RESNA Position on the Application of

Tilt, Recline, and Elevating Legrests for Wheelchairs

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The purpose of this document is to share typical clinical applications as well as provide evidence from the literature supporting the application of these Assistive Technology interventions to assist practitioners in decision-making and justification. It is not intended to replace clinical judgment related to specific client needs.

Background

Wheelchair technology has evolved considerably in the past fifteen years. Several power and manual features can be added to a power wheelchair to address a constellation of medical conditions. Previous Position Papers have addressed the medical benefits of seat elevation and standing. Tilt, recline, and elevating legrests are additional options that can be operated manually or that come as power options. This Position Paper addresses the common medical reasons for which these features are prescribed and the scientific and clinical evidence for such prescription.

A wheelchair users' survey study (Trail, Nelson, Van, Appel, & Lai, 2001) examined the utility of various wheelchairs and their features and found that tilt, recline, and elevating legrests were the most desirable features on a power wheelchair. Manual- and power-operated features of power wheelchairs allow for changes in body and leg position and are features that have gained clinical acceptance for people with disabilities who have limited ability to reposition or reorient their bodies independently.

Changes in body position are necessary to address issues related to postural alignment, function, physiology, transfers and biomechanical issues, contractures or orthopedic deformities, edema, spasticity, pressure management, comfort, or dynamic movement. Many payer sources and reviewers often believe that tilt and recline are interchangeable. While they may compliment each other, they are not interchangeable and serve very unique medical purposes.

Definitions

- Tilt systems change seat angle orientation in relation to the ground while maintaining the seat to back and seat to legrest angles. Traditional tilt operates in the sagittal plane while lateral and rotational tilt systems operate in the coronal or oblique planes respectively.
- Recline systems provide a change in seat to back angle orientation while maintaining a constant seat angle with respect to the ground.
- Elevating legrests allow individuals to change the angle of orientation of the legs and/or footrests relative to the seat, extending the knee. Some legrests are articulating, which means they lengthen while also extending the knee.

Manual or Power Functions?

Tilt, recline, and elevating legrests are available as either manual- or power-operated features. They serve a variety of medical purposes, which are described below. Clinicians prescribe power features if an individual's medical condition is such that they would benefit from one of these features, but if they are not able to operate the manual feature independently due to a constellation of cognitive, motor, or sensory impairments. These power features are generally medically necessary as long as the individual can operate the power version and have medical reasons for their use. Age should not be used as a determinant for whether or not an individual is capable of operating power features; the elderly and young alike are often able to use power features adequately. Rather, clinicians must evaluate each client's medical and social situation on a case by case basis (Kreutz, 1997; Lange, 2000b).

If an individual is unable to operate power or manual features independently, it may be necessary to prescribe manual features so that a caregiver can assist with positioning and care of the wheelchair user. These manual features are beneficial if the individual needs repositioning many times throughout the day. However, if the wheelchair user can operate power features independently, then those are most appropriate and should be prescribed.

Postural Realignment and Function

Tilt and recline provide a means for gravity assisted positioning. Some manufacturers allow for a fixed recline angle to be crafted into the wheelchair frame (Lange, 2000b; Sommerfreund & Masse, 1995). This is useful when the individual needs a degree of recline to accommodate trunk positioning, and this feature can be combined with a tilt system. However, the majority of individuals generally need recline angles that can be changed, especially if they spend the majority of their time in the wheelchair. Clinicians recommend that the user with poor trunk or head control can alter his or her center of gravity by altering tilt and recline angles to gain balance and stability (Kreutz, 1997; Lange, 2006). Postural alignment is especially important for children or adults with progressive or static scoliosis (Lange, 2000b).

According to many clinicians, tilt is useful for those with contoured seat backs since it maintains the appropriate angles for the client to remain in contact with the shape of the backrest (Kreutz, 1997). Because some recline systems cause shear forces against the individual's back, the problem of shear can be further compounded with a contoured backrest. The interface between the client and seat back can then be suboptimal. However, recline systems reported in the clinical literature (Kreutz, 1997; Pfaff, 1993) are available that allow the molded back to track along with the client as they recline, maintaining the seat interface. The clinician should ensure that the client stays in position when using any recline system with a molded back and should consider using tilt in combination with recline in these cases.

One benefit of proper alignment is enhancement of function (Nwaobi, 1987). For example, tilting anteriorly may be clinically beneficial to assist with functional reaching. Use of legrests and footrests have been shown to improve balance, completion of activities of daily living, and maintaining safe positioning during braking (R. A. Cooper, Dvorznak, O'Connor, Boninger, & Jones, 1998; Janssen-Potten, Seelen, Drukker, Spaans, & Drost, 2002). Tilt or elevating legrests can enable ground clearance for those with low seat heights who encounter obstacles or can improve access to load the chair into a vehicle. Those who maintain the legs in elevated position may need power features to change the position of the legrests regularly throughout the day in order to negotiate obstacles for clearance. Tilt can be used to promote stability in the chair when an individual tends to slide out of the chair due to extensor tone of the back or contractures. Individuals also sometimes use tilt for stability when driving downhill or when carrying objects in their laps.

Power features are especially important for pediatric users to allow them better access to their environment. More accessible environments may allow for early stimulation, which is important for achieving developmental milestones, especially in children with disabilities (Garcia-Navarro et al., 2000).

Physiological Implications

Proper postural alignment may also aid in maintaining vital organ capacity and has several physiological implications (Lacoste, Weiss-Lambrou, Allard, & Dansereau, 2003; Nwaobi, 1987) as documented below.

Orthostatic Hypotension

The prevalence of orthostatic hypotension is high in the general population (Bradley & Davis, 2003) but it especially affects individuals with such conditions as cardiac disease, Spinal Cord Injury (SCI), diabetes, neuropathy, Multiple Sclerosis, and Parkinsonism. Part of the management of acute symptoms such as dizziness includes assuming a recumbent or semi-recumbent position (Claydon, Steeves, & Krassioukov, 2006). Clinicians suggest that using a combination of tilt, recline, and power legrests can help to achieve such a position (Kreutz, 1997). One cross-sectional study that evaluated several interventions for orthostasis (Kreutz, 1997; Ten Harkel, Van Lieshout, & Wieling, 1992) showed that sleeping in bed with the head elevated at 10 to 20° improves symptoms. More research is needed to determine if positioning during the day, such as in power wheelchairs, might be of additional benefit for long-term management.

Visual Orientation, Speech, Alertness, Arousal, Respiration, and Eating

Some individuals may also need tilt and recline for visual orientation, speech, alertness, and arousal. It has been documented clinically that tilt and recline systems can be used to orient the trunk and head position (Kreutz, 1997; Lange, 2000a), stimulate the vestibular system (Lange, 2000a), improve line of sight (Kreutz, 1997), and to allow for better communication (Kreutz, 1997). Providing a slightly tilted or reclined position with headrest support can prevent neck hyperextension if neck flexors are weak. On the other hand, individuals whose neck and trunk are too flexed when sitting upright may need further tilt or recline to encourage extension. Clinicians use customized positioning to maximize breathing and speaking ability by maintaining vital organ capacity and to reduce risk for aspiration (D. Cooper, 2004; Hardwick, 2002; Lange, 2006). Therapists also sometimes use positioning for stimulation of digestion after meals (D. Cooper, 2004).

Bowel and Bladder Management

Some bowel and bladder management techniques such as changing protective undergarments or intermittent self-catheterization (ISC) require supine positioning (Wyndaele, 2002). Some individuals cannot comply with their recommended programs because they cannot position themselves appropriately and may require additional assistance (Wyndaele, 2002). Non-compliance with bladder programs may result in increased urinary tract infections and, ultimately, increased morbidity including renal complications (Salomon et al., 2006). Individuals with indwelling catheters may experience backflow of urine when using a tilt system. However, using features such as recline may allow an individual to perform their care independently and reduce the need for caregiver assistance.

Transfers and Biomechanical Issues

Positioning may also be necessary in order to improve transfer biomechanics of both the wheelchair user and the caregiver. When an individual is independently transferring from an upright position, the shoulder can experience forces as high as two and a half times mean arterial pressure (Bayley, Cochran, & Sledge, 1987). An individual can use tilt and recline to stabilize their trunk in order to position themselves properly for a transfer. Reducing load by adjusting the center of gravity during an independent or assisted transfer may reduce the risk for upper limb pain and injury (Herberts, Kadefors, Hogfors, & Sigholm, 1984). Recline may be used in combination with elevating legrests to enhance sliding transfers with a person in supine position. Anterior recline ("precline") can add momentum to the trunk for transfers. Anterior tilt can be used with a seat elevator to improve transfers from and to elevated positions or to reduce shoulder load when activities would otherwise need to be performed with arms overhead. Reducing this load is vitally important for preservation of upper limb function (Boninger & Stripling, 2007).

Better biomechanical position not only reduces the need for assistance for Activities of Daily Living (ADLs) and transfers but also reduces the risk of injury to caregivers (Edlich, Heather, & Galumbeck, 2003; Fragala & Bailey, 2003). Furthermore, by prolonging sitting tolerance with use of power features, the number of times a person may need to be transferred can be reduced.

Spasticity

Offering a client the ability to change joint angles can allow independent management of tone. Because tilt systems maintain static joint angles and thus muscle fiber length, clinicians use these features in those with spasticity to offer positional changes without eliciting increases in tone (Kreutz, 1997). Clinically, recline systems should be considered on a case by case basis for management of spasticity since it has been noted clinically that in some individuals recline can increase tone, especially in the spine extensors (Kreutz, 1997; Lange, 2006).

Contractures and Orthopedic Deformities

Clinicians argue that static seating systems can sometimes lead to contractures, especially in the hamstrings (Lange, 2006). Power elevating legrests are often medically necessary when an individual cannot independently operate manual legrests but needs to elevate the lower limbs to manage contractures or orthopedic deformities (Levy, Berner, Sandhu, McCarty, & Denniston, 1999).

Therapists also use elevating legrests to provide passive movement to the knee joints (Lange, 2006). When contractures are present, the legrests should be adjusted to the appropriate accommodative angle to prevent undue tension on the hamstrings and hip joints. It is recommended to use elevating legrests in combination with recline when passive extension of the knee is limited due to hamstring tightness as recline allows extension of the hip. Additional footplate extensions or angle changes might be necessary. Extending the knee near end range, however, can often elicit reflex spasticity in those with central nervous system disorders. Tilt systems with adjustable seat and back angles are also useful for positional changes in those with limited hip range of motion.

Those with limited hip flexion can use tilt and/or recline systems when the seat to back angle is appropriately configured. In some cases, therapists must set a limit to prevent closing of seat to back angle beyond the available hip range of motion so that excess force is not placed on the hips and the user is not pushed out of the seat (Kreutz, 1997). However, some people need to bring their trunk more upright for limited periods of time to engage in activities of daily living such as reaching. The impact of seat to back angle on function must always be considered.

Edema

Clinicians also use power elevating legrests to manage edema (Kreutz, 1997; Levy et al., 1999). The lower limbs of wheelchair users may act as a reservoir for fluid accumulation (Kinzer & Convertino, 1989). Elevation of the legs above the level of the left atrium by about 30 cm is generally recommended as part of the management of edema in conjunction with, rather than in lieu of, other measures such as support garments (Abu-Own, Scurr, & Coleridge Smith, 1994; Douglas & Simpson, 1995; O'Brien, Chennubhotla, & Chennubhotla, 2005). This allows for reduction in venous pressure and increases arterio-venous pressure and capillary flow. Elevating legrests, therefore, are most effective when used in combination with tilt to allow elevation of the legs above heart level. Some tilt systems, when combined with elevating legrests, still do not allow for adequate leg elevation above the heart and in these cases, elevating legrests must be combined with tilt and recline systems.

Pressure Relief

Studies comparing seating pressure among subjects with SCI, spina bifida (SB), and control subjects (Aissaoui, Kauffmann, Dansereau, & de Guise, 2001; Hobson, 1992; Vaisbuch, Meyer, & Weiss, 2000) have shown that individuals with disabilities experience seating pressures that are significantly higher or focused over smaller surface areas than those experienced by individuals without disabilities. A tissue's tolerance for pressure depends on the disability type as well as a number of additional factors, including age, nutrition, temperature, anatomical location, moisture, presence of incontinence, and tissue metabolism (Edlich et al., 2004; Sprigle, 2000).

A key component of preventing and managing pressure ulcers involves the use of various support surfaces and position changes to reduce forces. There are two different types of forces that act on tissues (Sprigle, 2000). "Normal" force acts perpendicularly to the skin surface. "Shear" force acts tangentially to the skin surface and or deeper tissues. Both can occlude blood and lymph vessels. Friction is a type of shear force that acts at the interface between the skin and supporting tissues. When shear occurs, the magnitude of the load needed to cause ischemia is reduced to half (Bennett, Kavner, Lee, & Trainor, 1979).

Valid and reliable outcome measures for seating pressure have not always governed clinical practice. Conventionally, manufacturers of pressure-relief products have felt that any load that exceeds 32 mmHg is harmful. This value came from a historical article in 1930 (Landis, 1930) calculated the capillary pressure of the fingernail bed to be approximately 32 mmHg and also from microscopic studies (Kosiak, 1959, 1961) in which 32 to 40 mmHg was considered a safe threshold. However, to date, no research has produced a cutoff value for load that is known to be causative for ulcer formation. In fact, one reliability study on pressure testing (Sprigle, Dunlop, & Press, 2003) has shown that peak pressure is not a reliable outcome measure and has suggested that the use of other, more reliable measures including average pressure may be more appropriate. One retrospective review of tissue oxygen measurement techniques (Coggrave & Rose, 2003) used transcutaneous oxygen tension as a reliable means of determining load on the tissue.

Duration of the load is also a factor in ulcer formation (Sprigle, 2000). Many clinicians maintain that even the best pressure relief cushions are inadequate to prevent pressure ulcers if the individual sits on it too long without adequate position changes (Lacoste et al., 2003). Therefore, current accepted practice is to provide a combination of cushion technology and means for position changes in order to prevent and treat pressure ulcers (Henderson, Price, Brandstater, & Mandac, 1994).

Wheelchair Pushups

Clinicians often prescribe power features when an individual cannot transfer into and out of the chair independently. This is based on the assumption that prolonged sitting increases risk for skin breakdown and limitations in ability to transfer precludes adequate weight shifting capability. There is, in fact, a wealth of scientific evidence to support this notion, but transfer ability is not the only factor that should be considered.

Many wheelchair users perform wheelchair “push-ups” as a way to alleviate pressure. Most individuals perform such maneuvers for approximately 15-30 seconds (Coggrave & Rose, 2003) but frequency is variable, with recommendations ranging from one shift every minute to one per hour (Boninger & Stripling, 2007; "Paralyzed Veterans of America. Pressure ulcer prevention and treatment following spinal cord injury: a clinical practice guideline for health care professionals," 2000; Vaisbuch et al., 2000). In one retrospective review article (Coggrave & Rose, 2003), transcutaneous oxygen tension of 46 subjects performing wheelchair pushups was measured. It was reported that each lift needed to last nearly 2 minutes, regardless of frequency, in order to return tissues to unloaded levels. This is clearly impossible, impractical, and undesirable for any wheelchair user, even if their upper limbs and joints are healthy. In fact, the load on the shoulder and arms during these maneuvers increases substantially and may predispose to repetitive strain injuries (Bayley et al., 1987; Reyes, Gronley, Newsam, Mulroy, & Perry, 1995). Thus, many clients who cannot transfer independently, and even some of those who can, need power seat functions on these bases alone.

Forward and Side Leaning

Several of the studies done in SCI and SB on seating pressures (Coggrave & Rose, 2003; Henderson et al., 1994; Hobson, 1992; Vaisbuch et al., 2000) have shown that forward or side to side leaning can be effective methods for relieving pressure over the ischial tuberosities. However, not all individuals who use wheelchairs have the arm strength or trunk control required to perform these maneuvers independently (Lacoste et al., 2003) or may not be able to do so due to autonomic dysreflexia or neurogenic bladder (Vaisbuch et al., 2000). Moreover, these maneuvers may not be effective when used with some cushions (Koo, Mak, & Lee, 1996). For those individuals who cannot perform adequate weight shifting, current clinical practice is to promote pressure relief by providing power features that the user can operate independently (Lacoste et al., 2003; Vaisbuch et al., 2000).

Power Features for Pressure Relief

Tilt and recline features provide the most pressure relief when used in combination. One study (Vaisbuch et al., 2000) found significantly lower maximum pressure in the combined position of 25° of tilt with 110° of recline in subjects with SB. A study in subjects without impairments (Aissaoui, Lacoste, & Dansereau, 2001) showed that 45° of tilt with 120° of recline provided a 40% load reduction. A study on 2 subjects with tetraplegia (Pellow, 1999) showed a trend toward interface pressure reduction with combination of 45° of tilt and 150° of recline.

Tilt alone may also confer some advantage for pressure relief. Significant ischial pressure relief has been shown at 65° of tilt (Henderson et al., 1994) and lower shear forces noted even at 25° (Hobson, 1992). However, one study showed that 15° or less provides no advantage in terms of pressure reduction (Aissaoui, Lacoste et al., 2001) however may have benefits for postural stability. Power Lateral and Rotational tilt can be beneficial in adding more degrees of freedom to the maneuvers available.

When effects of elevating legrests on posture were studied in subjects without impairments (Stinson, Porter-Armstrong, & Eakin, 2003) it was found that 120° of recline in combination with elevation of legs can significantly reduce seating interface pressure. When used alone, recline tends to reduce normal force but increase shear (Hobson, 1992), especially when individuals recline to 110 and 120° (Aissaoui, Lacoste et al., 2001). Care must be taken with sole prescription of recline because when used in isolation it may put a client at risk for skin breakdown, especially if the client does not know how to use it properly. Additionally, return to upright position after recline can also increase normal forces at the ischial tuberosities (Gilsdorf, Patterson, Fisher, & Appel, 1990), so clinicians often recommend using tilt before return to upright to minimize shear. Elevating legrests may also help in alleviating ischial and foot support pressure (Aissaoui, Heydar, Dansereau, & Lacoste, 2000) and can help reduce shear along the entire seating surface (Carlson, Payette, & Vervena, 1995). The aforementioned “shear reducing” recline systems (Pfaff, 1993) are thought to reduce shear forces, but at the time of this publication, the only evidence to support this is anecdotal. Yet, their utility is especially important clinically when they allow the user to remain in contact with the seat back for positioning purposes.

Simply providing these power features when they are medically necessary may not be adequate; training and follow-up is important. One survey study (Lacoste et al., 2003) showed that although 97.5% of individuals who had tilt and recline used these features every day, less than 35% used these features primarily for pressure relief but rather also to reduce pain and promote comfort. The majority of individuals used angles that were inadequate for pressure relief. There is also insufficient research that documents the appropriate duration and frequency of use of these features but clinicians sometimes estimate a duration of 30 seconds with a frequency of 15-30 minutes or 60 seconds every 60 minutes to be a conservative estimate given the research on wheelchair pushups and clinical practice guidelines published for SCI (Coggrave & Rose, 2003; "Paralyzed Veterans of America. Pressure ulcer prevention and treatment following spinal cord injury: a clinical practice guideline for health care professionals," 2000; Vaisbuch et al., 2000). This evidence substantiates the need for follow up visits with clients for extended biofeedback and training.

Pain, Fatigue, and Sitting Tolerance

Although clinicians may configure seating systems according to body dimensions, the types of seating systems an individual finds comfortable may be quite different from what their anthropometry may predict (Kolich, 2003). Ergonomic literature on drivers suggests that seating systems should not be configured solely based on static postures. Instead, sitting tolerance is a dynamic phenomenon that requires a dynamic assessment (Porter, Gyi, & Tait, 2003). Clinicians face time constraints when doing seating evaluations. The most experienced clinicians doing thorough evaluations are still not always able to assess all of the sitting postures the client will undoubtedly need to assume in daily life in a routine evaluation. In fact, many individuals' postures are so variable that more than 2 hours are needed to observe the critical seating postures an individual assumes to remain comfortable (Gyi & Porter, 1999). This suggests that power features, when used to promote dynamic sitting tolerance, may be useful to assume many postures beyond those seen in a clinical assessment. If power features are not available, and high interface pressures are present, individuals may seek alternative postures that may prolong sitting tolerance but that are poor for overall postural alignment, skeletal development, or function or that may hasten the onset of fatigue or pain.

While there is some disagreement in the literature about what reduces sitting tolerance, higher pressure has been found to be a significant factor (de Looze, Kuijt-Evers, & van Dieen, 2003; Goossens, Teeuw, & Snijders, 2005). Interestingly, in the aforementioned survey study (Lacoste et al., 2003), power wheelchair users stated they primarily used their features to promote comfort and reduce back and joint pain. Indeed, the ergonomic literature on automobile driving suggests back pain is one of the most common symptoms of sitting, especially when seating is not adjustable (Porter & Gyi, 2002). Distance traveled while driving and the number of hours spent sitting are significantly related to low back pain (Gyi & Porter, 1998; Porter & Gyi, 2002).

Dynamic Movement

When allowed to move freely, people are usually in constant motion (Branton, 1969). It is difficult for most individuals to tolerate unsupported and static seated positions for more than a short while (S. Reinecke, Bevins, Weisman, Krag, & Pope, 1985). People generally change postures up to 30 times per hour while sitting (Graf, Guggenbuhl, & Kreuger, 1991). Static seating systems can restrict an individual from assuming the variety of postures that are natural for the body (Bendix & Biering-Sorensen, 1983) and may cause the body to move into postures that are harmful (Bhatnager, Drury, & Schiro, 1985). The only effective way to endure a seated posture for an extended period of time and to be productive and functional in that posture is to change positions constantly (Lueder, 2005). The concept of "dynamic sitting" is endorsed in the ergonomic field for individuals who use office furniture and workstations (Kroemar, 1994) and should undoubtedly be applied to wheelchairs as well, since many wheelchair users may not have the extent of dynamic movement as able-bodied office workers. Power tilt, recline, and elevating legrests can provide individuals who use wheelchairs with a means of providing and assisting with dynamic movement.

Dynamic movement is healthy for the spine. Chair designs that allow passive motion during seating may actually help to prevent back pain (S. M. Reinecke, Hazard, & Coleman, 1994). The loading and unloading of intervertebral discs that occur during dynamic repositioning of the spine may increase nutrient supply to the discs (Andersson, 1981; Kolditz, Kramer, & Gowin, 1985). Indeed, this has also been shown in animal (Holm & Nachemson, 1983) and cadaveric (M. Adams & Hutton, 1983) models. Prolonged static sitting without appropriate back support can increase risk for herniated discs (Kelsey, 1975; (M. A. Adams, Green, & Dolan, 1994) because, when an individual slumps, their spine is flexed, and the anterior annulus experiences a compressive force about 50% higher than when the spine is naturally erect (M. Adams & Hutton, 1985). Reduction in the lumbar curvature during slumping may shift the load to ligaments which can then deform the spine (Kumar, 2004). In addition, while the apophyseal joints can resist intervertebral shear force when the spine is flexed, they are less able to resist compressive force than when in the erect position (M. Adams & Hutton, 1985).

Even when the pelvis is stabilized on the seat, if the backrest is supported at less than 110° of recline, the pelvis can still rotate posteriorly, resulting in flattening of the lumbar spine (Bendix & Biering-Sorensen, 1983; Nachemson, 1981), just as in unsupported sitting. Thus, the pelvis must be supported and the thigh to torso angle must be a minimum of 110° to keep the natural curve of the lumbar spine (Andersson, Murphy, Ortengren, & Nachemson, 1979; Keegan, 1953; Lueder, 2005; Nachemson, 1981). However, individuals in the reclined position also must reach farther to perform ADLs, increasing the load on shoulders and arms and shoulders (Lueder, 2005) as well as the cervical spine (Grandjean, Hunting, & Pidermann, 1983). Also clinically, tilting a seat with a static back angle causes increased thoracic flexion instead of extension (Engstrom, 1993). Therefore, in order to perform a variety of functional tasks comfortably and safely, most users will need varying degrees of recline. For a wheelchair user who is not able to independently cycle through a range of positions using a manually adjustable recline system but who needs to perform a host of functional tasks from the wheelchair, the solution is to use power-operated recline. Obviously, a clinician must consider how shear forces may act in these cases and reserve recline systems for those who can operate them safely and consider tilt in combination with recline.

Summary

Tilt, recline, and elevating legrests may be useful and medically necessary to address issues related to postural alignment, function, physiology, transfers and biomechanical issues, contractures or orthopedic deformities, edema, spasticity, pressure management, comfort, or dynamic movement. However they are not required for or desired by everyone therefore clinical judgment is required in prescription. RESNA therefore recommends power tilt, recline, and elevating legrests when such features are needed to treat or prevent the medical issues described above and when the user cannot operate the manual versions of these features.

While some of the recommendations for use of tilt, recline, or elevating legrests are based on clinical observations, the use of these features is also substantiated by a wealth of scientific literature that stems from research on sitting postures, interface pressures, ergonomics, and user surveys. Provision of one or all of these features may improve an individual's sitting tolerance and overall quality of life by increasing function and reducing pain, and reducing or delaying secondary complications from long term wheelchair use.

RESNA is an interdisciplinary association of people with a common interest in technology and disability. RESNA's purpose is to improve the potential of people with disabilities to achieve their goals through the use of technology. RESNA serves that purpose by promoting research, development, education, advocacy and provision of technology; and by supporting the people engaged in these activities.

Case Examples

Julie is a 24 year old female with SB. She recently developed chronic pressure ulcers on the bilateral ischial tuberosities requiring flap surgery. She presents for a new power wheelchair because hers is now in disrepair. She has been using a power wheelchair with pressure relief cushion and manually elevating legrests to control edema but has no power features. She now cannot operate the manual legrests because of carpal tunnel syndrome. She transfers out of the chair to catheterize herself. She was prescribed a new power wheelchair with tilt, recline, and power elevating legrests. Tilt was used in conjunction with recline for pressure relief. Tilt and elevating legrests were used together to manage edema more effectively. After 6 months of use she noted marked improvement in edema, and her wound closure remained intact. She also now is able to catheterize herself while in her chair, which she finds very useful when she is at work.

Louis is an 85 year old man with history of an ischemic stroke and left hemiparesis. He developed spasticity of the left hemibody that has been unresponsive to treatment with Botulism Toxin. His tone fluctuates, but he notes less spasticity and clonus when his legs are elevated. He can no longer ambulate but is able to stand pivot transfer independently. He lacks dexterity in his left hand to operate manual legrests or hand propel his current manual wheelchair and can no longer use foot propulsion for mobility. He was prescribed a power wheelchair with recline and power elevating legrests to manage tone and accommodate knee flexion contractures. With frequent repositioning of his limbs, Louis has noted an improvement in pain and spasticity.

Yolanda is a 46 year old female with Spastic Athetoid Cerebral Palsy. She is not able to self propel a manual wheelchair and is not independent with power mobility. Her caregivers are propelling her in a depot style manual wheelchair. They note that she slides out of the chair due to extensor tone and coughs and gags when eating because of her slumped position. She is prescribed an attendant-propelled manual wheelchair with manual tilt-in-space feature which aids in keeping Yolanda from sliding out of her chair. Yolanda does not have as much difficulty eating when her position can be changed so that she is more upright while eating.

Hank is a 32 year old man with C6 ASIA A Spinal Cord Injury. He uses a power wheelchair with tilt, recline, and power elevating legrests to control edema and spasticity and to provide pressure relief. He is being evaluated for a new power chair because of electrical problems. He has noted a progression in his scoliosis since his last visit and a significant trunk lean interferes with functional use of his arms. He is prescribed a new power chair with the same features, but this time, power lateral tilt is added. He typically uses slight lateral tilt at all times to improve trunk position, but also often independently adjusts the tilt to aid in pressure relief and stability. He has noted an improvement in reaching, comfort, and use of his computer access device.

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