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Assigning Levels of Evidence
Sources: Sackett[1], American Academy of Cerebral Palsy and Developmental medicine (AACPDM)[2], Paleg[3]

A review the literature revealed that most physical therapy systematic reviews use Sackett's Level to rate levels of evidence. For the purpose of this systematic review, gaps in both AACPDM and Sackett's levels made rating surveys difficult. Another challenge were multiple studies published from a single data set. The author has used a unique algorithm combined with an expanded rating system to assist clinicians in rating evidence. First, holes in the AACPDM and Sackett systems were filled. Specifically, high quality surveys (validated, reliable, established) were given a rating of II if there was a large sample size that was representative of the population, and III if the sample size was small or the randomization of the population was suspect. A poor quality (non-validated, without established inter and t=intra rater reliability, not used in severel previous studies) was assigned a level of IV. Furthermore, a grading system was devised. These scores were added to produce a V (value) score so that therapists could "grade" a particular practice pattern. Using the evidence to "score" the evidence for supported standing's effects on bone density would allow the clinician to choose the best supported parameters for an individual patient's diagnosis. Lastly, this scoring system penalizes multiple studies from a single data set. The underlying assumption ois that if there is an unknown bias or non-randomness of the sample, they outcomes for each additional study is dependent on the findings of the first study, since they pull from the same data pool. For example, in this systematic review, we have two sets of articles (4 total) from the same data (2). Each of the low level surveys has been assigned an evidence level of IV. Their V(value) level is therefore "2". If we were to add up this score, the total would be (4x2) 8. A closer look reveals that both data sets were very small, pulled from users who returned their manufacturer's warranty cards. From this small pool, the different researchers further dwindled the subjects by narrowing the diagnosis and limiting the survey to those who used their standers. In the end, the pool of responders was probably a very unique sample pool. The author of the current systemic review has created a system where the value of these "repeat" studies are diminished by a factor of .75 (25% reduction). In this way, new data collection is encourages so that the results are more easily generalized to all supported stander users.

Level	Type of Study	Definition of Terms
I	Systematic Review of Randomized Controlled Trials (RCTs) Large randomized trials with clear-cut results (and low risk of error) All or none case series	**Randomized Controlled Trials** A study in which the subjects have been randomly allocation to different interventions (or treatments)
II	Small randomized trial with uncertain results (and	**Cohort Study**

	moderate to high risk of error) Systematic reviews of cohort studies Individual cohort studies Low quality RCTs Non-randomized controlled trial Prospective cohort study with concurrent control group Large sample size survey using a validated, reliable established tool[3]	A clinical study with two groups (cohorts) of subjects, one that received the exposure of interest and another that did not, and then followed these cohorts forward for the outcome of interest
III	Systematic review of case-controlled studies Case-controlled study Cohort study with historical control group Single subject ABA design Small sample size survey using a validated, reliable established tool[3]	**Case-Control Study** A clinical study that involves identifying subjects with a clinical condition (cases) and subjects free from the condition (controls), and investigating if the two groups have similar or different exposures to risk indicator(s) or factor(s) associated with the disease.
IV	Nonrandomized, historical controls Poor cohort case controlled Case-control series Before and after case series without control group Single subject AB design Survey that had not established neither reliability nor validity[3]	**Case-control Series** A group or series of case reports involving patients who were given similar treatment and followed after treatment.
V	Expert opinion No controls, case-series only	**Case Series** A report on a series of patients with an outcome of interest. No control group is involved.

Sources: Sackett[1], AACPDM[2], Paleg[3]

For the purpose of this analysis, a scoring system was developed to weight each study so that each category could be ranked.

V=N*F
V(value)= total value of evidence in that category

N(number)= Number of studies
F(factor)= Sackett/AACPDM value (see chart)

Factor Calculator
Level I study = 10 points
Level II study = 7 points
Level III study = 5 points
Level IV study = 2 points
Level V study = 1 point

If 2 studied in the same category used the same data, the factor is reduced by 25%
V2=V1*.75

Synthesized Literature Review

	Author	**Level of Evidence**	**Results**	**Description of Study**	**Duration of Standing**	**Type of Stander**
No benefit seen						
	Bagley, 2005	Level II duration per session was neither controlled or specified	No difference on Rivermead Index, Barthel Index; the Rivermead Motor Assessment; the balanced sitting and sitting to standing components of the Motor Assessment Scale; the Trunk Control Test and the Hospital Anxiety and Depression Scale.	N= 140 N=69 Regular PT vs. N=71 Regular PT plus 14 days or sessions of passive standing	Differed for each subject based on their therapists clinical judgment	Oswestry Stander
	Miedaner, 1993	Level II only one subject used	No difference in Bailey Score	N=12 children w/ CP Randomized crossover design positioning equip vs. adult's lap	During testing only	Prone Stander

		stander				

	Author	Level of Evidence	Results	Description of Study	Duration of Standing	Type of Stander
Bladder Function V= 8						
	Dunn, 1998	Level IV	21% reported being able to empty their bladder more completely and decrease in bladder infections	N=99 w/ SCI Survey Same data as Walter, 1999	41% 1-6x/wk 66% 30-60min/session	Altimate Medical's Mobile Stand or Lifestand standing w/c
	Eng, 2001	Level IV	16% reported improved bladder emptying	N=126 w/ SCI Survey Same data as Huston, 2001	40 min 3-4x/wk on average	Walker and long leg braces or stander (1 subject used both)
	Gould, 1955	Level IV	Moving from the horizontal to the upright position produces a two- to threefold rise or more in bladder pressure, most of that occurring by the time the subject reached 60 degrees of tilt from supine	N=5 normal subjects	Stood only long enough to record bladder pressure	Rudimentary tilt table
	Huston, 2001	Level IV	53% reported improved bladder function	N=38 w/ SCI Survey Same data as Eng, 2001	Subjects stood for prolonged periods (>40 min/day)	Walker and long leg braces or stander (1 subject used both)
	Walter, 1999	Level IV	Reported fewer bladder infections	N= 99 w/ SCI Survey Same data as Dunn, 1998	>30 min/day standing vs. <30 min/day	Altimate Medical's Mobile Stand or Lifestand standing w/c

	Author	Level of	Results	Description of Study	Duration of Standing	Type of Stander

		Evidence				
Bone Density and Calciuria **V=58**						
	Ward, 2004	Level I	Vibration group had increase in BMD at proximal tibia while control group lost BMD; spine BMD increased in both groups	N=20 disabled ambulatory children	Mean 4.4/day 5 days/wk x6mos w/o vibration vs. w/ vibration 90hz	Prone Stander with tray with knee angle not controlled
	Birkhead, 1964	Level II	Standing was more effective than supine bicycle exercises in decreasing hypercalciuria	N=5 Normal subjects w/ induced tilt intolerance and hypercalciuria	3 hrs/day standing vs. 2 or 4 hrs of supine cycling vs. longitudinal supine skeletal pressure	Standing group received 3 hrs/day
	Caulton, 2004	Level II	Increased vertebral but not femoral bone density	N=26 children w/CP 9 month study Low-quality RCT downgraded due to inconsistency w/ compliance with duration of bout	Controls stood 4 ½ hrs/week before study and 3 hrs/wk during study Intervention group stood 4 ¼ hrs/wk before study and 6 ¼ hrs/wk during study	A variety of upright and semi-prone standers
	Goemare, 1994	Level II	Increased BMD of femoral shaft and lumbar spine at L3. Long leg braces group had higher BMD of proximal femur vs. those who stood in stander or standing wheelchair.	N=53 w/ SCI Cohort Study	Standing (N=38) vs. not standing (N=15)	Stander, standing wheelchair or long leg braces
	Gunjonsdittir, 2002b	Level II	Increase in BMD in 75% subjects in lumbar spine and proximal femur and/or distal femur	N= 4 children w/ CP Static vs. oscillating stander	30 min/day x5 days/wk for 8 wks in either static (N=2) or oscillating (N=2) stander In phase II, all subjects stood in both types o f standers for 3 sessions	Static and oscillating both set in 10 degrees prone and 25 degrees abduction
	Brunner, 1996	Level III	Stiffness and immobilization lead to femoral fractures (especially between age 8-16 years) and weight bearing can decrease this	N=37 children with CP Retrospective Cohort Study	Retrospective Chart Review at 2 orthopedic centers. No parameters are described.	One of the cases describes a child who, two weeks after repair of a femur fracture, was " mobilized in a stander"

	Author	Level of Evidence	Results	Description of Study	Duration of Standing	Type of Stander
Bone Density Continued						
	Kaplan, 1981	Level III	Calcium output decreased for both groups, more so for the 6mos s/p SCI group. After one week cessation of standing, calciuria returned to baseline	N=10 w/ incomplete SCI avg, C5-7 N=6 <6mos s/p SCI N=5 12-18mos s/p SCI Standing vs. exercises (N=10, yet 11 subjects are described. Perhaps one subject was included in both groups)	20 min/day 3-6 days total	Tilt table at greater than 45 degrees incline
	Katz, 2006	Level III	Increased calcaneal BMD	N=11 non-ambulatory children with quadriplegic CP Cohort Study downgraded since never published in peer reviewed journal	10hrs/wk (but 7.5 hrs/wk was minimal amt enough to maintain bone density)	Upright rigid stander (Easystand Magician)
	Stuberg, 1991	Level III	Bone density decreased in the 30 min/day group Bone density was maintained in the 60 min/day group.	N=20 nonambulatory children with CP who were using standing programs in their educational setting. Cohort Study downgraded since never published in a peer reviewed journal	30 vs 60 min/day x 9 mos followed by 3 mos of no standing	Not specified
	Thompson, 2000	Level III	Decreased levels of dynamic weight bearing were associated with deceased LE BMD	N= 28 16 children with neuromuscular impairment and 12 without Retrospective Cohort Study	Not addressed specifically	Looked at level of activity and amount of weightbearing

Bowel Function/Digestion V=18						
	Hoenig, 2001	Level III	More bowel movements, decreased time spent in bowel care, decreased use of enemas	N=1 w/SCI Single case description with crossover control phase	1 hr/day 5 days/wk	Upright power lift stander
	Netz, 2007	Level III	Improved sphincter control	13 nursing home residents (avg age 82) Downgraded since number of sessions too variable	12 week physical activity program performed in standing support device	Standing Support Device A stander which allows movement – similar to a standing box
	Dunn, 1998	Level IV	23% reported more regular bowel movements 13% reported bowel movements took less time	N=99 w/ SCI Survey Same data as Walter, 1999	41% 1-6x/wk 66% 30-60min/session	Altimate Medical's Mobile Stand or Lifestand standing w/c
	Eng, 2001	Level IV	16% reported improved bowel function 14% reported improved digestion	N=126 w/ SCI Survey Same data as Huston, 2001	40 min 3-4x/wk on average	Walker and long leg braces or stander (1 subject used both)
	Huston, 2001	Level IV	53% reported improved bowel function 45% reported improved digestion	N=38 w/ SCI Survey Same data as Eng, 2001	Subjects stood for prolonged periods (>40 min/day)	Walker and long leg braces or stander (2% used both)
	Richardson, 1990	Level IV	Reported improved bowel motility	Single subject w/ T-10 complete paraplegia Single subject AB	Avg 11.57 m/day, 3.86x/wk, over 2 yrs of monitoring	Standing wheelchair stood at 61 deg of inclination
	Walter, 1999	Level IV	Reported improved bowel regularity	N= 99 w/ SCI Survey Same data as Dunn, 1998	Compared subjects who stood 30 min/day or longer and subjects who less than 30 min/day	Altimate Medical's Mobile Stand or Lifestand standing w/c

	Author	Level of Evidence	Results	Description of Study	Duration of Standing	Type of Stander
Cardiopulmonary/Circulation/Edema V=26						
	Birkhead, 1964	Level II	Standing was more effective than supine bicycle exercises in decreasing orthostatsis	N=5 Normal subjects w/ induced tilt intolerance and hypercalciuria	3 hrs/day standing vs. 2 or 4 hrs of supine cycling vs. longitudinal supine skeletal pressure	Standing group received 3 hrs/day
	Jacobs, 2003	Level II	Using FES to stand resulted in an increase in metabolic activity and heart rate equal to that of recommended exercise	N=15 w/ T6-11 paraplegia Subjects stood with and without electrical stimulation	30 min bouts x3	EasyStand 5000 Parastep-1
	Brogren, 1995	Level IV	Decreased cyanosis Increased HR and BP Increased muscle activity EMG showed activity that did not occur outside of stander	N=3 w/spina bifida (2-7yo) T12-L5 N= 1 normal control Perturbation of platform while in stander Downgraded since no data or statistical analysis is presented	Unspecified	Long Leg Braces/Swedish Stander
	Edwards, 2007	Level IV	100% increased HR in standing	N=4 w/ SCI Before and after case series without control group	12 wk exercise program in supported standing position	Sys Ortho device for supported standing
	Eng, 2001	Level IV	12% reported improved breathing 22% reported improved circulation 13% reported decreased leg/foot swelling	N=126 w/ SCI Survey Same data as Huston, 2001	40 min 3-4x/wk on average	Walker and long leg braces or stander (1 subject used both)
	Faghri, 2001	Level IV	Estim helped decrease orthostatic hypertension in subjects with tetraplegia when they stood Both groups increased total peripheral resistance and HR Both groups decreased cardiac output, stroke volume and blood pressure	N=14 w/SCI N=7 w/ paraplegia N=7 w/ tetraplegia	Stander vs. FES and standing	Standing Frame
	Huston, 2001	Level IV	74% reported improved circulation 39% reported improved breathing 42% reported decreased swelling in	N=38 w/ SCI Survey Same data as Eng, 2001	Subjects stood for prolonged periods (>40 min/day)	Walker and long leg braces or stander (2% used both)

			legs and feet			
	Tanika, 1996	Level IV	BP decreased rapidly during first minute of standing when subjects stood actively as compared to passive standing	N=7 healthy subjects Before and after case series without control group	7 minutes	Tilt table at 60 deg vs. active standing
	Aukland, 2004	Level V	Decreased hypertension and initial low pO2 levels when standing performed daily	Single case study of 20yo subject s/p 3.25 yrs TBI	20-40 min	Rifton supine stander w/ progression to Easystand 5000

	Author	**Scakett Level**	**Results**	**Description of Study**	**Duration of Standing**	**Type of Stander**
Hip Integrity V=11						
	Macias, 2005	Level II	Standing in abduction resulted in improved hip migration percentage, acetabular index and maintenance of hip adductor muscle length for functional gait	N= 14 w/ spastic diplegia N= 7 controls N= 7 stood	45 min/day 7 days/wk 55-70 deg abduction	Plaster cast placed in stander
	Hägglund, 2005	Level V	0% children in program dislocated hips 100% children not in program dislocated hips	N=208 Ongoing monitoring with follow through of recommendations for stretching and positioning (incl. standing)	Comprehensive positioning program incl. standing	Swedish Standing Shell
	Pountney (2002)	Level V	Children using lying, sitting and standing positioning equipment before hip subluxation, maintained significantly more hip integrity than children who used only one or two pieces of positioning equipment	N= 59 children w/ bilateral CP	Not defined	Prone stander Chailey Stander

	Author	Level of Evidence	Results	Description of Study	Duration of Standing	Type of Stander
Motor Ability/Walking/Balance/Hand Function/Reaching V=41						
	Ahlborg, 2006	Level II	Motor performance improved (GMFM domains D and E)	N= 14 adults w/ spastic diplegia CP Standing w/ whole body vibration vs resistance training RCT	Static standing position on vibration platform, 50deg flexion at hips and knees x 6 min at 5-40hz	NEMES-LSC
	Jesinkey, 2003	Level II	Hand trajectory and reaching improved when child was in standing shell	N=15 children w/ spastic diplegia	standing shell vs dynamic foot orthoses vs neither	Standing Shell
	Green, 1993	Level III	36% improved their ability to sit and/or lay. 64% maintained ability	N=11 children w/ CP Postural management program incl. standing	30 min/day	Chailey Stander
	Netz, 2007	Level III	FIM improved for locomotion, mobility and motor score. 60% of subjects who required assistance to stand before intervention were able to stand indep on avg. 1 min and walk 14m with a walker	N=13 in nursing home unable to transfer or stand indep Dx incl. spinal stenosis, Parkinson's. cerebral ataxia, and stroke. Downgraded since number of sessions/wk too variable	8 wk control (no program) 12 wk physical activity program in stander Up to 5x/wk 30 min sessions	Standing Support Device A stander which allows movement – similar to a standing box
	Noronha, 1989	Level III	Simulated feeding was better in a prone stander vs. adaptive seating	N=10 w/ spastic diplegia	Only used during testing	Prone Stander
	Riek, 2008	Level III	Stander improved shoulder and arm positioning	Case series ANOVA N=5 subjects w/ SCI ASIA A	One of five conditions tested	Knee/ankle orthosis in standing
	Garrett, 2008	Level IV	50% improved balance and reported subjective improvements in other functional activities	N=2 children w/spastic cerebral palsy (hemiplegia and diplegia) Downgraded since never published in peer reviewed journal	Stood for 1-5 minutes bouts 2x/wk at 10-30hz for 4 weeks	Upright stander with tray on vibration platform
	Semler, 2006	Level IV	All 6 individuals were characterized by an improved mobility, which was documented by an increased tilt-angle or an improved BAMF-score	N= 6 children w/OI type III: N=2, OI type IV: N=2, CP (N=1), dysraphic defect of the middle and lower spinal cord (N=1)	2x/day x 6mos	Cologne Standing-and-Walking-Trainer powered by Galileo
	Zabel, 2005	Level IV	Improvements in walking incl. stride length, speed, stance time	N= 6 children w/CP (avg age 6.5 yrs)	Stood 3x/wk (does not specify for how long)	Not specified
	Nelson,	Level V	Trial #1; no change, Trial #2; 4%	N=1 w/ spastic paraplegia	60 minutes of work	Standing Table

	1997		increase in work productivity in stander vs. sitting, Trial #3; improved posture in standing in stander vs unsupported standing	Case report, no control		

	Author		Results	Description of Study	Duration of Standing	Type of Stander
Pain V=4						
	Eng , 2001	Level IV	10% reported decreased pain	N=126 w/ SCI Survey Same data as Huston, 2001	40 min 3-4x/wk on average	Walker and long leg braces or stander (1 subject used both)
	Huston, 2001	Level IV	32% reported decreased pain	N=38 w/ SCI Survey Same data as Eng, 2001	Subjects stood for prolonged periods (>40 min/day)	Walker and long leg braces or stander (1 subject used both)
	Warren, as cited in Walter, 1999	Level V Downgraded since second hand report	87% reported decreased pain	N=39 w/ SCI Phone survey	Avg 3-6.83x/wk	Stander or tilt table

Psycho-social V=8						
	Gunjonsdittir, 2002b	Level IV downgraded due to poor design	50% showed slight shift toward more active alert states in the dynamic (rocking) stander vs. static stander	N=4 children w/CP Descriptive Case series with non-controlled cross-over design	30 min/day 5 days/wk for 8 wks	Static 10 degree prone stander and a rocking/dynamic 10 degree prone stander both with 25 degrees abduction
	Huston, 2001	Level IV	87% reported feeling of well-being	N=38 w/ SCI Survey Same data as Eng, 2001	Subjects stood for prolonged periods (>40 min/day)	Walker and long leg braces or stander (1 subject used both)
	Walter, 1999	Level IV	Reported improved quality of life	N= 99 w/ SCI Survey	Compared subjects who stood 30 min/day or longer and subjects who less than 30 min/day	Altimate Medical's Mobile Stand or Lifestand standing w/c
	Eng, 2001	Level V	87% inc. well-being 11% dec in fatigue 7% improved sleep	N=126 w/ SCI Survey Same data as Huston, 2001	40 min 3-4x/wk on average	Walker and long leg braces or stander (1 subject used both)

				Downgraded since no data is supplied Same data as Huston, 2001		
	Warren, as cited in Walter, 1999	Level V	87% reported psychological improvement, feeling more relaxed, feeling healthier, increased motivation and felt physically more able	N=39 w/ SCI Phone survey Downgraded since second hand report	Avg 3-6.83x/wk	Stander or tilt table

	Author	**Level of Evidence**	**Results**	**Description of Study**	**Duration of Standing**	**Type of Stander**
Range of Motion **V=26**						
	Baker, 2007	Level II	Increased hip and ankle ROM compared to baseline and exercise phase	N= 6 w/MS RCT single crossover	30 minutes	Oswestry Stander
	Bohannon, 1985	Level III	Passive ankle dorsiflexion increased 3-17 degrees (.11-1.0 degrees/day)	N=20 neurologically involved patients	30 minutes 5-22 days, 2.3-6.4 treatments/wk	Tilt table with wedge so that heels were unsupported
	Richardson, 1990	Level III	Increased ROM of the ankle occurred with standing	N=1 w/ head injury ABA single subject	Tilt table 8 min/day for 27 days	Tilt table with one foot up on a platform
	Tsai, 2001	Level IV	Increased ROM ankle dosiflexion	N=17 w/ hemiplegia (stroke) 33-70yo avg 57 Before and after case series without control group	x30 min x1 session only	Tilt table
	Dunn, 1998	Level IV	38% reported increased ability to straighten their legs	N=99 w/ SCI Survey Same data as Walter, 1999	41% 1-6x/wk 66% 30-60min/session	Altimate Medical's Mobile Stand or Lifestand standing w/c
	Otzel, 2008	Level IV	Hip flexion inc. 5-6 deg bilaterally	N= 1 w/ spastic diplegia	10 minutes of WBV 3x/wk x6 wks	WBV Power Plate® In standing position
	Walter, 1999	Level IV	Reported improved ability to straighten their legs	N= 99 w/ SCI Survey Same data as Dunn, 1998	Compared subjects who stood 30 min/day or longer and subjects who less than 30 min/day	Mobile Standing Device (Mobile Stand by Altimate Medical)

	Author	Level of Evidence	Results	Description of Study	Duration of Standing	Type of Stander
	Warren, as cited in, Walter, 1999	Level V downgraded since second hand report	87% reported improved ability to stretch their legs	N=39 w/ SCI Phone survey	Avg 3-6.83x/wk	Stander or tilt table
Self-care **V=5**						
	Dunn, 1998	Level IV	68% reported standing device helped in daily home activities	N=99 w/ SCI Survey	41% 1-6x/wk 66% 30-60min/session	Altimate Medical's Mobile Stand or Lifestand standing w/c
	Eng, 2001	Level IV	13% reported improved self-care	N=126 w/ SCI Survey Same data as Huston, 2001	40 min 3-4x/wk on average	Walker and long leg braces or stander (1 subject used both)
	Huston, 2001	Level IV	42% reported improved self care	N=38 w/ SCI Survey Same data as Eng, 2001	Subjects stood for prolonged periods (>40 min/day)	Walker and long leg braces or stander (1 subject used both)
	Author	**Level of Evidence**	**Results**	**Description of Study**	**Duration of Standing**	**Type of Stander**
Skin **V=7**						
	Dunn, 1998	Level IV	17% reported fewer bedsores	N=99 w/ SCI Survey Same data as Walter, 1999	41% 1-6x/wk 66% 30-60min/session	Easystand or Lifestand standing w/c
	Eng, 2001	Level IV	11% reported improved skin care	N=126 w/ SCI Survey Same data as Huston, 2001	40 min 3-4x/wk on average	Walker and long leg braces or stander (1 subject used both)
	Huston, 2001	Level IV	17% reported improved skin integrity	N=38 w/ SCI Survey Same data as Eng, 2001	Subjects stood for prolonged periods (>40 min/day)	Walker and long leg braces or stander (1 subject used both)
	Walter, 1999	Level IV	19% of those who stood reported fewer bed sores	N= 99 w/ SCI Survey same data a Dunn, 1998	Compared subjects who stood 30 min/day or longer and subjects who less than 30 min/day	Altimate Medical's Mobile Stand or Lifestand standing w/c
Sleep/Fatigue **V=3**						
	Eng, 2001	Level IV	11% reported decreased fatigue 7% reported improved sleep	N=126 w/ SCI Survey Same data as Huston, 2001	40 min 3-4x/wk on average	Walker and long leg braces or stander (1 subject used both)

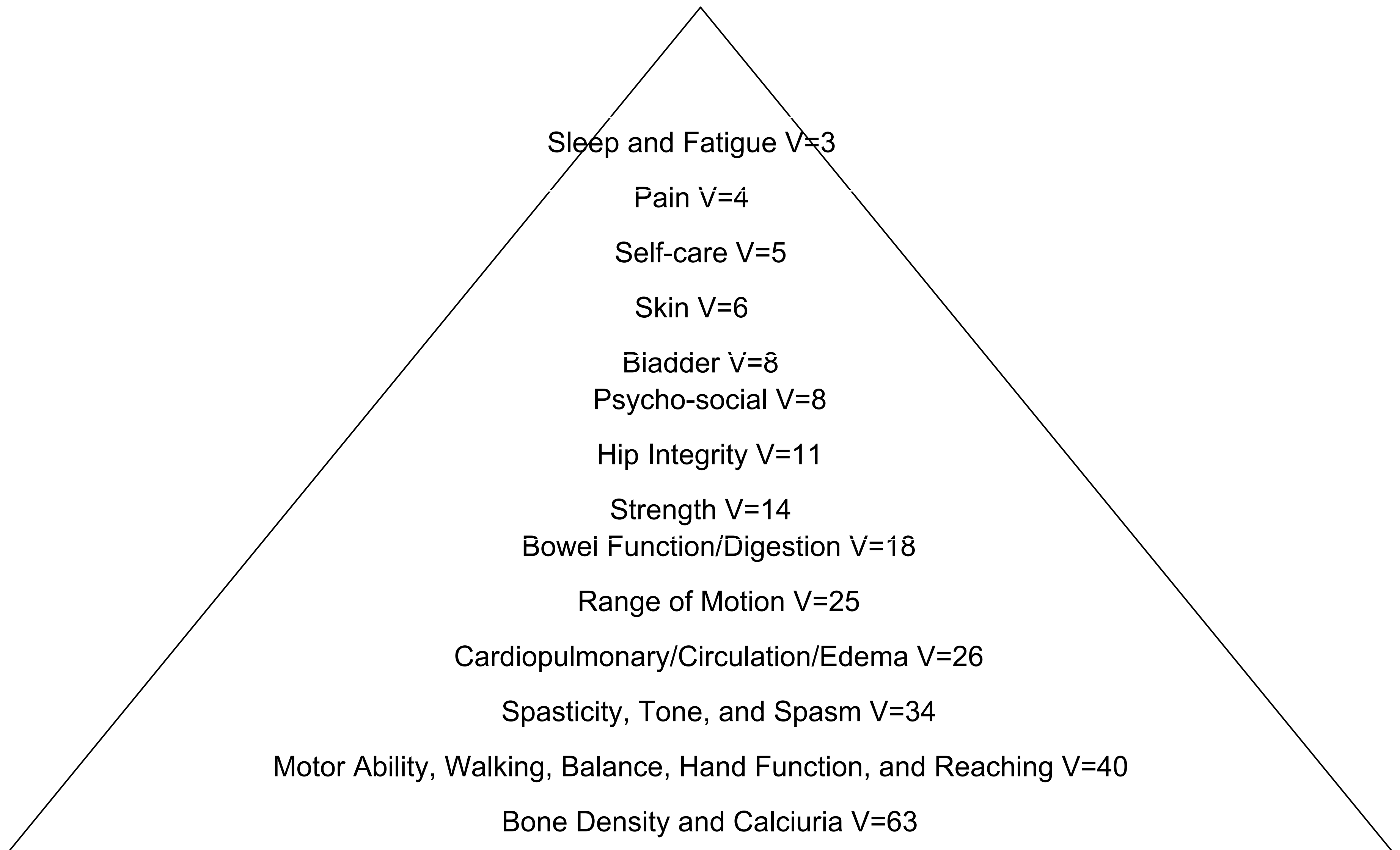
	Huston, 2001	Level IV	37% reported decreased fatigue 24% reported improved sleep	N=38 w/ SCI Survey Same data as Eng, 2001	Subjects stood for prolonged periods (>40 min/day)	Walker and long leg braces or stander (1 subject used both)

	Author	**Scakett Level**	**Results**	**Description of Study**	**Duration of Standing**	**Type of Stander**
Spasticity/Tone/Spasm V=34						
	Ahlborg, 2006	Level II	Spasticity decreased in knee extensors	N= 14 adults w/ spastic diplegic CP Standing w/ whole body vibration vs. resistance training RCT	Stood on vibration platform 50deg flexion at hips and knees x 6 min at 5-40hz	NEMES-LSC
	Tremblay, 1990	Level II	Reduced torque and EMG Increased ability to actively plantarflex Effects lasted 35 min	N=22 children w/ spastic CP N=12 intervention N=10 control	30 min stretch of triceps surae in stander w/ dorsiflexion Single bout	Modified tilt table
	Odeen, 1981	Level III	17% decrease in tone in supine and stretching 32% decrease in tone in standing and stretching plantarflexors group 26% decrease in tone in standing and stretching dorsiflexors group	N = 9 w/ paraplegia	30 min of stretch supine vs standing Stretch dorsi vs, plantarflexors	Intervention group stood at 85 deg on tilt table w/ feet in 15 degrees dorsal or plantar flexion
	Dunn, 1998	Level IV	42% reported decrease in leg spasticity	N=99 w/ SCI Survey Same Data as Walter, 1999	41% 1-6x/wk 66% 30-60min/session	Altimate Medical's Mobile Stand or Lifestand standing w/c
	Eng, 2001	Level IV	18% reported improved reflex control 7% reported decreased spasms	N=126 w/ SCI Survey Same data as Huston, 2001	40 min 3-4x/wk on average	Walker and long leg braces or stander (1 subject used both)
	Garrett, 2008	Level IV	Subject B had reduced spasticity	N=2 children w/spastic cerebral palsy (hemiplegia and diplegia)	Stood for 1-5 minutes bouts 2x/wk at 10-30hz for 4 weeks	Upright stander on vibration platform
	Huston, 2001	Level IV	60% reported improved reflex activity 24% reported reduced muscle spasms	N=38 w/ SCI Survey Same data as Eng, 2001	Subjects stood for prolonged periods (>40 min/day)	Walker and long leg braces or stander (1 subject used both)
	Otzel, 2008	Level IV	Post intervention scores for the	N= 1 w/ spstic diplegia	10 minutes of WBV 3x/wk x6	WBV Power Plate®

			MAS decreased in the right hip flexor and knee extensor.		wks	In standing position
	Tsai, 2001	Level IV	Reduced motor neuron excitability of the triceps surae Lasted 30 min	N=17 w/ hemiplegia (stroke) 33-70yo avg 57 Before and after case series without control group	x30 min x1 session only	Tilt table
	Zabel, 2005	Level IV	Improved muscle tone	N= 6 children with CP avg age 6.5 yrs	Stood 3x/wk (does not specify for how long)	Not specified

	Author	Sackett Level	Results	Description of Study	Duration of Standing	Type of Stander
Spasticity/Tone/Spasm Continued						
	Bohannon, 1993	Level V	Each day's standing trial was followed by an immediate reduction in lower extremity spasticity that lasted until the following morning.	N=1 w/ T12 spinal cord injury and intractable extensor spasms.	5 nonconsecutive days	Tilt Table
	Richardson, 1990	Level V	Reported improved spasticity	N=1 w/ T-10 complete paraplegia	Avg 11.57 m/day, 3.86x/wk, over 2 yrs of monitoring	Standing wheelchair stood at 61 deg of inclination
	Warren, as cited in Walter, 1999	Level V	87% reported decreased spasm	N=39 w/ SCI Phone survey	Avg 3-6.83x/wk	Stander or tilt table
Strength **V=14**						
	Ahlborg, 2006	Level II	Muscle strength increased at 90deg/sec	N= 14 adults w/ spastic diplegia CP standing w/ whole body vibration vs resistance training RCT	Stood in static standing position on vibration platform, instructed not to hold on to handles and try to bear wt equally on both feet and maintain 50deg flexion at hips and knees x 6 min at 5-40hz	NEMES-LSC
	Netz, 2007	Level III	Improved lower extremity muscle strength Downgraded since number of sessions too variable	N=13 in nursing home 57-102 yo avg 82yo Unable to transfer or stand indep Dx incl. spinal stenosis, Parkinson's. cerebral ataxia, and stroke.	8 wk control (no program) 12 wk physical activity program in stander Up to 5x/wk 30 min sessions	Standing Support Device A stander which allows movement – similar to a standing box

	Edwards, 2007	Level IV	Increased EMG activity	N=4 w/ SCI Before and after case series without control group	12 wk exercise program in supported standing position	Sys Ortho device for supported standing


Sleep and Fatigue V=3
Pain V=4
Self-care V=5
Skin V=6
Bladder V=8
Psycho-social V=8
Hip Integrity V=11
Strength V=14
Bowel Function/Digestion V=18
Range of Motion V=25
Cardiopulmonary/Circulation/Edema V=26
Spasticity, Tone, and Spasm V=34
Motor Ability, Walking, Balance, Hand Function, and Reaching V=40
Bone Density and Calciuria V=63

Protocols Sorted by Duration of Standing		
Duration of bout	**Study**	**Frequency**
6 minutes	Ahlborg, 2006	With vibration (25-40hz) and hips and knees at 50 degrees of flexion
11.57 minutes (mean)	Richardson, 1990	Avg 61 degree inclination, 3.86 days/wk x2 yrs
20-40 minutes	Aukland, 2004	20-40 min/ session
	Bohannon, 1985	30 min 5-22 total days 2.3-6.4x/week
	Baker, 2007	30 min 3x/week
	Dunn, 1998	66% stood 30-60min/day 1-5x/wk (Survey)
	Eng, 2001	30-40 minutes 3-4x/wk
	Faghri, 2001	30 min with and without electrical stimulation
	Gontkovsky, 2005	30-40 minutes daily
	Green, 1993	At least 30 minutes/day
	Gunjonsdittir, 2002	30 min/day 5 days/wk 8wks
	Herman, 2007	30min/day 3-6x over a 2 wk period
	Huston, 2001	40 min/day 3.8 days/wk for 55 months (Survey)
	Kaplan, 1981	20 min/day for 3-6 days total
	Odeen, 1981	30 min
	Trembley, 1990	30 min1 time only
	Tsai, 2001	30 min 1 time only
	Walter, 1999	30 minutes or more/day
45 min	Macias, 2005	45 min/day 7days/wk in 55-70 degrees abduction
60 minutes	Chad, 1999	20 minutes UE wt bearing, 20 min trunk wt bearing, 20 min LE wt bearing (so could be considered 20 min)
	Edwards, 2007	60 min 2x/wk for 2 weeks
	Hoenig, 2001	60 min 5x/wk
	Nelson, 1997	60 min during work session
2 hrs	Katz, 2006	2 hrs/day 5 days/wk
3 hrs	Birkhead, 1964	2 hrs x1 at 70 degree incline
Other	Caulton, 2004	Controls stood 4 ½ hrs/week before study and 3 hrs/wk during study

		Intervention group stood 4 ¼ hrs/wk before study and 6 ¼ hrs/wk during study

Compliance	
Author	**Results**
Auckland, 2004	20 y.o. s/p TBI (3.25yrs) was non-compliant w/ standing program 8 days in a row, initial pO2 levels were below 90 (too low to tolerate standing), and after just 3 days of non-compliance, subject experiences hypertension.
Daniels, 2005	Picking a stander that meets user and caregiver acceptability may improve compliance
Dunn, 1998	84% were using their standers 3% did not because they felt the devices were no good 4% felt the devices were too difficult to get in and out of 4% were not using their devices because of a medical problem
Eng, 2001	Cost of equipment is biggest deterrent
Gontkovsky, 2005	Single subject reacted to restraints used on tilt table with severe panic attacks. Relaxation techniques and deep breathing resulted in the patient being able to tolerate the stander for 3-40 minutes daily
Herman, 2007	Weight borne in stander is quite variable and in some instances was a fraction of the child's body weight
Huston, 2001	30% of 126 patients surveyed use standers Patients with lower newer injuries were more likely to stand Those who stood had more active lifestyles Of patients surveyed who did not stand, perceived barriers reported were: 33% too expensive 28% time constraints 26% unaware of device 18% lack of assistance 18% space constraints 3% did not have enough motivation or energy to stand Took 6.4 days to perceive benefits, and the benefits lasted 1.4days.
Lind, 2003	Survey of Swedish habilitation staff in 2001 revealed therapists, not physicians, educated families about standing and recommended standing equipment

Author	Results
Walter, 1999	Re-analysis of Dunn, 1998 Survey 74% of 99 subjects w/ SCI surveyed reported standing at least 1x/wk 33% stood at least 1x/day 41% stood at least 1x/wk 14% stood 1-3x/mo
Warren, as cited in Walter, 1999	Phone survey of 54 subjects w/ SCI 72% used device occasionally 50% used device in preceding 2 wks 50% used device at least 3x/wk 41% reported difficulty w/ device 13% had difficulty w/ transfers 4% reported back spasms 9% stopped standing due to difficulties w/ transfers 4% stopped standing because they had nowhere to keep it 11% stopped standing use due to (1 reason each) not feeling safe, bed sores, attendant had no time, pain in hip socket and amputated leg 2% (each) reported frame table too high, foot inversion, wheelchair not fitting in frame (for transfer) Standers located in living or family room (avg use 6.83x/wk) were more likely to be used than those located in the garage or patio (avg use 3x/wk) or bedrooms (avg use 4.53x/wk) Subjects living alone used their frames less than those who lived w/ another person

Negative Effects of Standing	
Author	**Results**
Auckland, 2004	Hypertension and low pO2 especially when 3-8 sessions are missed
Bahjaoui-Bouhaddi, 1998	Baroreflex (loss of bloddpressure). Study recommends monitoring BP and RR
Bondar, 1997	Autonomic dysreflexia (referred to as ANS failure) was due to impaired BP regulation
Dunn, 1998	9% dizziness 7% sweating 5% reported increased time needed for bowel care 3% reported increase in leg spasticity 1% reported being confined due to bone injury as a result of standing 1% headache 1% reported less ability to empty bladder
Eng, 2001	5% increased pain 5% increased fatigue 5% breathing difficulties 4% increased spasticity .8% dizziness
Gunjonsdittir, 2002	25% of children cried and had to be introduced to standing slowly over time
Gontkovsky, 2005	Subject experienced panic attacked caused by straps on stander
Huston, 2001	18% reported increased pain, fatigue, and breathing difficulties 13% reported increased spasticity 3% reported dizziness
Katz, 2006	Decreased wrist bone mineral density
Noronha, 1989	Subjects in prone stander tested lower on the ability to pick up small objects than when they were positioned in adaptive seating equipment
Walter, 1999	Re-analyzed Dunn,1998 one subject incurred a broken bone related to standing
Warren, as cited in Walter, 1999	4% reported back spasms 11% stopped stander use due to (1 reason each) not feeling safe, bed sores, attendant had no time, pain in hip

	socket and amputated leg 1/54 (each) reported feeling tired, dizziness, problem with torso balance 1/54 sustained fracture related to standing

Types of Stander	
Type of Stander	**Author**
Tilt Table	Bohannon, 1985 and 1993 Herman, 2007 Kaplan, 1981 Warren, 1985 as reported by Walter, 1999
Supine	Aukland, 2004 Herman, 2007 Trembley, 1990
Prone	Caulton, 2004 (in 8/26 subjects) Green, 1993 11 subjects w/ CP Gunjonsdittir, 2002 4 subjects with CP Miedaner 1993 in 1/12 subjects with CP Pountney , 2002
Upright (rigid support)	Aukland, 2004 (Easystand 5000) Caulton, 2004 18/26 subjects Hoenig, 2001 Jacobs, 2003 (Easystand 5000) Katz, 2006 (Easystand Magician) Nelson, 1997 (Preston Standing Box)
Upright (fabric/leather straps support	Bagley, 2005 Baker, 2007 Green, 1993 Warren, as cited in Walter, 1999
Standing Box	Netz, 2007
Long leg braces	Brogren, 1995 (Swedish Standing Shell)

	Goemaere , 1994 Jesinkey, 2003 (Swedish Standing Shell)
Long leg braces combined with A-Frame stander	Bleck, 1981
Standing wheelchair	Goemaere, 1994 Dunn, 1998
Self-propelled or mobile	Walter, 1999
Oscillating (rocking side to side)	Gudjonsdottir, 2002b
Plaster casts	Macias, 2005
Vibrating	Ahlborg, 2006
Sit to Stand	Aukland, 2004 Dunn, 1998
Standing Wheelchair	Richardson, 1990

Diagnosis Centered Analysis		
Diagnosis	**Study**	**Findings**
Cerebral Palsy		
	Ahlborg, 2006	Subjects were adults with spastic diplegia standing with vibration showed decreased knee flexion spasticity, increased strength and improved scores on GMFM
	Brogren, 1995	Improved postural responses
	Caulton, 2004	Increased bone density
	Chad, 1999	Increased bone density
	Garrett, 2008	Improved balance, decreased tone (this study combined standing with vibration)
	Gunjonsdittir, 2002	Increased bone density
	Herman, 2007	Less tilt means more weight bearing. The Rifton supine stander had higher level of weight bearing than the tilt table because the therapsist placed the children in the Rifton supine stander more upright
	Macias, 2005	Standing in 55-70 degrees of hip abduction in children 14-17 mos old with spastic diplegia resulted in improved hip migration percentage, acetabular index and maintenance of hip adductor muscle length for functional gait
	Miedaner, 1993	1/12 subjects stood in a prone stander during Bayley and had no change, while the majority of subjects tested in adaptive equipment improved in their adaptive equipment
	Stuberg, 1991	Standing for 60 min/day allowed children to maintain BMD over summer break (no standing occurred), if they only stood for 30min/day during the school year, they lost BMD over the summer break.
	Zabel, 2005	Stander use improved gait

Duchene Muscular Dystrophy		
	Spencer, 1962	1-2hrs/day on tilt or standing table
	Vignos, 1963	3 hrs daily
Guillain-Barre		
	Bohannon, 1985	Increased ankle range of motion
Hypoxia		
	Bohannon, 1985	Increased ankle range of motion

Diagnosis	Study	Findings
Multiple Sclerosis		
	Baker, 2007	RCT single bling crossover design. Stood and exercised in standing box and saw trend of decrease in Ashworth (spasticity) for knee flexion and ankle dorsiflexion, trend of decrease in spasm and increase in LE range of motion
Osteogenesis Imperfecta		
	Bleck, 1981	Describes a patient who used a stander, but no parameters are listed.
Spina Bifida		
	Brogren, 1995	Improved circulation, increased muscle activity (EMG) and increased postural reactions (n=3 age 2-7 yo, L12- L5)

Diagnosis	Study	Findings
Spinal Cord Injury		
	Dunn, 1998	Patients surveyed who used their standing equipment; reported increased bladder emptying, decrease in spasticity and increase in quality of life
	Edwards, 2007	Increased EMG activity and heart rate
	Eng, 2001	Of patients surveyd who used their standing equipment, reported improvement in well-being, circulation, skin, reflex activity, bowel and bladder, digestion, sleep, pain and fatigue.
	Goemaere, 1994	Patients who stood had increased bone density
	Gontkovsky, 2005	Patient with severe anxiety related to straps on stander was taught relaxation and deep breathing techniques that allowed him to tolerate passive standing
	Hoenig, 2001	Decreased constipation, time spent on bowel care and need for enemas
	Kaplan, 1981	Decreased calcium in urine and feces
	Richardson, 1990	Single Subject w/ T-10 complete paraplegia reported improved spasticity and bowel motility
	Walter, 1999	Survey by Dunn, 1998 reanalyzed for subjects who stood less than 30 min/day and those who stood 30 min or more/day showed that those who stood 30 min or more reported improved quality of life, fewer bed sores, fewer bladder infections, improved bowel regularity and improved ability to straighten their legs
	Warren, as cited in Walter, 1999	Survey of 54 subjects w/ SCI using standers or tilt tables 72% used device at least occasionally 50% used it at least 3x/wk 41% reported some difficulty w/ device

Stroke		
	Bagley, 2005	Patients with no trunk control/balance very acute stood for 14 consecutive days and compared with the controls that did not stand, no differences in River Mead was noted
	Bohannon, 1985	Increased ankle range of motion
Transverse Myelitis		
	Bohannon, 1985	Increased ankle range of motion
Traumatic Brain Injury		
	Aukland, 2004	Increased hypertension during standing after missing just sessions and decreased initial pO2 after missing just 3 sessions
	Bohannon, 1985	Increased ankle range of motion