“Wheelchair Seating Design for Preventing and Treating Decubitus Ulcers”
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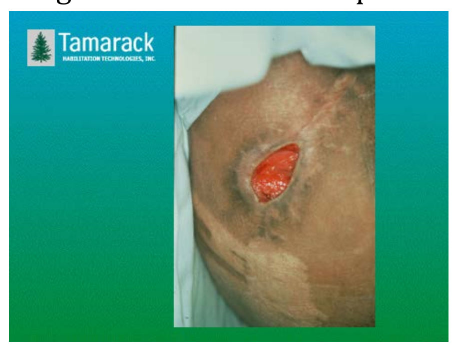
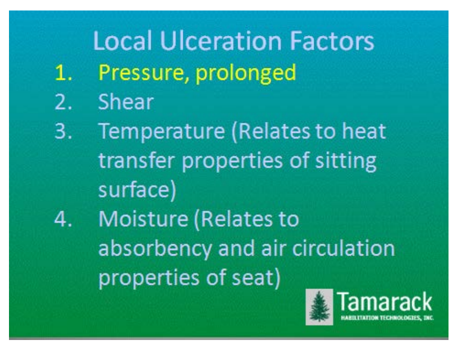
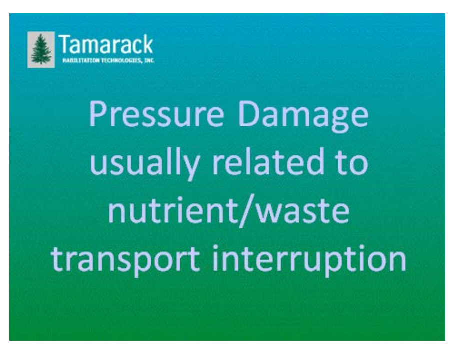
People who use wheelchairs for daily mobility and function, specifically those with impaired sensation, are at constant risk of developing a serious sub-pelvic or sacral ulceration. Decubitus ulcers destroy careers, marriages, quality of life, and are the third leading cause of death among people with spinal cord injury. The total cost of decubitus ulcer-related medical care in North America exceeds $10 billion.

It is extremely important that we focus on prevention because each occurrence or reoccurrence of a stage III or IV ulcer multiplies the difficulty of preventing the next one. The first step in prevention is to gain a <u>full</u> understanding of what are the direct causes.



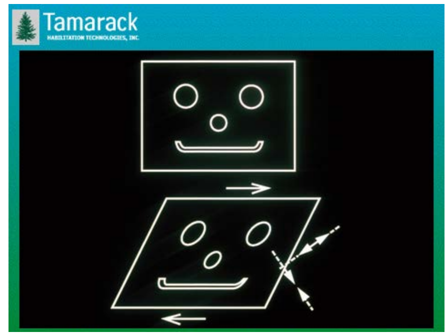
There are four physical conditions <u>at</u> the ulcer site which contribute to tissue trauma and which our seating design can affect. Those four are: pressure, shear, temperature and moisture. Of those four, pressure is the easiest to understand. When contact pressure is too great, blood cannot flow in to bring oxygen and nutrients to the cells nor remove metabolic byproducts. If that high contact pressure persists too long, cells die. This is the ischemia model. Up until now, the Ischemic model has dominated Decubitus Ulcer prevention product design almost exclusively. That has been, and continues to be a problem.





Shear, the second factor on my list, is not as simple and easy to visualize as pressure.

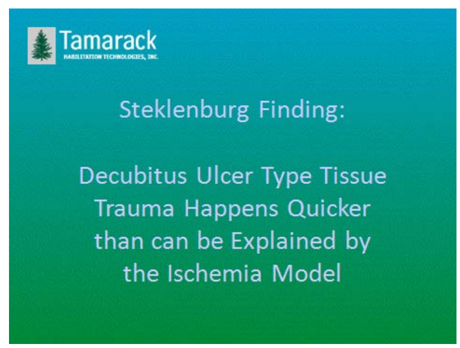
Shear is a type of deformation in which the neighboring levels/layers within the tissue are dragged or pulled parallel to each other. Some shear conditions are present within the soft tissue even when loading is purely compressive. However, when friction loads are also present, the magnitude of shear distortion rises and can be a very serious factor.

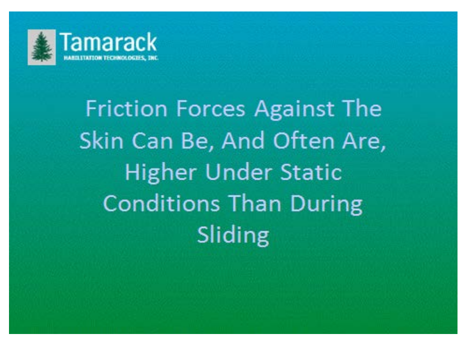


When shearing friction forces occur on top of pressure, this causes ischemia at much lower pressures. An ulcer can be generated in half the time under these circumstances.

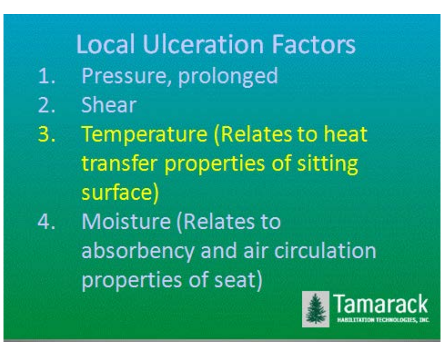
There is also credible evidence that the internal shear stress caused by friction causes direct fracturing of some of the biological microstructures.

There is a common misconception that friction loads and the shear damage they cause only occur if and as the skin slides across a contact material. If that occurs, the damage is abrasion and can be serious and immediate. However, friction and the soft tissue shear it causes, can be persisting and doing its damage all during the more static hours of wheelchair use (or bed use).

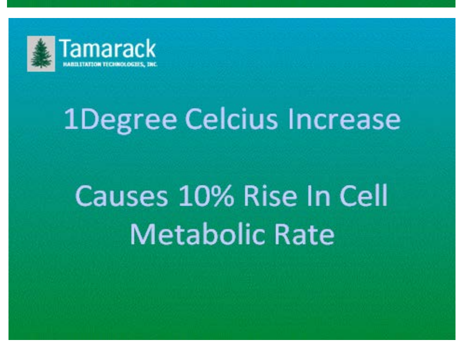




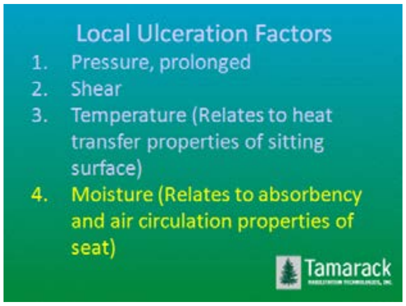
The friction and shear stress do not go away once the person settles into her/his wheelchair. This is particularly easy to understand when we consider Bennet's research.

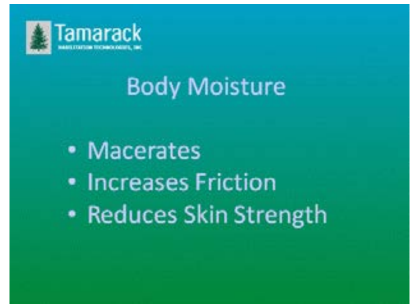


Temperature comes in as a factor because a one degree centigrade rise in temperature will increase cell



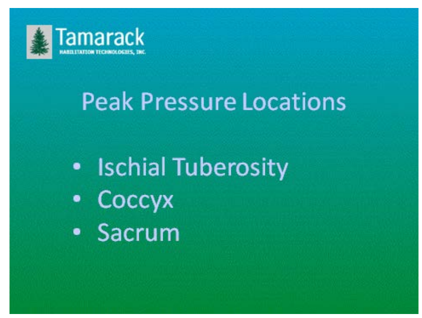
metabolic rate by approximately 10%. In other words, if we can keep at-risk anatomy a bit cooler, the onset of cell death will be delayed and the wheelchair user will have a larger margin of safety.



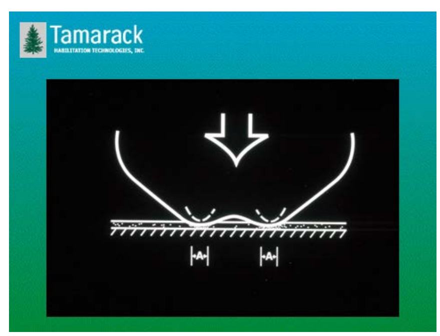


Moisture is last on my list but <u>not</u> necessarily least important depending on skin health and the contents of the "moisture". In addition to possible unhealthy skin reactions to the contents of urine and sweat, we know that moisture <u>weakens</u> the outermost layers of the epidermis. Moisture also tends to increase the friction characteristics of skin and fabric interfaces.

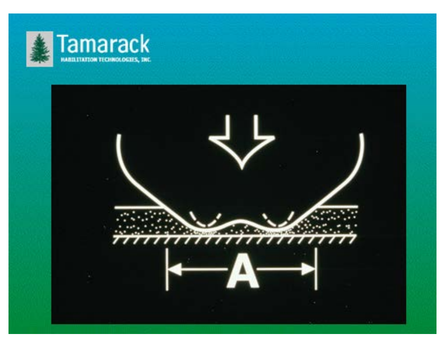
Now that we understand the several factors which <u>cause</u> decubitus ulcers, we may begin an orderly discussion of how we can design to minimize those contributing factors. <u>That</u> is what will give wheelchair users a wider margin of safety as they travel down the dodgy road of life.

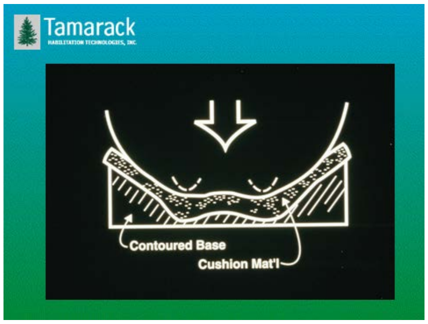


We know from long experience that excessive, damaging pressures occur where skeletal elements protrude closest to the skin surface in weight-bearing areas. It is in those locations, that the soft tissue cushion is thin, forces are concentrated, pressures (force per unit area) are greatest and least tolerated. There are three ways to reduce those peak pressures: 1. with cushioning materials; 2. by structural shaping of the support; and 3. with fluid flotation.



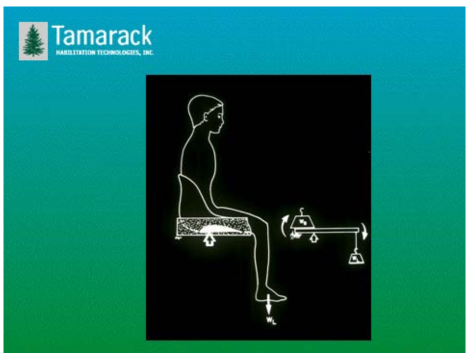
Cushion materials increase contact area and thereby reduce peak pressure but the at-risk locations continue to be the tissue at highest pressure. We can correct that by contouring/shaping the support. As orthotists and prosthetists, we know from long experience that shaping is an effective way to transfer forces





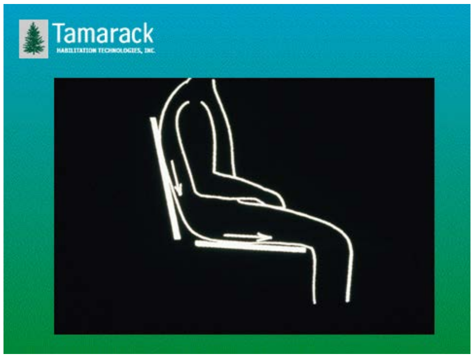
from bony, intolerant areas to areas of deeper soft tissue which is more force-tolerant. So, just like in a foot-bed or trans-tibial socket, a very good approach is to use a combination of shaping with only as much cushioning as is necessary because the user's position in the seat is not always perfect.

Finally, with regard to pressure, we must understand the role of the wheelchair footrest. If the wheelchair footrest is too elevated, it will totally negate any efforts to transfer weight bearing pressures from the pelvic area to the thigh areas. The posterior thighs can safely bear higher pressures than the ischia. Build a thigh fulcrum into the structural material of the seat cushion <u>and</u> put the footrest low enough so that the weight of the lower legs function like a lever to reduce pelvic contact pressures. This is impossible, of course, with an air flotation cushion.

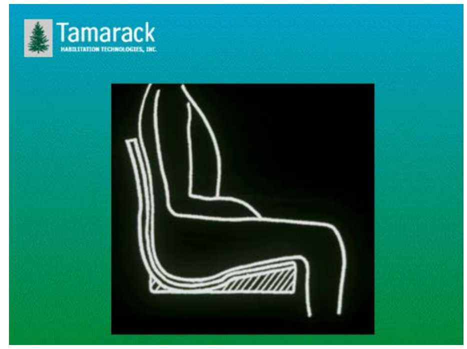


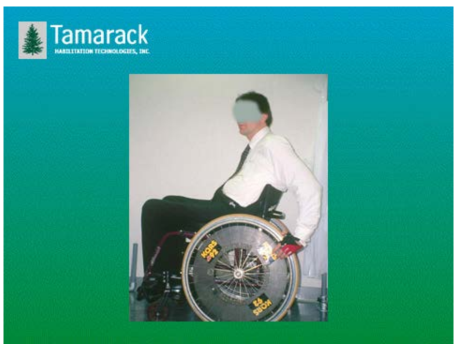
Fluid flotation is the third method listed above but has some negative characteristics and limitations. To truly "float" the user, the fluid must generate a weight-resisting pressure when in use. That too often results in fluid leakage which can rapidly or gradually reduce user protection to zero. A fluid support provides little pelvic and postural alignment stability for the more physically active users. A full fluid support surface does not provide an opportunity to transfer optimum loads forward onto the thighs.

The areas of greatest shear distortion <u>almost</u> always occur at the same locations as greatest pressure. That is because it is in those locations that the shear displacement is concentrated across a very thin layer of soft tissue. Also, those areas obviously have the contact pressure levels necessary to make high friction forces possible.

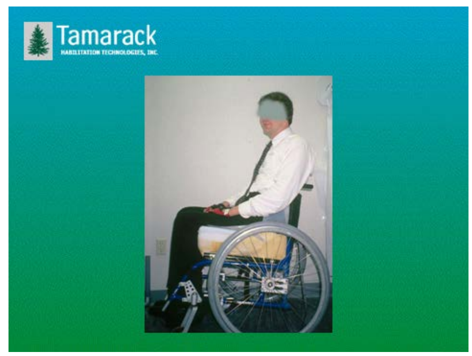


There are two ways to minimize shear. The first is by reducing the friction needed to keep your client in his/her chair. Reducing the tendency to slide is accomplished quite simply by creating a recess in the cushion which “cradles” the pelvis and an up-sloped/inclined thigh support area.



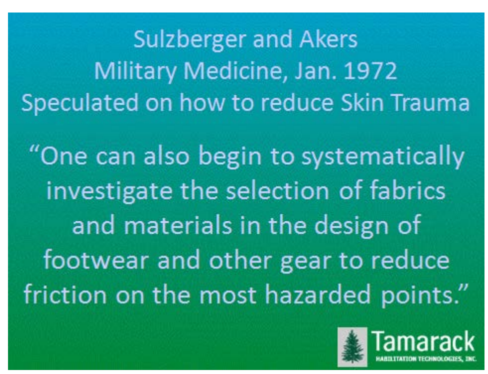


If you can provide lumbar and other back support to bring the wheelchair user to a more upright, less “slumped” posture, that will also help. You must be careful, of course, not to bring your client too close to the forward “tipping point”. Where that point of forward instability is, depends on the lesion level.



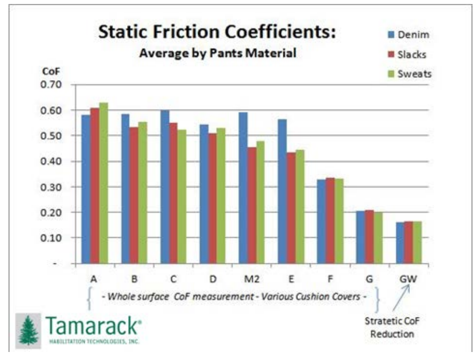
The second way of minimizing shear is to make friction forces almost impossible in the specific at-risk areas. Friction is not bad everywhere. It is bad only where it is contributing to tissue trauma. In other areas, friction is contributing to sitting stability and causing no problems.

Way back in the 1960’s, Dr. Sulzberger suggested how tissue in “hazarded areas” could be protected from friction/shear trauma. That is exactly the concept embodied in strategic friction management. Something called the Coefficient of Friction (COF) indicates at what level friction/shear forces are “maxed out” for a particular interface material combination.



Selecting the right materials for an interface can almost eliminate friction forces on that surface. An example of strategic friction management in seating is to build a

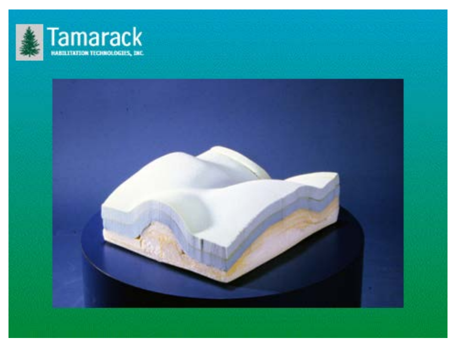
low friction fabric interface patch into the sub-pelvis area of the cushion cover.



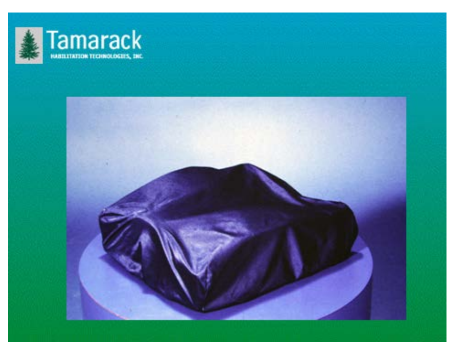
This graph compares friction characteristics of nine different cushion covers.

Reducing heat and moisture may <u>both</u> be facilitated by materials which allow air to circulate close to the skin.

Most cushions are made of closed-cell foam materials so they <u>insulate</u> and contain metabolic heat. If the cushion and/or the cushion <u>cover</u> are air-permeable, moisture may be evaporated reducing both moisture and temperature at the skin surface.

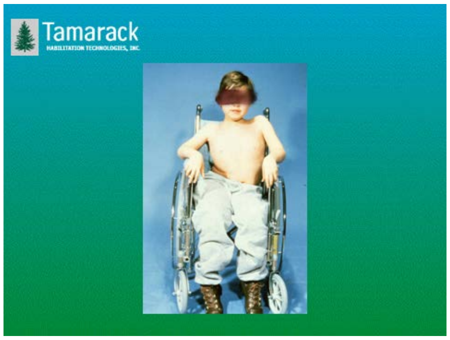


Since I am discussing some ways a cover may enhance the performance of a cushion, it should be mentioned that a poor cover can significantly <u>cancel</u> much of the benefit of a well designed cushion. An ideal cover should be of a stretchy, low modulus, bi-elastic material. Such a material allows the body to immerse down into the deeper contours of the cushion with minimal "tenting" resistance or folding. The opposite would be a heavy, stiff material stretched across the top of the cushion.

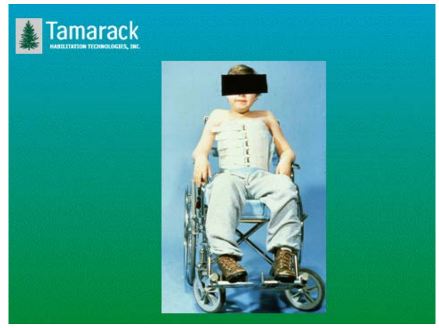


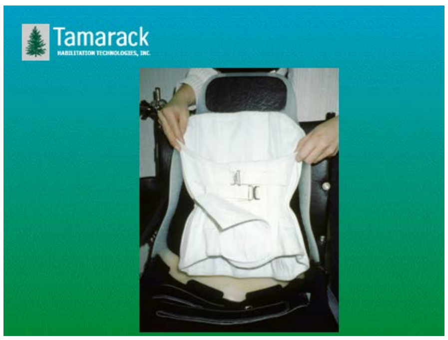
I don't want to end this presentation without a small diversion to comment on something rather simple you can do that can be a profound benefit for many of your spinal cord injury clients.

I discovered this while working with boys who had Duchenne Muscular Dystrophy. If you improve the posture of some people with SCI, they can't breathe as deeply. Flaccid abdominal muscles allow the gut to spill down and out below the ribs. That



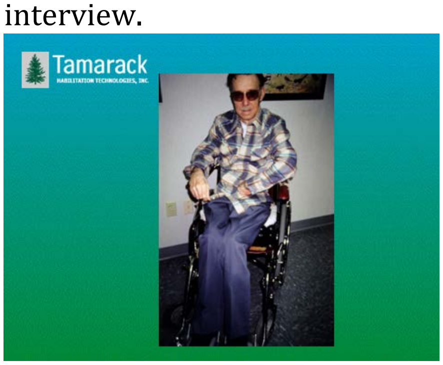
pulls the diaphragm down, diaphragm excursion is reduced and pulmonary inspiration volume is reduced.

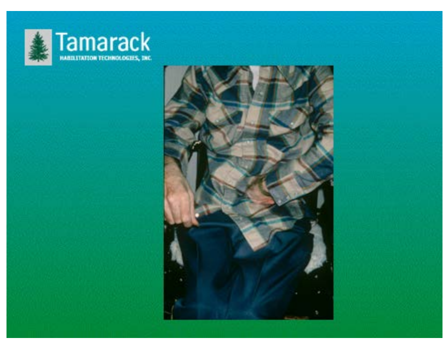




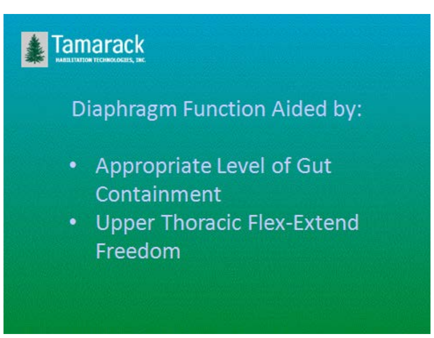
We found that the abdominal jackets we provided those boys to resist spine collapse made a big difference in their pulmonary function. Many people with SCI present with shallow breathing, weak cough, some even can't speak louder than a whisper. We encountered those things so often that I routinely would ask them to show me their strongest cough. I then knelt behind their chair, wrapped my arms around their midsection, squeezed gently and asked them to cough again. Often a moderate amount of abdominal compression and containment made a dramatic difference.

We provided them with fitted fabric jackets. The improved breathing, coughing and, in some cases, voice volume was remarkable. This gentleman was referred to us for better seating. Notice where his left fist is. It was there throughout our initial interview.





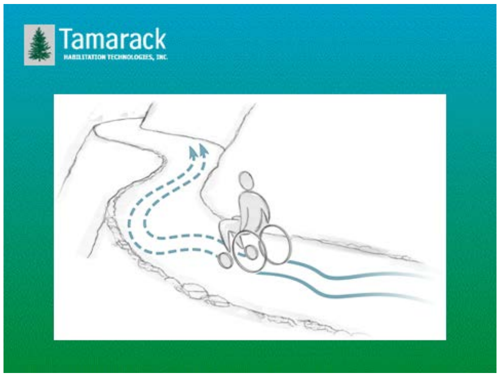
I knew why but I asked him. He said he just felt better with some pressure on his belly. We gave him an abdominal binder to free-up his left arm and hand.



In closing, remember that decubitus ulcers on a wheelchair user are <u>not</u> always from sitting. Ulcers may be acquired during time in bed, during toileting, bathing, or some other routine activity they forget to tell you about.

Also remember that people who live life in a wheelchair are constantly at risk and, because they are human, cannot avoid all the common mistakes and oversights.

If we can provide good seating, we can provide them with a wider margin of safety as they negotiate the road of life.



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