Evidence-informed clinical perspectives on selecting gait trainer features for children with cerebral palsy

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Background/Aims: *Children with cerebral palsy often use gait trainers to augment their mobility. These are supportive walking devices that take the weight of the body through a solid or fabric 'seat', stabilise the trunk, and support the pelvis. The purpose of this analysis article is to review the evidence and clinical considerations influencing the selection of gait trainer features for children with cerebral palsy and to describe gait trainer models.*

Methods: *A scoping methodology was used to identify any relevant research and clinical literature supporting the selection of different gait trainer features. An internet search was undertaken to identify a wide range of gait trainers currently available. Factors influencing the selection of different gait trainer features including frame and wheel style and support options are discussed, combining information from manufacturers' websites, expert opinion and evidence from the literature review.*

Results: *Twenty-seven articles were included in this study. These included nine intervention studies, three articles describing gait trainer development, three expert opinion articles, a survey of therapist opinion and a study comparing physical properties of three different gait trainers. In addition information on device features relevant to gait trainers was drawn from 10 intervention studies of children using hand-held walkers. Twenty-four different gait trainers were identified as being commercially available in the UK, Canada and USA at time of searching.*

Conclusions: *Evidence supporting selection of gait trainer styles and features for children with cerebral palsy is very limited. Further research is needed in all aspects of gait trainer assessment, selection and implementation. Clinical consensus may be helpful in providing guidance in decision-making around prescription and use of gait trainers and features for children with cerebral palsy who have differing clinical profiles and needs.*

Key words: ■ Cerebral palsy ■ Children ■ Gait trainer ■ Support walker

Submitted: 20 November 2015; accepted following double blind review: 5 July 2016

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Typically, developing children learn to roll around 3–4 months-of-age, sit at 6 months, crawl at 9 months and walk at around 12 months. By 15 months almost all children are able to walk (Adolph and Robinson, 2013). When children with delayed motor development are provided with augmented mobility, it stimulates their overall development (Livingstone and Paleg, 2014). One means of augmenting mobility is with gait trainers. These are walking devices that take the weight of the body through a solid or fabric 'seat', stabilise the trunk and support the pelvis. They may also be referred to as support walkers (Low et al, 2011a).

Children with cerebral palsy may be classified according to their gross motor function and need for assistive technologies using the Gross Motor Function Classification System (GMFCS) (Palisano et al, 1997). Infants and toddlers at GMFCS levels I and II may use gait trainers for short amounts of time to maximise participation until the onset of efficient gait. Children at level III may also require gait trainers as toddlers and use hand-held walkers or crutches in childhood. However, walking ability may decrease in adolescence (Hanna et al, 2009) and the need for a gait trainer may return. Children at levels IV and V typically require body-weight support along with additional trunk and pelvic control. Children at level IV are expected to be independently mobile indoors using a gait trainer, while those at level V might use these devices to access the environment, gain the medical benefits of exercise, but always require some degree of adult supervision and/or assistance.

A recent systematic review of gait trainer outcomes (Paleg and Livingstone, 2015) identifies evidence from non-randomised two-group studies reporting statistically significant impacts on level of mobility (Van der Putten et al, 2005; Eisenberg et al, 2009) and bowel function (Eisenberg et al, 2009). Remaining evidence is primarily descriptive but suggests a positive impact on stepping ability, independent mobility, walking distance and other activity outcomes such as transfers, posture and self-care. Some studies report a positive impact on affect, motivation, communication and participation. No negative outcomes were identified.

Survey data (Low et al, 2011a) suggests that gait trainer selection often relates to familiarity and availability of devices rather than any clear decision-making process. Low et al (2011a) suggest a need for further research and the development of clinical guidelines to support therapists' clinical reasoning around choosing between different models, features and orientations depending on individual children's needs and environmental considerations. The purpose of this article is to review the evidence and clinical considerations influencing the selection of gait trainer features for children with cerebral palsy and to describe gait trainer models.

METHODS

As part of a previously published systematic review on gait trainer outcomes (Paleg and Livingstone, 2015), an electronic database search was undertaken in November 2014 including CINAHL, Medline, EMBASE, and EBM Reviews. Search terms included: 'gait trainer'; 'supported walking'; 'support walker'; 'walking device'; 'body weight support gait trainer'; 'walker'; 'supported ambulation'; and 'David Hart Walker'. This search was updated in September 2015 and expanded to include grey literature.

A scoping methodology (Levac et al, 2010) was used to identify intervention research articles providing information on gait trainer features, descriptive articles providing clinical rationale for gait trainer features, and studies comparing walker features relevant to gait trainers.

In addition to electronic database and web searching, hand searching of relevant online conference abstracts and proceedings included: International Seating Symposium (2011–2015); American Academy of Cerebral Palsy and Developmental Medicine (2011–2014); European Academy of Childhood Disability (2011–2015); and World Congress of Physical Therapy (2011 and 2015). Relevant non-peer reviewed online magazines were also hand searched, including *Advance for PT*, *New Mobility Magazine*, *Rehab Management, Rehab & Community Care*, and *Today's Kids* and known researchers were contacted. In order to include only current expert opinion, any web or magazine articles that were more than five years old were excluded.

Data on gait trainer features and clinical rationale was extracted from articles meeting the inclusion criteria (*Table 1*). American Academy of Cerebral Palsy and Developmental Medicine criteria (AACPDM, 2008) were used to classify evidence level for included studies. AACPDM criteria provide levels of evidence for both group and single subject designs, with I being the highest quality of evidence (e.g. systematic review of randomised controlled trials or randomised single subject designs) and V being the lowest quality of evidence (descriptive case studies). Both authors agreed on all articles to be included, disagreements were resolved through discussion at all stages.

An internet search using the term 'gait-trainer' was undertaken to identify gait trainer models currently available in the United States (US), Canada and Europe. A gait trainer was defined as a non-mechanised support walker providing trunk and body weight support and suitable for use in a home environment. We excluded mechanised or robotic devices and large institutional-style gait trainers designed for use over a treadmill or clinic setting. Gait trainer models were analysed to identify the range of frame and wheel styles and support features that are currently available.

RESULTS

Twenty-seven articles were included in this study:

- Six gait trainer intervention studies that provided detail on gait trainer features and clinical implications (Wright et al, 1999; Broadbent et al, 2000; Wright and Jutai, 2006; Eisenberg et al, 2009; Farrell et al, 2010; McKeever et al, 2013)
- Three descriptive articles about gait trainer development (Meadows et al, 1992; Stallard et al, 1996; Botega et al, 2013)
- One survey of therapists regarding use of gait trainers (Low et al, 2011a)
- Two non-peer reviewed case reports (Low, 2004b; Carnevale, 2015) and an unpublished

Table 1. Characteristics of included primary studies						
Study	**Design**	**AACPDM Level of Evidence**	***N***	**Population**	**Gait Trainer and Features**	**Results relevant to gait trainer features**
Botega et al (2015)	Case series	Level IV	6	Mild to moderate spastic diplegia 5 ± 1.4 yrs	Walking aid with pelvic and axillary support	Axillary trunk stabilisation along with pelvic stabilization promotes a more upright posture and resulted in improved lower limb muscle synergism during gait in comparison to walking without the aid
Broadbent et al (2000)	Case reports	Level V	4	Quadriplegic: 9 years Diplegic: 14.5 yrs Hypotonia: 8 years Quadriplegic: 8 years	Walkabout - posterior hands-free walker used in combination with an orthotic leg guidance system	Ability to change % of body weight support with the child in the walker found to be critical. Children in this study varied from requiring 37% to 81% body-weight support and a change of 10% was found to have a profound effect. Transfers into this rear support walker with the control orthosis was difficult and took 2/3 adults. Steering was difficult due to having only front swivel casters and fixed rear wheels
Bundonis (2011)	Expert Opinion	Level V	n/a	n/a	n/a	First consider the amount of pelvic and trunk support needed and whether or not head support is needed. If the child has poor head control consider a device or whether arm support and trunk support will facilitate head lifting. Consider type of arm support and how they will hold onto the device. Will angling forward assist stepping? Ankle straps and prompts are helpful to reduce scissoring. For children who are weak, body weight support will be helpful. Make sure the child's feet are on the ground and bearing at least 50% of their weight. For children who pull forward into a flexed posture when provided with arm supports, consider a hands-free set up with trunk and a seat or saddle support only
Carnevale (2015)	Case report	Level V	1	GMFCS IV 8 years	Hand held posterior walker Anterior gait trainer with pelvic and trunk supports and handles Posterior gait trainer with pelvic and trunk supports and a pelvic harness but without arm supports or handles	Child was able to walk with posterior walker by taking all his weight through his arms and dragging his feet. The same situation was seen with an anterior gait trainer despite the added trunk and pelvic support. Adding body weight support through a pelvic harness and removing arm supports allowed child to walk hands-free. His posture and gait improved. After 12 months the trunk supports could be removed and the gait trainer changed to anterior again. The child had learned to walk using his legs and to maintain an upright posture without upper limb support. He was then able to use his arms on the handles to assist with steering rather than to hold himself up.
Eisenberg et al (2009)	Non-random two group study	Level III	22	GMFCS IV or V aged 3.5–10 years. 11 children in walking group mean 6.1 years. 11 age and sex matched controls mean 6.7 yrs	David Hart walker—combines a posterior hands-free walker with a reciprocating lower limb orthotic system	Parents preferred the hands-free style of walker but found transfers challenging with the older children. Children increased their time in standing in comparison to use of a standing frame—these children had not tried other gait trainers but were unable to use hand-held walkers due to insufficient upper limb control
Farrell et al (2010)	Case report	Level V	1	10 yrs	Lite Gait Walkable, Up n Go and Rifton Pacer	Able to walk 150 ft in Pacer with assistance to steer, whereas assistance of 2 adults was needed to walk 30 ft in the Up n Go and 60 ft in the Walkable. This difference may be explained by the lighter weight of the Pacer and the more supportive pelvic, trunk and upper limb supports. It is not clear if the Pacer was used in the anterior position but the front-leaning position may also have had a positive influence on ability to step and walking distance

Table 1. Characteristics of included primary studies (continued)

Study	Design	AACPDM Level of Evidence	N	Population	Gait trainer and features	Results relevant to gait trainer features
Fox-Hustwaite (2013)	Expert Opinion	Level V	n/a	n/a	Anterior gait trainers Posterior gait trainers Dynamic gait trainers	Anterior gait trainers are used for children who require more support and often include arm troughs or a tray. However, these make it difficult to access tables or other activities in the environment. Dynamic gait trainers provide support at the trunk and pelvis from behind but do not provide arm support. Angling the support column slightly forward can make it easier for the child to step. Dynamic gait trainers allow children to move hands-free and explore the environment. Directional caster locks allow the child to move in a straight line and eliminate the need for steering. Friction control or drag locks can be useful for children with high tone. If a child has increased tone on one side of the body, one lock can be set tighter than the other to help them move in a straight line. Anti-roll backs can be useful to help the child move forward instead of pushing back into extension
Greiner (1993)	Case series	Level IV	5	Spastic diplegia GMFCS level III 2–7 yrs	Four-wheeled posterior walker Two-wheeled anterior walker	The Posterior walker promoted more upright posture, decreased double stance time and increased walking velocity. Parents and children preferred the posterior walker
Levangie (1989a)	Case series	Level IV	13	Spastic diplegia GMFCS level III 2–10 yrs	Two-wheeled anterior walker Two-wheeled posterior walker Four-wheeled posterior walker	Significantly improved gait parameters when using the 4 wheeled posterior walker. No difference in gait between the 2 wheeled anterior and posterior walkers. Improved posture when using either the 2 or 4 wheeled posterior walkers in comparison with the anterior walker
Levangie (1989b)	Case series	Level IV	16	Spastic diplegia GMFCS level III 2–10 yrs	Rolling walker with vertical or horizontal handles	Handle position alone did not change gait parameters
Logan et al (1990)	Case series	Level IV	7 1	GMFCS level III Down syndrome 2.5–8 years	Pediatric Guardian anterior walker Kaye two-wheeled posture control walker	Improved postural alignment and gait characteristics in the posterior walker
Low (2004)	Case report	Level V	1	Cerebral palsy 12 yrs	Due to growth, child switched from a posterior gait trainer to an anterior gait trainer	Gait characteristics were better in the anterior gait trainer including foot and heel contact. Parents preferred anterior gait trainer as transfers were easier
Low et al (2011a)	Cross sectional	Level V	513	Paediatric physical therapists	Support walkers—defined as any walker that provided additional trunk, forearm and/or pelvic support	Support walkers used posteriorly 65% and anteriorly 53% of time. Most used accessories: trunk supports (87%); forearm supports (78%); pelvic seat or sling (67%); anti-scissoring systems (61%). 31–50% of children able to progress from support walkers to hand-held walkers
Low et al (2011b)	Case Series	Level IV	10	GMFCS levels IV and V Mean age 7.5 years (SD 3.3 years)	Dynamic posterior hands-free gait trainer vs anterior gait trainer with soft seat	For the sub-group who hadn't previously used a gait trainer (*n*=6), gait characteristics were improved in the dynamic gait trainer, but there were no significant differences across the whole group. Families of six of the children found transfers into the anterior gait trainer easier
Mathis (1975)	Case report	Level V	1	GMFCS level III	Anterior wheeled walker	Added forearm gutters with vertical handles to help reduce overall extensor tone and allow child to step forward
Mattsson and Anderson (1997)	Case series	Level IV	10	Spastic or ataxic diplegia GMFCS level III 8–17 years	Anterior wheeled walker Posterior wheeled walker	No difference in oxygen cost, speed or perceived exertion between anterior and posterior walkers. More children preferred the posterior walker

Table 1. Characteristics of included primary studies (continued)						
Study	**Design**	**AACPDM Level of Evidence**	***N***	**Population**	**Gait trainer and features**	**Results relevant to gait trainer features**
McKeever et al (2013)	Semi-structured interviews	Qualitative	19	Interviews with parents 3 years after their child began using walker. GMFCS III or IV aged 9–15.5 years at interview Mean: 10.7 years	Hart walker—combines a posterior hands-free walker with a reciprocating lower limb orthotic system	Parents value the physical benefits of being upright. They also reported psychosocial benefits such as improvements in communication and ability to participate with peers, as well as enhanced freedom and independence
Meadors et al (1994)	Case report	Level V	2	GMFCS level III 2 years 6 months	Kaye Posture Control Walker	Abductor bar at mid-calf height was helpful in preventing scissoring in both children. One child also benefitted from the addition of hip guides and an adapted hand-grip to promote midline posture
Meadows et al (1992)	Case report	Level V	10	CP GMFCS level IV	Arrow Walker Straddle style frame	Forward leaning position helps facilitate walking. Directional locking casters can help children to move in a straighter line and prevent 'slewing'. Arrow shaped frame allows children to get close to desks
Naganuma (1991)	Case report	Level V	1	Spastic quadriplegia 4.5 years	Kaye Posture Control Walker	Adding arm troughs was effective for a child who was unable to grasp with an extended arm on one side. A lateral pad was added to the bar behind the pelvis to help maintain symmetry in stance and walk
Paleg et al (2015)	Laboratory comparison of 3 gait trainers	NA	NA	Configured for a 4-year-old child	KidWalk Mustang Pacer	The KidWalk (mid-wheel drive) was the heaviest, while the Pacer (U-frame) was the lightest. Initiation forces on tile were equivalent for the Pacer and KidWalk, while the Mustang had the highest initiation force. Initiation forces on carpet were lowest for the KidWalk
Park et al (2001)	Case series	Level IV	10	Spastic diplegia GMFCS III 7–12 yrs	Guardian anterior walker and Kaye two-wheel posture control walker	The posterior walker was associated with more upright posture and reduced energy demands
Stallard et al (1996)	Descriptive	Level V	14	Severe cerebral palsy	Orlau Locomotor Guidance System	Lower extremity orthotics can be helpful in promoting ambulation in a severely disabled population. Orthotics can be locked to also provide supported standing. The stability provided by this hands-free system promoted upper limb function. Transfers are challenging for children over 8 years. Some children were able to transition to using the walker without the orthotic over time
Thompson-Rangel et al (1992)	Case report	Level V	1	GMFCS III 5 years	Kaye two-wheel posture control walker	Pelvic laterals added to assist child to maintain hip alignment in the walker. Modified handle with a stop, to improve upper extremity positioning and alignment. Increased functional mobility in the walker with these changes
Thomson (2005)	Book—expert opinion	Level V	n/a	Cerebral palsy and other multiple and complex disabilities	Rifton Pacer	Front leaning support position at chest and forearms facilitates stepping and moving forward. Body weight support with hips free to move in order to shift weight is important for stepping
Wright et al (1999)	Pre-test post-test one group study	Level IV	20	GMFCS IV or V 4–12.8 years Mean 7.9 years	Hart walker—combines a posterior hands-free walker with a reciprocating lower limb orthotic system	Increased participation due to hands-free style. Ability to walk with better alignment due to the orthotic component
Wright et al (2006)	Repeated measures one group study. 24 and 36 months follow-up	Level IV	19	GMFCS III or IV, aged 9–15.5 years at time of assessment after 3 years of use. Mean 10.7 yrs	Hart walker—combines a posterior hands-free walker with a reciprocating lower limb orthotic system	Ability to steer increased due to the orthotic component. Increased participation due to hands-free style. Difficulty using with older children due to safety and size restrictions

study comparing dynamic and static gait trainers (Low et al, 2011b)

- Expert opinion on gait trainers in the form of a book (Thomson, 2005) and two non-peer reviewed articles (Bundonis, 2011; Fox-Hustwaite, 2013)
- One study reviewing inertial properties of a sample of gait trainers (Paleg et al, 2015).
- 10 articles reviewing features relevant to gait trainers in studies on hand-held walkers (Mathis, 1975; Levangie et al, 1989; 1990; Logan et al, 1990; Naganuma, 1991; Thompson-Rangel et al. 1992; Greiner et al, 1993; Meadors et al, 1994; Mattsson and Andersson, 1997; Park et al, 2001).

Twenty-four models of gait trainers currently available in the USA, UK and Canada were identified (*Table 2*). Since specific models and features change over time, we include the manufacturers websites to allow access to the most updated information. Models currently available were analysed to identify major types and features relevant to discussion in this article.

DISCUSSION AND ANALYSIS

Frame style

Two major frame styles were identified: a U-shaped frame (see *Figure 1*), and straddle frame (see *Figure 2*). A U-shaped frame is

15.145 Table 2: Gait trainer models and manufacturers

Model	Manufacturer	Website	Notes
1. Bronco	R82, Denmark	Snugseat.com	Anterior straddle frame. Designed for outdoor use
2. Buddy Roamer	Moorings, UK	Buddyroamer.com	Posterior U frame. Hands-free, dynamic
3. Comet	Drive Medical, USA	Drivemedical.com	Anterior U frame
4. Crocodile	R82, Denmark	Sungseat.com	Anterior/posterior U Frame. Converts to walker
5. Dynamico	Ormesa, Italy	Mobility-usa.com	Anterior U frame. Soft fabric seat, trunk support for balance only
6. Gait Master	Mulholland, USA	Mulhollandinc.com	Anterior U frame. Has lift system
7. Gator	R82, Denmark	Snugseat.com	Anterior/posterior U frame. Converts to walker
8. Grillo	Ormesa, Italy	Mobility-usa.com	Anterior/posterior U frame
9. Hart	Hart, UK	Hartwalker.com	Posterior straddle frame. Hands-free with reciprocator. 4,3,2 or 1 wheels options. Requires a Hart-certified orthotist
10. Kaye	Kaye Products, USA	Kayproducts.com	Anterior/posterior U frame. Most models convert to walker. Suspension conversion kit is available for walker or as dedicated unit.
11. Kidwalk	Prime Engineering, USA	Primeengineering.com	Posterior U frame. Hands-free, Dynamic in three planes, Mid-wheel drive
12. Mey Walk 2000, MK4 and Miniwalk	Meyland-Smith, Denmark	PacificRehab.com	Anterior U frame. Trunk support for balance only. Some models have lift system
13. Mustang	R82, Denmark	Snugseat.com	Anterior/posterior straddle frame
14. New LiftWalker	New LiftWalker, USA	Newliftwalker.com	Anterior U frame. Has lift system
15. Nurmi Neo	Ottobock, Germany	Ottobockus.com	Anterior/posterior U frame. Converts to walker
16. Pacer	Rifton, USA	Rifton.com	Anterior/posterior U frame
17. Pony	R82, Denmark	Snugseat.com	Anterior straddle frame
18. Smart	Advanced Orthotic Designs, Canada	Aodmobility.com	Posterior straddle frame. Hands-free with reciprocator. Requires a SMART certified orthotist
19. Star	Drive Medical, USA	Drivemedical.com	Posterior U frame
20. Taos	Sky Medical, USA	Taos1.com	Posterior straddle frame. Hands-free with reciprocating orthotics. Needs fitting by a TAOS certified orthotist
21. Trekker	Drive Medical, USA	Drivemedical.com	Anterior/posterior U frame. Copy of Pacer
22. Up-N-Free	Easy Walking, USA	Easy-walking.com	Anterior U frame. Allows user to rise up and down within restricted range to practice sit to stand and floor to stand transitions. Limited support options. Has lift assist mechanism
23. Up-N-Go	Easy Walking, USA	Easy-walking.com	Anterior U frame. Allows user to rise up and down within restricted range to practice sit to stand and floor to stand transitions. Many support options. Has lift assist mechanism
24. Walkabout	Mulholland, USA	Mulhollandinc.com	Posterior U frame. Hands-free, Dynamic in one plane of motion

Figure 1. U-shaped frame

Figure 2. Straddle frame

either in front or behind and on either side of the child. It is open between the legs making transfers easier and may give more freedom for leg movement and manoeuvring the device. They may have sling seats, solid dynamic, or solid seats. Some primarily U-shaped frames have rigid seats and the option to add a solid support between the legs. Straddle style frames have solid seats and often part of the frame goes between the legs at ankle level. This rigid part of the frame can be particularly helpful for children with strong adductor tone who tend to scissor and get their feet stuck together. It is most helpful if the centre bar has a flat side guard extending down to just above ground level so there is no danger of toes getting caught. In a child who could walk with a handheld walker, a bar style abductor support was found to be most helpful at mid-calf level. If it was any higher, it would catch on the ankle/foot orthotics and any lower could catch the toe (Meadors et al, 1994). True straddle frames do not have bars on the outside of the legs. This may be helpful for children with dystonia or erratic leg movements who may get their feet caught on the outer parts of the frame or run over their own toes.

Survey evidence suggests that therapists may be split between a preference for anterior (53%) and posterior (65%) gait trainers (Low et al, 2011a). In children with cerebral palsy who are able to walk using typical handheld walkers, a posterior walker promotes more upright posture and improved gait parameters (Levangie et al, 1990; Logan et al, 1990; Greiner et al, 1993; Park et al, 2001). No difference in oxygen consumption was found in one study (Mattsson and Andersson, 1997) but energy demands were reduced in the posterior walker in another (Park et al, 2001). However, minimal research has been conducted evaluating the impact of anterior versus posterior support in children using gait trainers. In one case report (Low, 2004) an adolescent switched to an anterior gait trainer with improvement in gait characteristics, while in a younger child (Carnevale, 2015), a posterior hands-free walker promoted better gait and trunk posture.

The choice between anterior and posterior configurations is often led by the type of transfer and availability of different types of supports. For example, head supports are more commonly available with posterior gait trainers, and full arm support is more readily available with an anterior gait trainer. If the child needs to be angled significantly forward in order to step, then an anterior gait trainer may be more appropriate. Posterior gait trainers tend to encourage more upright posture and stepping, but may lead to uncontrolled extension and pushing backwards in some children.

Several studies report that transfers into posterior gait trainers are more challenging, especially with older children (Stallard et al, 1996; Wright et al, 1999; Broadbent et al, 2000; Wright and Jutai, 2006; Eisenberg et al, 2009; McKeever et al, 2013). In a case report of a 12-year-old with cerebral palsy the parents found transfers into an anterior gait trainer easier (Low, 2004). With posterior devices, the gait trainer is behind the child and the child faces the adult as they are transferring in. With anterior devices, the child faces the device and the adult is behind during transfers. Some children may be able to perform a standing transfer forward into an anterior gait trainer from their wheelchair, whereas it may be difficult to pivot around into a posterior gait trainer. Many children at GMFCS levels IV and V will need to be lifted into a gait trainer and a mechanical lift may assist with this; or a gait trainer that has an incorporated lifting mechanism can be used.

Wheel and caster options

Paleg et al (2015) evaluated the ease of forward motion and inertia of three different gait trainers, and found that drive style and wheel size have a significant influence on forces required to initiate movement on different surfaces. On a smooth tile surface, initiation forces were equivalent for the lightest (4 solid 5.7" casters) and the heaviest (24" wheels and 5" casters) models while the model with larger (6.7") foam-filled casters had the highest initiation force. On carpet, initiation forces were lowest for the heaviest mid-wheel drive system (see *Figure 3*).

Figure 3. Mid-wheel drive

Having four free wheels make a gait trainer more likely to slide laterally rather than turn. Two directionally fixed wheels and two swivel caster systems can either be rear, front or mid-wheel drive. These all rotate to turn, although the mid-wheel drive styles are able to turn in place more easily due to the centre of mass of the child and the wheel axle being close together. To add complication, many four caster systems are available with directional wheel locks. The most common clinical set-up is to lock the rear casters and allow the front wheels to swivel—with this set-up they act more like a front wheel drive system with two fixed wheels and two swivel casters. Locking all four casters, or locking the swivel casters on a two fixed wheel, two swivel caster system may be helpful for increasing speed and stepping when walking forward down a hallway, but does not build directional control. Many children start with all four wheels locked directionally, then progress to front wheels free and back wheels directionally locked. Directional locking of casters may be beneficial for children with spasticity, ataxia or unequal control (Meadows et al, 1992).

In some gait trainers, the wheel position is adjustable. When the wheels are in the forward position, it steers more responsively; in the rear position, it tracks straighter. In a gait trainer with mid-wheel drive, one wheel can be moved forward and the other back to accommodate asymmetrical motor control or strength. This same result can be accomplished in gait trainers with friction or drag locks by increasing the 'drag' on the 'fast' side. Young children often begin moving backwards first. After a time, however, a therapist might choose to use anti-rollbacks to shape the behaviour. Children at GMFCS levels IV and V might require anti-roll backs to use their movements to go forward.

Pelvic and body weight support options

Some gait trainers are regular handheld posterior walkers with the option to add pelvic supports and a seat. The minimal sling type seat is designed as a safety measure for a child who occasionally loses postural control, rather than for a child who requires body-weight support. They may be appropriate for the 31–50% of children using gait trainers who are anticipated to move relatively quickly to using handheld walkers (Low et al, 2011a). Early studies describe the benefit of pelvic lateral support to promote symmetry and gait parameters for this group (Naganuma, 1991; Thompson-Rangel et al, 1992).

Other gait trainers can be used with soft padded seats or flexible fabric supports that provide body weight support. The amount of postural support can be reduced over time for children who are progressing in their abilities. The flexible seat allows more movement of the pelvis and some limited rotation of the trunk. For gait trainers with solid seats, some are rigid, some are dynamic in the sagittal plane only, while others are dynamic in the sagittal, anterior-posterior and frontal planes. Children with dystonia may resist rigid controls and therefore flexible or dynamic components may be helpful (Cimolin et al, 2009). Likewise, children with hypotonia, may 'hang' on rigid supports and benefit from more flexible or dynamic components.

Suspension systems, where the flexible pelvic support is suspended from overhead supports, allow for postural sway to allow the user to activate righting and balance systems in conjunction with standing and/or stepping. This may enhance motor function progress in children anticipated to progress to more independent walking (Damiano et al, 2011).

Broadbent et al (2000) found that the children in their study ranged from requiring 37–81% body-weight support, and a change of 10% was found to have a profound effect. The ability to adjust the amount of body weight support with the child in the device is very helpful.

Trunk support options

Some gait trainers provide full postural trunk supports, while others only provide a support that limits excessive trunk movement within a narrow range. Most devices offer circumferential supports that may be rigid or flexible and children should not be allowed to 'hang' or weight bear on or around their brachial plexus. In a report of a novel walking aid, axillary support was used to promote better trunk alignment in children with cerebral palsy who can walk without aids (Botega et al, 2013).

A few models can be ordered with systems that support and stabilise the shoulder girdle. These systems may be indicated for children with the lowest level of trunk control. In one case report (Farrell et al, 2010) the child was able to walk significantly further and step more independently in a lightweight anterior walker with circumferential trunk support and a flexible seat, in comparison to an institutional body-weight support suspension system and a system with less supportive trunk and pelvic components.

The position of the centre of mass in relation to the wheels affects manoeuvrability. In some gait trainers, the centre of mass is fixed although the trunk support can be angled forwards or back. In others, the centre of mass can be adjusted. Lengthening the distance between the child and the centre of mass improves forward tracking, while shortening this distance increases manoeuvrability.

Arm support options

Parents may prefer the more typical appearance of a hands-free gait trainer (McKeever et al, 2013) and describe the benefits for increasing communication, participation and inclusion in activities with others (Wright et al, 1999; Wright and Jutai, 2006). Cioni et al (2011) have suggested that using hands for body support may be detrimental to learning and exploration; it has been suggested that arm swing may promote the central pattern generator and improve stepping (Behrman et al, 2008). Using a gait trainer with forearm supports that stabilise the shoulder girdle might also limit trunk rotation, balance responses and postural adjustments to weight shifts. For children with visual impairment, a hands-free gait trainer leaves the hands free to 'trail' or to use a cane for mobility and orientation. Children with dystonia may be more comfortable in a hands-free device where there is less chance of them hitting the device with their hands, provided their legs do not hit the frame.

While most children at GMFCS level V require additional trunk, head and arm stabilisation, many children at GMFCS level IV should be encouraged to use their arms and hands to explore the environment and practice postural control. While most reports of hands-free walkers include children at GMFCS levels IV and V, two reports from the same study (McKeever et al. 2013; Wright and Jutai, 2006) describe use of a hands-free walker with children at GMFCS level III. Most commonly, these children learn to walk with posterior walkers, whereby they take most weight through their arms. Since this facilitates use of the upper extremity musculature to stabilise the upper trunk, they often have difficulty taking independent steps where they must stay upright using spinal musculature. Use of a hands-free gait trainer may facilitate development of more upright posture and stepping and is confirmed in a recent case report (Carnevale, 2015). Some gait trainers, typically thought of as including arm support can also be set-up to use hands-free. For children walking with hand-held walkers, the addition of arm gutters and vertical handles has been found to be helpful in decreasing spasticity and improving ability to step (Mathis, 1975), although handle position alone does not change gait parameters (Levangie et al, 1989).

Leg and thigh support systems

Straddle type gait trainers typically have the option for solid adductor supports between the thighs and ankles. U-shaped frames typically have options for soft ankle cuffs that may be able to slide along bars attached to the side frame. Some gait trainers have articulating leg cuffs that can provide semi-rigid support to prevent adduction and also excessive abduction at the thighs. Some U-frame gait trainers with solid or dynamic seats have the option of an extended seat with an abduction skirt to limit adduction at the thighs.

A few gait trainer models use a hybrid of orthoses and gait trainer. In general, the orthotic devices are designed for a single user, require frequent adjustment by an orthotist and transfers are more challenging. Some have a method to ensure or encourage reciprocal stepping and studies report improved alignment and ability to step with this feature (Stallard et al, 1996; Wright et al, 1999; Broadbent et al, 2000; Wright and Jutai, 2006). Wright and Jutai (2006) also report that ability to steer the gait trainer independently through trunk rotation increased.

Head support options

Children without adequate head control should be considered for a head support. This can be accomplished through the addition of soft neck supports or a head support mounted to the gait trainer. Some gait trainers do not have head supports and only a few allow use of other manufacturers' head supports. Gait trainers that can be set up in anterior or posterior configurations may have head support options available only in the posterior configuration.

Limitations

The literature search was challenging as the term 'gait trainer' tends to bring up literature concerned with robotic and body-weight support treadmill training, whereas terms like 'walking' and 'support walker' are challenging to narrow down. On the whole, there is a paucity of research evidence to support therapists' clinical reasoning around the selection of gait trainer types and features. The level of evidence is very low and a quality rating was not conducted or appropriate (Levac et al, 2010). Research is needed in every aspect of gait trainer assessment, selection and implementation. There are many barriers to conducting higher-level research in this area, the first being withholding an intervention that may benefit children at a vulnerable stage in development. Another being the limited outcome measures that have been demonstrated to be sensitive and appropriate for use in this area (Richards et al, 1997). A valuable first step may be to complete larger surveys or an expert consensus to clarify clinical reasoning and application of gait trainers.

CONCLUSION

Many factors need to be considered when selecting an appropriate gait trainer for a specific child, including muscle tone, movement patterns, need for support, as well as inertial forces. Functional considerations such as whether or not the device needs to fold or be light enough to lift in and out of a vehicle may also influence selection. Many questions remain about which frame configurations and support features are appropriate for children with different clinical profiles and needs. No definitive recommendations can be made based upon the evidence currently available and therapists should consider all influencing factors prior to comparing different gait trainers with individual children.

Conflict of interest: The first author has worked as an educational consultant for various manufacturers and suppliers of gait trainer. Funding from these sources did not influence or bias this work. The second author has no conflicts of interest to disclose.

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