing a pressure ulcer are very high.

Because they are expensive to treat the significantly lower cost of preventing through good clinical practice makes good business sense for nursing homes, health care organizations and insurance companies.

Seat Cushion Requirements

- Functional
- Comfortable
- Clinically safe
- Easy to use

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In order for the good technology available in seat cushion to work for a specific client a clinician must keep these 4 variable in mind:

A cushion has to be easy to use and easy to move around. The cushion has to do what it claims it is supposed to do. As clinicians it is most important to keep solutions functional!

A cushion may provide excellent pressure relief but if it doesn't supply stability then it may not be safe or effective for a client to use.

Reaching from the seated posture when you don't know how your pelvis is going to shift or move creates a feeling of instability. This may lead to falls, twists and secondary injuries.

It must take the resources of the individual and their environment into consideration. Cushions have varying levels of need for maintenance, inflation, care, installation, replacement, etc.

Factors Affecting Seat Interface

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

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These are the factors that affect the interface between the client's buttocks and their cushion.

- How much body weight and how is it distributed.
- How thin is the client?
- What is their gender?
- What are the material properties of the cushion?
- What are the bio-mechanical factors affecting the position of their pelvis?

All of these things affect weight distribution.

Shape of the buttocks and shape of the cushion must fit like a foot into shoe to permit both comfort and function.

Cushion Materials Properties

- Density (kg/m³)
- Stiffness - indentation load displacement (ILD)
- Thermal characteristics (Is the cushion an insulator or conductor?)
- Friction

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Density is measured in kilograms per meter squared. Some cushions are quite heavy and difficult to move if client has reduced strength or endurance.

Stiffness is how easy a cushion is to compress. It is important to know how much compression a cushion withstand before bottoming out and no longer providing pressure relief. Stiffness is measured in ILD. If a heavy load does not create much indentation in a cushion then it is said to have a high ILD.

Does the cushion hold heat in or let heat pass through and move away from the client's body. Since heat is a factor in skin breakdown this can be an important material property for some clients.

Does the cushion allow sliding? Is it easy to reposition the pelvis? This factor also has an affect on the frequency of the need for repositioning. It should not be so slippery that it is difficult to maintain a position?

There is not one cushion that gives all of the characteristics that might be needed by a particular client. This is why "trade-offs" are necessary.

Cushion Properties Influence

- Pressure distribution
- Stability
- Interface temperature
- Reliability

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The material properties of the cushion affect the way the body that is seated on that cushion functions in the seated posture.

Varieties of Seating Technology

- Solid base
- Flat foam
- Generic contoured foam
- Cut-out foam
- Viscous fluid (gel)
- Solid gel
- Air floatation
- Custom contoured foam
- Plastic honeycomb
- Dynamic systems

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Look at these characteristics of cushions as an indicator of the spectrum of possible features. There is not one commercial product that provides all of these characteristics

Every cushion manufacturer claims that their cushion does everything but this is not true.

Solid Base

- Good stability
- No pressure distribution
- Conductor of heat
- Reliable



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This kind of base gives good stability.

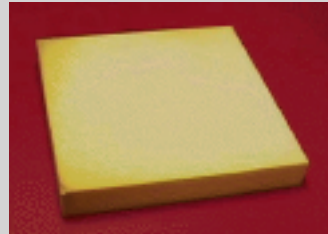
The more solid the base the more likely it is to not insulate but to allow heat to be transferred away from the body.

This base is likely to lead to pressure problems if there are risks but it is very reliable.

This kind of base might be used to reduce the effects of a sling seat in a folding wheelchair and paired with some other form of cushion for pressure distribution.

Flat Foam

- Good stability and dynamic
- Poor pressure
- Concerns with long-term resilience
- Insulator of heat
- Somewhat reliable
- Shear



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This kind gives good stability with a little pressure relief. When you remove the pressure of the body it defects back to its original shape.

Foam has its own science. Expensive foams give good pressure relief and cheaper foams do worse. Over time and as they wear out, foams lose their stiffness and deflect less and less.

This kind of cushion is less expensive than other kinds of supports.

It insulates and holds heat.

Foam is easy to insert in a wheelchair because flat foam can go into a seat in any orientation

The type of cover changes the coefficient of friction

Generically Contoured Foam Cushions

- Poor thermal properties (insulator).
- Pressure distribution is sensitive to the fit.
- Foam density and stiffness must be considered.
- Good dynamic properties (damping).
- High shear
- Light weight

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Most off-the-shelf contoured cushions fit some average body shapes. If the client is average and fits the cushion then this can be very good. Any pelvic or postural abnormalities will make this a poor choice.

Those made with good quality foams tend to last longer.

This cushion will absorb impact transmitted through wheelchair from an uneven surface. This gives the skeleton better suspension.

High shear can be an issue.

Foam can be easily altered/ to remove pressure from certain parts of the pelvis.

Denser foams have higher ILD.

Must be oriented correctly in the wheelchair seat.

Generically Contoured Foam Cushions



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Redistribute pressure away from one area.

Cutting the foam may mean that pressure is added to other areas. Overall posture must be considered when any alteration is made. Long term care facilities are notorious for not dealing effectively with this problem.

Poor skin integrity in one area of the buttocks means problems in other parts of the buttocks as well.

