



**RESNA POSITION ON THE APPLICATION OF**  
**WHEELCHAIR STANDING DEVICES:**  
**2013 CURRENT STATE OF THE LITERATURE**

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## **ABSTRACT**

This document, approved by the Rehabilitation Engineering & Assistive Technology Society of North America Board of directors on Dec. 23, 2013, shares typical clinical applications and provides evidence from the literature supporting the use of wheelchair standers.

## **KEYWORDS**

Wheelchair, standing, power features, rehabilitation

## **RESNA Position on the Application of Wheelchair Standing Devices: 2013 Current State of the Literature**

### **Introduction**

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

### **Background**

People with disabilities are at risk of many secondary conditions that are directly related to immobility. Standing through the use of a stationary standing device, or through use of standing features on a manual or power wheelchair, is an essential component in the medical and rehabilitative care of some individuals. The beneficial effects of standing have been reported as a clinical consensus statement in our prior work (Arva et al., 2009). The purpose of this manuscript is to update this RESNA Position on the Application of Wheelchair Standing Devices with more current and additional scientific literature.

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

- Improve functional reach and access to enable participation in Activities of Daily Living (ADLs) (e.g. grooming/hygiene, cooking, toileting, reaching medication)
- Improve mobility and lower limb function in those with preserved muscle strength in lower limbs
- Improve range of motion and reduce the risk of contractures
- Promote vital organ capacity including pulmonary, bowel and bladder function
- Promote bone health
- Improve circulation
- Reduce abnormal muscle tone and spasticity
- Reduce the occurrence of pressure ulcers
- Reduce the occurrence of skeletal deformities
- Provide numerous psychosocial and quality of life benefits

Special precautions must be exercised when utilizing standers in order to avoid the risk of injury, such as fractures. A licensed medical professional (i.e. physical or occupational therapist) must be involved with the 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 controller moves the seat surface from horizontal into a vertical or anteriorly sloping position while

maintaining vertical position of the legrests and backrest, thus extending the hip and knee joints. A full vertical standing position can be achieved directly from sitting, or through gradual angle changes from a supine 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.

The scientific literature cited here supporting standing programs in wheelchairs has been drawn from research conducted with stationary standing devices, tilt tables, and various wheelchair standers. However, discussion of medical benefits of standing programs in able-bodied individuals and in those with disabilities involving functional electrical stimulation, body weight supported treadmill training, and neuroprostheses falls outside the scope of this manuscript.

Compliance rates with home standing programs has been shown to be over 70%, and the benefits of standing are seen even if individuals begin a standing program several years after disability onset (Walter et al., 1999). Wheelchair standing devices address the following medical and functional needs:

### **Functional reach and ADLs**

Our previous paper described how standing allows the user to have more vertical and forward access to perform ADLs. An integrated wheelchair standing system may allow for moving about while in a standing position so that the medical benefits described below can be reaped while an individual carries out their daily routine. This may also improve compliance with the system. In one study involving a convenience sample of children with cerebral palsy, use of standing frames resulted in ADLs being carried out successfully, compared to no use of a stander (Gibson, Sprod, & Maher, 2009).

### **Mobility**

Standing programs also are of benefit to those who can ambulate at various levels of independence and in those who have the potential to ambulate. After undergoing standing programs, improvements have been documented in gait such as speed, biomechanics, and stride length (Salem, Lovelace-Chandler, Zabel, & McMillan, 2010). Upper and lower limb function and ambulation also improved in a case series of patients with multiple sclerosis and spinal cord injury using stationary standers (Hohman, 2011).

### **Range of motion and contractures**

While not a substitute for therapy, standing does have a beneficial effect on range of motion and can be a way some individuals can treat and prevent contractures independently. In a single blind crossover study, a therapeutic standing program for 30 minutes daily for 3 weeks improved hip and ankle range of motion more than did a 3 week daily exercise program in people with multiple sclerosis (Baker, Cassidy, & Rone-Adams, 2007). In children with cerebral palsy, hamstring length has also been shown to

improve after standing frame use compared to no standing (Gibson et al., 2009). Individuals with spinal cord injury also report greater joint range of motion with longer periods of standing (Walter et al., 1999).

Standing is also recommended as part of routine rehabilitation for some patients. A review article on the evidence for standing programs in children with developmental disabilities recommended standing for contracture prevention and management (Stuberg, 1992). Clinical practice guidelines for the management of patients with Duchenne muscular dystrophy, drafted by expert clinicians via a work group at the Centers for Disease Control and Prevention, recommend standing as an important component of rehabilitation and for contracture management (Bushby et al., 2010a, 2010b).

Standing may also be beneficial for the hip joint after surgery. The incidence of hip dislocation was found to be lower in children with cerebral palsy who undergo targeted interventions that include both surgery and standing programs (Hägglund et al., 2005).

### **Vital organ capacity**

Our previous work described how the posture attained through standing increases the volume within the chest and abdominal cavities and is thought to have a beneficial effect on vital organ function. These benefits span several organ systems:

- **Pulmonary:** In addition to previously reported improvements in respiratory symptoms and complications, several measures of pulmonary function have been found to improve with standing. In critical care patients, standing with assistance of a tilt table was found to increase ventilation (Chang, Boots, Hodges, Thomas, & Paratz, 2004). In patients with Duchenne muscular dystrophy, a standing frame program improved vital capacity and peak expiratory flow (Galasko, Williamson, & Delaney, 1995).
- **Bowel and bladder:** Our prior work presented evidence that standing has a beneficial outcome on bowel motility, which may reduce the occurrence of constipation and bowel incontinence and the time needed to carry out a bowel program. We also described how standing may improve bladder emptying and reduce the occurrence of UTIs. Additional evidence suggests that individuals with general debility who undergo standing programs have shown improvement in voluntary sphincter control (Netz et al., 2007). A survey of 99 individuals with spinal cord injuries also revealed fewer UTIs and improved bowel regularity attributed to standing (Walter et al., 1999).

### **Bone Health**

Our prior Position Paper presented the evidence that mechanical loading of the lower limbs via standing maintains bone mineral density and may reduce the risk of osteoporosis and fractures. In fact, systematic reviews of the literature have shown that of all the medical benefits of standing, the scientific evidence for improved bone health is the strongest (Glickman, Geigle, & Paleg, 2010; Pin, 2007). Technology for measuring bone density has improved over time, which may have contributed to the vast amount of evidence on this topic.

Although the amount of weight distributed through the lower limbs can vary depending on the standing device used, two studies found that non-ambulatory children undergoing a standing program have an average weight-bearing load of 68% to 85% of body weight (Bernhardt et al., 2012; Herman, May, Vogel, Johnson, & Henderson, 2007; Kecskemethy et al., 2008). Standing has been shown to produce significant increases in bone mineral density of vertebral bodies (Caulton et al., 2004) and in the femurs (Chad, Bailey, McKay, Zello, & Snyder, 1999; Gudjonsdottir & Mercer, 2002) of children with cerebral palsy as well as in lower limbs of people with spinal cord injuries (Aleksa, Tamulaitiene, Sinevicius, & Juocevicius, 2008).

Vibration is sometimes added to standing programs as a way to increase bone mineral density further than standing alone. Although we are aware of no studies that assess the effects of vibration stemming from regular power wheelchair use itself on bone mineral density, the literature is positive on the use of externally applied vibration. A study in individuals with spinal cord injuries and control subjects identified optimal vibration frequency and amplitude as well as patient posture that could prevent or treat osteoporosis (Alizadeh-Meghbrazi, Masani, Popovic, & Craven, 2012). Addition of vibration to standing programs has been reported to increase bone mineral density of the vertebrae in one individual with a spinal cord injury (Davis, Sanborn, Nichols, Bazett-Jones, & Dugan, 2010).

Dynamic weight bearing, where reciprocal loading is used to achieve forces similar to those during ambulation, has in one study been shown to improve bone density in children with cerebral palsy more than passive standing (Damcott, Blochlinger, & Foulds, 2013). Effects were seen in the distal femur when using a dynamic stander for 15 months.

### **Cardiovascular**

Our prior Position Paper discussed evidence that those who use standers report improvements in lower extremity circulation. However, even though standing is sometimes used to allow an individual's blood pressure to acclimate to upright positions, additional evidence (Chelvarajah, 2009) shows that orthostatic symptoms may limit one's ability to tolerate a standing program. In some cases of spinal cord injury, dynamic weight bearing can induce cardiovascular responses similar to exercise (Edwards & Layne, 2007). These studies suggest that experienced clinicians should be involved in developing and monitoring such programs.

### **Tone and Spasticity**

The role of standing in reducing tone and the treatment of spasticity has also been described in our prior publication. In addition, review articles on the treatment of spasticity in multiple sclerosis and cerebral palsy include standing as playing a critical role (Freeman, 2001; Pin, 2007). Studies in children with various types of cerebral palsy, in those with spastic hemiplegia in particular, and in children with developmental disabilities showed improved spasticity with standing using a tilt table (Stuberg, 1992;

Tremblay, Malouin, Richards, & Dumas, 1990; Tsai, Yeh, Chang, & Chen, 2001). Case studies and case series (Hohman, 2011; Shields & Dudley-Javoroski, 2005) have shown improved spasticity with standing programs in patients with multiple sclerosis and spinal cord injury.

Besides its effects on bone mineral density, whole body vibration when combined with standing has also been found to have beneficial effects on modulation of spasticity in spinal cord injury (Sayenko, Masani, Alizadeh-Meghbrazi, Popovic, & Craven, 2010). Research studies show that standing wheelchair users have experienced significant reduction in spasticity (Dunn, et al, 1988; 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 relief**

Standing systems play an important role in pressure relief for those who may have limited ability to independently weight shift or who sit for long periods. Our prior work discussed the role of standing in reducing the risk of pressure ulcers. The use of standing has been found to reduce load on a wheelchair seat by 40% (Sprigle, Maurer, & Sorenblum, 2010). Edlich, et al (Edlich et al., 2004) discuss the pivotal role standing plays in a comprehensive pressure ulcer prevention program. Indeed, Walter, et al showed that individuals with spinal cord injuries who stood 30 minutes or more per day reported fewer pressure ulcers than those who stood less than 30 minutes per day (Walter et al., 1999). Over 400 school based physical therapists in one survey study also cited pressure relief as a key feature of standing (Taylor, 2009).

### **Skeletal deformities**

Clinical consensus in our prior work discussed how standing plays a major role in promoting trunk extension, hip alignment and position of the femoral head within the acetabulum, which are important especially during maturation of the young skeleton. Indeed, research has shown that standing frame programs may delay onset and progression of scoliosis in patients with myopathies (Galasko et al., 1995).

### **Psychosocial and quality of life benefits**

We also previously discussed the many benefits of standing with respect to community living skills, vocation, and leisure activities. A survey study of school based physical therapists reported that standing programs enhance social and educational opportunities of children (Taylor, 2009). Quality of life benefits seem to be dose dependent, with longer standing programs resulting in greater improvements in standing than shorter programs (Walter et al., 1999).

### **Precautions**

In spite of the numerous benefits, standing may not be appropriate for all individuals, and it is imperative that a user receives an appropriate assessment. Clinicians must consider cardiovascular, orthopedic, and positioning implications before putting a client in a standing device of any kind.

The most common cardiovascular concern is orthostatic (postural) hypotension, which may exceed a prevalence of 30% in those with disabilities (Low, 2008). Clinicians should check for blood pressure and dizziness while standing up, especially for new clients with recent injuries.

Lower limb contractures are another concern. Contractures may be as prevalent as 66% in conditions like spinal cord injury (Dalyan, Sherman, & Cardenas, 1998; Diong et al., 2012). Some degree of contracture can be accommodated in a standing device (either mechanically or electronically); however, care must be taken to ensure that soft tissue damage is avoided by not overstretching tight muscles, especially if a client lacks sensation.

Another concern is fracture risk. Bone density loss can reach levels as high as 50% in individuals with spinal cord injury, and caution is advised when loading bones that may have low density (Dudley-Javoroski & Shields, 2012), which might cause fractures if standing is done prematurely, without a well-designed progressive standing program. It is thought that fracture risk can be minimized by using a method of standing that extends the hips and knees prior to maximal loading (e.g., promoting a change in position from supine to standing). If a user has low bone mineral density or osteoporosis it is generally recommended that a tilt table trial of gradual standing be conducted under the direction of a licensed medical professional (i.e. physical or occupational therapist) to determine the user's standing tolerance and safety. If a client has not been standing for a significant period of time, it is recommended that physician clearance be obtained prior to starting a standing program to determine tolerance.

Clients with extreme positioning needs must be assessed to ensure that both the sitting and the standing position provide appropriate support for stability and function. When using custom-molded seating systems, caution must be exercised due to potential shifting of the positioning components. Additionally, some amount of sacral shearing might occur while standing up or sitting down so attention must be paid to skin integrity in the sacral region. Standing wheelchairs with shear reduction technology can reduce these risks. Finally, it is important to note that standing wheelchairs are not compatible with one-piece seating systems (as the seat to back angle must change).

### **Frequency of standing**

Animal studies have shown that short bouts of standing-- that is, more frequent standing/loading several times per day may-- be more osteogenic than less frequent, longer duration periods of standing (Robling, Hinant, Burr, & Turner, 2002). Standers integrated into wheelchair bases allow for spontaneous and frequent utilization of



standing. Frequency and duration of standing routines are recommended on an individual basis.

A recent systematic review of dosing for standing in children has given further clarification of the best evidence for standing duration and frequency (Paleg, Smith, & Glickman, 2013). After a thorough review of the available literature, standing a minimum of five days per week is necessary. During each standing session, a minimum of 60 minutes is needed to affect bone density and hip stability. Range of motion improvements in the lower extremities require a minimum of 45 minutes, while spasticity reduction may occur with as little as 30 minutes per session of standing.

## **Summary**

It is RESNA's position that wheelchair standing devices are medically beneficial for wheelchair users by: improving functional reach and access to enable participation in ADLs, improving mobility and lower limb function in those with some preservation of lower limb strength, improving range of motion and reducing the risk of contractures, promotion of vital organ capacity including pulmonary, bowel and bladder function, promoting bone health, improving circulation, reducing abnormal muscle tone and spasticity, reducing the occurrence of pressure ulcers and skeletal deformities, and providing numerous psychosocial and quality of life benefits.

## **Case Examples**

Zach is a 14-year-old boy with Duchenne Muscular Dystrophy. He is beginning to have difficulty with ambulation, and is highly susceptible to falling. When he stands, his posture is asymmetrical and is not considered therapeutic. Furthermore, he requires bilateral upper extremity support for balance, which limits his independence with ADLs in the standing position. After an extensive trial, a power standing wheelchair (as well as power tilt/recline/elevating leg rests) was prescribed for Zach to provide independent, safe, functional mobility and allow him greater functional independence. By having the standing system, he is also able to achieve therapeutic, symmetrical standing – ultimately decreasing the overall rate of progression of contractures, scoliosis, and the secondary complications that arise from such deformities (respiratory compromise, pain, etc.) At a 4 year follow up, Zach was still using the standing system regularly, and was able to stand at his high school graduation ceremony with his classmates.

Ms. N. is a 23 year old female with a diagnosis of spastic quadriplegic cerebral palsy. She is currently completing her college degree in psychology and plans to go into rehabilitation counseling when she graduates. She has been using a power standing wheelchair for the last eight years and is in the process of obtaining a new power standing wheelchair. She uses the stander in all aspects of her day. She stands regularly for 30-40 minute intervals. During this time, she frequently does school work using her computer and her upper extremity support tray. She uses the stander at school to give presentations when needed. She uses the stander to access clothes in her closet. She requires assistance with dressing but she prefers to select her clothes independently. She washes

dishes in the sink and helps to put them in the cabinets from a standing position. Given her short height of 4'9", she would not be able to complete most of these activities using only a seat elevator, as that would not raise her high enough to reach the items or the sink. Without the standing feature, she would be much more dependent in her activities.

J.C. is a 45 year old male with a diagnosis of paraplegia due to a T10 spinal cord injury. He works full time, traveling to and from work daily by himself. He also lives alone. Prior to sustaining his injury, J.C. derived great pleasure from baking pies. After his accident, he could not continue to bake these as he could not bear enough weight to work the dough and roll it out. He came in for evaluation reporting he was saddened that he could no longer bake and would like to find a way to return to this leisure activity. He was requesting a device that provided him with the opportunity to stand and that could also be used in the home as a wheelchair for function. J.C. was provided with the Lifestand Helium Wheelchair which allowed him the ability stand independently and to roll out dough, which in turn allowed him to return to making pies and breads. He followed up several months after receiving his new wheelchair stating that use of the Helium had improved his quality of life because he was able to return to his hobby of baking.

RESNA, the Rehabilitation Engineering and Assistive Technology Society of North America, is the premier professional organization dedicated to promoting the health and well-being of people with disabilities through increasing access to technology solutions. RESNA advances the field by offering certification, continuing education, and professional development; developing assistive technology standards; promoting research and public policy; and sponsoring forums for the exchange of information and ideas to meet the needs of our multidisciplinary constituency. Find out more at [www.resna.org](http://www.resna.org).

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