Material characteristics of wheelchair cushions are as varied as the needs of wheelchair riders. Understanding these characteristics will provide a better client-cushion match.

by Stephen Sprigle, Ph.D.

One of the characteristics of our health care system is the commercial availability of many types of products, including wheelchair cushions. However, this wide choice of cushions can be both a benefit and a drawback.

Published studies have compared several types of cushions by judging their ability to prevent skin redness or by measuring interface pressure under the buttocks. The overwhelming results of these studies show that no one cushion is best for all people and that cushions should be judged on an individual basis. Thus, clinicians who prescribe wheelchair cushions must accept the responsibility of choosing a cushion that will provide its user with optimal function and posture while not putting the user at risk of developing skin problems.

To illustrate the enormity of this task, ABLEDATA, a national data base of rehabilitation products, lists more than 250 commercially available cushions. These cushions range in cost from $25 to more than $350. Many of these products are very useful, and many are fairly useless. Only by understanding the material properties of cushions can a clinician be better prepared to judge a cushion on its ability to meet a wheelchair rider’s specific needs rather than on its packaging.

**Material Worth**

Cushions are made from different materials and possess many different properties, but most can generally be classified as foam, viscoelastic foam, solid gel, viscous fluid and air. Several cushions are designed to offer support and pressure relief by combining different materials.

The following is an overview of materials and their properties:

- **Foam**: typically polyurethane or latex, is the most common material used in cushions today. It is lightweight, but susceptible to damage from light and moisture. Foam compresses under weight which allows it to be good cushion material.
- **Viscoelastic foam** has distinct time-dependent qualities. If you push on it quickly, it will resist deformation more than if you push on it slowly. Like regular foam, it is lightweight and must be protected from light and moisture.
- **Solid gel cushions** are also viscous in nature, but they do not compress under weight. Instead, gel deforms and displaces as a person sits on it. Gel is heavier than foam and must be encased because it can dry out if exposed to air. The term gel is used here to describe materials with similar properties and is not intended to describe a particular chemical composition.
- **Viscous fluid cushions** have replaced water cushions, which were prevalent several years ago. The material is a thick polymer or grease-like fluid that displaces when a person sits on it. A few combination cushions use a viscous fluid packet placed in a foam base to combine pressure relief, from the fluid, with pre-contoured support, from the foam.
- **Air cushions** have an air-tight container that holds the gas and prevents leakage. The design of this container can drastically affect cushion performance. Inflation can be adjusted to meet individual needs, but must be monitored to ensure optimal effectiveness.

**Property Values**

Each of these materials will provide a good support surface, but they also have properties that may not ideally suit a person’s seating needs. Of the many properties, five to consider when evaluating cushions is discussed here: density, stiffness, resilience, damping and envelopment.

- **Density** describes foam and is simply the weight of a cushion, given its volume.

A low-density foam will fatigue faster than a foam with higher density, if both are subjected to similar loads. For example, mat-

**Cushion Materials and Properties**

- **Foam**: good envelopment, high shear, good dynamic properties (damping), good long- and short-term resilience, poor thermal characteristics.
- **Viscoelastic foam**: good envelopment, high shear, mixed dynamic properties (cannot absorb impact loads), mixed resilience (will return after a day’s use, but its creep and stress relaxation hinders recovery from dynamic sitting loads), good thermal characteristics.
tress overlays can be made from a less dense material than seat cushions because a person lying on foam distributes his weight differently from a person who is seated.

Often, density is used to describe the hardness or softness of a cushion, but this is not technically correct. The measure of a cushion’s hardness is better described by its stiffness. Foam stiffness is a relative measure of depth to which a person will sink into the cushion. (4) A soft material may bottom out, leading to high sitting pressures, but a cushion that is too stiff and does not compress will also induce high pressures.

Resilience describes two concepts: the ability to recover shape in response to changing forces and the ability to maintain force properties after loading. A cushion with long-term resilience will recover its force properties overnight after a day of use. A cushion with short-term resilience will quickly recover from impacts and typical movements of the person in the wheelchair.

Foam and air cushions have both long- and short-term resilience. Viscoelastic foam will recover its shape and force properties when unloaded, but it may take a few minutes longer than regular foam.

Viscous fluid cushions have neither long- nor short-term resilience. A material that flows, like a viscous fluid, may not recover from loads as the fluid is displaced away from bony prominences; therefore, it must be manually repositioned. This lack of resilience is the reason clinicians instruct their clients who use viscous fluid cushions to knead the cushions each day before transferring onto them.

- The ability of a cushion to dampen, or soften, impacts, similar to a shock absorber, affects comfort and tissue loading during activity. Generally, a material that compresses or flows will dampen better than one that does neither. To check the ability of a cushion to dampen, simply drop a weight onto the cushion. If the weight sinks into the cushion, the impact is dampened. If the weight hits with a thud, the cushion does not dampen well. This same test will also illustrate the resilience of a material as the material tries to return to its original shape after the impact.

- Foam and air cushions dampen impact better than gel and viscoelastic foam. A viscous fluid cushion may or may not dampen impact, depending on the viscosity and volume of the fluid and the container that encases it. If an impact displaces too much fluid under a bony prominence, the fluid will not automatically return to cushion that area.

- Envelopment is the ability to surround or contain the buttocks. Good envelopment helps reduce peak pressures, such as bony prominences and objects in pockets, about the buttock contour and will increase stability through greater contact area.

Because it compresses, foam usually exhibits good envelopment. Viscoelastic foam envelops the buttocks well and provides a stable base. Flat solid gel does not compress and does not envelop the buttocks well. Viscous fluid would not envelop well by itself; however, many cushions use contoured base with the viscous fluid to get better envelopment.

Over-inflating an air cushion will not allow the body to sink into it adequately, thereby decreasing envelopment and sitting stability.

In addition to the five cushion properties discussed here, the seating environment is also affected by other such properties, including creep, horizontal stiffness and thermal characteristics.

Cushion covers are another important factor in evaluating proper seating support. The best cushion design will be useless if it is encased in a poor cover.

Covers should stretch and allow air exchange. A tight, nonstretch cover will affect envelopment because it will restrict the movement of the cushioning material. A covering material that “hammocks” or sags will reduce envelopment, and the surface tension of a hammocked material may increase shear.

A cover should promote air exchange or it will affect the cushions ability to respond to temperature. Materials like certain polyknits, cotton and Lycra fabrics are good.

Material properties can directly influence pressure points, stability, heat accumulation and friction. All of the materials used in seating today have their good and bad points, so a clinician should carefully assess the needs of the user and the environment in which the cushion will be used. Remember, no studies have been published to date that prove one type of cushion is better than another across a population of wheelchair riders.

References

3. Volume is determined by weighing a standard size block of foam and is designated in pounds per cubic foot (lbs/ft³). Seat cushions generally have densities between 1.5 and 3 lbs/ft³.
4. Foam stiffness is determined by an indentation load deflection test, which measures the force required to indent the foam by 25 percent of its thickness. Test values for cushions usually range between 30 and 70 pounds.

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