Pressure Injury Prevention: Seated But Not Still

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By Stephen Sprigle, PhD, PT, and Sharon Sonenblum, PhD

Pressure injuries (PrI), previously termed pressure ulcers, remain a critical problem for wheelchair users, with negative consequences on nearly every aspect of their lives.[1-3] Individuals with PrIs experience reduced mobility, activity and participation,[2-4] greater unemployment,[5] and are at increased risk for future PrI development[6] and premature death.[7] Wheelchair users at risk of PrIs include a disparate list of medical diagnoses such as spinal cord injury (SCI), multiple sclerosis (MS), cerebral palsy, spina bifida, and other neurological and orthopedic conditions that impact mobility and sensation.[8] This article presents research results that indicate in-seat movement can be effective in promoting tissue health of wheelchair users who are at risk of developing pressure injuries.

The formation and underlying causes of PrIs are quite complex, with multiple influencing factors.[1] By definition, PrIs form in response to forces on tissue, and studies on PrI etiology have naturally focused on the damaging mechanisms of tissue loading. Long-standing research has clearly demonstrated that the damaging effects of tissue loads are related to both its magnitude and duration.[9-12] Simply stated, tissues can withstand higher loads for shorter periods of time.

For obvious reasons, researchers cannot cause ulcers in people, so we make inferences when applying results about PrI etiology to inform clinical interventions. In fact, clinical interventions addressing both the magnitude and duration of buttocks loading are based upon research findings. As a part of wheelchair evaluations, clinicians address magnitude of loading when selecting wheelchair cushions that offer proper buttocks support for their clients. These evaluations also include the training of a pressure-relief regimen that seeks to reduce load duration by regularly shifting weight off the load-bearing tissues of the buttocks.[13-17] Persons who are physically able to perform pressure reliefs are taught to lift their buttocks off the cushion surface, lean forward, and/or lean to each side. A few guidelines have been published recommending that persons perform pressure reliefs with varying frequencies ranging from 15 to 30 seconds every 15 to 30 minutes to 60 seconds every hour.[15,18-20]

We have been studying how wheelchair users move within their seats, including weight shifts and pressure reliefs. These activities share the goal of redistributing weight over the buttocks surface during sitting. We distinguish weight shifts and pressure reliefs by their magnitude and duration. Pressure reliefs are volitional actions that seek to completely off-load the ischial tuberosities. Weight shifts are any activity that redistributes the forces on the buttocks for at least several seconds. This research was motivated by the hypothesis that wheelchair users should be encouraged to move within their seat and to perform functional activities that alter the loading on their buttocks. We set out to study the hypothesis that, “Just because one sits, doesn’t mean one should sit still.”

Two research approaches have been used: 1) controlled experiments that measure physiological and biomechanical parameters, and 2) monitoring weight shifts during everyday life. Two groups of wheelchair users have been studied to date: power wheelchair users with a tilt-in-space (TIS) seating system and full-time manual wheelchair users. Together, these cohorts represent full-time wheelchair users who are taught to perform pressure reliefs. One group uses a mechanical system, whereas the other uses changes in posture or positioning to unweight the buttocks.

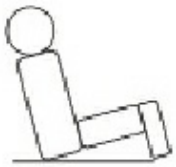
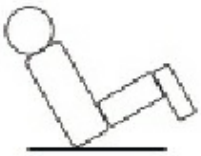
TILT POSITION	INCREASE IN MEAN BLOOD FLOW COMPARED WITH UPRIGHT (SD)	P-VALUE
 15°	8% (19%)	0.016
 30°	24% (48%)	0.003
 45°	84% (84%)	0.007

Table 1. Increase in blood flow during tilt.

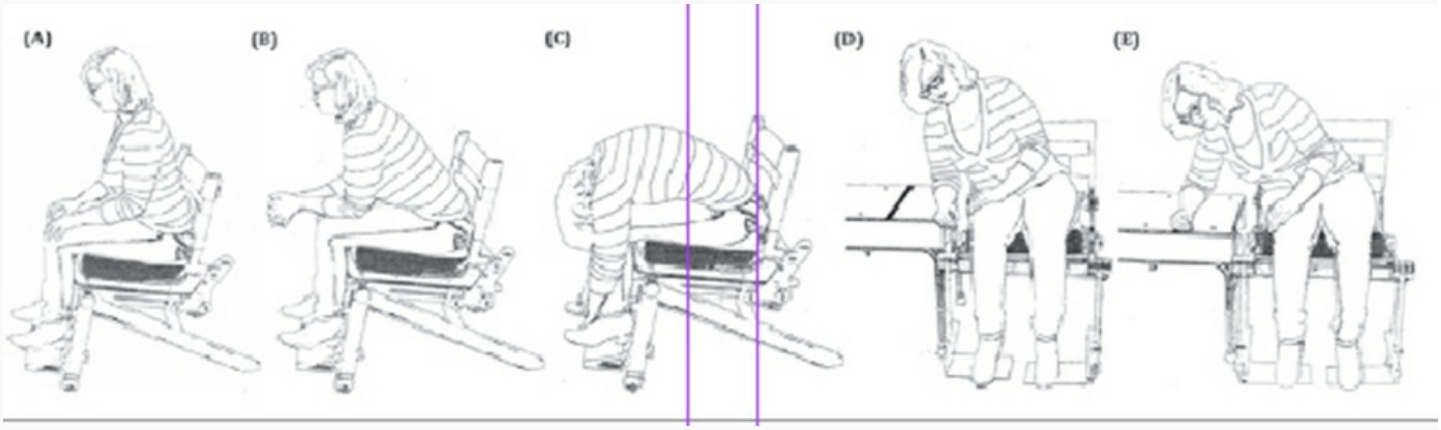


Figure 1. Changes in pressure and blood flow compared to upright sitting. [22]

	POWER TILT	
	Position	**Mean (SD)**
Smaller Movements	Angle change of 5° lasting > 20 sec	3.0 (2.9)
Larger Movements	Tilts > 30° lasting > 1 minute	0.3 (0.5)

Effectiveness of Weight Shifts During Controlled Experiments

Using controlled experiments, interface pressure and blood flow were measured directly under the ischial tuberosities as participants adopted different positions and postures.

Power TIS users were seated in their own wheelchairs and were sequenced through different magnitudes of tilt.[21] Physics dictates that the greater the tilt, the less body weight will be transferred through the buttocks to the seat surface. This is, in fact, one medical justification for TIS when prescribed for persons unable to adequately shift their weight independently. Table 1 shows the changes in ischial pressure and blood flow during three magnitudes of tilt: 15º, 30º, and 45º. One surprising result is that a significant, albeit small, benefit results from the smaller 15 degrees of tilt. The expected result is also demonstrated, namely, the greater the tilt, the greater the impact. Is 15 degrees enough to protect skin? We cannot infer that, but we did learn that smaller tilt magnitudes have a positive effect on blood flow.

MANUAL WEIGHT SHIFTS	
Position	**Mean (SD)**
Weight Shift: Pressure Reduction > 30%	2.4 (2.2)
Pressure Relief: Complete unloading of both buttocks lasting > 15 seconds	0.4 (0.5)

Table 2. Pressure reliefs and weight shifts measured in everyday life.

Manual wheelchair users were studied differently. Each participant sat on three different cushions and was asked to adopt five different postures.[22] These postures included techniques to perform pressure reliefs (full forward and side leans) as well as postures that result in smaller shifts in the seated posture during leaning and reaching activities. Figure 1 illustrates the studied postures and reports the changes in ischial pressure and blood flow compared to a self-selected upright posture. The important result is that many postures have a significant effect on the buttock tissues. In particular, resting the elbows on the thighs results in a 95% increase in ischial blood flow compared to an upright posture, and side leans can increase blood flow more than three times than in upright.

Pressure Reliefs and Weight Shifts During Everyday Life

To extend the results of the controlled studies, we wanted to characterize the weight shift and pressure relief behavior of wheelchair users as they went about their daily activities.[23,24] Instrumentation was added to their wheelchairs that monitored seat angle in the TIS users and seat weight distribution in the manual wheelchair users. Data was captured for 1 to 2 weeks.

The results showed a similarity in both groups (Table 2). Neither group adhered to the pressure relief regimen as taught during rehabilitation, but both performed weight shift activities at a much higher frequency. Power TIS users tilted past 30º an average of 0.3 time per hour or once every 3 1/3 hours, and manual wheelchair users performed a pressure relief every 0.4 hours or once every 1 ½ hours.

Trying to study whether in-seat movement prevents PrI is complex. It requires a fairly large sample of users who are monitored for extended periods of time. Furthermore, PrIs can result from situations that do not reflect cushion performance. For instance, a person might sit on other surfaces (ie, sofa, bathing chair) that contribute to injury. Another approach is to monitor the in-seat movement of people who have experienced multiple sitting-related PrI and compare them to persons who have not had recurrent injuries. This does not fully address causation but offers useful insight. Figure 2 shows the results from manual wheelchair users in both groups. We found that persons who have experienced recurrent PrI move much less than those who do not. In the very least, it corroborates the finding of the controlled experiments and informs the importance of educating wheelchair users to move.

These results may not be too surprising to clinicians, but they underscore a few important points. The first is that pressure reliefs are not performed at the frequency they are taught. If one considers a functional perspective, this might not be all that surprising. Tilting rearward to 45 degrees or holding a push up or full forward lean places people in nonfunctional postures. This might be considered disruptive during everyday life. If one thinks about this, behaviors that adversely disrupt daily activities are not limited to wheelchair users. There is enough evidence to suggest that many people do not exercise as much, eat as well, or avoid unhealthy behaviors as they intend.

This study also produced interesting insight into weight shifts. Remember that we defined weight shifts as smaller changes in position that are held for shorter periods of time. Weight shifts can occur during functional activities such as reaching or leaning, or may result from postural changes that impact buttocks loading. Power TIS users utilized the

tilt function often, just not to the extreme magnitudes that they were instructed to adopt for pressure reliefs. In fact, they tilted 5 degrees or more 10 times more frequently than they performed pressure reliefs. Similarly, manual wheelchair users performed six times more weight shifts than pressure reliefs per hour.

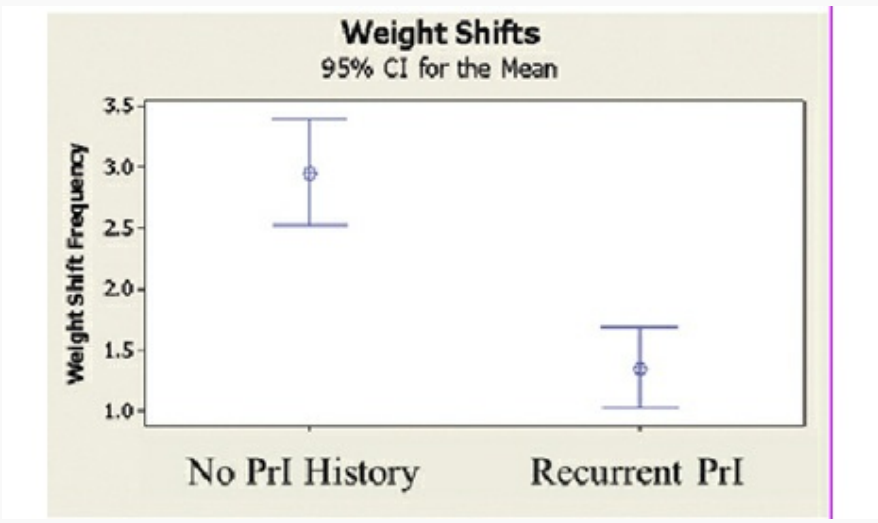


Figure 2. Weight shift frequencies of manual wheelchair users with and without a history of recurrent pressure injuries.

Clinical Implications

- Weight shifts are based upon research linking pressure magnitude and duration to PrI formation. Clinicians should attend to both magnitude and duration of buttocks loading during their interventions.
- Seated activity is good. Putting wheelchair users in a position that they perform activities is both important for functional independence as well as for tissue health.
- Encourage activity. Leaning and reaching has positive tissue benefits. During an intervention, wheelchair users should be taught strategies to perform tasks from the seated posture that not only promote functional activity but redistribute loading on their buttocks.
- Most persons do not have a weight shift routine. Clinicians should accept the fact that simply delivering weight shift training and instruction does not translate into adherence. Individualized training, during which “feasible and realistic” weight shifts are discussed, may be worth consideration. This is not to suggest that full weight shifts should not be taught. However, augmenting pressure relief instruction with weight shift instruction appears warranted.
- Take TIS users through a full range of tilt to decrease fear. TIS chairs are very stable, but achieving full tilt can be disconcerting for users. Furthermore, TIS users should be encouraged to use the tilt feature as often as possible. Sitting at 15^0 tilt helps reduce the forward sliding tendency in the chair and also has a positive effect on buttock blood flow. As this might be a functional posture during certain activities, it can be taught as such. In our study, one-third of participants spent the majority of time in $>15^0$ of tilt and 80% spent more than 1 hour per day in tilt exceeding 15 degrees. **RM**

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