Wheelchair Cushion Science in a Nutshell: A Primer on the Science that should Be Driving Your Clinical Choices

Forces in Seating

Force:

"is a push or pull upon an object resulting from the object's interaction with another object. Whenever there is an interaction between two objects, there is a **force** upon each of the objects."

What Forces are Acting on Individual as He Sits?

- Gravity
- Counter Forces from the Support Surfaces
- Joints for Movement
- Muscular Forces
- Shear
- Friction

Now Put Individual in Motion and He Has to Resist additional forces

- Acceleration
- Deceleration
- Centrifugal Force

Pressure: "the force applied perpendicular to the surface of an object per unit area over which that force is distributed."

Shear: "Are forces that are tangential to surface of tissue"

Shear Strain- movement of tissues in relation to bony structures; tissue deformation

Tension: "the pulling force transmitted axially through an object connecting two other objects."

Cushion Cover Material Tension

Surface Area (less tension may allow for coverage by greater surface area)

Skin Tension

Anthropometry: "the study of human body measurements especially on a comparative basis"

Venus vs. Mars

Greatest variance between which landmarks? – hip to hip - trochanter to trochanter – IT to IT

Measurements

Tissue-Body Shapes- We're All Just Bags of Squishy Stuff! Put Squishy Stuff Into a Mold…

- Unloaded Shape
- Loaded Contour Shape
- New Loaded Contour Shape When Change the Foam Mold Density

Immersion-How Far Did You Sink In?
Envelopment-How Well Did It Conform To You?
Magnitude – how large are the values?

Measuring Efficacy

Benchmarking Performance

Immersion

Envelopment

Magnitude

Accommodating Load and Shape

Mechanisms

Compression/Deflection

Displacement

Tension

Forces at work

Reaction

Hydrostatic

How cushion materials work

Foam & Resilient Materials

Mechanism

Compression

Tension

Characteristics

Stiffness

Indentation Force Deflection (I.F.D.) The amount of force in pounds required to compress a std. foam sample 25% of its height

Reaction Time

Temperature Stability

Fluid

Mechanism

Viscous Fluids

Displacement(Fluids Require a Container)-Design is Critical

Air

Displacement and Compression

Characteristics

Viscosity-"the property of a fluid that resists the force tending to cause the fluid to flow"

Does Viscosity Matter?

For immersion no, for stability maybe

Non-Newtonian, Bingham Plastic Fluids: "behave as a solid at low stresses but flow as a viscous fluid at high stresses"

Yield Stress

Temperature Stability

Gel

Mechanism

Elastic Displacement

Material Reaction to Shear-

Gel Reaction to Shear

Foam Reaction to Shear

Fluid Reaction to Shear

A Cushion's Job? Meet Users Needs for:

Tissue integrity, Positioning, Stability, Sitting tolerance, Independence, Maintenance, Economics

Example of Lateral Stability with narrow base of support vs wider base

Load Distribution

Primary

Femurs, Trochanters, Ischial Tuberosities (highest risk)

Secondary

Iliac Spine/Fossa, Ramus, Lower Thoracic & Upper Lumbar spine

Load Re-distribution vs. Equalization

If the trochanters and the ischial tuberosities are hydrostatically loaded, the best you can achieve is equal loads between them.

So, we want to direct the load? What do we need to do? Depends on the materials and the design of those materials

Foam Design Techniques

-Pre-contour- Remember foam is compressible and produces a reaction force.

-Anthropometric design

-Reduce surface tension

-Density and material combinations