



RESNA Position on the Application of
Wheelchair Standing Devices

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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^{1,2}. Standers integrated into wheelchair bases enhance the beneficial effects of standing since they allow for more frequent, random and independent performance of standing than in 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 ADLs (Activities of Daily Living (i.e. grooming, cooking, reaching medication)
- Enhance independence and productivity
- Maintain vital organ capacity
- Reduce the occurrence of Urinary Tract Infections
- Maintain bone mineral density
- Improve circulation
- Improve passive range of motion
- Reduce abnormal muscle tone and spasticity
- Reduce the occurrence of pressure sores
- Reduce the occurrence of skeletal deformities, and
- Enhance psychological well being.

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.

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.

Definition

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, or 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 following medical and functional needs:

Functional reach and access to ADLs

Standing adds 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 the client's 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 indoors and outdoors activities – it can aid productivity and integration at work, school, church, or enhance independence for example 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 Injury (SCI) is time constraints, lack of assistance, and/or lack of space for an extra device².

Passive Range of Motion, Contractures

Standing extends the hip and knee joint to provide position change. Animal studies have shown that muscles which were fixed in a flexed position resulted in increased contractures of the joints, especially when the bones are still growing^{3,4}. Many people in wheelchairs have limited access to therapy or care givers 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 gastro-intestinal capacity and functioning. This can prevent or delay many 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 ². Standing can help also reduce congestion and coughing ⁵.
- *Gastro-Intestinal problems.* Standing wheelchair users also experienced lesser or delayed occurrence of gastro-intestinal complications, for example via improvement in gastric emptying ^{1,2}.
- *Bowel function.* Some users have experienced improved bowel regularity, reduced constipation, and lesser occurrence of accidental and unregulated bowel movement as a consequence of using wheelchair standers ¹. Elimination of chronic constipation and significant reduction in bowel care time has also been shown as a result of frequent standing ^{2,6}. 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 reported that they were able to empty their bladders more completely than prior to using the device ¹.

Urinary Tract Infections

Urinary Tract Infections (UTI) is the third most frequent complication for clients with SCI ⁷, and a frequent secondary complication for many other wheelchair users. Prolonged immobility causes hypercalcemia, increased urinary calcium output ⁸, and also reduces bladder emptying ¹. By reducing contributing risks, standing wheelchairs have been shown to reduce the occurrence of UTI for wheelchair users ¹, which could lead to kidney infections.

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 all together, 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 (CP) or Spina Bifida, as well as adults with Stroke, Multiple Sclerosis and SCI⁹. Even if BMD loss has not yet occurred in a user, standing can be an effective mean 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 the high risk of fractures¹⁰⁻¹². Studies with astronauts and people in bedrest quantify the negative effect of weightlessness and lack of weightbearing on BMD¹³⁻¹⁷. This loss can be as high as 36% loss of the cross sectional area of a non-weight bearing bone within a month¹⁸. In bed rest, the average urinary calcium loss at the peak is about -150 mg per day, which corresponds to 0.5 percent of total body calcium¹⁹⁻²¹. For people with disabilities, numerous studies point out the benefits of frequent passive standing and weight bearing/exercise on BMD²²⁻²⁵.
- *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^{26,27}. 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 maintenance¹⁸. Dietary changes, such as increased intake of calcium and/or vitamin D, have not proven effective at minimizing disuse bone loss²⁸.
- *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 resistance²⁹. 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 gravity³⁰. 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 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 is to 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^{18, 31-34}. A recent study of children with disabling conditions found that a 6 months standing program with a stationary stander still resulted in BMD reduction (-6.3%), while utilizing vibrating plates underneath the standers actually increased BMD (+11.9%) in the subjects³⁵. 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 (such as carpet edges, door thresholds, tile edges, etc.) all 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 by just performing 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)³⁶. 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 pre-training levels^{37, 38}. 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 is more likely. Additionally, integrated standers allow for standing nearly any time for any length of time, 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 stander². Some benefits are reduced swelling in the legs and feet.

Tone

Wheelchair standers also aid in reduction of access muscle tone; research indicates that muscle stretch combined with weight loading reduces muscle tone more than stretching alone (32% vs. 17%)³⁹. 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

Research studies show that standing wheelchair users have experienced significant reduction in spasticity^{1,2}. 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 spasticity⁴⁰.

Pressure sores

When fully standing, pressure is 100% relieved off the Ischial Tuberosities (ITs). However, when tilting or reclining, there is only partial redistribution of pressure underneath the ITs^{41, 42}. Pressure ulcers are the primary complication for people with SCI⁷, and many other adults who sit in wheelchairs all day long. There is evidence that users have suffered fewer pressure sores while using standers⁴¹, or integrated wheelchair standers^{1,2}.

Skeletal deformities

Clinical experience suggests that extension of the upper trunk and proper alignment of the hip during standing helps 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, and enable recreational activities.

Examples include but are not limited to:

- Improve ability to reach higher shelves in grocery stores and other shopping facilities
- Ability to access vending machines, payphones, high elevator buttons, coffee shop counters, etc.
- Stand up to access fax machines, drawers, client files, and other necessities at work
- Enable certain jobs which need to be performed from a standing position (such as hotel receptionist, clerical, medical, hair stylist, etc.)
- Enhance recreational activities, for example by standing up with others on a ball game.

Additional benefits

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

- Reduce fatigue due to benefits mentioned earlier, thereby prolonging tolerance to staying in the wheelchair for longer periods of time
- Enable some male users to use a public urinal independently as opposed to transferring to a toilet or using catheterization

- Reduce the need for attendant care by lessening the need to transfer in and out of the wheelchair, the ability to range independently and perform ADLs
- Reduce back pain and risk of injury for 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 to improve their alertness and/or improve 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 number 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 with clients after prolonged bedrest.

Psycho-social indications

A standing position can lend wheelchair users a heightened sense of confidence and equality, by enabling eye to eye conversations with the non-disabled society. Many everyday and special occasions in our society require standing; citing of the Pledge of Allegiance at school, graduations, weddings, demonstrations, introductions to people, religious services, etc. When a person is allowed to stand with everyone else any time (afforded by 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 already has fixed contractures of the lower extremities. However, the amount of extension may have to be limited mechanically or electronically, especially in 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 is to be carefully observed while standing.
- 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

trial a stander to assess standing tolerance. Prior examinations might be warranted, such as X-rays and bone density assessment.

- Existing BMD loss and osteoporosis might cause fractures if attempting to stand prematurely and without a well designed progressive standing program.
- Postural hypotension: check for blood pressure and dizziness while standing up, especially for new clients with recent injuries.
- 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. Stander 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, the occurrence of pressure sores and skeletal deformities; and enhancing psycho-social well-being.

Case Examples

JD 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 has developed due to frequent transfers. After 6 months of use a marked improvement is noticed in his upper extremity function, his speech and swallowing, as well as his comfort and tolerance to staying in the wheelchair all day.

Larry is a 65 year old gentleman 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 six-month follow-up assessment he reported standing 4 to 6 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 that allowed him to get a full night's sleep. There was also 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 a kyphosis, and 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 standing feature was prescribed for him due to severe complaints of shoulder and upper quadrant pain and decreased upper extremity function. This was due to repeated overhead activities at home and work. With the manual wheelchair with standing feature he was able to work for longer periods of time and care for his children. The standing feature allowed 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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Sackett model definition of levels:

Level I:

Evidence is obtained from meta-analysis of multiple, well-designed, controlled studies.

Level II:

Evidence is obtained from at least one well-designed experimental study.

Level III:

Evidence is obtained from well-designed, quasi-experimental studies such as non-randomized, controlled single-group, pre-post, cohort, time, or matched case-control series

Level IV:

Evidence is from well-designed, nonexperimental studies such as comparative and correlational descriptive and case studies

Level V:

Evidence from case reports and clinical examples

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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.

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