

# Wheelchair Cushions: Design vs. Materials



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## INTRODUCTION

At the most basic level, a wheelchair cushion needs to address comfort, skin care and postural control. It must be durable and provide consistent performance over time and in varying climates, environments and temperatures. If a cushion is provided that accomplishes reasonable comfort and postural control, but inadequate

protection against sitting-induced pressure ulcers, then the cushion isn't an appropriate choice. If the use of a wheelchair cushion results in skin breakdown, regardless of the benefits relative to other outcomes, it cannot be used.

Each wheelchair user presents a unique skin-risk profile. The National Pressure Ulcer Advisory Panel (NPUAP)<sup>1</sup> recognizes several key risk factors for pressure-ulcer development. Decreased mental status, exposure to moisture, incontinence, device-related pressure, friction, shear, immobility, inactivity and nutritional deficits are outlined in their educational materials. Additional variables that are independently

associated with pressure ulcers have also been identified.

Salzberg, et al,<sup>2</sup> identified seven independent factors out of a list of 15 from a previously published scale. These independent factors were established for risks related to paralysis: level of activity, level of mobility, complete spinal cord injury, urine incontinence or moisture, autonomic dysreflexia, pulmonary disease and renal disease. Notice that pressure is not identified as an independent risk factor, therefore it must be coupled with other factors to create risk for pressure-ulcer development (e.g., pressure and time, or pressure and moisture with shear).

Wheelchair cushion design should directly address the extrinsic risk factors cited above (heat and moisture, pressure, friction and shear) and, through effective design, influence the intrinsic issues, especially those related to activity and mobility. Therefore, wheelchair cushions should be selected relative to their ability to protect skin and maximize mobility and activity. As basic and intuitive as this may sound, it isn't so simple in practice.

## Understanding the Extrinsic Risk Factors

**Pressure**—This is the normal force experienced perpendicular to the cushion surface. Traditional wheelchair cushions for at-risk sitters have focused on the principle

of pressure distribution, i.e., the ability of the cushion material to conform to bony prominences, decrease peak pressures and uniformly distribute pressure over the sitter-cushion interface. A multitude of materials have been incorporated into cushion design to accomplish this goal with varying degrees of success. Pressure mapping has evolved as a useful, though limited, tool to measure interface pressures and help predict a cushion's viability as a pressure management tool.

**Shear**—The force experienced parallel to the support surface is called shear. A high shear interface can result in friction between the sitter's skin and the cushion when the sitter actively moves across the cushion surface. Additionally, a high shear interface can "lock down" clothing and skin to the cushion surface, resulting in tension and potential tissue trauma and capillary tears/trauma as bony prominences move against underlying soft tissue and vascular structures.

**Pressure and Shear**—The management of pressure influences shear; shear doesn't occur in the absence of pressure. Rub your hands together and, as you do, slowly increase the pressure. What happens? Do you feel increased heat as you increase pressure? Now keep your hands moving laterally but

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separate your hands to eliminate pressure. What happens? There is no more shear as pressure is eliminated. Measurement of shear is still very much in its infancy, and its prognostic value has yet to be clearly defined.

**Heat, Moisture and Shear**—Recent studies, as cited by Berlowitz and Brienza,<sup>3</sup> have demonstrated that superficial dermal injuries without deep underlying tissue damage results from moisture and shear. Also noted is the impact of elevated temperature in exacerbation of ischemia related to pressure-ulcer development.

#### Managing the Extrinsic Risk Factors

**Pressure**—Increasing performance in pressure distribution typically compromises cushion performance relative to stability and postural control. If the materials selected for skin protection are temperature sensitive, then performance characteristics of the cushion will

be influenced by temperature. Air pressure is affected by altitude and influences performance of cushions that utilize contained air. If a cushion support is inherently

unstable, then optimizing activity and mobility is a challenge at best.

The alternative to pressure distribution is incorporation of prosthetic and orthotic sciences where firm, accurately contoured and stable materials are selected to intentionally support select areas of the body that may be tolerant of pressure, reducing or eliminating pressure from at-risk areas. This approach tends to provide greater stability without compromising skin protection. Improved stability and postural control are the key

ingredients to the promotion of activity and mobility.

**Shear**—Once again, materials such as fluids and air, which are most capable of transferring the effects of interface shear into the cushion, tend to be relatively less stable than non-flowing static materials. Less stable means less mobile. For decades, prosthetists have been reducing or eliminating pressure at distal ends of residual extremities and, by doing so, eliminating shear as well. Again, these principles, when used in cushion design, can increase shear where possible and eliminate it elsewhere.

**Pressure and Shear**—Pressure and shear are essential for postural control and stability in cushion design. Safe application of these forces is very much dependent on the user's presentation. Successful use of prosthetic and orthotic principles in seating is dependent on the amount of weight-bearing soft tissue that can be safely loaded. The proximal thighs and posterior-lateral buttocks tend to be tolerant of the supportive forces of pressure and shear, while bony prominences are not.

**Heat, Moisture and Shear**—Maintenance of dry air space at the sitter-support surface interface is essential for regulation of body temperature, both locally and systemically. Accurate design and material selection is necessary to create dry air space around risk areas, and should be coupled with cover materials that wick moisture from the sitter into the air space for evaporation. Additionally, protecting the cushion materials from saturation by urinary and/or fecal incontinence, sweat and other substances is imperative for cushion durability and maintenance of a sanitary microenvironment.

#### CONCLUSION

Seating design at its best works to control extrinsic risk factors, thereby influencing intrinsic factors toward improved health,

activity and mobility. Traditional mechanisms of pressure and shear management have shortcomings relative to the degree of stability and control they provide. Appropriate application of prosthetic and orthotic principles provides an alternative to the traditional use of the pressure distribution model, and may promote greater activity and mobility while also promoting skin health. Design and material development that can maintain dry air space at the sitter-support surface interface may reduce superficial skin trauma related to heat, moisture and shear. **D**

#### REFERENCES

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