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RESNA Position on the Application of Wheelchair Standing Devices

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ABSTRACT This document, approved by the Rehabilitation Engineering & Assistive Technology Society of North America (RESNA) Board of Directors in March 2007, shares typical clinical applications and provides evidence from the literature supporting the use of wheelchair standers.

KEYWORDS power features, rehabilitation, standing, wheelchair

INTRODUCTION

The purpose of this article is to share typical clinical applications as well as provide evidence from the literature supporting the application of wheelchair standing devices to assist practitioners in decision making and justification. It is not intended to replace clinical judgment related to specific client needs.

BACKGROUND

Clinical experience suggests that wheelchair users often experience painful, problematic, and costly secondary complications due to long-term sitting. Standing is an effective way to counterbalance many of the negative effects of constant sitting (Dunn et al., 1998; Eng et al., 2001). Standers integrated into wheelchair bases enhance the beneficial effects of standing since they allow for more frequent, random, and independent performance of standing than among persons who use standing devices outside of a wheelchair base. Integration of this feature into the wheelchair base also enables standing to enhance functional activities.

It is RESNA's position that wheelchair standing devices are often medically necessary, as they enable certain individuals to:

- Improve functional reach to enable participation in activities of daily living (ADLs) (e.g., grooming, cooking, reaching medication)
- Enhance independence and productivity
- Maintain vital organ capacity
- Reduce the occurrence of urinary tract infections (UTIs)
- Maintain bone mineral density
- Improve circulation
- Improve passive range of motion

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- Reduce abnormal muscle tone and spasticity
- Reduce the occurrence of pressure sores
- Reduce the occurrence of skeletal deformities
- Enhance psychological well-being

Special precautions must be exercised when utilizing standers in order to avoid the risk of injuries such as fractures. A licensed medical professional (physical or occupational therapist) must be involved with assessment, prescription, trials, and training in the use of the equipment.

Definitions

A standing feature integrated into a wheelchair base allows the user to obtain a standing position without the need to transfer from the wheelchair. A mechanical or electromechanical system manipulated via levers or the wheelchair's controls moves the seat surface from horizontal into a vertical or anteriorly sloping position while maintaining verticality of the legrests and backrest, thus extending the hip and knee joints. A full vertical standing position can be achieved directly from sitting, through gradual angle changes from a laying position, or a combination of these positions. Most wheelchair standers allow for full or partial extension of the hip and knee joints and full upright or partially tilted positions. Wheelchair standers are available on manual or power wheelchair bases. Wheelchair standing devices address the medical and functional needs described in the sections to follow.

Functional Reach and Access to ADLs

Standing adds a significant amount of vertical access. Since the seating surface moves into a vertical position, typically the amount of additional vertical access equals the user's seat depth. This allows people to access kitchen cabinetry, light switches, microwaves, mirrors, sinks, hangers, thermostats, medicine cabinets, and many other surfaces to enhance their abilities to perform ADLs, depending on their upper extremity function. An integrated wheelchair stander system allows for moving about while in a standing position, and standing can become an integral and functional part of the day and the user can perform a variety of ADLs while in the standing position, combining functional and medical benefits. A standing position can be assumed as needed, both for indoor and outdoor activities–it can aid productivity and integration at work, school, church, or enhance independence, such as when shopping for groceries. Being able to perform standing from one's wheelchair also minimizes transfers, thereby enhancing safety, conserving energy, and reducing dependency. Research suggests that in addition to expense and lack of awareness, the major reasons for not using stationary standers for wheelchair users with spinal cord injuries (SCIs) are time constraints, lack of assistance, and/or lack of space for an extra device (Eng et al., 2001).

Passive Range of Motion, Contractures

Standing extends the hip and knee joint to provide position change. Animal studies have shown that muscles fixed in a flexed position result in increased contractures of the joints, especially when the bones are still growing (Trudel & Uhthoff, 2000; Trudel et al., 1999). Many people in wheelchairs have limited access to therapy or caregivers who can provide the necessary amount of ranging; standers integrated with the wheelchair base allow them to perform this important activity on their own and with higher frequency. Standing, however, should not be considered as a substitute for therapy.

Vital Organ Capacity

During standing, the pelvis tends to assume a more anterior tilt or neutral position, allowing for an increase in lumbar lordosis as compared to sitting. This in turn helps establish a better alignment of the spine and extend the upper trunk. Extension of the upper trunk results in reduced pressure on the internal organs, thereby enhancing respiratory and gastrointestinal capacity and functioning. This can prevent or delay many of the secondary complications so often seen in wheelchair users.

- *Respiration:* Many users experience improved lung capacity when standing often. Studies have shown that those who stand frequently in standing power wheelchairs have lesser or delayed occurrence of respiratory complications and improved respiratory volume (Eng et al., 2001). Standing can also help reduce congestion and coughing (Stainsby & Thornton, 1999).

- *Gastrointestinal problems:* Standing wheelchairs users also experience lesser or delayed occurrence of gastrointestinal complications, for example via improvement in gastric emptying (Dunn et al., 1998; Eng et al., 2001).
- *Bowel function:* Some users have experienced improved bower regularity, reduced constipation, and lesser occurrence of accidental and unregulated bowel movements as a consequence of using wheelchair standers (Dunn et al., 1998). Elimination of chronic constipation and significant reduction in bowel care time have also been shown as a result of frequent standing (Eng et al., 2001; Hoenig et al., 2001). Chronic constipation can lead to bowel obstruction, a dangerous condition often requiring surgery. Unregulated bowel movements can lead to fecal incontinence at a time when the client cannot be cleaned by a caregiver, increasing the risk of developing pressure sores.
- *Increased bladder emptying:* Users of standing devices have reported that they are able to empty their bladders more completely than prior to using the device (Dunn et al., 1998).

Urinary Tract Infections

UTIs are the third most frequent complication for clients with SCIs and a frequent secondary complication for many other wheelchair users (McKinley et al., 1999). Prolonged immobility causes hypercalcemia, increased urinary calcium output, and also reduces bladder emptying (Issekutz et al., 1966). By reducing contributing risks, standing wheelchairs have been shown to reduce the occurrence of UTIs, which could lead to kidney infections (Dunn et al., 1998).

Bone Mineral Density

Many wheelchair users experience significant reduction in bone mineral density (BMD) due to the lack of weight bearing in the lower extremities. In fact, without gravitational or mechanical loading of the skeleton, there is a rapid and marked loss of bone. This results in osteoporosis and risk of fractures. Research suggests that weight bearing is superior to nutritional supplements in preventing BMD loss and that the mechanical loading of the bones should be dynamic for full prevention of BMD loss. It also appears that with discontinuation of the weight-bearing program, BMD levels will continue to decrease and/or return to pre-weight-bearing values.

While stationary standers lessen the loss of BMD, wheelchair standers may actually eliminate BMD loss altogether, given their ability to provide dynamic weight bearing through the lower extremities. Populations with a variety of disabilities have been studied for loss of BMD, such as children with cerebral palsy or spina bifida, as well as adults with stroke, multiple sclerosis, and SCIs (Thompson et al., 2000). Even if BMD loss has not yet occurred in a user, standing can be an effective means to help prevent this secondary complication.

- *Loss of BMD:* Review studies establish the direct relationship between weightlessness and loss of BMD, as well as the relationship between osteoporosis and a high risk of fractures (Ehrlich & Lanyon, 2002; Martin & Houston, 1987; Martin & McCulloch, 1987). Studies with astronauts and people in bed rest quantify the negative effect of weightlessness and lack of weight bearing on BMD (Lutz et al., 1987; Mazess & Whedon, 1983; Whedon, 1982, 1985; Whedon et al., 1976). This can be as high as 36% loss of the cross-sectional area of a non-weight-bearing bone within a month (Lanyon et al., 1986). In bedrest, the average urinary calcium loss at the peak is about 150 mg per day, which corresponds to 0.5% of total body calcium (Deitrick et al., 1948; Donaldson et al., 1970; Hangartner, 1995). For people with disabilities, numerous studies point out the benefits of frequent passive standing and weight bearing/exercise for BMD (Goemaere et al., 1984; Kaplan et al., 1978, 1981; Kunkel et al., 1993).
- *Fractures and loss of independence:* Loss of BMD leads to osteoporosis and the consequent risk of fractures. Articles on children with osteogenesis imperfecta recommend frequent standing in childhood to maximize adulthood independence by minimizing fractures and the likelihood of broken bones (Binder et al., 1984; Bleck, 1981). Many people with disabilities often heal slower as well. Fractures may limit short- and long-term function.
- *Supplements:* Evidence suggests that while appropriate nutritional supplements may reduce calcium loss from the bones, mechanical loading is superior to supplements for BMD maintenance (Lanyon et al., 1986). Dietary changes, such as increased intake of calcium and/or vitamin D, have not proven effective at minimizing disused bone loss (Sinaki, 1995).

- *Mechanical weight loading:* Living bones constantly adapt themselves to the mechanical forces applied to them, and their structure is directly linked to their weight-bearing activity and forces occurring due to movement against resistance (Simkin & Ayalon, 1990). Weight-bearing activity can be thought of as any activity that is done while upright, requiring the bones to partially or fully support the body's weight against gravity (Bonnick, 1994). Impact-loading, weight-bearing activity therefore involves some impact or force being transmitted to the skeleton during weight bearing. Standing provides mechanical loading through the longitudinal axes of the lower extremity bones. When the body is upright and extended, the bones of the lower extremities carry the entire weight of the body, and therefore loading is most efficient. Since the lower extremities normally carry the entire body's weight, they are the most prone to bone degeneration due to reduced or limited weight bearing.
- *Dynamic loading:* Further studies clarify that standing should be dynamic (higher multitude and varied magnitude) in order to fully prevent loss of BMD. According to the scientific literature, static loading is less efficient than dynamic loading in prevention of BMD loss (Fritton et al., 2000; Lanyon, 1986; Lanyon & Rubin, 1984; McLeod et al., 1988; Rubin & Lanyon, 1984). A recent study of children with disabling conditions found that a 6-month standing program with a stationary stander still resulted in BMD reduction (of 6.3%), while utilizing vibrating plates underneath the standers actually increased BMD (by 11.9%) in the subjects (Ward et al., 2004). This is of utmost importance regarding standing wheelchairs, since they offer dynamic loading in a variety of ways. When using a mobile wheelchair base during standing, vibration occurs due to the movement of the wheelchair applying dynamic loads to the bones of the lower extremities. In addition, small obstacles (e.g., carpet edges, door thresholds, tile edges) provide dynamic input when the user drives over them. Standers integrated with a wheelchair base also allow for frequent loading of the bones throughout the day simply via partial standing.
- *Maintenance of weight bearing:* For the weight-bearing exercise to be effective, the mechanical stress placed on the bone must exceed the level to which the bone has adapted (i.e., short periods of intense loading can produce more new bone than long-term routine loading) (Frost, 1990). However, long-term routine loading is important in maintaining bone density. And although bone responds to mechanical loading, it is easier to lose bone through inactivity than to gain more through changes in functional loading. When weight-bearing exercise is not continued, bone mass reverts to pretraining levels (Dalsky et al., 1988; Drinkwater, 1994). With standers integrated into a wheelchair base, the user is not dependent on circumstances (such as caregiver availability) to continue standing. Consequently, maintenance of a standing program and higher frequency of standing are more likely. Additionally, integrated standers allow for standing nearly any time for any length of time, and therefore weight loading is more likely to be of random distribution, which appears to be superior in BMD loss prevention.

Circulation

Users have also experienced improvement in lower extremity circulation as a consequence of utilizing a wheelchair stander (Eng et al., 2001). One benefit is reduced swelling in the legs and feet.

Tone

Wheelchair standers also aid in reduction of excess muscle tone; research indicates that muscle stretch combined with weight loading reduces muscle tone more than stretching alone (32% vs. 17%) (Odeen & Knutsson, 1981). Some users experience tone reduction in their upper extremities due to better skeletal alignment in a standing position. This may translate into improved speech and better hand and arm function to perform ADLs. Tone reduction can improve comfort, minimize further range of motion losses, improve function, and conserve energy.

Spasticity

Studies show that standing wheelchair users have experienced significant reduction in spasticity (Dunn et al., 1998; Eng et al., 2001). This helps with transfers, can aid in better sleep, reduces fatigue and pain, and improves positioning in the wheelchair. Standing has an immediate and significant effect on spasticity (Bohannon, 1993).

Pressure Sores

When fully standing, pressure is completely relieved off the ischial tuberosities (ITs). However, when tilting or reclining, there is only partial redistribution of pressure underneath the ITs (Aissaoui et al., 2001; Hobson, 1992). Pressure ulcers are the primary complication for people with SCIs and many other adults who sit in wheelchairs all day long (McKinley et al., 1999). There is evidence that users have suffered fewer pressure sores while using standers or integrated wheelchair standers (Dunn et al., 1998; Eng et al., 2001; Hobson, 1992).

Skeletal Deformities

Clinical experience suggests that extension of the upper trunk and proper alignment of the hip during standing help delay typical skeletal deformities often seen in people who sit in a wheelchair for long periods of time, such as fixed posterior pelvic tilt, kyphosis and scoliosis of the spine, and windswept deformities of the lower extremities. During standing, the head of the femur usually ends up better seated in the acetabulum, which is important especially for children to promote healthy skeletal alignment as well as to promote proper development of the acetabular socket.

Community Environments, Vocational and Recreational Benefits

Integrated wheelchair standers can benefit users in a variety of community settings to enhance their independence, improve vocational activities, and enable recreational activities. Examples include but are not limited to the following:

- Improved ability to reach higher shelves in grocery stores and other shopping facilities
- Ability to access vending machines, payphones, high elevator buttons, coffee shop counters, and so forth
- Improved ability to stand up to access fax machines, drawers, client files, and other necessities at work
- Ability to be employed in certain jobs that need to be performed from a standing position (e.g., hotel receptionist, clerical or medical worker, hair stylist)
- Enhanced ability to engage in recreational activities (e.g., standing up with others in a ball game).

Additional Benefits

Additional benefits of utilizing an integrated wheelchair standing system include but are not limited to:

- Fatigue is reduced due to the benefits mentioned earlier, thereby prolonging tolerance in terms of staying in the wheelchair for longer periods of time.
- Some male users can use a public urinal independently as opposed to transferring to a toilet or using catheterization.
- The need for attendant care is reduced by lessening the need to transfer in and out of the wheelchair and improving the ability to range independently and perform ADLs.
- Back pain and risk of injury are reduced among caregivers by minimizing the amount of transfers they need to perform.
- Partial standing provides an anteriorly sloped femur position, which can translate into a better pelvic alignment and enhanced lumbar lordosis. Clinical experience suggests that some clients find this position improves their alertness and/or their upper extremity function.
- Many children who use mobility equipment throughout the day are on intensive standing programs. They often have a stander at school and one at home. Integrating standing into the wheelchair base reduces the necessary amount of equipment and ensures more frequent and independent initiation of standing.
- Standing up with a tilt table function (gradual angle change into upright) may help alleviate problems with orthostatic hypotension, especially after prolonged bedrest.

Psychosocial Indications

A standing position can lend wheelchair users a heightened sense of confidence and equality by enabling eye-to-eye conversations with the nondisabled society. Many everyday and special occasions in our society require standing, such as citing of the Pledge of Allegiance at school, graduations, weddings, demonstrations, introductions to other people, and religious services. When a person is allowed to stand with everyone else (via an integrated wheelchair standing device), there is a much better sense of integration and the disability becomes less visible, self-esteem is enhanced, acceptance by others is perceived to be higher, and depression is often reduced.

Contraindications

In spite of the numerous benefits, a standing wheelchair might be contraindicated without appropriate assessment. Not everybody is an appropriate candidate for standing. Some contraindications and precautions include but are not limited to:

- *Existing contractures:* The client may benefit from partial weight bearing even if he or she already has fixed contractures of the lower extremities. However, the amount of extension may have to be limited mechanically or electronically, especially in the case of a client without sensation. A wheelchair stander is a powerful device and may cause harm if attempting to overstretch contracted muscles.
- *Skeletal deformities:* Both the sitting and the standing position have to provide appropriate support for stability and function, so special accommodations may have to be provided for people with significant deformities, especially if those deformities are not flexible. Skeletal alignment should be carefully observed while standing.
- *Lack of standing tolerance:* If the client has not been standing for a significant amount of time (schedules vary by person and circumstances), it is necessary to obtain a physician's approval and test a stander to assess standing tolerance. Prior examinations might be warranted, such as X-rays and bone density assessments.
- *BMD loss:* Existing BMD loss and osteoporosis might cause fractures if attempting to stand prematurely and without a well-designed progressive standing program.
- *Postural hypotension:* Blood pressure and dizziness should be checked while standing up, especially for new clients with recent injuries.
- *Sacral shearing:* Some amount of sacral shearing might occur while standing up or sitting down; attention must be paid to skin integrity in the sacral region.
- *Adaptive or custom seating:* Standing systems will not work with one-piece seating systems (as the seat to back angle changes) or highly contoured seating systems due to shear.

Frequency of Standing

Frequency and duration of standing routines are recommended on an individual basis. They vary by tolerance, fatigue, level of current BMD, and functional goals. In general, standing is recommended as long and as often as the user can tolerate comfortably to increase the benefits. Standers integrated into wheelchair bases allow for spontaneous and frequent utilization of standing.

SUMMARY

It is RESNA's position that wheelchair standing devices are medically beneficial for wheelchair users by enabling them to reach, improving ADL abilities, enhancing independence and productivity, maintaining vital organ capacity, bone mineral density, circulation, and range of motion, reducing tone and spasticity and the occurrence of pressure sores and skeletal deformities; and enhancing psychosocial well-being.

CASE EXAMPLES

J. D. is a 19-year-old male with spastic athetoid quadriplegic cerebral palsy. He has been driving a power wheelchair for mobility since he was 6. A power wheelchair with a standing feature was prescribed to him due to the need for frequent standing, functional goals, to enhance independence, and to reduce his mother's back pain, which she developed due to frequent transfers. After 6 months of use, a marked improvement was noted in his upper extremity function, his speech and swallowing, as well as his comfort and tolerance with respect to staying in the wheelchair all day.

Larry is a 65-year-old man with multiple sclerosis for the last 15 years. On initial evaluation, he was experiencing significant problems with lower extremity spasticity that interfered with his ability to sit in a wheelchair and to be transferred with the assistance of his wife. He was using a manual wheelchair with a limited seating system and was developing a severe kyphosis of the spine. He also had issues with bowel and bladder control, lower extremity edema, and poor affect. Following careful assessment and an extensive trial of a stander, he was provided with a power wheelchair equipped with a passive stander as well as tilt in space, reclining backrest, and elevating legrests. At a 6-month follow-up assessment, he reported standing four to six times per day for 15 to 30 minutes. He was observed to have significantly decreased lower extremity spasticity to the point where he was no longer taking anti-spasticity medication. His wife reported this further made transferring him safer and more manageable. It also allowed him to have improved bed mobility so that he could get a full night's sleep. Moreover, there was no noted edema in his lower extremities, and he reported far fewer bowel and bladder accidents to the point where he was comfortable going out in the community on a weekly basis. He demonstrated improved ability to reach and carry out tasks at different surface heights, was observed to be able to sit more upright with less kyphosis, and demonstrated improved affect.

Mr. D. is a 36-year-old male with a diagnosis of tetraplegia due to a C7 spinal cord injury. He is the primary caretaker of two young boys and works part time as a barber. In the community, he utilizes a rigid frame wheelchair. A manual wheelchair with a standing feature was prescribed for him due to severe complaints of shoulder and upper quadrant pain and decreased upper extremity function caused by repeated overhead activities at home and work. With the manual wheelchair and its standing feature, he was able to work for longer periods of time and care for his children. The standing feature allowed Mr. D. to complete activities in his forward plane. This led to a significant decrease in complaints of shoulder pain and improved upper extremity function.

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